NERA
ECONOMIC CONSULTING

Assessment of the AER's Proposed Productivity Assumptions

Prepared for CitiPower, Powercor, SA Power Networks and United Energy

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Background

The Australian Energy Regulator (AER) regulates electricity Distribution Network Services Providers (DNSPs) through rolling five-year price controls referred to as resets. At each reset, the AER sets the level and trend of operating expenditure over the following five-year period. Productivity growth assumptions are one of three factors which affect the trend rate of growth in operating expenditure.

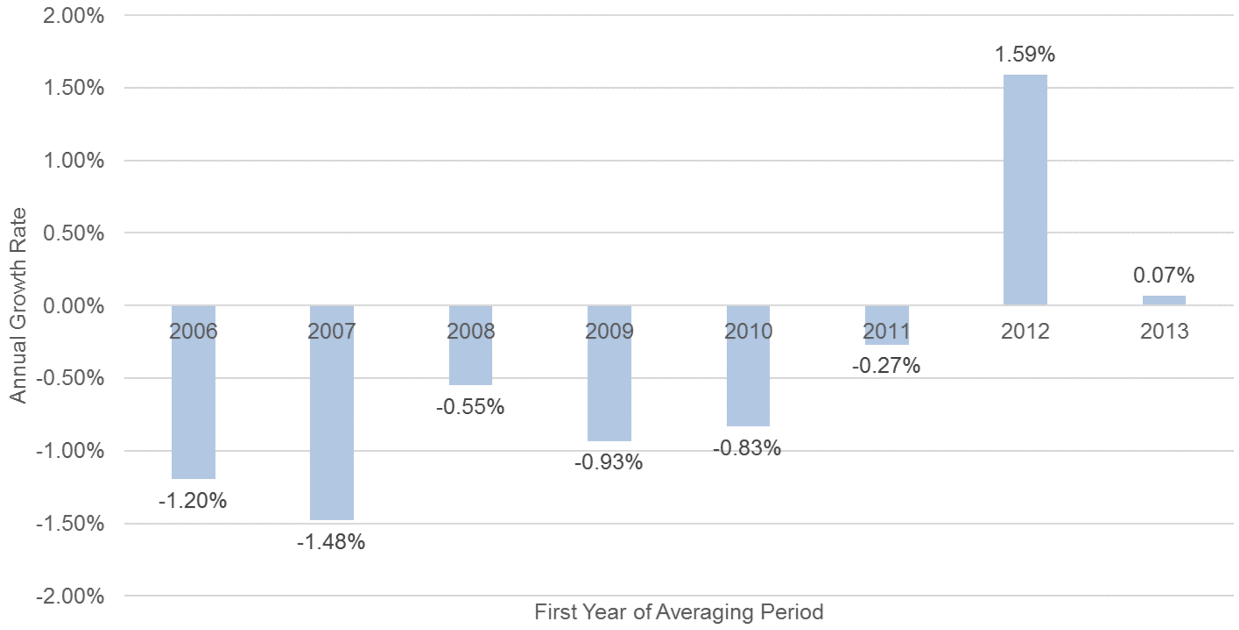
The AER published a Draft Decision on its future approach to assessing productivity growth for operating expenditure on 9 November 2018. The Draft Decision proposes six options for setting productivity growth assumptions at DNSPs' resets. Citipower, Powercor, SA Power Networks and United Energy commissioned NERA to review the AER's approach from an economic perspective for consistency with its statutory objectives under the National Electricity Law (NEL).

The Case for Change is Weak: The Period Since 2012 is a Special Case and May be Driven by Measurement Error and One-off Events

The AER has historically set productivity growth assumptions for DNSPs at zero per cent per annum. The AER has done so on the basis that observed historical productivity growth between 2006 and 2012 was negative and its belief that a negative productivity growth assumption would be inconsistent with the broader regulatory regime and arose due to specific regulatory obligations that it does not foresee arising in future. It also argues that negative productivity growth is unreasonable because DNSPs should be able to improve productivity over time. The AER relies heavily on its observation that Multilateral Partial Factor Productivity (MPFP) has risen in the period since 2012, on average, albeit that productivity has decreased on average since 2006.

In practice, the AER's case for change is weak. Productivity estimates are notoriously volatile, prone to measurement error and growth in them is frequently negative for years at a time. One-off factors, such as tightening regulation, may have distorted productivity growth estimates in the late 2000s. However, one-off factors such as restructuring that cannot be replicated in future or measurement error will have influenced productivity estimates since 2012. Discarding half of the dataset and selecting a point to begin averaging is necessarily subjective, which is why international regulators that rely on historical productivity estimates frequently rely on periods in excess of 20 or 30 years. In the AER's case, concentrating on the period since 2012 leads to the highest productivity growth assumption of any averaging period ending in 2016 and starting in any year from 2006 to 2013 (see Figure 1 below).

Figure 1: Industry Multilateral Partial Factor Productivity (MPFP) for Different Averaging Periods Ending with 2016 Data: AER Methodology (Option 4)



Source: NERA Modelling using DNSP data published by Economic Insights.

AER's Duties and Economic Criteria for Appraising Productivity Growth Assumptions

When considering changing a productivity growth assumption, the AER must comply with its statutory duties and most particularly the obligation to ensure that DNSPs are able to recover the efficient costs of operating their businesses. The AER does not explicitly use systematic criteria in assessing alternative options for change in the Draft Decision. However, in the context of the AER's base-step-trend approach, the AERs duties to allow efficient cost recovery require the following criteria to hold:

- *Approach captures underlying trends in productivity for DNSPs*: Any productivity assumption must reflect the productivity improvement that would be attainable by an efficient DNSP.
- *Approach separates productivity from catch-up*: The AER adjusts DNSPs' allowances separately if it deems them to be inefficient. A productivity adjustment is additional to this "catch-up" adjustment. Therefore, any adjustment must not reflect efficiency improvements amongst inefficient DNSPs as they catch up to the frontier.
- *Approach is objective and stable over time*: The AER's approach should not be highly sensitive to start and end years and should demonstrate longer-term productivity trends. Its approach should also be credible such that it can continue to use the approach in subsequent price control periods. Changing approaches frequently will risk perceptions of cherry-picking and could systematically deny cost recovery over time.
- *Approach does not limit incentives to reduce costs*: The AER should not introduce perverse incentives which would encourage DNSPs to make business decisions with a view to influencing their current or future productivity targets.

Appraisal of the AER's Proposed Options

The AER proposes six options for defining the productivity assumption for future resets. We describe each and the salient criteria below (productivity adjustment in brackets, where a positive number means improving productivity, and, hence, a negative adjustment to allowed opex):

- *Option 1: The status quo (0 per cent per annum)*. The AER's approach thus far has been to review the underlying trends in productivity (which show negative productivity growth) and then apply an adjustment which truncates the adjustment at zero. In other words, the status quo only results in a 0 per cent adjustment where the AER's long-term measures of productivity growth continue to be negative. This approach has the advantage that it offers regulatory stability. In practice, the best available evidence on productivity growth is that it has been declining over the long term. Accordingly, the status quo may overstate likely productivity growth (i.e. declining costs). Indeed, we note that in a similar situation, the New Zealand Commerce Commission elected to apply a negative, rather than zero, productivity growth assumption.
- *Option 2: Productivity growth from increased undergrounding (plus 0.5 per cent per annum).* This approach uses an alleged relationship between undergrounding, opex and the AER's average industry growth in undergrounding to estimate productivity growth. However, the AER's method is econometrically flawed and similar methods have been roundly rejected by appeal bodies in the UK. The potential for productivity growth from undergrounding will vary significantly by DNSP and therefore the AER's approach systematically overstates the likely productivity growth for some DNSPs.
- *Option 3: Undergrounding productivity plus the gas distribution trend (plus 1 per cent per annum).* This approach takes the result of Option 2 and adjusts DNSPs allowances by a further 0.5 per cent per annum to take account of ongoing productivity as estimated in the gas sector. In principle, the AER does not need to use indirect or non-electricity measures if a robust electricity-specific approach is available. In any case, this approach relies heavily on the doubtful equivalence of productivity growth in electricity and gas, and may double-count the potential cost savings resulting from changes in operating conditions, since the gas distribution trend may capture cost savings from changes in operating conditions. It is also unnecessary: even if the AER wished to exclude years in which DNSP productivity was falling due to alleged additional regulatory obligations, it could introduce controls into its econometric analysis of the electricity sector.
- *Option 4: Using industry-average Multilateral Partial Factor Productivity (MPFP) growth (plus 1.6 per cent per annum).* This approach is an industry average of MPFP, excluding DNSPs which the AER deems are materially inefficient. MPFP estimates are notoriously volatile and prone to measurement error. The AER's short averaging window is likely to be biased by that volatility. The AER compounds the impact of measurement error on its estimates because its estimated growth relies only on the first and last years of the averaging period. The approach to identifying outliers is not objective. As an estimate over a short-horizon it is likely to include catch-up, not least from TasNetworks which amalgamated during the period and experienced the third most rapid MPFP growth. The selection of 2012-2016, which has the highest productivity growth rate of plausible averaging windows, suggests cherry-picking and results in a growth assumption that is not consistent with the historical evidence. The short averaging window reduces

regulatory lag and discourages cost reduction by DNSPs that are held in common with others.

- *Option 5: Using labour productivity growth (plus 0.9 per cent per annum).* This approach takes sector-wide labour productivity growth forecasts as estimated by DAE and multiplies by DNSPs' labour share of opex. DAE relies heavily on labour productivity for the general economy, and an assumption that labour opex weights remain constant, to forecast productivity for DNSPs. In practice, the evidence that the former in particular is correct is weak at best. DAE's approach to forecasting is a black box. Accordingly, DAE's analysis does not provide a reliable guide to future changes in DNSPs' opex.
- *Option 6: A holistic approach (plus 1 per cent per annum).* The AER reviews the findings of approaches 2 through 5 and selects an adjustment near the middle of the range of the results of the other options. The approach is "holistic" by name and not by nature in that it explicitly excludes consideration of the evidence relied on at previous reviews to determine productivity growth assumptions (i.e. negative productivity growth as indicated by Option 1). Option 6 does not meet the AER's duties to allow recovery of efficient costs because the options considered in the average are themselves unreasonable.

Alternative Measures that Better Meet the Requisite Criteria

Our analysis of the AER's proposed options suggests revisions that would improve the accuracy of its estimates and better meet the relevant criteria for AER's decision. These include:

- *Option A: Undergrounding with a DNSP-specific levels-based coefficient (c. plus 0.14 per cent per annum).* This approach modifies the AER's Option 2 in three ways. First, it estimates a coefficient on the *proportion* of undergrounding rather than on the *logarithm* of the proportion of undergrounding to conform to econometric best practice. Second, it applies the coefficient to DNSP-specific growth in undergrounding share rather than industry-wide growth. Third, it adds data from 2017, which was not available at the Draft Decision. This approach better reflects the likely cost savings that an efficient DNSP could achieve given the ability of each DNSP to underground, though it may introduce perverse incentives to not reduce opex. These perverse incentives are limited by using the longest-possible window, from 2006 to 2017. Option A leads to an adjustment that varies by DNSP, from *plus* 0.06 per cent to 0.29 per cent, with an average of *plus* 0.14 per cent (per annum).

- *Option B: SFA Time Trend with 2006-17 data (minus 1.9 per cent per annum).* This approach uses the time trend from EI's SFA C-D model, but uses 2006-17 data. This approach captures long-term shifts to the frontier in the electricity sector; separates catch-up from frontier shift; and is determined objectively and could be extended in future years by adding more years' data. Frontier DNSPs theoretically have a small disincentive to reduce costs in order to affect the time trend, but the long window of data limits the benefits these DNSPs could realise in doing so.

- *Option C: SFA Time Trend with 2012-17 data (minus 1.5 per cent per annum)*: This approach is identical to that of Option B, but excludes years prior to 2012 in which the AER has argued DNSPs suffered negative productivity growth due to regulatory obligations which will not reflect future conditions. Option C captures shorter-term shifts to the frontier in the electricity sector; separates catch-up from frontier shift; and is determined objectively and could be extended in future years by adding more years' data. However, the shorter series relative to Option B means that it does not capture longer-term productivity and is more susceptible to disincentives for frontier DNSPs to reduce costs, as well as subjective decisions on which window to use. Options B and C could be combined with Option A above and the combined model would have similar rationale to the AER's Option 3. For internal consistency, the models would need to be fully re-estimated using a levels specification of the underground share.

- *Option D: Long-term MPFP (minus 1.0 per cent per annum)*. This approach modifies the AER's Option 4 to use all of the data available – all 13 DNSPs measured from 2006 to 2017 – and uses a logarithmic regression averaging approach rather than a continuous compounding approach. Option D is more stable and more objective than Option 4, uses all of the available evidence and minimises the incentive effects of relying on DNSPs' own data to set productivity targets.

We provide a summary assessment of each option in Table 1 below.[1] As should be clear from the table, our revised options A-D result in consistently lower productivity growth assumptions than the six proposed by the AER and three suggest the AER should make positive adjustments to forecast opex. Taken together, the evidence we have reviewed suggests that the AER has no objective basis for departing from its status quo assumption of zero productivity growth for DNSPs.

1 Green = Approach satisfies criterion in practice and in theory; Amber = Approach may violate criterion in theory, but may not be a problem in practice; Red = Approach violates criterion in theory and in practice.

Table 1: Review of the AER's and NERA's Productivity Approaches

	AER Approaches					NERA Approaches			
	Option 1: The status quo (econometric approach bound by 0)	Option 2: Productivity growth from increased undergrounding	Option 3: Undergrounding productivity plus the gas distribution time trend	Option 4: Using industry average opex MPFP growth	Option 5: Using forecast labour productivity growth	Option A: Undergrounding with a DNSP-specific levels coefficient (2006-17 data)	Option B: SFA Time Trend (2006-17 data)	Option C: SFA Time Trend (2012-17 data)	Option D: Long-term MPFP (2006-17 data)
Applied rate-of-change (% p.a.)	0%	0.5%	1.0%	1.6%	0.9%	0.06% - 0.29% (0.14% avg)	-1.9%	-1.5%	-1.0%
Approach captures the trend in productivity	🔴 Underlying trend is unlikely to be 0%, as assumed by the status quo	🔴 Does not reflect productivity gains which could be achieved by any single DNSP. Functional form illogical.	🔴 Same as Option 2, plus inconsistent assumptions from a different industry.	🔴 Choice of window (and included companies) is arbitrary and short, making this approach unlikely to capture long-term productivity.	N/A May capture underlying trends provided no substitution toward other inputs. DAE measure a black box and may not reflect DNSPs' inputs.	🟢 Assumption is in line with what is achievable for a single DNSP, using intuitive functional form.	🟢 Assuming 2006-17 is relevant on an ongoing basis, this approach precisely captures ongoing productivity for DNSPs.	🟡 Arbitrary choice of window means approach does not identify long-term productivity changes.	🟢 Assuming 2006-17 is relevant on an ongoing basis, this approach precisely captures ongoing productivity for DNSPs.
Approach separates productivity from catch-up	🟡 Assumption is 0%, so criterion is not relevant.	🟢 Two LSE models include catch-up efficiency gains in coefficients. Only SFA model aims not to. But quantitative effect of catch-up small.	🔴 Same as Option 2, plus gas trends include some non-SFA models, which capture catch-up efficiency gains in the gas sector and may have material impacts on productivity growth assumptions.	🟡 AER removes companies it deems "materially inefficient", but unclear it is objective/accurate in doing so.	🟢 Estimated over a wide dataset unlikely to be influenced by catch-up efficiency.	🟢 Coefficient based on SFA model, which explicitly aims to estimate the efficient frontier.	🟢 Coefficient based on SFA model, which explicitly aims to estimate the efficient frontier.	🟢 Coefficient based on SFA model, which explicitly aims to estimate the efficient frontier.	🟡 In the long-term, DNSPs will not consistently catch up. However, with only 12 years' data, there may be some catch-up included.
Approach is objective and stable over time	🟢 AER has used this approach until now and could continue to do so indefinitely.	🔴 Logarithmic specification implying accelerating work is not sustainable in the long-term.	🔴 Same as Option 2, plus unclear why AER would continue to use gas trends when electricity trends become more reliable.	🔴 Choice of window is arbitrary and unstable. Highest productivity growth from broad range of estimation windows may suggest cherry picking.	🔴 Connection to economy-wide labour productivity is not stable.	🟡 Growth in UG share must slow down, but our linear approach assumes constant undergrounding which may be sustainable in the medium term.	🟢 Internally consistent with other parts of the efficiency assessment, and objectively uses all available data.	🟡 Internally consistent with other parts of the efficiency assessment, but requires arbitrary selection of start year.	🟢 Estimated over the longest period possible and hence the most stable measure available.
Approach does not limit incentives to reduce costs	🟢 Individual DNSPs' actions do not influence the application of this assumption, because it is set to zero.	🟢 Industry-average approach may limit DNSPs' ability to individually shift targets materially.	🟢 Same as Option 2. Use of gas trend makes it virtually impossible for an electricity DNSP to influence that component of the target.	🟡 Given short estimation window, industry-average approach reduces incentives for DNSPs part of wider groups to reduce costs.	🟢 Individual DNSPs could not materially influence DAE's (economy/sector wide) productivity indices.	🟡 Approach based on individual DNSPs means they could theoretically influence their own targets, but unlikely to do so. Long-term model limits this incentive risk.	🟢 Targets set by frontier companies, so these companies could influence targets in subsequent periods, but long-term model limits this incentive risk.	🔴 Targets set by frontier companies, so these companies could influence targets in subsequent periods.	🟢 Industry-average approach, plus long-term averaging, removes DNSPs' ability to individually shift targets materially.
Overall Assessment	🟡 Does not reflect underlying trend, but at least reflects existing approach.	🔴 Does not reflect underlying trends and aribrtrarily punishes some companies.	🔴 Same as Option 2, but includes further irrelevant information.	🔴 Highly sensitive to subjective decisions about sample window and size.	N/A Insuffiient information on method to appraise or apply.	🟡 Likely reflects underlying trends, but constant undergrounding not sustainable.	🟢 Performs strongly in all four criteria.	🟡 High bar required to exclude pre-2012 data objectively, and this has not been met.	🟢 Performs strongly in three criteria, but may not be a long enough window to separate out catch-up.

1. Introduction

The Australian Energy Regulator (AER) regulates electricity Distribution Network Services Providers (DNSPs) through rolling five-year price control processes referred to as resets. At each reset, the AER sets the level and trend of operating expenditure over the following five year reset period. Productivity growth assumptions are one of three factors which affect the trend rate of growth in operating expenditure.

The AER published a Draft Decision on its future approach to assessing productivity growth for operating expenditure on 9 November 2018.[2] The Draft Decision proposes six options for setting productivity growth assumptions at DNSPs' resets:

- **Option 1:** zero based on the status quo;
- **Option 2:** 0.5 per cent per year based on the AER's estimate of the impact of undergrounding on costs;
- **Option 3:** 1 per cent based on a combination of Option 2 and the time trend in operating expenditure for gas DNSPs;
- **Option 4:** 1.6 per cent per year based on recent trends in Multilateral Partial Factor Productivity (MPFP);
- **Option 5:** 0.9 per cent per year based on a forecast of labour productivity; and
- **Option 6:** 1 per cent based on a "holistic" assessment of the above evidence. Option 6 is the AER's preferred option.

Citipower, Powercor, SA Power Networks and United Energy commissioned NERA to review the AER's approach from an economic perspective for consistency with its statutory objectives under the National Electricity Objective (NEO).

This report proceeds as follows:

- Chapter 2 reviews the AER Draft Decision, including the evidence it presents and the alternative options it proposes for assessing productivity growth;
- Chapter 3 describes the AER's statutory objectives under the National Energy Law (NEL) and National Energy Rules (NER). It also sets out criteria for setting productivity growth assumptions, given the AER's statutory objectives.
- Chapter 4 evaluates the undergrounding component of Options 2 and 3;
- Chapter 5 evaluates the application of the time trend from the operating costs of gas DNSPs for setting productivity assumptions for electricity DNSPs as part of Option 3;
- Chapter 6 evaluates the use of recent trends in MPFP under Option 4;
- Chapter 7 evaluates the use of labour productivity under Option 5; and
- Chapter 8 sets forth alternative approaches which better meet our proposed criteria; and
- Chapter 9 concludes.

[2] AER(2018), Forecasting productivity growth for electricity distributors, Draft Decision Paper, November 2018.

2. AER's Approach to Setting Productivity Targets

As part of its revenue resets for Australian electricity DNSPs, the AER sets productivity growth assumptions over the reset period. Historically, the AER has set a zero productivity growth assumption based on econometric modelling (which shows negative productivity growth). In its Draft Decision document, published on 9 November 2018, the AER proposes to set future productivity growth assumptions at 1 per cent for electricity DNSPs based on a "holistic" appraisal of a variety of evidence. This chapter reviews the AER's historical practice and the Draft Decision, including explaining the AER's reasoning behind its proposed 1 per cent productivity growth assumption. The chapter proceeds as follows:

- Section 2.1 describes the AER's historical approach to estimating productivity growth for Australian electricity DNSPs. Its econometric methods based on data since 2006 have previously suggested that productivity growth was negative over time but it has assumed zero productivity growth on the assumption that it would fund increases in costs through a higher level of the revenue allowance.
- Section 2.2 describes the evidence that the AER considers in recommending a 1 per cent productivity growth assumption at future resets. That evidence includes recent trends in Multilateral Partial Factor Productivity (MPFP), econometric evidence on the trend in productivity growth for electricity DSNPs and in other sectors and labour productivity growth in the broader utilities sector.
- Section 2.3 sets out the AER's proposed options for setting the productivity assumption and describes the AER's preferred "holistic" approach. The AER draws on all of the sources of evidence that does not result in a negative productivity figure and selects a number broadly in the middle of the resulting range.

2.1. The AER's Previous Decisions on Ongoing Productivity Improvement

The AER has historically set an assumption of zero productivity growth for electricity. The AER relied on econometric analysis to assess the degree of productivity growth for DNSPs over time. The analysis prepared by its consultant has previously shown negative productivity growth. The AER subsequently discarded these coefficients because it did not consider that DNSPs would become less productive over time and because it argued that it already compensated for reduced productivity through step changes in allowances.

The AER broadly describes this approach and the reasons for it in the Draft Decision Paper:

> "Since publishing the [Expenditure Forecast Assessment] Guideline in 2013 we have looked at the productivity growth estimated by our stochastic frontier analysis Cobb Douglas cost frontier model as the primary information source to inform our forecast of productivity growth. One advantage of this approach, and one reason why we adopted it, was for consistency between our productivity, output and price growth forecasts. We used the output weights estimated by the same model to forecast output growth.
>
> If we are going to use historic productivity growth to forecast we need to be satisfied that past productivity performance is reflective of what can be achieved going forward. However, we have not been satisfied that the past productivity growth that

> we have estimated, particularly for the period 2006 to 2012, occurred in 'business as usual' conditions. This reflects the significant new regulatory obligations that distributors were required to meet, and which required significantly increased opex, but with no change in measured output. Consequently we did not use the estimated negative historic productivity growth to forecast opex productivity growth.
>
> We considered that a prudent and efficient distributor would not reduce its productivity over time unless it needed to increase its costs to meet a non-discretionary obligation. Given that we generally fund the costs of new and material regulatory obligations through step changes we have, in the past, forecast zero productivity growth. We maintain the view that, as long we provide step changes for the costs of new regulatory obligations, forecast productivity growth should be non-negative. We have previously stated that we did not consider the negative productivity growth we were seeing would continue. We expected distributors to make positive productivity growth in the medium to long term"[3]

For example, for the 2014-2019 reset for New South Wales and the Australian Capital Territory, AER relied on analysis prepared by Economic Insights (EI).[4] EI calculated partial factor productivity (PFP) for opex using Stochastic Frontier Analysis and relying on a Cobb-Douglas production function.

EI drew on the AER's economic benchmarking data, which AER obtained through the Regulatory Information Notice (RIN) for the 13 DNSPs over a period of 8 years. The AER specifically stated in its 2013 RIN:

> "For the purposes of measuring change in productivity a long data set is preferable. An eight year data set should be sufficient to set up our economic benchmarking models. We do not consider there is merit in reducing the time series further because Economic Insights requires at least eight years of data for index-based economic benchmarking such as multilateral total factor productivity."[5]

However, EI initially ran into problems with unstable econometric estimates, even for simple models, due to "insufficient variation in the data". They therefore added data from DNSPs in New Zealand and Ontario to increase the number of observations. Longer time series were available for the additional data, but EI only included data from the past 8 years in keeping with the Australian data.

As a result, EI's forecasts for PFP growth from 2014-2019 were based on data from individual DNSPs in Australia, New Zealand from 2006-2013 and Ontario from 2005-2012. EI's analysis resulted in negative estimates for partial productivity growth rates for opex of *minus*1.6 per cent for Ausgrid and ActewAGL, *minus* 1.5 per cent for Endeavour and *minus*1.3 per cent for Essential Energy.[6]

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3 AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p. 10.

4 Economic Insights (17 November 2014), Economic Benchmarking Assessment of Operating Expenditure for NSW and ACT Electricity DNSPs.

5 AER (November 2013), Regulatory Information Notices to Collect Information for Economic Benchmarking.

6 Economic Insights (17 November 2014), Economic Benchmarking Assessment of Operating Expenditure for NSW and ACT Electricity DNSPs, p.55.

EI ultimately recommended that the AER assume that DNSPs would experience zero productivity growth because it argued that:[7]

- step changes allowed in the previous regulatory reset distorted productivity growth. EI expressed concern that DNSPs would receive the double benefit of a step change and lower productivity growth assumptions;
- "declining opex partial productivity is very much an abnormal situation"; and
- DNSPs would have lower incentives for cost reduction if the AER awarded a negative productivity growth rate.

2.2. The AER's Rationale to Change its Approach to Productivity at the Upcoming Regulatory Reset

The AER released a draft decision paper detailing changes to its proposed approach to forecasting opex productivity growth. The AER motivates the changes with three main factors, none of which make a compelling case for change:

Firstly, the AER states that "evidence now suggests that distributors across the industry have improved their opex productivity performance since around 2012".[8] In other words, the AER selects the period since 2012 because that period exhibits the positive productivity growth the AER expects to see. However, the selection of the period since 2012 for analysing productivity growth is arbitrary. As an estimation period selected to generate a positive productivity growth assumption, it cannot be an unbiased estimate of productivity growth in future.

Moreover, as is clear from the evidence presented by the AER (see Figure 2.1 below), since 2012 and before, DNSPs' productivity has not smoothly trended downwards or upwards. In practice, the clearest lesson from the data is that DSNPs' MPFP fluctuates materially from year to year. As a result of these fluctuations, and as we discuss in Chapter 6, although MPFP has been increasing *on average* since 2012, many DNSPs have experienced declining productivity in at least part of that period and productivity over both longer and shorter periods has declined.

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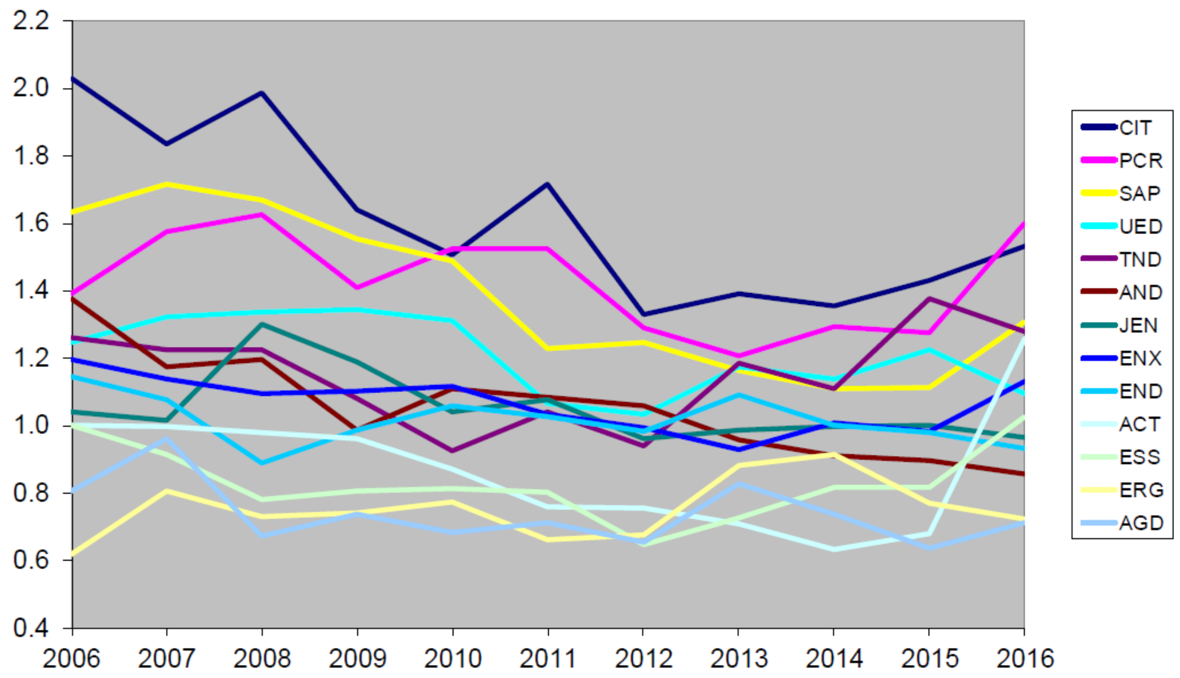
7 Economic Insights (17 November 2014), Economic Benchmarking Assessment of Operating Expenditure for NSW and ACT Electricity DNSPs, p.56.

8 AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p. 11.

Figure 2.1: Opex Multilateral Partial Factor Productivity (2006-2016)



Source: AER Draft Decision, Figure 2.

Secondly, the AER cites the Consumer Challenge Panel's (CCP) recent submission that it is reasonable to expect businesses operating in competitive environments to aim for positive year-on-year productivity growth. CCP also claims that this sort of productivity growth is a required aim for network businesses to meet the NEO.[9] However, the CCP is incorrect that businesses in competitive environments should expect *measured* productivity growth to the be positive. Given the limited range of outputs included in EI's measure of productivity for DNSPs, it should be of no surprise that productivity growth has been negative on average and neither should it be a surprise were that to continue in future. Since these are the only outputs which the AER takes into account in its benchmark, a negative productivity estimate merely means that opex needs to increase to take account of mismeasurement. Indeed, as a result of negative measured historical productivity growth, the New Zealand Commerce Commission used a negative partial productivity factor when forecasting opex for the last price reset for electricity distributers.[10]

In any case, due to the practical problems with measuring productivity, productivity measures are often negative in competitive industries: for instance, 11 of 16 industrial categories have experienced at least one period of negative growth of five years or more for Australia since 1990.[11] To exclude periods when productivity growth is negative therefore will

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9 Consumer Challenge Panel (May 2018), CCP10 Response to Evoenergy regulatory Proposal 2019–24 and AER Issues Paper, p. 12.

10 New Zealand Commerce Commission (28 November 2014), Default price-quality paths for electricity distributors from 1 April 2015 to 31 March 2020: Low cost forecasting approaches, pp. 24-27.

11 Australian Bureau of Statistics (24 January 2018), 5260.0.55.002 Estimates of Industry Multifactor Productivity, Australia, Table 26: Productivity growth cycles – Market sector industries (a) (b).

systematically bias estimates of future productivity growth: The future, like the past, is likely to consist of periods of both negative and positive productivity growth.

Thirdly, the AER has now applied a zero per cent forecast to all DNSPs. Accordingly, the AER "consider[s] it is an appropriate time to reconsider how we forecast opex productivity growth".[12] In principle, it is not relevant to the AER's statutory duties to ensure all DNSPs have been subjected to the same productivity assumption. Instead, the AER's duties require it to set an allowance which covers the efficient costs of each DNSP at each reset, based on the best available evidence on future trends in productivity (see section 3.1).

The AER considers four sources of information in its decision on productivity growth for DNSPs' opex:

- Historical opex MPFP performance;
- Econometric analysis of the time trend in historical opex;
- Econometric analysis of the impact of undergrounding on DNSP's costs; and
- Historical and forecast growth in labour productivity.

We discuss how these sources of information inform its proposals in Section 2.3 below, and describe the mechanical details behind each source of information in Chapters 3 to 7, where we also appraise each of the AER's options.

2.3. AER Proposed Approaches

The AER presents and discusses six options to set opex productivity growth, based on the evidence described in section 2.2 above:

1. The status quo (zero productivity growth, but informed by negative productivity growth in practice).
2. Using the productivity growth from the increased proportion of undergrounding as estimated by its econometric analysis of electricity DNSPs' opex (*plus* 0.5 per cent productivity growth).
3. Using the productivity growth from the increased proportion of undergrounding as estimated by its econometric analysis of electricity DNSPs' opex, plus the time trend estimated in gas distribution econometric studies (*plus* 1.0 per cent productivity growth).
4. Using industry average opex MPFP growth, adjusted to remove catch up by eliminating four "materially inefficient" firms (*plus* 1.6 per cent productivity growth).
5. Relying on its forecasts of labour productivity growth (*plus* 0.9 per cent productivity growth).
6. A "holistic approach" that draws on all sources of information to forecast productivity growth (*plus* 1.0 per cent productivity growth).

The AER notes that Option 1 has the advantage that it is consistent with its output and price growth forecasts for DNSPs. Nonetheless, it disregards option 1, on the basis that:

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12 AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p. 11.

- it would "generally provide for the costs of new and material regulatory obligations" and does not expect negative productivity growth to continue. [13]
- recent opex MPFP has been increasing;
- it does not account for increased undergrounding; and
- it relies on a single econometric model, with which the Australian Competition Tribunal had expressed concerns.

It is unclear how the last of these alleged disadvantages in particular disqualifies the status quo from more detailed consideration: in principle at least, the AER could rely on the average of the time trends from multiple econometric models as it proposes to do for the coefficients on undergrounding and from the gas industry.

The AER argues that Option 2, relying on the trend in undergrounding and its undergrounding coefficient, has the advantage of being consistent with DNSPs' opex allowance under the benchmarking regime and of relying on multiple econometric models. The AER suggests that it assumes zero productivity growth for technical change. In fact, option 2 merely assumes that all other unmeasured factors offset productivity growth due to technical change.

The AER augments Option 2 in Option 3 by including a time trend from gas distribution, which the AER argues accounts for technical change "that is reasonably reflective of the time trend that can be achieved by an efficient and prudent electricity distributor."[14]

Under Option 4, the AER, relies on a short-run trend in MPFP growth in electricity distribution since 2012. The AER states that the advantages and disadvantages of this approach as follows:

> "One advantage of this approach is that it relies on evidence for electricity distribution and does not require evidence from other industries. The estimated opex MPFP appears to provide clear evidence that Australian electricity distributors have made positive opex productivity growth since 2012.
>
> One disadvantage of this approach is that it relies on data from a relatively short period and uses only a reduced number of distributors. This will increase the uncertainty around how reflective this forecast will be of opex productivity that can be achieved going forward." [15]

Under Option 5, the AER would rely on forecasts of labour productivity based on work produced by Deloitte Access Economics. The AER argues that the forward-looking nature of Deloitte's work is an advantage because it captures expected changes in productivity but that the disadvantage of this approach is inconsistency with DNSPs opex allowances determined through the econometric benchmarking regime. [16]

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[13] AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p. 22.

[14] AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p. 24.

[15] AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p. 24.

[16] AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p. 24.

Option 6 is the AER's preferred option, of relying on a "holistic" appraisal of the evidence discussed under Options 2 to 5. In practice, Option 6 is "holistic" by name and not by nature in that it explicitly excludes consideration of the evidence relied on at previous reviews to determine productivity growth assumptions (i.e. negative productivity growth as indicated by MPFP modelling, from which the AER previously derived a 0 per cent adjustment in Option 1). Options 2 to 5 yield a range of *plus* 0.5 to 1.6 per cent, of which two – Option 3 and Option 5 – are close to the middle of the range at around 1 per cent. As a result, the AER concludes that "we are satisfied that this a reasonable expectation of the opex productivity growth that an efficient and prudent distributor can achieve".[17]

[17] AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p. 26.

3. The AER's Duties and Role of the Productivity Assumption

The Draft Decision paper does not set out transparent criteria for assessing whether a productivity growth assumption is appropriate for setting the allowed revenues of electricity DNSPs or how much weight to place on each measure. In practice, the AER adopts an average figure of Options 2 to 5 which is broadly equivalent to placing equal weight on each source of evidence.

Nonetheless, readers may divine some high-level criteria that the AER considers when evaluating each of the Options (as described in section 2.3). For instance, the AER's criteria appear to include the requirement that the productivity growth assumption is non-negative (as can be seen from its discussion of Option 1). The failure to spell out its criteria leads to a lack of transparency in the AER's decision-making and an inconsistent application of those criteria to each of the Options. For instance, the AER mentions the advantage of consistency (or disadvantage of inconsistency) with its benchmarking of operating costs in evaluating Options 1, 2 and 5 but does not evaluate Options 3 and 4 by this criterion. (In)consistency with its benchmarking of operating costs is equally relevant to the evaluation of Option 3, which assumes a time trend from the gas industry and other benchmarking parameters from the electricity industry, and Option 4, which relies on the same outputs as the benchmark but excludes environmental factors.

This chapter sets out the criteria that the AER should apply in assessing productivity measures based on the AER's duties and objectives, economic principles and international practice. The Chapter proceeds as follows:

- Section 3.1 sets out the AER's objectives and the statutory requirements of the AER in assessing productivity growth for DNSPs;
- Section 3.2 introduces the criteria that the AER would need to adopt in setting a productivity assumption, from an economic perspective;
- Section 3.3 explains that the AER's productivity assumption must capture the likely trend in efficient costs;
- Section 3.4 explains that the AER's productivity assumption should exclude catch-up and take account only of frontier shift;
- Section 3.5 describes the need for objectivity, transparency and stability to meet the AER's statutory duties from an economic perspective.; and
- Section 3.6 explains that the AER's approach should preserve incentives for efficient operation.

3.1. The AER's Objectives and Statutory Requirements

The NEL and the NER guide the AER's regulation of electricity networks. These two pieces of legislation lay out the functions, responsibilities and powers of the AER.

3.1.1. The National Electricity Law

The goal of the NEL, set out in the NEO, is:

> "… to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to—
>
> (a) price, quality, safety, reliability and security of supply of electricity; and
>
> (b) the reliability, safety and security of the national electricity system."[18]

The Revenue and Pricing Principles (RPP) of the NEL further stipulate that a network service provider "should be provided with a reasonable opportunity to recover at least the efficient costs the operator incurs in (a) providing direct control network services; and (b) complying with a regulatory obligation or requirement or making a regulatory payment".[19]

According to the NEL, when performing a regulatory function or power, the "AER must […] perform or exercise that function or power in a manner that will or is likely to contribute to the achievement of the national electricity objective".[20] Furthermore, the AER "must take into account the revenue and pricing principles when exercising a discretion in making those parts of a distribution determination […] relating to direct control network services".[21]

3.1.2. The National Electricity Rules

While the NEL sets out the AER's statutory requirements, the NER provides a more detailed implementation framework that the AER is required to follow in meeting those requirements.

The NER requires that a DNSP's opex proposal must achieve the operating expenditure objectives, which are to meet or manage expected demand; comply with all regulatory obligations or requirements; maintain quality, reliability and security of supply; and maintain the safety of the distribution network.[22]

The NER also defines the criteria against which the AER assesses whether a DNSP's proposal achieves the operating expenditure objectives:[23]

> "The *AER* must accept the forecast of required operating expenditure of a *Distribution Network Service Provider* that is included in a *building block proposal* if the *AER* is satisfied that the total of the forecasting operating expenditure for the *regulatory control period* reasonably reflects each of the following (the *operating expenditure criteria*):
>
> (1) The efficient costs of achieving the *operating expenditure objectives*: and
>
> (2) The costs that a prudent operator would require to achieve the *operating expenditure objectives*; and

18 National Electricity (South Australia), Act 1996, Schedule – National Electricity Law, Section 7.

19 National Electricity (South Australia) Act 1996, Schedule – National Electricity Law, Section 7A(2).

20 National Electricity (South Australia), Act 1996, Schedule – National Electricity Law, Section 16(1).

21 National Electricity (South Australia), Act 1996, Schedule – National Electricity Law, Section 16(2).

22 National Electricity Rules, v114, clause 6.5.6(a).

23 National Electricity Rules, v114, clause 6.5.6(c). Italics in original.

(3) A realistic expectation of the demand forecast and cost inputs required to achieve the *operating expenditure objectives*."

If the AER is not satisfied that the DNSP's proposal satisfies the operating expenditure criteria, it must provide its own estimate of required opex that does satisfy the criteria.[24]

Additionally, per clause 6.12.2, when replacing a DNSP proposal with its own estimate, the AER must "set out the basis and rationale of the determination, including: (1) details of the qualitative and quantitative methods applied in any calculations and formulae made or used by the AER".[25]

3.2. Criteria for Setting a Productivity Improvement Target

As described in section 3.1, briefly summarised, the AER's duties are:

- promoting the *long-term* interests of consumers with respect to price, quality and security of supply (to comply with the NEO); and
- accepting DNSP' forecast of operating expenditures, where they are a realistic forecast efficient costs that would be incurred by a prudent operator, or else explaining any deviation from those forecasts (under the NER).

These high-level criteria provide a legal basis for the AER's decision-making.

From an economic perspective, these criteria amount to assessing whether a given productivity assumption will allow a DNSP to recover its anticipated efficient costs of operation. Consumer's interest in the long-lived assets of electricity networks is itself necessarily long term. Assuming higher productivity growth than DNSP's were realistically able to achieve would systematically deny operators the opportunity to recover their efficient costs. It would therefore undermine investment in electricity networks and violate the AER's obligations under the NEO. On the other hand, assuming lower productivity growth than was in fact possible would violate the AER's obligations under the NEO to promote consumers' interests with respect to price or under the NER to accept realistic forecasts of efficient costs. Similarly, assumptions on productivity growth that blunted incentives for cost reduction over time and therefore the prices that consumers would pay would violate the AER's obligations to promote consumers' long-term interest with respect to the price paid for network services.

The conceptual definition of productivity is clear: Productivity is the rate of transformation of physical inputs to physical outputs. However, measuring productivity change is notoriously difficult – not the least of which is that it relies on an accurate specification of the inputs and the outputs. Calculation and weighting of these inputs and outputs raises a number of important theoretical and empirical questions, many of which the OECD highlights in its manual on productivity assessment.[26] Total factor productivity (TFP) not only measures technological change but also captures the effect of average movements to/from the frontier, economies of scale, variations in capacity utilisation, and measurement error. As a result, Jorgenson and Griliches, academics amongst the founding fathers of productivity analysis,

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24 National Electricity Rules, v114, clause 6.12.1(4).

25 National Electricity Rules, v114, clause 6.12.2.

26 OECD (2001) Measuring Productivity, Measurement of aggregate and industry level productivity growth, OECD manual. Available on-line: http://www.oecd.org/std/productivity-stats/2352458.pdf

have described TFP estimates as the "residual" or the "Measurement of Our Ignorance".[27] The Partial Factor Productivity (PFP) measures relied on the AER may further result from changes in the combinations of capital, labour and intermediate services employed in the process of production. They are therefore yet further removed from trends in underlying productivity that TFP analyses.

Forecasting productivity change is yet more challenging than measuring it. In the absence of financial markets which aggregate and collect market expectations on productivity growth and a universally accepted and well-understood theory of what drives productivity, the AER (in common with other regulators) has little alternative but to rely on historical trends.

Such a productivity assumption can only ever be a realistic expectation of efficient costs, as required by the AER's obligations under the NER, if we may anticipate that the future period reflects the past. In order to ensure that regulated companies have a reasonable prospect of recovering their expected efficient costs, the productivity assumption must also comply with the following criteria:

- **Approach captures trends in productivity for DNSPs:** The approach must rely on data which may reasonably reflect the change in opex allowances for DNSPs given the AER's other assumptions as part of the reset process. Trends in productivity are both volatile and cyclical. Accordingly, the approach must capture long-term trends in productivity improvement to iron out noise in the dataset;
- **Approach separates productivity from catch-up:** The approach must identify ongoing efficiency improvement, and not catch-up efficiency improvement or non-replicable structural changes;
- **Approach is objective and stable over time:** The approach must be stable over time in order to limit regulatory discretion and prevent 'cherry-picking' between methods at each reset so that costs are systematically below companies' costs.
- **Approach does not limit incentives to reduce costs:** The approach should not have an adverse impact on consumers by reducing incentives for cost reduction and therefore resulting in higher costs over time;

We elaborate on each of these criteria in sections 3.3 to 3.6 below.

3.3. Approach Captures Underlying Trends in Productivity for DNSPs

The productivity growth assumption employed by the AER at DNSP resets must reflect a realistic expectation of DNSP's prospects for reducing their operating costs. That requirement imposes at least three conditions on the method for estimating productivity growth using historical trends.

Firstly, the data series chosen should reflect historical productivity growth for DNSPs. All else equal, the AER should prefer approaches which draw on data from electricity distribution in Australia as the closest available comparators for any given electricity DNSP. Internationally, regulators have relied on a basket of sectors with similar characteristics, where they believe that historical productivity growth is not likely to be representative of

27 Jorgenson, D.W. and Griliches, Z. (1967) The explanation of productivity change, Review of Economic Studies, vol. 34 (3) p.249.

future growth. In selecting series from other sectors, the AER would need to take account of any differences between those sectors and DNSPs or rely on a range of alternative industries to eliminate idiosyncratic effects. For instance, the British energy regulator, Ofgem, and the Dutch regulator, the Authority for Consumers and Markets (ACM), both use a broad basket of industries in assessing productivity. Those industries include construction, transportation, storage and other utility sectors (see Appendix A).

Second, the productivity measure must be consistent with the other components of opex allowances: base opex, output growth and assumptions about real input prices. While it is unlikely that any component of the allowance will be estimated perfectly, any statistical error in each measure will tend to counteract errors in the other measures, resulting in an opex allowance that likely reflects efficient costs *in the round* even if it fails to reflect efficient costs arising from each driver. For example, if the AER were to overestimate input price inflation in its econometric models, this error would appear as productivity growth. DNSPs would correspondingly be over-compensated on input price growth but under-compensated on productivity improvements, but could still be appropriately compensated for its efficient opex in the round.

The AER's productivity assumption does not stand in isolation. It is the residual or balancing term in the reset process (or as Jorgensen and Griliches put it, the "Measurement of Our Ignorance"): an estimate of productivity, however accurate on a standalone basis will deny DNSPs the prospect of recovering their efficient costs if the AER does not compensate the DNSP for other factors that cause efficient opex to rise. For instance, if operating costs are rising sharply over time because the AER has consistently underestimated the volume of outputs (or excluded some important categories of output entirely), the AER's productivity growth assumption may legitimately be negative. A productivity growth assumption that is negative does not necessarily indicate that technology is regressing over time. Instead, it may indicate that the efficient frontier is shifting backwards as a result of other external conditions.

Third, the productivity measure must use data over a long-time period. Productivity measures tend to be volatile and procyclical over time even averaged over large datasets with many observations.[28] Accordingly, estimates of productivity growth derived from short periods of time are likely to misrepresent future productivity growth. Figure 3.1 shows Multifactor Productivity for the Australian economy as a whole and GDP between 1982 and 2017. As can be seen from the figure, productivity (shown in blue) broadly tends to lead GDP growth (in dark grey), especially in the first half of the period. The range of productivity growth is between *minus* five and *plus* three per cent per annum.

[28] See for example, Boisso, Grosskopf and Hayes (2000), Productivity and efficiency in the US: effects of business cycles and public capital, *Regional Science and Urban Economics*. "we have found that during recessions productivity decreases as a result of both diminished efficiency and reduced technical innovation. During booms it is both improved efficiency and greater innovation that lead to increased productivity." The OECD manual on productivity measurement and the UK Department for Business and Skills (BIS) make very similar points in their manuals on productivity assessment.

Figure 3.1: Multifactor Productivity and GDP Growth for Australia (1982-2017)

Source: MPFP data from Australian Bureau of Statistics, GDP data from world bank

Moreover, this range may become more volatile when focussing on one specific industry, as individual firms may experience one-off productivity improvements (for example, due to a major company restructuring, as is the case with TasNetworks), which will influence the industry-wide productivity level in that year. Relying on a single year or a short selection of years, especially when considering productivity in a single industry, may materially over- or under-state the long-term trend in productivity growth.

Regulators internationally are acutely aware of the dangers of relying on a short-term series:

- In the UK, Ofgem draws on a long-term data from 1970 to 2007 and relies on an average across a collection of industries that Ofgem identifies as relevant for the entire period (Ofgem does not rely on data from electricity gas and water supply because it argues that it includes catch-up effects);
- The Dutch regulator, ACM, uses data from Dutch electricity DNOs from 2005-2015 to set the productivity trend. Oxera, in a study published by ACM in 2016, recommended using data between 1992 and 2008 to capture two complete business cycles;[29] and
- North American regulators typically rely on a broad dataset for electricity distributors (or gas distributors in the gas sector) from across the United States. The dataset used contains cost information provided in the same format since 1973 as part submissions to the Federal Energy Regulatory Commission (FERC).

[29] Oxera (January 2016), Study on ongoing efficiency for Dutch gas and electricity TSOs, Prepared for Netherlands Authority for Consumers and Markets, p.35-36.

3.4. Approach Separates Productivity from Catch-up

Formally speaking, the growth accounting framework that underpins productivity analysis assumes that all markets are perfectly competitive and all firms are maximising inputs. In particular, productivity measures aggregate the value of inputs and outputs using expenditure-weighted shares. These expenditure weights only accurately reflect the value of the outputs and inputs in markets in the instantaneous competitive equilibria of classical economic theory.[30]

In practice, real world markets take time to equilibrate and at any moment in time some firms will not be operating at the frontier. As a result, changes in productivity measures consist of both:

(1) Catch-up by inefficient firms that redeploy their factors of production more efficiently over time; and

(2) "Frontier shift" of the maximum technically-feasible production by all firms in the market.

The AER's approach to estimating efficient opex for DNSPs accounts separately for these two sources of potential productivity improvement. The AER accounts for catch-up, i.e. convergence to the frontier, by estimating efficient opex using comparative benchmarking. As a result, the productivity growth assumption in the reset process should reflect only frontier shift, as the AER itself puts it in the Draft Decision:[31]

> "When we apply this approach it is important to remember that forecast opex must reflect the efficient costs of a prudent firm. To do this it must reflect the productivity improvements a prudent and efficient distributor can reasonably be expected to achieve. For this reason, our forecast of productivity growth reflects our best estimate of the shift in the **productivity frontier.** Our productivity growth forecast should not include any productivity growth required for an inefficient firm to catch-up to the productivity frontier. If we consider that a distributor is materially inefficient, we make an efficiency adjustment to its revealed opex (also referred to as base opex). This sets opex equal to the level required by an efficient and prudent firm on the productivity frontier in the base year. To the extent we think that the productivity frontier will shift over the forecast period, we account for this in the forecast productivity growth rate."

International regulators recognise the importance of excluding catch-up in their productivity targets, albeit that they use different methods for excluding it:[32]

- US regulators take long-term averages using a dataset that stems back to 1973. In practice, catch-up is not one-way and firms will converge on and away from the efficient frontier over time as market conditions change. Accordingly, taking a long-term average

[30] For a full discussion of the growth accounting framework and its assumptions, see NERA (2013), Estimating Real Price Effects and Ongoing Efficiency, 5 April 2013, chapter 4.

[31] AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p. 8-9. Emphasis added.

[32] For a discussion of international precedent, see Appendix A.

enables US regulators to average out periods of catch-up with periods of falling away from the efficient frontier and avoid systematic bias in the calculation of productivity.

- The British regulator, Ofgem, and the Dutch regulator, the ACM, calculate average productivity growth over long time periods also. Moreover, both Ofgem and the ACM exclude sectors in which they suspect that firms have systematically converged on the efficient frontier over time. For instance, in Great Britain, Ofgem has argued that productivity growth in the Electricity, Gas and Water Supply sector is likely to include material catch-up due to the increased efficiency that followed privatisation.
- The German regulator takes the alternative approach of calculating the shift in the efficiency frontier itself. The Bundesnetzagentur (BNetzA) estimates productivity growth using a Malmquist index. The BNetzA derives the index from movements in the efficiency frontier it estimates in its benchmarking analysis over time. The Malmquist index relies on a technique called Data Envelopment Analysis which the AER does not conduct for Australia. However, it is conceptually equivalent to the coefficient on time that the AER estimates in its Stochastic Frontier Analysis (SFA) models.

3.5. Approach is Objective and Stable over Time

Promoting efficient investment is an important part of the AER's duties under the NEO. Setting cost allowances in an unpredictable fashion and where the decision-making is not transparent deters efficient investment. Accordingly, the AER should rely on stable, objective *methods* to assess productivity growth. Changing methods at each review, especially where those methods identify the highest productivity growth across a range of options, may cause concern that the AER is opportunistically reducing prices in the short-term and not promoting consumers' long-term interests. Even without impugning the AER's motives, changing methods at each reset offers no guarantee that cost allowances will track efficient costs over time. For instance, using a long-term rolling average consistently at each review will systematically include all the years with high and low productivity growth over time. However, changing averaging periods at each review risks decoupling the long term productivity target from underlying efficient costs.

The stability of the *methods* does not necessarily imply that the *estimate* of productivity is itself stable. In principle, a consistent approach may show that productivity growth is changing over time. In practice, the noise in productivity estimates (described in section 3.3 above) means that stability in the productivity growth assumption is also likely to be desirable in meeting the AER's objectives: short-term changes in apparent productivity may well result from measurement error. Short-term evidence therefore provides no objective basis for changing productivity targets.

Internationally, regulators have frequently chosen to retain consistent methods for assessing productivity over time because it removes subjectivity from the process of setting allowed revenues. Ofgem, for instance, has relied on the same approach to forecasting productivity improvement since electricity Distribution Price Control Review 5 (DPCR5) conducted in 2010.[33] North American regulators typically rely on the same long-run dataset at each review

[33] For example, in its 2014 "RIIO-ED1" decision for electricity distribution companies, Ofgem used the same productivity assumption that it used in its 2012 "RIIO-T1/GD1" decision for gas distribution and transmission (gas and electricity) companies, which itself used the same approach used at DPCR5.

and in many cases without much commentary because they take the need for a stable method in established regulatory regimes. One recent exception is a decision by the Alberta Utilities Commission (AUC). The Commission upheld analysis conducted by NERA to estimate Total Factor Productivity for regulated companies and explicitly drew the link between the need for consistent methods, objectivity and using long-run averages to determine likely productivity growth. The Commission commented:

> "Because the parameters of the [RPI minus X] formula will be used to determine customer rates in a contested regulatory process and those rates will be in place for a number of years, the significance of the objectivity, consistency, and transparency of the TFP analysis to be employed in calculating the X factor cannot be overstated. In this respect, the Commission observes that having extensively scrutinized and tested NERA's study, the companies were satisfied that NERA's TFP analysis complies with these criteria. The Commission agrees… In the Commission's view, NERA's approach of using the longest time period available allows a smoothing out of the effect of variations in economic conditions on the estimate of TFP growth, without engaging in a subjective exercise of picking the start and end point of a business cycle."[34]

3.6. Approach Does Not Limit Incentives to Reduce Costs

Compliance with the NEO requires the AER to "promote efficient operation and use of electricity services or the long term interests of consumers of electricity". Assets in electricity distribution networks have operational lives that are decades long. Consumers therefore have a long-term interest in the efficient operation of energy networks. Promoting consumers' long-term interest is necessarily not a static exercise but relies on incentivising DNSPs to operate energy networks increasingly efficiently over time.

Assuming a high level of productivity growth does not increase incentives for efficient operation. Indeed, in extreme cases, setting a productivity assumption that was too high could result in a company spending an inefficiently low amount on opex: Where a regulator sets an allowance at such a level that it threatens the ongoing viability of a business, the operator may not be able or willing to raise the necessary finance for investment or maintenance of its plant and equipment.

In general, the fixity of allowances, rather than their level, provides the incentive for cost reduction. A fixed allowance (or a predetermined rate of pass-through) allows firms to increase their returns by reducing their costs. (Partly) fixed allowances therefore provide incentives for cost reduction. As allowances gradually catch-up with expenditure over time, consumers benefit from the increase in efficiency in the form of lower prices. Thus, X-factors (i.e. the trend in cost allowances for future years) serve to share returns with customers rather than provide incentives for cost reduction

Accordingly, in setting a cost allowance, the AER would ideally pick a method that was independent of the actions of the DNSP being regulated. If the productivity assumption at

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Source: (1) Ofgem (30 July 2014), RIIO-ED1: Draft determinations for the slow-track electricity distribution ompanies – Business plan expenditure assessment, para. 12.59; (2) Ofgem (27 July 2012), RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix, para. 3.2.

[34] AUC (September 2012), Decision 2012-237, p.61, 66 & 73-4.

future resets was likely to increase if DNSPs reduced costs, DNSPs would face reduced incentives to increase efficiency: the prospective fall in opex allowances could act as a deterrent to cost reduction.

As a result, the AER must trade-off the benefits of setting productivity targets that closely reflect individual DNSPs' prospects of cost reduction with the impact that doing so might have on perverse incentives. Accordingly, to satisfy this criterion alone, the AER better meets it statutory objectives by relying on:

1. Longer-term averages of productivity growth, which are more stable over time and less affected by changes in DNSPs' costs in any given year;
2. Averages of more firms rather than fewer, because the impact of a single firm reducing costs is smaller on its future allowances if there are more firms in the sample; and
3. Evidence from other sectors which do not depend exclusively on DNSPs (e.g. related sectors such as construction).

In practice, these approaches frequently come into conflict with the other criteria set out in this report for the AER's decision-making. Averages of more firms rather than fewer (option 2 above) may include firms which are experiencing catch-up to the efficiency frontier. Relying on sectors other than electricity (option 2 above) means the AER's approach may not capture the likely trend in efficient opex if those sectors experience different productivity growth. However, using long-term averages of DNSPs' productivity growth (option 1 above) does not conflict with the other criteria. Indeed, the other criteria set out in this report also point to relying on long-term averages to estimate future productivity growth.

4. Options 2 and 3: Undergrounding as a Driver of Productivity

Options 2 and 3 set the productivity assumption based on the AER's econometric analysis of DNSPs' opex. Both rely on the coefficients relating opex to the share of each DNSP's cables that are underground. Option 2 bases productivity just on these coefficients (multiplied by the expected change in undergrounding), while Option 3 additionally includes a generally technological change element derived from gas industry econometric models. In this chapter, we review the application of the undergrounding variable as a driver of productivity allowances based on the criteria we set out in Chapter 3. We discuss the use of the gas industry time trend separately in Chapter 5.

This chapter proceeds as follows:

- Section 4.1 provides a brief overview of the AER's approach to estimating the impact of undergrounding on opex;
- Section 4.2 explains that the ability to underground and the likelihood of undergrounding varies materially between DNSPS. The AER's approach therefore penalises companies which are unable to underground rapidly.
- Section 4.3 explains the functional form relied upon by the AER is implausible, as appeal bodies have recognised in the United Kingdom;
- Section 4.4 explains that the AER's assumption about future rates of undergrounding may not be sustainable;
- Section 4.5 concludes by evaluating the undergrounding approach against our criteria for assessing productivity assumptions.

Additionally, we discuss an alternative approach to controlling for undergrounding savings in Section 8.1.

4.1. Background to Approach

In the Draft Decision, the AER argues that, because underground cables fail at a lower rate than overhead lines and do not require vegetation management, "if a distributor increases the proportion of its network that is underground its opex would decrease, all else equal. That is, it would improve its opex productivity".[35]

EI/AER's three econometric models include a company's length of underground cables as a share of its total circuit length as a "'business condition' explanatory variable".[36] As with the other cost drivers in the model, the variable appears in a logarithmic form, meaning that a 1 *per cent* (rather than a 1 *percentage point*) growth in undergrounding share correlates with a fixed per cent change in opex. For instance, a company that increases its undergrounding share from 50 per cent to 51 per cent has increased it by 1 percentage point, but 2 per cent. If the correlation between cost and increased undergrounding were causal, an increase from 50 to 51 per cent would imply that costs would fall by two times the coefficient on undergrounding in the AER's benchmark.

35 AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p.16.

36 AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p.16.

In the left column of Table 4.1 below, we show the coefficient on the undergrounding variable in the three models as presented in the Draft Decision. The Draft Decision relies on models estimated for the 2017 benchmarking exercise and therefore uses data from 2006 to 2016. We expect that the AER's final decision on productivity may be based on the 2018 benchmarking exercise (estimated using data from 2012 to 2017), so we present the coefficients from the 2018 models on the right side of the table.

Table 4.1: Coefficient on Undergrounding Share by Model and Year

	2017 Models	2018 Models
SFA Cobb-Douglas	-0.144	-0.113
LSE Cobb-Douglas	-0.177	-0.195
LSE Translog	-0.159	-0.159
Average	**-0.160**	**-0.155**

Source: Economic Insights[37]

Over the period since 2006, all DNSPs have increased the proportion of their networks which are underground. Based on the AER's logic this should decrease opex and therefore increase opex productivity (all else held equal).

Table 4.2 shows each DNSP's average share of underground cables and the average annual growth rate, over the relevant window. We present calculations based on data underpinning the 2017 benchmarking exercise shown in the Draft Decision, as well as those based on data underpinning the 2018 benchmarking exercise, which we assume may be used in the AER's final decision on productivity.[38] The industry averages in the table, as well as in the Draft Decision, are calculated based on industry *totals*, effectively a weighted average of DNSPs by length of underground cable.

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37 (1) Economic Insights (31 October 2017), Economic Benchmarking Results for the Australian Energy Regulator's 2017 DNSP Annual Benchmarking Report, Tables 3.3-3.5., (2) Economic Insights (9 November 2018), Economic Benchmarking Results for the Australian Energy Regulator's 2018 DNSP Annual Benchmarking Report, Tables 3.3-3.5.

38 We further assume that, consistent with the decision to base the 2018 econometric models only on data from 2012 onwards, the AER will only calculate the average undergrounding growth rate on this window.

Table 4.2: Underground Cables Share and Growth

	2017 Benchmarking (2006-16)		2018 Benchmarking (2012-17)	
	Avg UG Share	Avg UG Growth	Avg UG Share	Avg UG Growth
ACT	51.6%	1.5%	54.6%	1.0%
AGD	35.2%	1.4%	36.9%	1.1%
CIT	47.2%	1.6%	49.3%	0.7%
END	31.8%	2.6%	34.7%	2.9%
ENX	30.7%	2.7%	33.1%	1.7%
ERG	4.6%	8.6%	5.7%	4.0%
ESS	3.6%	5.5%	4.1%	3.3%
JEN	26.0%	2.6%	28.3%	2.2%
PCR	6.4%	5.7%	7.4%	5.1%
SAP	18.3%	2.0%	19.3%	1.2%
AND	11.7%	4.2%	13.3%	3.8%
TND	10.0%	2.1%	10.8%	1.1%
UED	20.2%	1.8%	21.9%	3.9%
Average	**12.6%**	**3.4%**	**14.0%**	**2.6%**

Source: NERA analysis on EI benchmarking input data

To project the impact of undergrounding on future operating costs, the AER assumes that DNSPs will continue to increase their underground shares at the industry average growth. It therefore multiplies the industry average growth rate in Table 4.2 by its average coefficient in Table 4.1 to estimate that the average DNSP will reduce its opex by 0.5 per cent per annum (i.e. 3.4 per cent times -0.160) due to undergrounding. AER uses 0.5 per cent as its full productivity assumption in Option 2, and part of its productivity assumption in Option 3. Updated for 2018 growth rates and coefficients, this rate falls to 0.4 per cent because the coefficients on undergrounding and growth of undergrounding fell on average over the period.

4.2. The AER's Method Arbitrarily Penalises Companies that Underground Less

In Option 2 and 3, the AER proposes to define the productivity adjustment in part on the industry-average growth rate of undergrounding.

By using an industry-average growth rate, the AER does not reflect the drivers of opex for any one company, but rather sets a target which would only be appropriate for a single, notionally-average DNSP.

The decision to move lines underground is not one that can be justified based on operating cost savings alone. While companies do realise opex savings through undergrounding, the capital cost of replacing overhead lines with underground cables is generally much larger. Therefore, in making a case for undergrounding a company must generally justify the capital cost (and increased bills) for other reasons, for example environmental reasons or visual amenity. Indeed, setting allowances based on industry-average undergrounding creates an artificial incentive for DNSPs to propose undergrounding more of their networks, even when doing so does not benefit consumers over the long term.

For a DNSP for whom these other considerations make the ongoing undergrounding process cost-beneficial, it may also realise the opex savings associated with undergrounding. However, for a DNSP which does not have a compelling reason to move its network underground, the AER's proposed approach penalises it arbitrarily.

As a result, relying on the industry-average share of undergrounding does not capture the likely trend in productivity for each DNSP. The range of the average growth in undergrounding between 2006 and 2016 across was 1.4 to 8.6 per cent.[39] In other words, some DNSPs have been able to reduce costs over six times as much as others as a result of undergrounding over the past decade. Setting an allowance based on average undergrounding growth would therefore fail to reflect the efficient costs of companies which were able to increase their undergrounding less (or more) rapidly than others.

4.3. The AER's Functional Form is Counter-Intuitive

The AER bases its assessment of the impact of undergrounding on productivity on the outputs of its econometric models, which include DNSPs' underground share as a driver. As with the other variables in its regression, the AER uses the natural logarithm of the variable to define the natural logarithm of opex. Therefore, the models assume that DNSPs reduce opex by a fixed percentage for each percentage increase in the percentage of underground share. However, this functional form does not reflect the true relationship between underground share and opex, in which a *percentage point* increase in undergrounding share is likely to yield a fixed percentage decrease in opex. (Or equivalently, that DNSPs opex is a weighted average of the costs of underground and overground lines).

For example, consider two hypothetical DNSPs, each with 100km of total circuit length. DNSP A has 10km underground and 90km overhead, while DNSP B has 50km underground and 50km overhead.

Both DNSPs propose to underground 1km of overhead line, increasing their underground share by 1 percentage point each. For both DNSPs, this would result in opex savings associated with reduced maintenance and vegetation management on 1km of network, an equal savings for both networks.

However, according to the AER's approach, DNSP A has increased its underground share by 10 per cent (1km undergrounded divided by existing 10km undergrounded), while DNSP B has only increased its underground share by 2 per cent (1 new km underground divided by existing 50km underground). The AER's model thus assumes that DNSP A will be able to achieve a 1.6 per cent reduction in opex, while DNSP B will only be able to achieve a 0.32 per cent reduction in opex.

In the most recent regulatory review in the UK water sector, the regulator Ofwat set cost allowances in part on econometric models which included, among others, the natural logarithm of the proportion of distribution input from rivers as a driver. Similarly to the undergrounding variable for DNSPs, this variable assumes a percentage increase in the proportion yields the same percentage change in costs irrespective of the percentage point change.

39 Based on NERA analysis of AER's 2017 benchmarking data.

One water company, Bristol Water, referred Ofwat's decision to the Competition and Markets Authority (CMA). The CMA substituted Ofwat's decision with its own based on its own econometric models, and criticised elements of Ofwat's econometric models. The CMA argued: [40]

> "We do not consider it sensible to take the logarithm of this proportion for the specification of the explanatory variable. […] This would imply, for example, that the effect on a company's cost of moving from 5% river water abstraction to 10% river water abstraction (a 100% increase in the proportion) would be the same in £ million as if that company moved from 40% to 80% river water abstraction (similarly, a 100% increase in the proportion)."

The CMA's criticism of Ofwat's econometric specification is identical to criticism of the AER's: that increasing the underground share of a network from 40 per cent to 80 per cent should yield a larger percentage savings in opex than increasing from 5 per cent to 10 per cent. As a result, the AER's specification and the coefficient on undergrounding is an unreliable basis for setting productivity assumptions because it will not reflect the likely trend in future productivity growth due to undergrounding.

4.4. The AER's Assumed Growth in Undergrounding is Not Sustainable

Using historical data from 2006-2016, the AER calculates that the undergrounding share has increased by 3.4 per cent per annum, and it assumes that this rate will continue during the subsequent control periods.

The AER's assumption about future growth in undergrounding is vulnerable to a similar criticism to that levelled at the functional form in section 4.3 above. The AER calculates projected growth as a constant annual percentage growth of a variable itself expressed as a percentage. The AER has calculated growth rates over a ten-year period, at the beginning of which the proportion of the network that was underground will have been smaller than at the end of the period. The expected volume of undergrounding compounds geometrically over time, meaning that in each year, a DNSP would be expected to underground an ever-greater *additional proportion* (or an ever great number of kilometres) of its network to keep pace with the AER's productivity assumption. Similarly, DNSPs with a larger share already underground would be expected to underground a greater proportion each year than those with a smaller proportion, because 3.4 per cent of, say, 50 per cent is much larger than 3.4 per cent of 10 per cent.

In Figure 4.1 below, we show the underground share that the AER assumes each DNSP will achieve in each year of a hypothetical five-year price control period from 2017 to 2021. The Figure relies on each DNSP's share of undergrounding in 2016 as a starting point, and a 3.4 per cent growth in the underground share annually.

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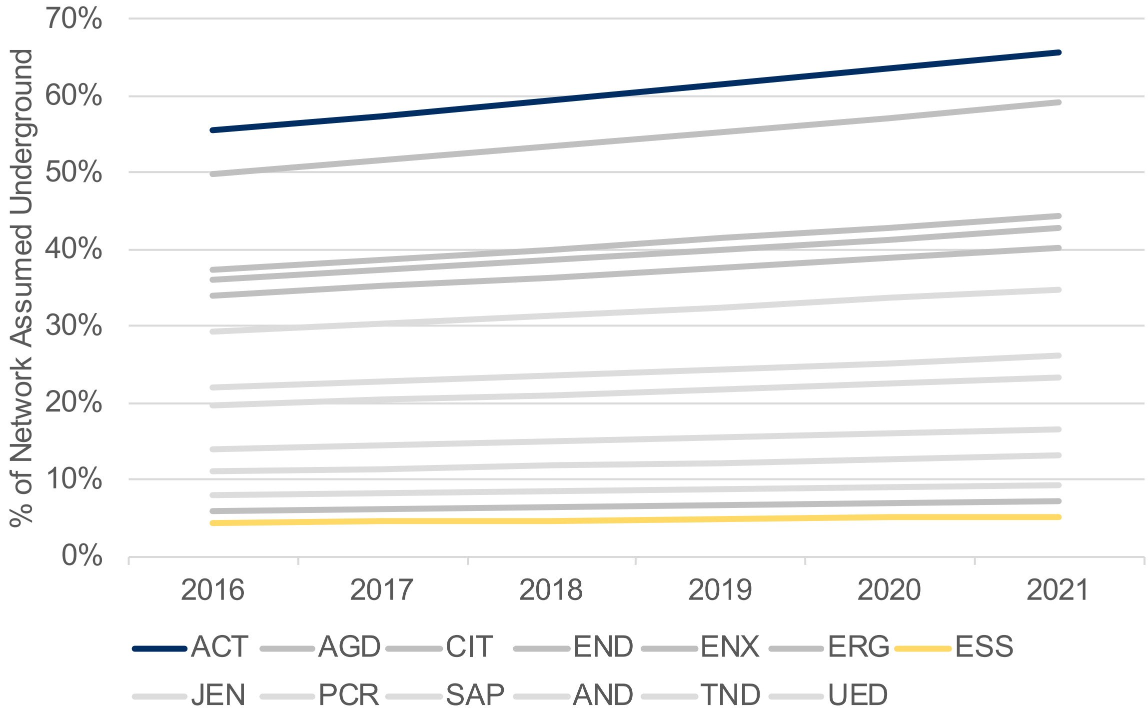
40 Competition and Markets Authority (4 March 2015), Notice of Reference: Determination of Price Controls for the period from 1 April 2015 – Appendix 4.1, para. 173.

Figure 4.1: The AER's Assumed Rate of Undergrounding by DNSP



Source: NERA Analysis

As shown in the figure, the AER's approach assumes that Evoenergy (ACT) will be able to underground more than 10 per cent of its network by the end of the control period, achieving an underground share of 65.7 per cent by 2021. By 2034, the AER's approach assumes that 102 per cent of Evoenergy's network will be underground. On the contrary, it assumes that Essential Energy (ESS) will only underground 0.8 per cent of its network by 2021.

Using average growth rates calculated over 2012 to 2017, as in the 2018 benchmarking update, the compounding effect is smaller, but the principle remains: DNSPs which already underground a large share of their networks are assumed to underground a larger share to achieve productivity targets, and all networks are assumed to underground a larger share each year than in the year before.

4.5. Conclusions

In summary, we compare the AER's proposal to use the change in DNSPs' underground share against the criteria we have set out.

- *Approach captures underlying trends in productivity*:

  The AER's proposed methodology does not capture underlying trends in productivity for a single, efficient DNSP. By measuring expected undergrounding growth across the whole industry, rather than for companies individually, the AER's approach rewards some DNSPs and punishes others for external conditions which determine the extent of undergrounding already carried out and the undergrounding workload which is efficient to carry out in the future period, without capturing what is efficient for *that* DNSP to do.

The coefficients on undergrounding that the AER estimates are consistent with the econometric equations that the AER uses to set the base level of opex using its benchmarking analysis. However, by measuring undergrounding share in logarithmic terms, the AER implies that companies with a larger proportion already underground will increase their undergrounding proportion at a higher rate than those with a lower proportion, and that all DNSPs' work will accelerate over the price control period. Neither implication reflects the decisions that an efficient or prudent operator would make.

- *Approach separates productivity from catch-up*:

  The LSE models are not consistent with this criterion because they measure relationships between opex and drivers for inefficient DNSPs in addition to frontier DNSPs. The objective of the productivity adjustment is to capture the change in *efficient* costs, and the inclusion of the LSE models includes some amount of catch-up in addition to ongoing productivity. Therefore, the AER's proposed approach does not meet this criterion.

- *Approach is objective and stable over time*:

  The AER's use of the logarithmic specification assumes a compounding effect which is not realistic or sustainable, because it implies that (i) a company will underground a larger share of its network each year as the existing share increases; and (ii) a company with a larger share already will underground at a faster rate (but achieving the same opex savings) than a company with a smaller share.

  Like any econometric analysis, if the AER were to change the functional form used to estimate opex for DNSPs, it may affect the coefficient estimated for undergrounding. The stability of the assumption on productivity growth would therefore depend crucially on how the AER updated its econometric models over time.

- *Approach does not limit incentives to reduce costs*:

  The AER's approach of assuming an industry-average rate of undergrounding is unlikely to create material perverse incentives. A single DNSP could not materially affect the productivity target by carrying out more or less undergrounding work.

5. Option 3: Gas distribution time trend

In addition to capturing the productivity growth from undergrounding (already discussed in Section 4), Option 3 links DNSPs' rate of change to ongoing technological change, measured in the Australian gas distribution industry to be 0.5 per cent per annum. We review this component of Option 3 below.

- Section 5.1 provides background on the AER's approach to estimating the time trend in opex from the gas sector;
- Section 5.2 discusses differences between the gas and electricity sector which may mean that gas distribution is a poor proxy for electricity distribution;
- Section 5.3 explains that the AER's use of the time trend in gas is not econometrically robust; and
- Section 5.4 concludes and evaluates against our criteria for assessing productivity improvement.

5.1. Background to Approach

The AER notes that the time trend in econometric cost models (such as those used to benchmark efficient opex in the electricity and gas industries) captures all changes in cost not captured by other drivers in the econometric model. Because the econometric models already capture changes in output levels and input prices, the time trend therefore captures "changes in technology, changes in process, or changes in legislative or regulatory obligations".[41]

The AER first considered using the time trends from EI's three econometric benchmarking models presented in the 2017 benchmarking reports, estimated using DNSP data from 2006 to 2016. These trends, by definition, capture technology changes and process changes in the electricity distribution sector, as well as the most relevant changes in regulatory obligations.

However, all three coefficients are positive, indicating worsening productivity over time. The AER argues that this worsening productivity is driven by negative productivity growth in the period between 2006 and 2012, a period with "significant new regulatory obligations that distributors were required to meet, and which required significantly increased opex, but with no change in measured output".[42]

Because it concludes that the electricity time trends are unlikely to reflect potential future improvements in productivity, the AER instead uses time trends estimated in the gas distribution sector. The AER argues that the gas distribution sector is a good proxy for the electricity distribution sector in this case because it:[43]

- "shares many similarities with the electricity distribution sector";
- "has not been subject to the same regulatory changes" as the electricity distribution industry, leading to more stable productivity performance; and

[41] AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p.15.

[42] AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p.10.

[43] AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p.15.

- Is regulated "using econometric models similar to those [used] for electricity distribution".

In selecting time trends from the gas distribution sector, the AER refers to the three most recent econometric studies of the industry:

- EI's 2015 opex efficiency report on behalf of Jemena Gas, with two models from which the AER draws time trend coefficients;[44]
- EI's 2016 opex efficiency report on behalf of Multinet Gas, with six models from which the AER draws time trend coefficients;[45] and
- ACIL Allen's 2016 opex efficiency report on behalf of Australian Gas Networks, with six models from which the AER draws time trend coefficients.[46]

The 14 coefficients range from -0.0026 to -0.0073, indicating that productivity in the gas industry has improved by 0.26 per cent to 0.73 per cent per annum over the modelled period.

The AER takes a straight average of these coefficients and therefore estimates that electricity DNSPs can achieve productivity improvements through technological change at a rate of 0.5 per cent per annum.

5.2. Differences Between Gas and Electricity

If, having assessed the 2018 EI coefficients, the AER determines that historical productivity change in electricity does not reflect future productivity change, it may be appropriate to use the gas industry as a proxy. Whether productivity trends achieved in the gas distribution sector proxies well for those that could be achieved in the electricity distribution sector depends on:

- Whether the two industries use the same or similar input factors (i.e. labour and materials);
- Whether the two industries face similar operating conditions.

We assess the extent to which the industries are similar in these two respects below. Furthermore, we propose alternative methods based on the electricity sector itself in Sections 8.2 and 8.3.

5.2.1. Similarities and differences in input factors

We have not assessed the composition of the labour force of an electricity distribution company and a gas distribution company, but it is plausible that they hire a similar mix of employees from a similar or the same hiring pool. For example:

- Both companies will have similar administrative structures and staff geared towards operating a large, regulated regional monopoly utility business. Due to their similarities

44 Economic Insights (25 February 2015), Relative Opex Efficiency and Forecast Opex Productivity Growth of Jemena Gas Networks, Table 5.3.

45 Economic Insights (22 August 2016), Gas Distribution Businesses Opex Cost Function, p.19. Note: Time is measured quarterly in these models, so coefficients are multiplied by 4 for the AER's purposes.

46 Australian Gas Networks (20 December 2016), Final Plan Attachment 7.3 – Opex Partial Productivity Analysis – A Report by ACIL Allen Consulting, Tables 4.1 and 4.3.

on an administrative and regulatory level, staff working with respect to these functions may even move between the two industries with little retraining required.

- Both companies will have engineers to carry out skilled works on the networks. While the companies' engineering staff may have *similar* backgrounds, the hiring pool is unlikely to be common between them, as such staff may have already specialised in e.g. electrical engineering in training and/or university.
- However, even where the types of employees hired is similar, we have not assessed the relative size of each of these groups, so the *average* employee may not be similar between the two companies.

Electricity and gas distribution companies likely do not rely on similar material inputs, because the material inputs into each company are highly specific to that industry.

5.2.2. Similarities and differences in operating conditions

From a regulatory and administrative perspective, a gas and electricity distribution company may face similar conditions, in that both provide utility services to domestic and non-domestic users.

However, the physical conditions each operates in are not similar:

- Electricity distribution networks are largely above ground, with additional costs caused by weathering, vegetation management, bushfires, etc, which gas distribution networks do not face;
- While both are regulated energy utilities serving the general public, electricity distribution companies serve around 11 million customers while gas distribution companies serve around 5 million.[47] This implies that electricity distribution companies reach rural customers that do not have access to network gas, meaning that electricity distribution companies are more rural on average; and
- Electricity distribution networks are facing a rapidly changing industry, as distributed energy resource capacity grows. There is no equivalent process in the gas sector.

If the conditions faced are not comparable, the cost reductions achieved by one industry may not be achievable by the other. It may be more appropriate to use a proxy sector which is similarly rural and above ground to the electricity distribution sector, for example railways or telecommunications.

5.3. The AER's Approach is Not Econometrically Robust

Even if the productivity change in the gas distribution sector reflects what is reasonably achievable by an efficient electricity DNSP, the AER has not estimated future productivity growth robustly for at least three reasons.

5.3.1. The evidence on which the AER relies is mixed and often statistically insignificant

Of the 14 time trend coefficients the AER uses, six of them are not statistically significant at the 5 per cent level, including five of the six estimated by ACIL Allen. In other words, in

47 Electricity Networks Australia: About Us. URL: https://www.energynetworks.com.au/about-us

nearly half of the models the AER uses, there is more than a 5 per cent chance that there is *no* productivity improvement and that the model shows a negative coefficient (and positive productivity growth) only by chance.

Moreover, other model specifications that the AER does not use in the Draft Decision, such as the fixed effects models in EI's 2016 report for Multinet Gas, actually show a positive trend coefficient, implying negative productivity growth.[48]

5.3.2. The gas time trend is not additive with the undergrounding effect

Under Option 3, the AER uses the gas time trend to proxy for general improvements in technology and resource management, while separately estimating the productivity gains which can be achieved through a cheaper operating environment (i.e. a greater share of the network is underground).

Conceptually, adding the effects together could only be appropriate if each measure exclusively captures the effect that it aims to – i.e. the gas time trend does not capture any cost savings due to a cheaper operating environment, and the undergrounding effect does not capture any cost savings due to technological or resource management improvements. We have not reviewed the gas econometric models in detail, but the time trends may include cost savings that gas networks achieved through cheaper operating environments. In other words, the time trends may not control for the gas sector's equivalent process to undergrounding, meaning that the AER's approach would require DNSPs to achieve the same savings from technological and resource management savings (which may not be comparable, in any case) while also double-counting the savings that could be achieved through a cheaper operating environment.

Moreover, from an econometric perspective, any time trend is estimated as just one component of a larger econometric model, and it is not appropriate to combine coefficients from different models into a single productivity target. An econometric model may effectively explain DNSPs' costs in aggregate, but where two drivers are related, it may not reliably distinguish the effect of each. For instance, DNSPs have increased their underground share over time, and both the underground share and the year are used as drivers in the AER's econometric model. Because the underground share and the year both increase over time, the models may incorrectly "allocate" some technology-related productivity improvements (which should be captured by the time trend) to increases in underground share, and vice versa, while *correctly* identifying the combined effect. By selecting coefficients from different models, the AER may double-count (or even under-count) some of the productivity gains which can be achieved through technological progress and improved resource management.

We demonstrate the magnitude of this inconsistency in Table 5.1 below, by re-estimating each of EI's 2017 models with the time trend forced to be -0.0054, consistent with the average time trend across the gas models that the AER samples (and indicating a productivity *improvement* of 0.54 per cent per annum). The table demonstrates that, when forcing the model to assume productivity improvement in line with the gas industry, it assigns a smaller

48 Economic Insights (22 August 2016), Gas Distribution Businesses Opex Cost Function, p.25.

and sometimes counterintuitive weight to the cost savings achievable through undergrounding.

Table 5.1: Coefficient on Underground Share

	SFA	LSE-CD	LSE-TL	Average
EI 2017 Models	-0.144	-0.177	-0.159	-0.160
Forced Gas Trend	0.060	-0.139	-0.101	-0.060
Delta	0.204	0.038	0.058	0.100

Source: EI and NERA analysis

If the AER ultimately uses ongoing productivity from the gas sector as a proxy for that from the electricity sector, it should re-estimate its models to ensure that it does not double-count the cost savings which can be achieved through undergrounding. However, this can create counter-intuitive relationships, with one model suggesting that costs increase as the undergrounding share increases. Therefore, by applying a time trend estimated from a different sector, it does not appear that the AER can create a productivity assumption that is both internally-consistent and intuitive.

5.3.3. Non-SFA models capture catch-up efficiency gains in addition to frontier shift

In least squares models, the time trend captures productivity improvements for the industry as a whole, including catch-up efficiency gains for those which are not on the efficient frontier. An SFA model, by contrast, separately identifies the shift of the efficient frontier from firm-specific catch-up efficiency improvements.

Of the 14 models that the AER proposes to use for the gas time trend, eight are not SFA models, meaning that the time trends capture catch-up efficiency improvements. The AER separately adjusts DNSPs' allowances for material inefficiencies and proposes to use the productivity adjustment only to capture the capture the shift in the efficient frontier.

By using coefficients which also capture catch-up efficiency, the AER double-counts the ability for inefficient electricity DNSPs to catch-up to the frontier, and assumes that efficient DNSPs can improve their own productivity at the same rate as an inefficient company. We therefore recommend that any use of gas time trends be limited to those estimated in SFA models.

5.4. Conclusions

In summary, we compare the AER's proposed approach against the criteria we have set out.

- *Approach captures underlying trends in productivity*:

  The gas time trends proposed by the AER may not capture underlying trends in electricity productivity for several reasons. First, the electricity and gas industries face fundamentally different cost inputs and conditions, and may not be able to achieve the same technological improvement as a result. Second, many of the coefficients are not statistically significant and therefore may appear to demonstrate productivity improvements in the gas sector only by chance. Third, by combining with an undergrounding coefficient from electricity-specific models, the AER may double-count genuine productivity improvements and assume that DNSPs can achieve the same operating environment improvements achieved in the gas sector (in addition to undergrounding).

- *Approach separates productivity from catch-up*:

  The use of gas time trends from models other than SFA models mixes in the catch-up efficiency improvements of inefficient (gas) companies. Therefore, the AER's approach holds efficient DNSPs to a standard only achievable by inefficient firms, and double-counts inefficient DNSPs' ability to catch up to the frontier.

- *Approach is objective and stable over time*:

  The AER could conceivably continue to use a trend from the gas sector for the foreseeable future. However, it is not clear whether it could credibly continue to do so as electricity-specific measures become more stable.

- *Approach does not limit incentives to reduce costs*:

  The use of a time trend from the gas industry cannot create any perverse incentives unless a gas network and an electricity network share the same ownership. However, it is unlikely that a gas network would incur additional costs and appear inefficient relative to the rest of its industry in order for its sister electricity network to have a slightly easier productivity target.

6. Option 4: Multilateral Partial Factor Productivity

Option 4 of the AER's draft decision paper uses the average annual MPFP growth for DNSPs from 2012 to 2016 to forecast productivity growth. The AER uses a reduced sample of firms by excluding those that the AER deems 'materially efficient' and estimates 1.6 per cent for annual productivity growth.

This Chapter evaluates Option 4 in the light of the criteria for the AER's adoption of a productivity assumption set out in Chapter 3. The Chapter proceeds as follows:

- Section 6.1 describes the approach that the AER has followed in deriving Option 4;
- Sections 6.2 to 6.5 discuss the data, estimation window, and averaging methods adopted by the AER. The AER relies on data that could capture the underlying trend in productivity growth in principle. In practice, the estimation window and averaging methods chosen by the AER materially overstate historical productivity gains, even for the recent past.
- Section 6.6 explains that the AER's method attempts to separate catch-up and frontier shift but that its approach is not objective. In particular, the AER's approach does not exclude TasNetworks which has experienced rapid productivity growth after going through structural change;
- Section 6.7 explains that the AER has changed its approach to select the largest feasible estimate of productivity growth using MPFP methods without objective justification. The AER's approach is therefore neither stable nor objective;
- Section 6.8 analyses the incentive properties of relying on historical MPFP to estimate productivity growth. The section demonstrates that short-term averages of historical MPFP reduce incentives for productivity growth for firms held in common with other DNSPs; and
- Section 6.9 concludes by comparing against our criteria.

6.1. Background to Approach

Opex MPFP is an index that measures the quantity of specified outputs (in this case: energy throughput; ratcheted maximum demand; customer numbers; circuit length; and customer minutes lost) produced to the quantity of opex used. It is a 'partial' factor in the sense that it excludes capex inputs and focusses only on opex.

EI reports the MPFP index in its annual benchmarking reports for the AER. In the Draft Decision, the AER relies on the 2017 annual benchmarking report, which contains data from 2006-2016.

The AER presents the MPFP index for each DNSP for the periods 2006-2012, 2012-2016 and 2012-2016. However, the AER concentrates on productivity growth since 2012 only to derive its estimate of frontier shift. The sole justification for relying on the period since 2012 is that the AER has "seen the opex MPFP performance of electricity distributors improve since 2012."[49]

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[49] AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p.14.

The AER excludes four distributors that Economic Insights had found to be materially inefficient in their 2017 benchmarking assessment (EvoEnergy, Ausgrid, Energex, Essential).[50] Among the remaining DNSPs, average annual productivity growth since 2012 ranged between *minus* 5.3 per cent and 7.7 per cent. The AER used the average figure for the remaining DNSPs of 1.6 per cent per annum to estimate frontier shift from the MPFP index.

Table 6.1: Average Annual Opex MPFP Growth by Business, per cent

Distributor	Current period	Base year efficient?	Average annual opex MPFP growth		
			2006–16	2006–12	2012–16
Evoenergy	2014–19	No	2.3	–4.7	12.7
Ausgrid	2014–19	No	–1.2	–3.5	2.2
CitiPower	2016–20	Yes	–2.8	–7.1	3.6
Endeavour Energy	2014–19	Yes	–2.1	–2.5	–1.4
Energex	2015–20	No	–0.6	–3.1	3.3
Ergon	2015–20	Yes	1.6	1.5	1.6
Essential Energy	2014–19	No	0.3	–7.3	11.5
Jemena	2016–20	Yes	–0.7	–1.3	0.1
Powercor	2016–20	Yes	1.4	–1.2	5.4
SA Power Networks	2015–20	Yes	–2.2	–4.5	1.2
AusNet Services	2016–20	Yes	–4.7	–4.4	–5.3
TasNetworks	2017–19	Yes	0.1	–4.9	7.7
United Energy Distribution	2016–20	Yes	–1.3	–3.1	1.4
Industry average			**–0.9**	**–3.5**	**3.0**

Source: AER Draft Decision, Table 2.

6.2. The AER's Method Uses Relevant Data But is Not Consistent

The requirement for the AER to set cost allowances that recover the efficient costs of prudent operators necessitates that the AER relies on relevant data series that can provide a reliable guide to productivity growth for efficient electricity DNSPs.

Option 4 relies on average growth in an index of electricity DNSPs' productivity over time. Provided that the future reflects the past, relying on MPFP is therefore amongst the most direct evidence on the potential growth of DNSPs in future that AER considers. As a partial measure of productivity MPFP data holds capital constant and it will, therefore, run the risk of picking up capital-labour substitution as productivity growth.

The MPFP data used in Option 4 is not consistent with the AER's benchmarking analysis to set the level of opex allowance. For instance, the MPFP index does not control for environmental variables that feature in the benchmark but does control for energy delivered and customer minutes lost which do not. Accordingly, the MPFP measure is more likely to

50 Economic Insights (31 October 2017), Economic benchmarking results for the Australian Energy Regulator's 2017 DNSP benchmarking report.

deny recovery of efficient costs than an approach based on the AER's opex benchmark directly, which at least attempts to control for a wider range of factors, including environmental variables, and in a way that is consistent with the base level of the opex allowance.

Although relying on the series itself may be consistent with its statutory objective, the AER's method for calculating a productivity growth assumption from the MPFP index makes at best inefficient use of the data available. At worst, it may materially overstate likely productivity growth in electricity, for at least three reasons detailed in sections 6.3 to 6.6 below.

6.3. The AER's Estimation Window is Too Short to be Reliable

The AER uses a time-period of just five years to calculate the productivity trend for opex. As described in section 3.3, productivity estimates are volatile over time and relying on short-term trends may provide a misleading picture of likely productivity growth. As a result, international regulators use datasets of forty years or more to assess likely productivity growth (see Appendix A).

Precedent within Australia also makes clear the importance of using a long data set to assess productivity. For instance, in the AER's data request to DNSPs, it asked for 8 years of data from firms:

> "For the purpose of measuring change in productivity a long data set is preferable. An eight year data set should be sufficient to set up our economic benchmarking models. We do not consider there is merit in reducing the time series further because Economic Insights requires at least eight years of data for index-based economic benchmarking such as multilateral total factor productivity."[51]

The AEMC has also previously stated its position on the appropriate length of datasets for assessing productivity in a 2011 report: "We are of the view that at least 8 years of robust and consistent data will be required to establish a TFP growth rate that could be used in a TFP methodology for price and revenue determinations."[52]

The AER's consultants on benchmarking analysis for electricity DNSPs, Economic Insights, also directly cites this position while outlining its own decisions to use the longest available dataset for their 2013 Economic Benchmarking.[53] In the same report, Economic Insights states that fewer than eight years of data would provide relevant information "but with less confidence that it was a representative trend".

Using a longer time-trend would materially affect the AER's assumptions productivity growth. Although the AER does not provide detailed analysis of alternative averaging periods in its Draft Decision, it does publish the underlying data behind its calculations on which Economic Insights also draws for its benchmarking analysis.

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[51] AER (November 2013), Regulatory Information Notices to Collect Information for Economic Benchmarking.

[52] AEMC (30 June 2011), Review into the use of total factor productivity for the determination of prices and revenues, p.23.

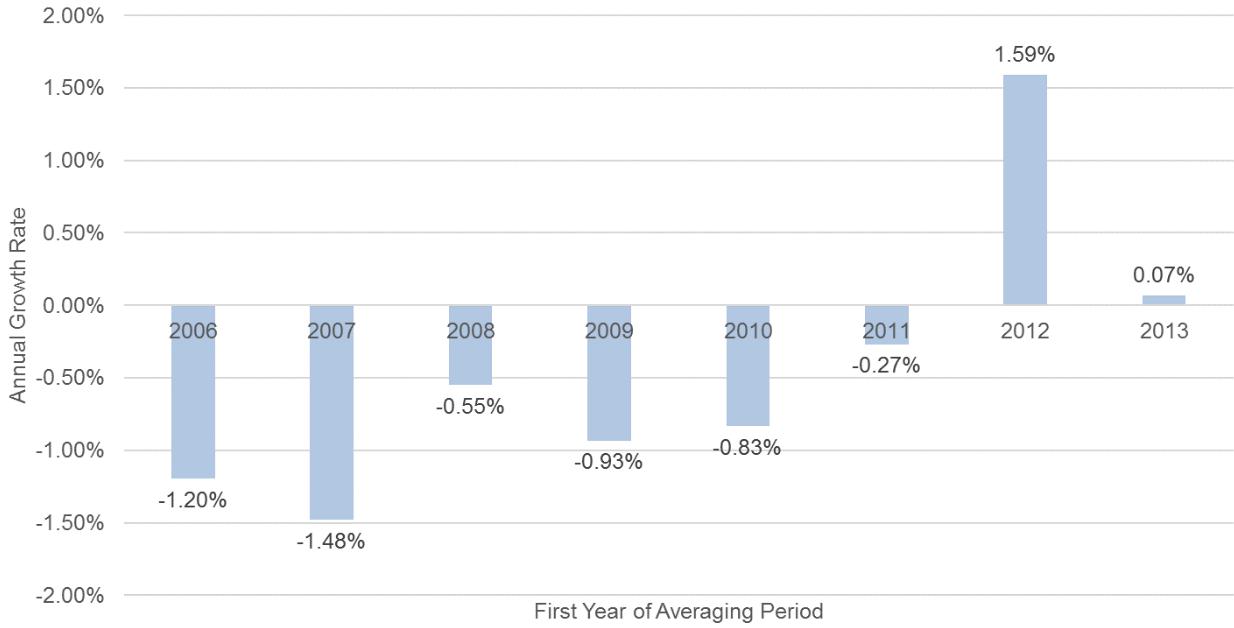
[53] Economic Insights (25 June 2013), Economic Benchmarking of Electricity Network Service Providers

To assess the impact of averaging growth over different periods, we replicated AER's calculations. The AER did not clearly specify its methods in the Draft Decision, but it appears to have taken an unweighted average of the annual MPFP growth between 2012 and 2016. The AER states that it excluded "materially inefficient" firms from the sample to avoid including catch-up in the productivity measure. Although not entirely clear from the Draft Decision which DNSPs were "materially inefficient" by the AER's definition, we understand from subsequent correspondence that the AER sample excluded four: Evoenergy, Ausgrid, Energex, and Essential.

Figure 6.1 presents the results of our replication. The year written under each bar represents the start-year of the averaging period using Economic Insights dataset published alongside its 2017 Benchmarking report. Our result for 2012-2016 is 1.59 per cent, which is equal to the AER's own result reported to 1 decimal place of 1.6 per cent. As can be seen from the Figure, AER's choice of 2012-2016 as an averaging period represents the maximum possible MPFP growth figure that the AER's calculation method could yield for any averaging period ending in 2016 and starting in any year from 2006 to 2013. This analysis shows that the AER's estimated productivity growth rate is precarious and very sensitive to including or excluding just one additional year: Including 2011 causes the annual growth rate to fall to *minus* 0.27 per cent and excluding 2012 reduces annual growth to 0.07 per cent.

Volatility in the MPFP measures rather than any long-term indication that productivity growth will be higher in future is likely to be the principal driver behind these results. In any case, the AER does not justify starting the averaging period in 2012 specifically. Given that the choice of 2012 as a starting point is essentially arbitrary, that this choice has such a large impact on the estimated growth rate is undesirable. As can be seen from the Figure, it materially overstates future productivity growth based on past data. It illustrates the importance of relying on long-run data to dampen the effect of this volatility in MPFP measures. If the AER had followed international precedent and selected the longest time period available it would have used all the data since 2006 and would have estimated future productivity growth at *minus* 1.2 per cent.

Figure 6.1: Industry MPFP Results for Different Time Periods: AER Methodology



Source: NERA Modelling using DNSP data published by Economic Insights.

6.4. The AER's Unweighted Average Overstates Productivity Growth

The AER presents industry average productivity growth for 2006-12 (*minus* 3.5 percent), 2012-16 (3.0 per cent) and 2006-16 (*minus* 0.9 per cent) in Table 2 of the Draft Decision. Although the AER does not specify its method for calculating the industry average, the results correspond to the industry-wide figures calculated by EI in its 2017 benchmarking report for the AER. EI's estimates of MPFP measure the total change in industry outputs divided by the total change in industry inputs. In other words, it is a weighted-average of productivity growth across the firms in the industry.

The AER argues that reliance on the EI estimates for the industry as a whole may overstate the likely productivity increase for DNSPs in future. Accordingly, the AER seeks to eliminate a subset of "materially inefficient" DNSPs. As the AER put it:

> "So while the industry has averaged opex MPFP growth of 3.0 per cent per annum between 2012 and 2016, this is likely to include a degree of 'catch-up' that we do not want to include in our opex productivity growth forecast. We think the average growth rate of 1.6 per cent for those distributors whose base opex we did not find materially inefficient is more reflective of the shift in the productivity frontier over the period 2012–16 than the average rate over the whole industry."[54]

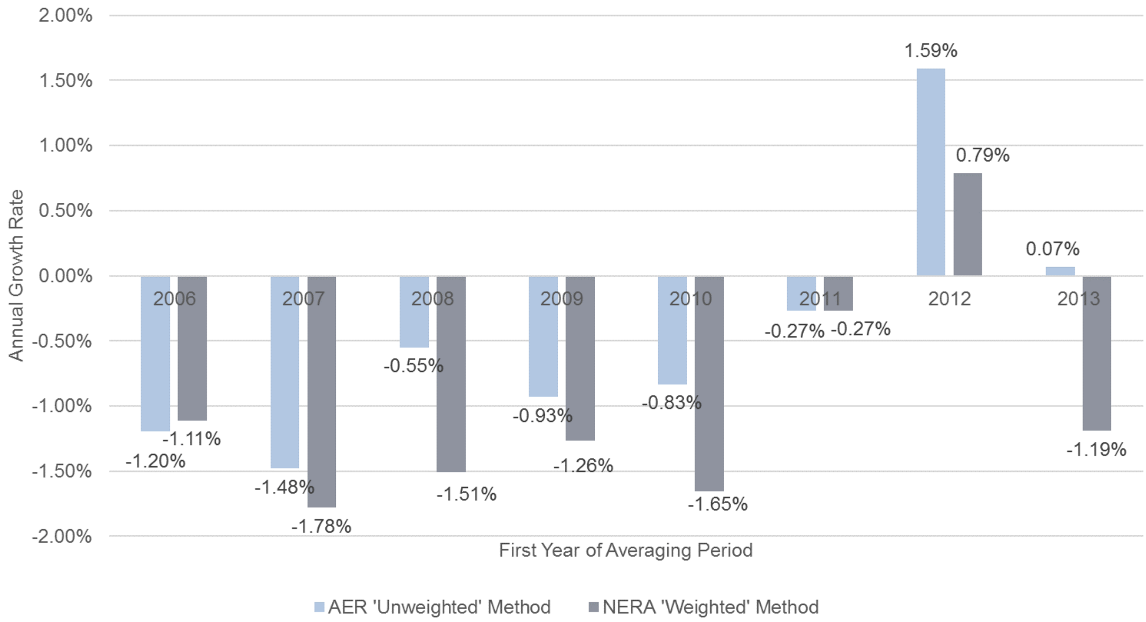
Reading the above quotation, one could be forgiven for understanding that the 3.0 and 1.6 per cent figures were analogous statistics for the industry and the restricted sample. In practice, however, our replication of the AER's approach shows that the AER relied on an *unweighted* average of firms in the restricted sample. Possibly unintentionally and at least without clearly

[54] AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p. 14.

specifying the basis for change, the AER changed not just the companies in the sample, but the method of calculation.

Weighting yields a more accurate measure of industry productivity growth, as it prevents a small DNSP with unusually fast or slow productivity growth from skewing results. We replicated EI's MPFP analysis in order to take a weighted average of MPFP growth over different time periods for the restricted sample used by the AER. Figure 6.2 presents a comparison of the AER's 'unweighted' method and EI's/NERA's 'weighted' method. As can be seen from the figure, presenting weighted averages reduces the average MPFP growth for 2012-16 from 1.59 per cent to 0.79 per cent and decreases productivity growth for most other averaging periods. Accordingly, at least insofar as AER intended to calculate an average for the restricted sample that was equivalent to the average for the industry with which it draws equivalent, it should use a productivity growth assumption of 0.79 per cent per annum. The AER uses the industry-wide figure for 2016.

Figure 6.2: Industry MPFP Results for Different Time Periods and Different Growth Calculation Methods



Source: NERA Modelling using DNSP data published by Economic Insights.

6.5. The AER's Formula for Calculating Growth Rates Is Sensitive to the Start and End Year

The AER's method for calculating compound average growth rates for productivity growth relies only on the start and end years of the averaging period. Specifically, to calculate annual growth rates, the AER employs an exponential growth method with continuous compounding, calculated using the following formula:

$$Annual\ growth\ rate = \frac{\ln(MPFP_t - MPFP_s)}{t - s}$$

Where *t* is the final averaging period and *s* is the initial averaging period. This method therefore only incorporates two data points from the range.

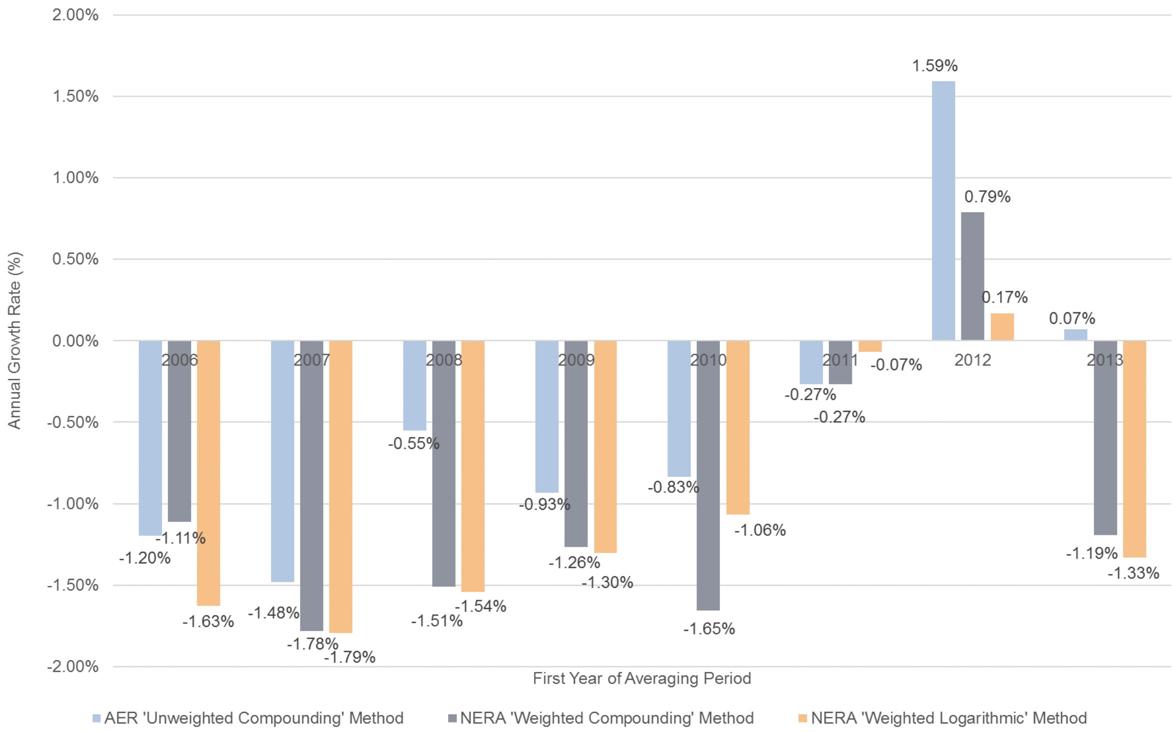
This method reinforces the effect of the volatility of MPFP series on the average growth rate and ignores any information that might be provided by interim years in the sample. If the end year in the sample has a positive measurement error and the beginning year in the sample has a negative measurement error, the AER's exponential growth method will exaggerate underlying MPFP growth over the averaging period. The sensitivity of the average to the start and end years is a key driver of the large variation between averages taken between 2011-16, 2012-16 and 2013-16 observed in Figure 6.1 and Figure 6.2 above.

Alternative methods for estimating the trend rate of growth would make better use of all the data available. For instance, a logarithmic growth method that employs econometric methods to plot a line of best fit onto the logarithm of the MPFP index. This utilises every data point in the averaging period. As a result, this measure is less vulnerable to shocks at the beginning or end of the period.

Figure 6.3 shows the difference between the two continuous compounding growth measures presented thus far (the AER's 'unweighted' method and NERA's 'weighted' method), and the 'logarithmic' method. Estimates using the logarithmic method have a smaller standard deviation compared to both alternatives since they are less affected by fluctuation in the first year of the averaging period.

Table 6.2 presents the standard deviations for the three measures. 2012-2016 still reflects the global maximum for productivity growth, but the effect is far less drastic, and shows that annual growth in productivity between 2012 and 2016 was 0.17 per cent. In other words, using a logarithmic regression method suggests that much of the productivity growth observed between 2012 and 2016 is due to volatility in the years 2012 and 2016 specifically, rather than due to underlying productivity trends.

Figure 6.3: Industry MPFP Results for Different Time Periods and Different Growth Calculation Methods



Source: NERA Modelling using DNSP data published by Economic Insights.

Table 6.2: Standard Deviations For Different Growth Calculation Methods

Averaging Method	Standard Deviation
AER ‘Unweighted Compounding’	0.9%
NERA ‘Weighted Compounding’	0.8%
NERA ‘Weighted Logarithmic’	0.7%

Source: NERA Modelling using DNSP data published by Economic Insights.

6.6. The AER’s Measure Includes TasNetworks, Which May be Experiencing Catch-up

The AER removed distributors that it argued may be experiencing catch-up from the sample, so that its forecast does not include “any productivity growth required for an inefficient firm to catch-up to the productivity frontier.”[55] The AER therefore calculates average growth rates on a reduced sample of nine DNSPs, which excludes four firms it deems “materially inefficient”.

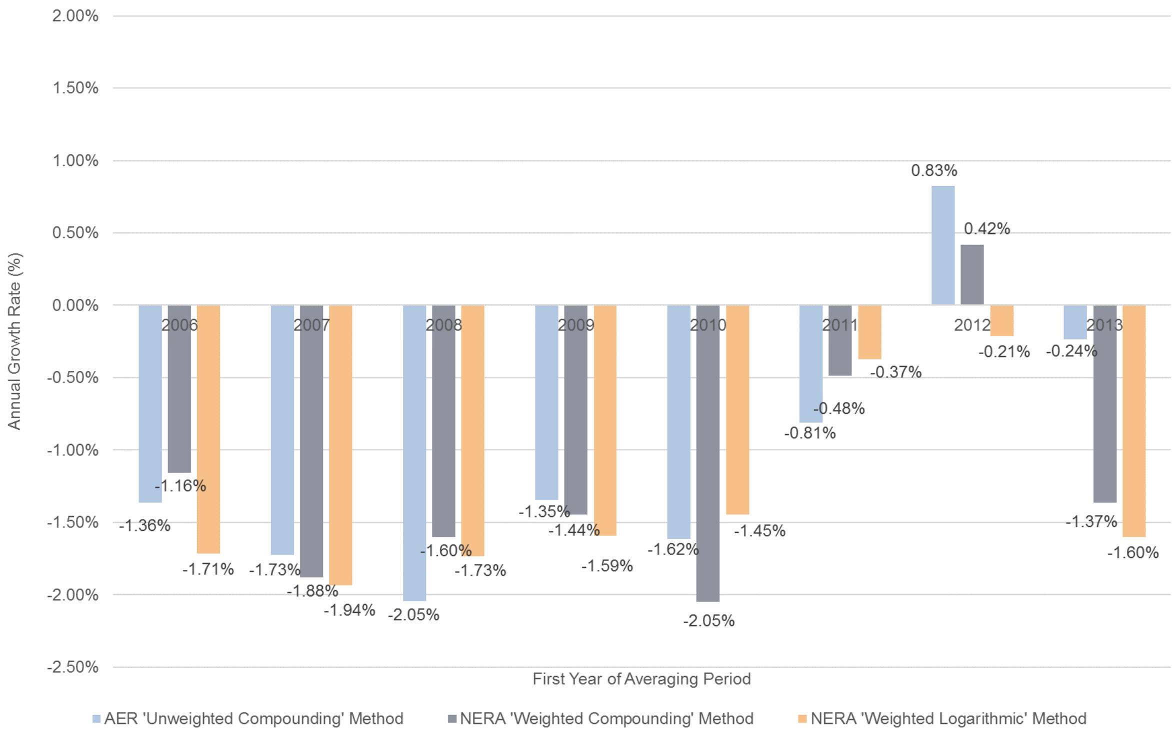
55 AER (November 2018), Draft Decision Paper: Forecasting Productivity Growth for Electricity Distributors, p.9.

It is unclear how the AER selected these four firms. The cost efficiency scores in EI's 2017 Economic Benchmarking results show that the majority of firms are inefficient.[56] Therefore, firms other than the four selected by the AER may exhibit catch-up efficiency. In any case, the least efficient firms are not necessarily those that are most likely to experience catch-up to the frontier over time.

In the absence of clear, defensible criteria, the AER's decisions over whether to exclude individual firms to eliminate catch-up are necessarily subjective. Of the thirteen DNSPs, two experienced MPFP growth over ten per cent per year between 2012 and 2016 – Evoenergy and Essential Energy – both of which the AER excluded. TasNetworks was the DNSP with the third fastest growth between 2012 and 2016 of 7.7 per cent per year.

TasNetworks was formed on 1 July 2014 by the amalgamation of Aurora's distribution network and Transend's transmission network. Following the amalgamation, TasNetworks saw its MPFP measure rise 25.3 per cent from 2014-15. As can be seen from Figure 6.4, removing TasNetworks from the sample further reduces the average MPFP growth between 2012 and 2016 to between *minus* 0.27 and *plus* 0.83 per cent depending on the method chosen (0.17 to 1.59 per cent including TasNetworks).

Figure 6.4: Comparison of Industry MPFP Results for Different Time Periods (ending in 2016) and Different Growth Calculation Methods for Sample without TasNetworks



Source: NERA Modelling using DNSP data published by Economic Insights.

Additionally, in its 2018 benchmarking report, the AER notes that "some networks are now beginning to catch-up to the more efficient networks", namely Ausnet Services, Ergon Energy and Endeavour Energy, none of which were excluded from the MPFP analysis in the

[56] Economic Insights (31 October 2017), Economic Benchmarking Results for the Australian Energy Regulator's 2017 DNSP Benchmarking Report, p.21.

Draft Decision.[57] This underscores the subjectivity of the decision to include some networks and exclude others each year that the exercise is performed.

The AER's estimated growth rates are sensitive to the inclusion of DNSPs which may have experienced catch-up. In order to eliminate catch-up, the AER would need to exclude all firms which had experienced structural change rather than simply those with faster rates of growth or DNSPs it identifies as inefficient (which may not be catching-up). In short, therefore, the AER's Option 4 approach likely captures some catch-up and thus does not measure the productivity shift of the efficient frontier.

Alternatively, as we discuss in Section 8.4, the AER could rely on methods which are less prone to the inclusion or exclusion of particular firms or one-off catch-up events, by taking long-term averages or estimating changes in the efficient frontier rather than industry-average productivity.

6.7. The AER's Approach Departs from Previous MPFP Analyses

Making objective decisions and adopting consistent methods over time are key to lowering regulatory risk and delivering value to consumers over the long-term. Departures from existing methods should be well-reasoned and reflect the likely trends in efficient costs.

Figure 6.1 to Figure 6.4 above show that the AER's proposed method for assessing productivity growth using MPFP data is to select the maximum possible assumption from those available (at least for averaging periods starting between 2006 and 2013 and ending in 2016). In and of itself, selecting a parameter that happens to result in a high productivity target need not deter investment where the regulator is adopting a consistent approach over time. Short term averages of historical productivity growth would fluctuate up and down over time and average out at the same value as a long-term assumption. However, where regulators opportunistically depart from existing methods in order to reduce prices in the short term, they will deter existing investment.

In the case of a productivity assumption for electricity DNSPs, the AER has departed from its previous practice. At previous resets, the AER drew on data from 2006 to 2012 in its calculations. One could characterise the choice of 2006-2012 as either six years of data or the longest available period. Both of these are inconsistent with the Draft Decision control, which uses just four years of data from 2012-2016. As Figure 6.1 shows, using either six years of data or the longest available time series would result in a substantially lower assumption on productivity growth: using data from 2010-2016, the AER would find an annual MPFP growth rate of *minus* 0.83 per cent, while using the whole period would yield -1.20 per cent. Both are comfortably negative, and hence much lower than the AER's quoted 2012-2016 figure of *plus* 1.6 per cent.

6.8. The AER's Approach May Reduce Incentives to Reduce Costs

Relying on historical MPFP to estimate productivity growth introduces a circularity between efforts to reduce costs undertaken by DNSPs and their future productivity allowances.

[57] AER (November 2018), Annual Benchmarking Report – Electricity distribution network service providers, p.19.

Relying on short-term averages of MPFP may undermine incentives for cost reduction particularly for DNSPs that are part of wider holding companies.

Under the AER's base-step-trend approach, DNSPs benefit from a portion of cost reduction within a regulatory period. They also benefit from the regulatory lag between reducing opex and the resetting of allowances to an estimate of efficient opex.

To provide incentives for efficient operation, the AER introduced the Efficiency Benefit Sharing Scheme (EBSS) in 2008. The scheme aims to "provide for a fair sharing between NSPs and network users of efficiency gains and losses made during a regulatory control period".[58] Under the EBSS, when a DNSP's actual opex is lower than the forecast by the AER for the period, the difference between forecast and actual opex is shared between the NSP and consumers. Likewise, when a DNSP's actual opex overshoots the forecast, the extra cost is shared in the same way. The scheme provides for a 30:70 sharing of benefits and losses between the DNSP and the consumer. The AER aims to ensure more consistent incentives by ensuring that any efficiency gain (or loss) is accrued over the following five years, even if those years fall across two regulatory periods.

The more frequently the AER estimates productivity growth and the larger an impact cost-reducing effort has on the average historical productivity measure, the lower the incentive to reduce costs. The AER's proposed productivity measure using MPFP relies on average growth across nine DNSPs. If each group were independent and of equal size and the AER were to update productivity assumptions at each reset to reflect recent trends, DNSPs would keep around 8/9ths of the benefits of cost reduction assigned to them under the EBSS. If the AER were to take a long-term average however, DNSPs would keep a larger proportion of their cost reductions because the productivity target for the following regulatory period would be less affected by reductions in cost in the prior period. The additional "regulatory lag" resulting from taking longer-term averages to estimate productivity improvement would create stronger incentives for increasing productivity over time.

In practice, however, some DNSPs have common shareholders, which reduces incentives for productivity improvement where the AER is likely to impose tougher productivity targets on all the companies in the group.

6.9. Evaluation of Option 4 against Criteria

- *Approach captures underlying trends in productivity*:

  The AER's approach relies on a relevant dataset which captures historical changes in productivity for electricity DNSPs. However, the averaging period chosen by the AER is just five years of growth from 2012 to 2016 and yields the highest productivity growth assumption in the AER's range of 1.6 per cent per year. The AER chooses this period because it is concerned that earlier periods are polluted by increased obligations on DNSPs that increased opex over time and will not be repeated in future. However, the AER does not have a compelling reason to select 2012 specifically and averaging over 2011 to 2016 or 2013 to 2016 results in materially lower productivity growth assumptions. The inherent volatility in MPFP measures at least partly accounts for the large differences from averaging over similar periods. Adopting alternative averaging

[58] AER (November 2013), AER Efficiency Benefit Sharing Scheme for Electricity Network Service Providers*,* p.3, para. 15.

methods to better reflect productivity growth over time, such as weighting productivity growth by the proportion of industry opex and estimating a logarithmic trend, reduces MPFP growth to 0.17 per cent per year, even for the 2012-2016 period.

- *Approach separates productivity from catch-up*:

  Unlike econometric methods such as SFA, the change in MPFP is a measure of average productivity growth, not frontier shift directly. The AER attempts to exclude firms that benefit from material catch-up efficiency. However, its methods are not objective and do not exclude at least one firm, TasNetworks, which has gone through structural change and experiences the third largest productivity growth rate over the period 2012-2016. The AER should instead estimate changes in the frontier or rely on the long term average used by regulators internationally.

- *Approach is objective and stable over time*:

  The AER's approach relies on an estimation window that is material, which is a departure from its previous practice and which it does not justify specifically. Accordingly, Option 4 provides no assurance that the AER is not cherry-picking results to reduce prices in the short term rather than protect consumers' long-term interests.

- *Approach does not limit incentives to reduce costs*:

  Relying on short-term average growth rates in MPFP for electricity DNSPs introduces a circularity between productivity growth for DNSPs and future productivity targets, particularly for DNSPs that are owned by common shareholders. The AER would sharpen incentives for cost reduction and productivity improvement by adopting a longer averaging period.

7. Option 5: Using Forecast Labour Productivity Growth

Option 5 relies on labour productivity forecasts provided by Deloitte Access Economics (DAE) to forecast productivity growth for DNSPs.[59] The basis of DAE's paper is not transparent but it does clearly rely on economywide forecasts of labour productivity. The relationship between labour productivity in the economy as a whole and for utilities is weak.

This chapter proceeds as follows:

- Section 7.1 describes the AER's approach to forecasting labour productivity in more detail;
- Section 7.2 explains that the DAE paper on which the AER relies is opaque and provides limited details that would allow for a thorough appraisal beyond that it is a weighted average of productivity indices across the economy, including utilities;
- Section 7.3 explains that the AER's method relies on the presumption that future labour productivity growth for DNSPs is closely related to that for the economy as a whole, but that the evidence base for that proposition is weak;
- Section 7.4 explains that the AER's approach implies that the productivity of all other factor inputs remains constant. In practice, one material reason for labour productivity gains is substitution towards capex or energy, materials and externally-sourced services which boost the productivity of labour. These other factor inputs may experience falling productivity themselves as the ratio of them to labour inputs increases.
- Section 7.5 concludes and evaluates Option 5 according to the four criteria for productivity growth assumptions set out in Chapter 3.

7.1. Background to Approach

DAE uses a proprietary macroeconomics model to forecast utilities and economy-wide wage growth and productivity growth. DAE does not provide any background calculations and only high level descriptions of its approach to forecasting labour productivity:

- Labour productivity in the utilities sector is defined as a combination of the following three factors:
- Gross Domestic Product (GDP) divided by all employed persons in Australia, which defines national labour productivity;
- Gross State Product (GSP) divided by all employed persons in that state, which defines state-wide (economy-wide) labour productivity; and
- National sectoral Gross Value Added (GVA) divided by all employed persons in that industry in Australia.

The three factors are weighted together using unknown weights, but factors with lower volatility (e.g. GSP from larger states) appear to receive higher weight.[60]

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[59] Deloitte Access Economics (19 July 2018), Labour Price Growth Forecasts.

[60] Deloitte Access Economics (19 July 2018), Labour Price Growth Forecasts, p.28.

DAE forecasts that labour productivity in the Australian utilities sector will grow by between 1.2 per cent and 1.7 per cent per annum between 2018-19 and 2023-24, though it is not clear how DAE forecasts the three components above that feed into its measure of utilities labour productivity.[61]

The AER uses DAE's average annual productivity growth rate (equal to 1.5 per annum to 2023-24) and multiplies by its labour input weight of 59.7 per cent to derive an *opex* (rather than just labour) productivity growth forecasts of 0.9 per cent per annum.

7.2. DAE's Approach Is Too Opaque to Appraise in Detail

Due to the opaque nature in which DAE derives its labour productivity forecasts, it is not possible to properly assess whether the approach satisfies our appraisal criteria. For example:

- It is not clear how DAE derives forecasts for the three component factors of its utilities productivity forecast;
- It is not clear precisely how DAE derives weights to combine the three factors, nor is it clear what the weights themselves are;
- It is not clear how the AER has derived its labour share of opex, what it includes, and how applicable it is to each DNSP.

Therefore, it is not possible to say whether the approach satisfies our first criterion: that it captures underlying trends in productivity. By extension, it is not possible to say whether it is appropriate to be used at all.

7.3. DAE's Approach Places Weight on Irrelevant Economy-Wide Forecasts

As described in Section 7.1, DAE's utilities labour productivity forecast is composed of three factors, only one of which is specific to the utilities sector. In addition to its measure of utilities GVA, DAE includes measures of economy-wide productivity in Australia and in each state, and it provides little detail as to how it weights each factor, except to say that "these three values are weighted based on factors reflecting the volatility of the various data".[62]

We have not assessed the volatility of each data series, but Figure 3 in the Draft Decision demonstrates that utilities productivity across Australia is more volatile than economy-wide productivity.[63] As a result, DAE has likely placed significant weight (but unclear how much) on economy-wide measures of productivity which are not specific to utilities. If so, the overall approach could only capture underlying trends in DNSP productivity if economy-wide labour productivity is similar to utilities-specific labour productivity.

Neither Deloitte, nor the AER provide detailed analysis of the link between productivity in the economy as a whole and in the utilities sector. The AER's analysis is limited to a single Figure in its report (reproduced as Figure 7.1 below) and the following summary text:

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61 Deloitte Access Economics (19 July 2018), Labour Price Growth Forecasts, p.28

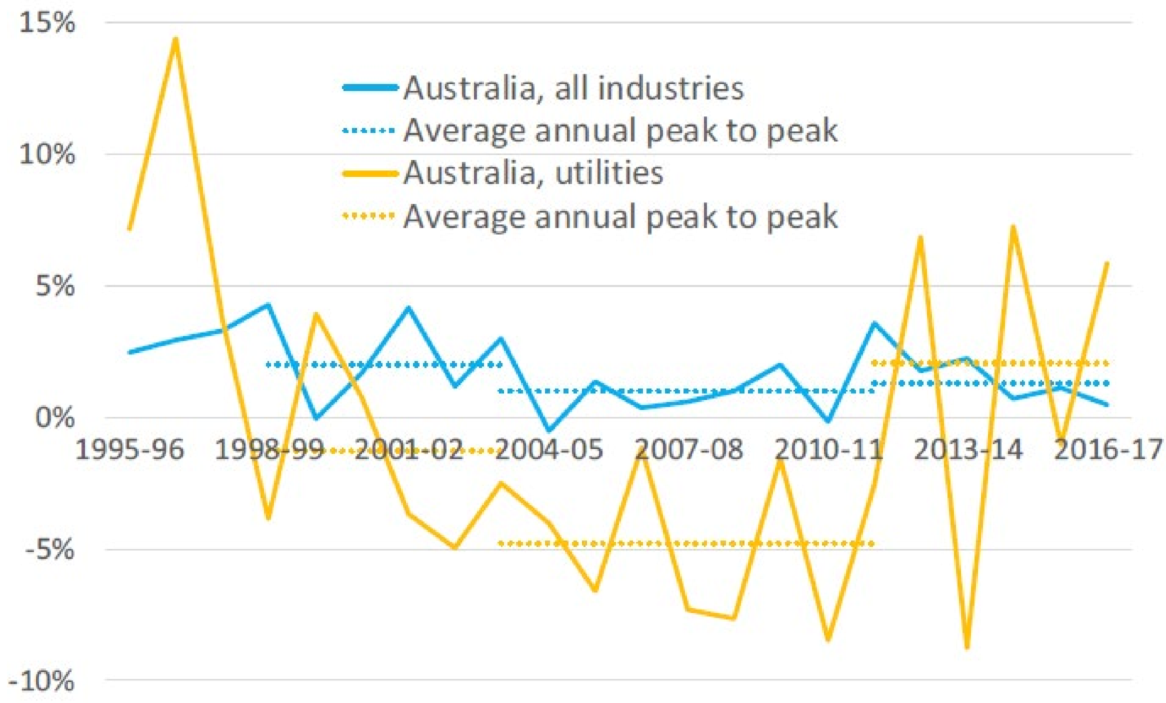
62 Deloitte Access Economics (19 July 2018), Labour Price Growth Forecasts, p.28.

63 AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, Figure 3.

> "Apart from greater year to year volatility, quality-adjusted labour productivity in the utilities industry appears to follow the same broad pattern as it does for the economy as a whole. We can see that for both the utilities industry and the economy as a whole, quality adjusted labour productivity fell in the period 2003–04 to 2011–12 before rising again in the period from 2011–12 to 2015–16 (see table 8). This suggests that economy wide productivity drivers also influence the utilities industry."[64]

In other words, the AER's analysis of the link between labour productivity for the economy as a whole and the utilities sector consists of comparisons between the averages in three arbitrarily-chosen periods of allegedly five, eight and three years' length. On the basis that the averages go down and then up over these specific windows, the AER concludes that economy-wide productivity is a useful guide to future productivity for DNSPs.

Figure 7.1: Labour and Utilities Productivity in Australia (1995-2017)



Source: AER Draft Decision, Figure 3.

The AER's evidence base for the relationship between economy-wide productivity and sector-specific productivity is weak for at least four reasons.

Firstly, the evidence does not suggest that productivity growth between the two categories tends to be at a similar *level*. Of the three periods over which the AER compares the two categories, the difference in average growth rate is greater than 3 percentage points in two periods and 3.5 percentage points lower on average over the 17 year-period as a whole.[65] Whilst that could, in principle, partly reflect negative productivity growth for DNSPs alone in the late 2000s, electricity DNSPs are only one constituent part of the index, which will

64 AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, page 20.

65 AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, Table 8.

include water companies, gas distributors and the rest of the utility supply chain. Accordingly, the lower growth in productivity in utilities is not due to regulatory obligations imposed on DNSPs alone, which the AER has argued justifies ignoring evidence from before 2012.

Secondly, not only does productivity growth differ between the wider economy and utilities, but the differences between economy-wide labour productivity and labour productivity in the utility sector are not stable. Labour productivity in utilities grew slower than the wider economy by

- 3.3 per cent between 1998/99 and 2003/04;
- 5.8 per cent between 2003/04 and 2011/12; and
- *Minus* 0.7 per cent between 2011/12 and 2015/16.

Thirdly, the peaks and troughs of the utilities and economy-wide productivity measures are non-coincident from one year to the next, as can be plainly seen from the graph. One can also demonstrate this lack of correlation mathematically.

The "correlation coefficient" is a more formal measure of the relationship between two variables. It varies between *minus* 1 and *plus* 1. A coefficient of *plus* 1 implies that two variables are perfectly correlated such that they always move together and by a proportionate amount. A coefficient of *minus* 1 suggests that two variables are perfectly *inversely* correlated such that when one *increases*, the other *decreases* by a proportionate amount. A coefficient of zero suggests that there is no relationship between the two variables.

The AER did not provide the dataset behind Figure 3 of the Draft Decision. Nonetheless, the underlying data is available from the Australian Bureau of Statistics. Calculating correlation coefficients on that data demonstrates the weakness of the relationship that can be observed in the Figure. The correlation coefficient between productivity in the wider economy and utilities is:

- *Minus* 0.76 for the underlying index, suggesting that over the sample period productivity for utilities went down whenever productivity for the wider economy increased; and
- *Plus* 0.146 for the growth rates, suggesting that around 15 per cent of movements in the productivity growth rate of utilities were correlated with those in the wider economy.

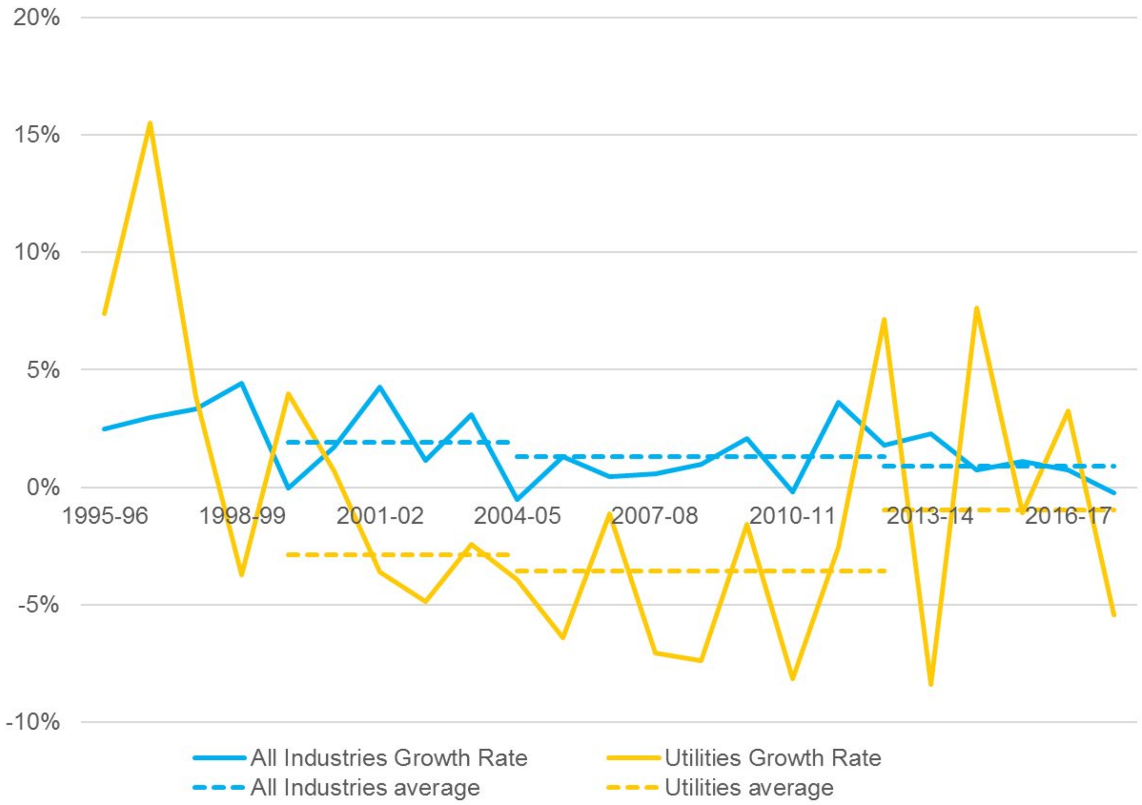
Neither of these metrics suggests a strong relationship that would justify substituting economy-wide productivity growth for that in utilities to forecast the productivity growth of DNSPs.

Fourthly, the relationship that the AER alleges is not stable or robust to the averaging periods selected. Figure 7.2 shows labour productivity growth for all industries and utilities for Australia using the data provided by the Australian Statistics Bureau.[66] The figure includes dashed lines which show the averages over the periods 1999/2000 to 2004/15, 2004/15 to 2012/13 and 2012/13 to 2017/18 (i.e. starting the averaging period one year subsequent to the

[66] The data is not identical to the data relied upon by the AER for the last two years in the sample: The Figure includes one extra year (2017-18) and the result for 2016-17 year is slightly different to the result shown in Figure 3 of the Draft Decision (shown also as Figure 7.1 above), which may be due to restatement of the underlying productivity index.

AER's averaging period and calculating the average up to 2017/18, the latest available data). As can be seen from the Figure, the average productivity growth over each period no longer follows the same trend: Average productivity growth for all industries falls over each averaging period. Average productivity growth for the utilities industry falls between periods one and two and then rises in the third period. Given that such minor changes in the averaging period undermines the AER's contention that labour productivity economy-wide and in the utilities sector follow the same trend, the AER's evidence that the two are closely correlated is weak at best.

Figure 7.2: Labour Productivity Using Latest Data



Source: NERA Analysis on ABS Data

We therefore conclude that economy-wide measures of productivity do not capture underlying trends in productivity *relevant to DNSPs*. The extent to which the AER's overall approach in Option 5 meets this criterion depends on how little weight DAE has placed on non-comparable measures of productivity, but these weights are not available.

7.4. Labour Productivity Approach Requires Constant Productivity in Other Inputs

The AER proposes to apply a labour productivity adjustment only to the share of opex which relates to labour, while leaving the remainder of costs unaffected by productivity changes. This approach is internally consistent only if productivity of other inputs (such as materials) remains constant over time.

In theory, this may not be the case. For example, a single electrician could become more productive if they are provided with a second piece of equipment, say a power drill. However, the productivity as measured from the perspective of the drill will probably decline: each drill is individually used less often and has less output associated with it. Beyond this simplified example, labour productivity tends to be higher as a business becomes more capital-intensive, but the productivity of the (large amount of) capital employed decreases.

By assuming that the productivity and level of other inputs remains constant, the AER's approach may overstate the level of productivity that is achievable by a DNSP.

7.5. Conclusions

In summary, we compare the AER's proposed approach against the criteria we have set out.

- *Approach captures underlying trends in productivity*:

  For several reasons, AER's Option 5 may not capture underlying trends in productivity, though the lack of clarity in the approach makes it difficult to fully assess against this criterion. First, the productivity target may be set primarily based on economy-wide productivity growth and may therefore fail to capture the underlying trends most relevant to a DNSP. Second, the AER's approach may assume that DNSPs may be able to achieve the same productivity gains on outsourced labour that it achieves on its internal labour. Third, the AER's approach ignores that improved labour productivity may be offset through worsening productivity in other inputs.

- *Approach separates productivity from catch-up*:

  Because the labour productivity measures capture a large proportion of the economy outside of DNSPs (or even utilities in general), it is unlikely to be heavily skewed by catch-up efficiency rates.

- *Approach is objective and stable over time*:

  The AER's approach may be heavily dependent on using economy-wide labour productivity growth as a proxy for utilities labour productivity growth (depending on the weights of the three factors in the DAE modelling). Historically, these growth rates have not been similar, so it does not appear that the AER could continue to reliably use this approach if the DAE modelling places significant weight on unrelated productivity measures.

- *Approach does not limit incentives to reduce costs*:

  Because the labour productivity forecasts are estimated across a wide segment of the economy, no DNSP could act in such a way that would have a material effect on DAE's forecasts. Therefore, Option 5 satisfies this criterion.

8. Proposed Alternative Approaches

The above chapters review the options set out in the AER's Draft Decision. Our analysis of these options suggests revisions that would improve the accuracy of its estimates and better meet the relevant criteria for AER's decision.

The options we suggest below generally show smaller productivity improvements (and even negative productivity improvements). When viewed holistically, as the AER does in Option 6, our methods suggest that the AER has no objective basis for departing from its status quo assumption of zero productivity growth for DNSPs.

8.1. Option A: Undergrounding with a DNSP-specific levels-based coefficient.

As described in Chapter 4, the AER's proposed method to adjust DNSPs' allowances based on undergrounding share fails to reflect the drivers of efficient costs. We recommend two necessary changes to the AER's approach:

- Each DNSP's target should be based on its *own* assumed rate of undergrounding rather than the industry-average; and
- The opex savings should be calculated using a linear, rather than logarithmic, approach. Such a functional form would assume that moving 1 per cent of a network underground yields the same percentage opex savings irrespective of the share already underground. This functional form likely reflects reality better than a logarithmic one.

We have re-estimated the three econometric models using the logarithmic specification for the underground variable (as in the AER's approach) and using the level form (as we recommend). The tables below show the coefficient on the variable alongside the p-value, with a value of 0.05 or below indicating statistical significance.

Table 8.1 is based on the AER's 2017 models (2006-16 data), which underpin the Draft Decision. Table 8.2 adds 2017 data to the estimation which has become available since the release of the Draft Decision, and which underpin our Option A. We do not include the new SFA TL model because it does not form part of the AER's Draft Decision. Note that a negative coefficient in an econometric model (as shown below) indicates positive productivity growth.

Table 8.1: Underground Share Coefficients – 2006-16 data

	SFA C-D		LSE C-D		LSE TL	
	Log	**Level**	**Log**	**Level**	**Log**	**Level**
Coeff.	-0.144	-0.350	-0.177	-0.631	-0.159	-0.555
p-value	0.000	0.008	0.000	0.000	0.000	0.000

Table 8.2: Underground Share Coefficients – 2006-17 data

	SFA C-D		LSE C-D		LSE TL	
	Log	**Level**	**Log**	**Level**	**Log**	**Level**
Coeff	-0.148	-0.345	-0.181	-0.625	-0.160	-0.545
p-value	0.000	0.008	0.000	0.000	0.000	0.000

It may additionally be most appropriate to rely exclusively on the coefficient from the SFA model for the purposes of a productivity adjustment, because, according to the AER, SFA "estimate[s] the *frontier* relationship between inputs and outputs".[67] By contrast, the LSE models estimate the relationship between inputs and outputs across all firms, including those which are inefficient. Thus, the SFA model is consistent with the objective of the productivity adjustment, which is designed to reflect the AER's "best estimate of the shift in the productivity frontier. It is not intended to include any 'catch up' to the frontier for a distributor that is materially inefficient".[68] Therefore, we use only the SFA coefficient estimated using 2006-17 data for Option A.

Table 8.2 shows that a frontier DNSP that undergrounds 1 per cent of its network, whether it is increasing from 10 per cent to 11 per cent or 50 per cent to 51 per cent, can yield a 0.35 per cent reduction in opex (using the SFA coefficient).

As discussed above, Option A assumes that DNSPs underground at a rate consistent with their own historical undergrounding rates. We have therefore calculated the average percentage-point increase by DNSP over the 2006-17 period, and multiply the SFA coefficient in Table 8.2 by each DNSP's average. Thus, Option A implies an annual productivity improvement of between 0.06 per cent (for Essential Energy) and 0.29 per cent (for Endeavour Energy), or 0.14 per cent on average across the industry.

Below, we compare our Option A against the criteria we have set out.

- *Approach captures underlying trends in productivity*:

  Under Option A, DNSPs are assumed to carry out underground workload levels in line with workload levels they have previously achieved, which captures the DNSP-specific trend in undergrounding. Furthermore, we estimate opex savings using an intuitive functional form that reflect actual cost relationships.

- *Approach separates productivity from catch-up*:

  The objective of the productivity adjustment is to capture the change in *efficient* costs, and hence an SFA model is the appropriate choice. Therefore, since our approach is based solely on the SFA model, it meets the criterion.

- *Approach is objective and stable over time*:

  Our suggested approach assumes that each DNSP will underground a similar length of network each year, which is a stable assumption at least in the medium term so long as there remains enough overhead line to underground. Additionally, the coefficients are

67 AER (November 2017), Annual Benchmarking Report, p.5. Emphasis added.

68 AER (November 2018), Draft decision paper: Forecasting productivity growth for electricity distributors, p.5.

determined objectively using the full data available, and so could be updated in an objective and stable fashion.

- *Approach does not limit incentives to reduce costs*:

  If productivity targets were set based on each DNSP's historical undergrounding rate, a DNSP could affect its future target by carrying out less work. However, the decision to move sections of network underground is not primarily driven by potential opex savings, so DNSPs are unlikely to have sufficient incentive to manipulate targets by carrying out less undergrounding work. Moreover, by using the longest possible window, DNSPs have less ability to affect their targets on an ongoing basis.

8.2. Option B: SFA Time Trend (2006-17 data)

Because they aim to capture shifts to the efficient frontier, SFA models are useful for identifying the underlying trend in productivity for frontier DNSPs. Economic Insights estimates SFA models using the available DNSP data, but the AER does not propose to use the coefficient, arguing that it partially reflects a period from 2006 to 2012 when increasing obligations caused productivity to decline.

The AER has not provided any support for its claim that the 2006-12 is not comparable for ongoing productivity improvement, and it is thus not clear that the SFA coefficient, using the fullest window possible, is not appropriate to index DNSPs' opex allowances.

In the absence of compelling evidence that the 2006-12 period is not comparable, we therefore propose that the AER use coefficients from SFA modelling to capture the ongoing technological changes while also capturing omitted factors which may also drive efficient opex. Even if the 2006-12 period is not comparable, the AER could adjust the econometric specification of its modelling to capture this period (e.g. a "dummy variable" for DNSPs in affected states during this period).

The AER has released its 2018 benchmarking update since the release of the Draft Decision, and we assume that it will rely on this updated data for its Final Decision.[69] Therefore, Option B uses the coefficient estimated on data from 2006 to 2017, even though the 2018 benchmarking models exclude data prior to 2012.

Additionally, the AER has introduced a new model in its 2018 benchmarking report: the SFA TL model. We have not appraised this model as it is not mentioned in the Draft Decision, making it unclear what role it will have in the Final Decision.

Re-estimating the three models included in the Draft Decision using 2006-17 data, we calculate a *decline* in productivity of between 1.9 and 2.1 per cent per annum, though some may be attributable to omitted factors which drive DNSPs' efficient opex. Because the SFA model captures the shift in the frontier, this coefficient is more appropriate than the other two.

For Option B, we therefore propose a productivity shift of *minus* 1.9 per cent per annum. The decline in productivity may not represent worsening productivity alone – it additionally captures changes to DNSPs' efficient costs which are not captured separately in the econometric models, such as additional safety-related outputs. This coefficient could be

[69] Economic Insights (9 November 2018), Economic Benchmarking Results for the Australian Energy Regulator's 2018 DNSP Annual Benchmarking Report, Tables 3.3-3.5.

combined with the coefficient on underground share, though in order to be internally consistent, the full model would need to be re-estimated using a levels specification on the underground share variable.

We compare Option B against the criteria we have set out.

- *Approach captures underlying trends in productivity*:

  The use of a long-term electricity time trend captures underlying historical trends in productivity so long as the econometric model fully captures other drivers of costs, such as input prices and output growth.

  Additionally, a time trend taken from the same model from which the undergrounding coefficient is taken will be internally consistent and not double-count historical productivity improvements. Even if this trend suggests worsening productivity, this may in fact simply capture some other omitted factor which drives increases in DNSPs' efficient costs, such as additional safety-related outputs.

- *Approach separates productivity from catch-up*:

  Our proposed approach uses an SFA time trend, which aims to measure drivers of costs for efficient, rather than average, DNSPs.

- *Approach is objective and stable over time*:

  Using the trend in electricity provides a stable approach over time, because it is likely that electricity data will be deemed more suitable in future regulatory controls than any other sector. Furthermore, by using the longest window available, the AER can continue to update without the need to make subjective decisions regarding the data window.

- *Approach does not limit incentives to reduce costs*:

  There is the potential for an incentive effect if the AER uses time trends from the electricity industry: a frontier DNSP could theoretically increase its expenditure over the course of one period in order to increase the time trend for the next period. However, by using the longest data window available, each business decision made by a DNSP in a year has a limited effect on the trends estimated across the industry and across many years.

8.3. Option C: SFA Time Trend (2012-17 data)

Using the longest possible data window better captures longer-term productivity improvements rather than short-term effects, and may limit DNSPs' incentives to reduce costs. However, if the AER's claims regarding 2006-12 data do indeed have merit (which we do not find to be the case), then it may be appropriate to consider an SFA time trend using a truncated data series from 2012 to 2017.

EI and the AER estimate this coefficient in the 2018 benchmarking update, which indicates declining productivity amongst efficient DNSPs of 1.5 per cent per annum in the SFA C-D model, which defines our proposed Option C. While we have not appraised the SFA TL model, it also indicates declining efficiency of 1.5 per cent per annum.[70] As with Option B,

[70] Economic Insights (9 November 2018), Economic Benchmarking Results for the Australian Energy Regulator's 2018 DNSP Annual Benchmarking Report, Tables 3.3-3.6.

some of this apparent decline in productivity may be as a result of some omitted factor which increases DNSPs' efficient costs, such as additional safety-related outputs.

Additionally, this coefficient could be combined with the coefficient on underground share, though in order to be internally consistent, the full model would need to be re-estimated using a levels specification on the underground share variable.

We compare Option C against the criteria we have set out.

- *Approach captures underlying trends in productivity*:

  The use of a limited window fails to capture long-term underlying trends and may be subject to cherry-picking.

- *Approach separates productivity from catch-up*:

  This approach uses an SFA time trend, which aims to measure drivers of costs for efficient, rather than average, DNSPs.

- *Approach is objective and stable over time*:

  The use of an arbitrary window relies on subjective decision making. However, the approach is stable, in the sense that the AER could continue to extend the approach as more data becomes available.

- *Approach does not limit incentives to reduce costs*:

  Compared to Option B, this option provides some disincentive to reduce costs, because the coefficient is estimated on a shorter time frame.

8.4. Option D: Long-term MPFP

In Chapter 6 we presented our discussion of the AER's Option 4, which draws on a measure of MPFP calculated for a sample of firms that the AER decided represented the productivity frontier. Drawing on our critiques presented in Chapter 6, we present our Option D below, which follows a similar approach as Option 4 but with some differences in application:

- We use the full available dataset, from 2006 to 2017. This ensures that the approach captures underlying productivity trends and is less susceptible to one-off occurrences and volatility. Additionally, this method is objective, because it removes the subjective choice of start and end year.

- We use a weighted average of firms' productivity, weighted according to EI's Tornqvist index. This ensures that smaller firms do not have an unrepresentative impact on productivity.

- We use a logarithmic least-squares method to calculate growth, which uses all data points to fit a line rather than just the first and last point. Thus, this approach ensures that the end result is not sensitive to the start- and end-year productivity level any more than to that in any other year.

- We include all firms in the averaging sample. By using the longest possible window, it is not necessary to remove firms to account for catch-up efficiency. Further, by including all firms, we remove the inherently subjective process of selectively removing firms suspected of making catch-up gains from the sample. Including all firms in an estimate using a long enough time period provides for a more stable approach.

We calculate the MPFP growth rate using the latest data set available, from 2006 to 2017. The resulting estimate suggests an annual MPFP growth rate of *minus* 1.0 per cent. This negative result may be the result of omitted factors which drive DNSPs' efficient costs.

- *Approach captures underlying trends in productivity*:

  Because this approach is based on DNSP data over the longest possible period, Option D captures underlying productivity trends in the electricity sector.

- *Approach separates ongoing productivity from catch-up*:

  Unlike econometric methods such as SFA, the change in MPFP is a measure of average productivity growth, not frontier shift directly. However, by using the longest possible time period, the effect of catch-up efficiency is minimised, as individual companies are not able to continually catch up over a long period of time. It is not clear whether the 12 years of data from 2006 to 2017 are sufficient for this to be the case.

- *Approach is objective and stable over time*:

  Option D is estimated over the longest possible time period, and hence can has been determined and can be updated objectively. Selecting the longest period would ensure that the AER is not cherry—picking results to reduce prices in the short term rather than protect consumers' long-term interests. By using a logarithmic regression approach rather than a continuous compounding approach, Option D is also less sensitive to productivity levels in the first and last year of the estimation period.

- *Approach does not limit incentives to reduce costs*:

  Relying on short-term average growth rates in MPFP for electricity DNSPs introduces a circularity between productivity growth for DNSPs and future productivity targets, particularly for DNSPs that are owned by common shareholders. Adopting longer periods reduces these disincentives.

9. Conclusion

In the previous chapters, we review the AER's proposed application of a productivity adjustment to DNSPs' subsequent price control periods, and we propose a range of alternative approaches.

9.1. Assessment Criteria

For each of AER's approaches and our own approaches, we appraise against four criteria:

- *Approach captures the trend in productivity*: Fundamentally, in order to be consistent with the AER's statutory duties as set out in the NEL and the NER, any productivity adjustment must reflect the productivity improvement that would be attainable by an efficient DNSP. In other words, it must reflect the underlying trends in productivity.
- *Approach separates productivity from catch-up*: The AER separately adjusts DNSPs' allowances if it deems them to be inefficient. A productivity adjustment is additional to this "catch-up" adjustment. Therefore, any adjustment must not reflect efficiency improvements amongst inefficient DNSPs as they catch up to the frontier.
- *Approach is objective and stable over time*: The AER's approach should not be highly sensitive to start and end years and should demonstrate longer-term productivity trends. Its approach should also be credible such that it can continue to use the approach in subsequent price control periods.
- *Approach does not limit incentives to reduce costs*: The AER's approach should not introduce any perverse incentives which would encourage DNSPs to make business decisions with a view to influencing their current or future productivity targets.

9.2. Proposed Approaches by the AER and NERA

The AER has proposed six approaches to adjust DNSPs' allowances:

- *Option 1: The status quo*. This approach continues the AER's past decisions and makes no adjustment to allowances for ongoing productivity, based on evidence of declining productivity.
- *Option 2: Productivity growth from increased undergrounding.* This approach uses coefficients of DNSPs' underground circuit length as a share of total circuit length on opex, and multiplies by industry average growth in underground share, leading to a productivity adjustment of *plus* 0.5 per cent per annum.
- *Option 3: Undergrounding productivity plus the gas distribution trend.* This approach takes Option 2 and additionally adjusts DNSPs allowances by a further 0.5 per cent per annum to take account of ongoing productivity as estimated in the gas sector, leading to an adjustment of *plus* 1.0 per cent per annum.
- *Option 4: Using industry average opex MPFP growth.* This approach measures MPFP growth for DNSPs from 2012 to 2016, and takes an industry average excluding DNSPs which are materially inefficient, leading to an adjustment of *plus* 1.6 per cent per annum.

- *Option 5: Using labour productivity growth.* This approach takes sector-wide labour productivity growth forecasts as estimated by DAE and multiplies by DNSPs' labour share of opex, leading to an adjustment of *plus* 0.9 per cent per annum.
- *Option 6: A holistic approach.* The AER reviews the findings of approaches 2 through 5 and selects an adjustment of *plus* 1.0 per cent per annum, which is near the middle of the range of the results of the other options.

We have proposed four alternative approaches:

- *Option A: Undergrounding with a DNSP-specific levels-based coefficient.* This approach modifies the AER's Option 2 but (a) estimates the coefficient using a levels rather than a logarithmic specification and (b) applies the coefficient to DNSP-specific growth in undergrounding share rather than industry-wide growth. This leads to an adjustment that varies by DNSP, from *plus* 0.06 per cent to 0.29 per cent, with an average of *plus* 0.14 per cent (per annum).
- *Option B: SFA Time Trend (2006-17 data).* This approach uses the coefficient from EI's SFA C-D model, but using the longest data series available, i.e. from 2006 to 2017. This leads to an adjustment of *minus* 1.5 per cent per annum. We note that this could be combined with Option A above (equivalent to the AER's Option 3), but, for internal consistency, the model would need to be fully re-estimated using a levels specification of the underground share.
- *Option C: SFA Time Trend (2012-17 data)*. This approach uses the coefficient from EI's 2018 SFA C-D model, which excludes data prior to 2012. This leads to an adjustment of *minus* 1.5 per cent per annum (implying worsening productivity). We note that this could be combined with Option A above, but, for internal consistency, the model would need to be fully re-estimated using a levels specification of the underground share.
- *Option D: Long-term MPFP*. This approach modifies the AER's Option 4 to use all of the data available – all 13 DNSPs measured from 2006 to 2017 – and a logarithmic averaging approach, and results in an adjustment of *minus* 1.6 per cent per annum.

9.3. Appraisal of Approaches Against Criteria

In Table 9.1 below we summarise our review of each method proposed by the AER and by NERA in this report against our criteria. We do not separately assess the AER's Option 6 because this is simply an amalgamation of its other options. [71]

[71] Green = Approach satisfies criterion in practice and in theory; Amber = Approach may violate criterion in theory, but may not be a problem in practice; Red = Approach violates criterion in theory and in practice.

Table 9.1: Review of the AER's and NERA's Productivity Approaches

	AER Approaches					NERA Approaches			
	Option 1: The status quo (econometric approach bound by 0)	Option 2: Productivity growth from increased undergrounding	Option 3: Undergrounding productivity plus the gas distribution time trend	Option 4: Using industry average opex MPFP growth	Option 5: Using forecast labour productivity growth	Option A: Undergrounding with a DNSP-specific levels coefficient (2006-17 data)	Option B: SFA Time Trend (2006-17 data)	Option C: SFA Time Trend (2012-17 data)	Option D: Long-term MPFP (2006-17 data)
Applied rate-of-change (% p.a.)	0%	0.5%	1.0%	1.6%	0.9%	0.06% - 0.29% (0.14% avg)	-1.9%	-1.5%	-1.0%
Approach captures the trend in productivity	🔴 Underlying trend is unlikely to be 0%, as assumed by the status quo	🔴 Does not reflect productivity gains which could be achieved by any single DNSP. Functional form illogical.	🔴 Same as Option 2, plus inconsistent assumptions from a different industry.	🔴 Choice of window (and included companies) is arbitrary and short, making this approach unlikely to capture long-term productivity.	N/A May capture underlying trends provided no substitution toward other inputs. DAE measure a black box and may not reflect DNSPs' inputs.	🟢 Assumption is in line with what is achievable for a single DNSP, using intuitive functional form.	🟢 Assuming 2006-17 is relevant on an ongoing basis, this approach precisely captures ongoing productivity for DNSPs.	🟡 Arbitrary choice of window means approach does not identify long-term productivity changes.	🟢 Assuming 2006-17 is relevant on an ongoing basis, this approach precisely captures ongoing productivity for DNSPs.
Approach separates productivity from catch-up	🟡 Assumption is 0%, so criterion is not relevant.	🟢 Two LSE models include catch-up efficiency gains in coefficients. Only SFA model aims not to. But quantitative effect of catch-up small.	🔴 Same as Option 2, plus gas trends include some non-SFA models, which capture catch-up efficiency gains in the gas sector and may have material impacts on productivity growth assumptions.	🟡 AER removes companies it deems "materially inefficient", but unclear it is objective/accurate in doing so.	🟢 Estimated over a wide dataset unlikely to be influenced by catch-up efficiency.	🟢 Coefficient based on SFA model, which explicitly aims to estimate the efficient frontier.	🟢 Coefficient based on SFA model, which explicitly aims to estimate the efficient frontier.	🟢 Coefficient based on SFA model, which explicitly aims to estimate the efficient frontier.	🟡 In the long-term, DNSPs will not consistently catch up. However, with only 12 years' data, there may be some catch-up included.
Approach is objective and stable over time	🟢 AER has used this approach until now and could continue to do so indefinitely.	🔴 Logarithmic specification implying accelerating work is not sustainable in the long-term.	🔴 Same as Option 2, plus unclear why AER would continue to use gas trends when electricity trends become more reliable.	🔴 Choice of window is arbitrary and unstable. Highest productivity growth from broad range of estimation windows may suggest cherry picking.	🔴 Connection to economy-wide labour productivity is not stable.	🟡 Growth in UG share must slow down, but our linear approach assumes constant undergrounding which may be sustainable in the medium term.	🟢 Internally consistent with other parts of the efficiency assessment, and objectively uses all available data.	🟡 Internally consistent with other parts of the efficiency assessment, but requires arbitrary selection of start year.	🟢 Estimated over the longest period possible and hence the most stable measure available.
Approach does not limit incentives to reduce costs	🟢 Individual DNSPs' actions do not influence the application of this assumption, because it is set to zero.	🟢 Industry-average approach may limit DNSPs' ability to individually shift targets materially.	🟢 Same as Option 2. Use of gas trend makes it virtually impossible for an electricity DNSP to influence that component of the target.	🟡 Given short estimation window, industry-average approach reduces incentives for DNSPs part of wider groups to reduce costs.	🟢 Individual DNSPs could not materially influence DAE's (economy/sector wide) productivity indices.	🟡 Approach based on individual DNSPs means they could theoretically influence their own targets, but unlikely to do so. Long-term model limits this incentive risk.	🟢 Targets set by frontier companies, so these companies could influence targets in subsequent periods, but long-term model limits this incentive risk.	🔴 Targets set by frontier companies, so these companies could influence targets in subsequent periods.	🟢 Industry-average approach, plus long-term averaging, removes DNSPs' ability to individually shift targets materially.
Overall Assessment	🟡 Does not reflect underlying trend, but at least reflects existing approach.	🔴 Does not reflect underlying trends and aribtrarily punishes some companies.	🔴 Same as Option 2, but includes further irrelevant information.	🔴 Highly sensitive to subjective decisions about sample window and size.	N/A Insuffiient information on method to appraise or apply.	🟡 Likely reflects underlying trends, but constant undergrounding not sustainable.	🟢 Performs strongly in all four criteria.	🟡 High bar required to exclude pre-2012 data objectively, and this has not been met.	🟢 Performs strongly in three criteria, but may not be a long enough window to separate out catch-up.

9.3.1. Approach captures underlying trends in productivity

None of the AER's proposed approaches reliably captures underlying trends in productivity which could be achieved by an efficient DNSP. Two of the AER's approaches, Options 4 and 5, may capture underlying trends in productivity, but have been estimated in an arbitrary and/or opaque fashion, and are therefore unlikely to reflect DNSPs' potential for productivity improvements on an ongoing basis.

By contrast, our Options A, B, and D are designed to precisely estimate underlying trends in productivity relevant to an efficient DNSP. If the period prior to 2012 is indeed fundamentally different and non-comparable to the next price control period, then Option C captures relevant underlying trends, though we have not seen compelling evidence that the pre-2012 period is not relevant. While three of our four models imply *negative* productivity growth, this may capture some omitted factor which inflates DNSPs' costs, such as safety-related outputs. It may also reflect an actual decline in productivity for legitimate reasons. Under either explanation, our approaches capture underlying trends in efficient costs in the historical period, and it is not clear that these trends are inapplicable to the future period.

9.3.2. Approach separates productivity from catch-up

Two of the AER's approaches separate productivity from catch-up efficiency, though the first of these (Option 2) only does so empirically, as the difference in coefficients between the SFA model and the other models is small. The other option (Option 5) is estimated over a wide enough sample that catch-up efficiency is not a relevant concept. For those approaches which include the effect of catch-up efficiency, the approach sets targets which are unattainable to DNSPs operating efficiently.

Our approaches generally perform better with respect to this criterion because they are either based on an SFA approach, which aims to measure changes in the efficient frontier, or based on a longer period of data where catch-up efficiency gains have little effect on the average.

9.3.3. Approach is objective and stable over time

Because the AER's approaches do not capture underlying trends in productivity, they are not sustainable over an extended period of time. Moreover, some of the AER's approaches (Options 4 and 5) appear to be sensitive to the window over which they are estimated, and the AER/DAE have not selected those windows in a transparent or objective manner. Therefore, these approaches are unlikely to reflect what is attainable in the future.

By contrast, our approaches are internally-consistent with other components of the cost-assessment process (e.g. the base-year efficiency assessment). Option C requires a subjective decision as to a cut-off date before which data is not relevant. Options A, B and D use the longest window available, and are therefore determined objectively.

9.3.4. Approach does not limit incentives to reduce costs

Because the AER's approaches are generally divorced from DNSPs' *actual* productivity, DNSPs' actual business decisions have virtually no influence over the proposed productivity targets, removing the potential to create perverse incentives.

All of our approaches are based on electricity-specific data, so DNSPs could theoretically factor the productivity adjustment into their business decisions. However, in the case of Options B, C and D, this disincentive is limited by the fact that targets are determined across several DNSPs. In the case of Options A, B and D, this disincentive is limited by the fact that targets are estimated over the longest possible period (2006-17), so each year's decisions will have little impact on forward-looking targets.

9.4. Appraisal of Approaches Against the AER's Statutory Duties

Based on our appraisal of the evidence provided by the AER and our proposed alternative approaches, we conclude that the AER has no objective basis to depart from its status quo approach of applying no adjustment. If it is to do so, its adjustment would not reflect the efficient costs of a DNSP and would not allow a prudent operator to recover its operating expenditure. Therefore, none of the AER's proposed approaches satisfy the opex criteria included in the NER and are therefore inconsistent with clauses 6.5.6(c) and 6.12.1(4) of the NER.

By failing to remunerate companies for their efficiently-incurred opex, the AER disincentivises efficient investment in the network. A DNSP may not make efficient investments in expanding or improving its network if it knew that it would not be fully remunerated for the additional opex that those expansions or improvements would yield. As a result of inefficiently-low investment, future consumers of electricity could see an increase in price and/or a decrease in quality, safety, reliability and security of supply of electricity.

The AER's proposed approaches are therefore not in the long-term interests of consumers of electricity, and therefore do not meet the National Electricity Objective, as defined in the National Electricity Law.

Appendix A. International Precedent Summary Table

Country	Regulatory Methods
UK	▪ Ofgem uses a long-term trend to set productivity in gas and electricity. – It draws on EU KLEMS, a dataset from 1970 to 2007. ▪ Ofgem does not use data from energy because it is distorted by industry-wide catch-up efficiency resulting from privatisation. – Instead, it uses a weighted average of productivity growth from a wide range of industries, including Construction, Manufacture of Chemicals and Chemical Products, Manufacture of Electrical & Optical Equipment, Manufacture of Transport Equipment, Sale, Maintenance & Repair of Moter Vehicles/Motorcycles; Retail Sale of Fuel, Transport & Storage, and Financial Intermediation. ▪ Ofgem relies on TFP and PFP indices, calculated from both Gross Output data and Value Added data. These indices are calculated and presented as part of EU KLEMS
US/Canada	▪ There is a heterogeneous picture across state and provincial regulators. Some (California, Maine, Massachusetts, Oregon, Ontario, British Columbia, Alberta) use TFP-based approach. ▪ FERC Form 1 dataset is a widely used and publicly available source for electricity distribution data from at least 1994 until the present. – FERC Form 1 compiles US wide data ▪ Some states/provinces (Massachusetts, Alberta) use the longest available data, reaching back to 1973.
Germany	▪ BNetzA aims to use the longest possible sampling period “to smooth out temporary effects”. This entails 2006-2016 for gas, and 2006-2017 for electricity. – It relies on data from the regulated industries themselves ▪ BNetzA use DEA and SFA estimation for efficiency benchmarking. – It uses a Malmquist index, which can identify frontier shift and catch-up effect separately ▪ Productivity growth is estimated separately for electricity and gas sectors
Netherlands	▪ To regulate DSOs, ACM follows an index-based approach, calculating the change in the cost/output ratio – It uses data from 2004-2015 for electricity, and 2005-2015 for gas. – It relies on data from the regulated industries themselves ▪ Since there are only two TSOs (one in electricity and one in gas), ACM follows a different method: – It uses a wighted average of results from econometric analysis of selected sectors of the Dutch economy. – These sectors are chosen to reflect the common functions of a TSO, including: IT and other information services, Telecommunications, Construction, Electricity, gas and water supply, Transportation and storage, and Financial and insurance activities. – It also draws on international studies on TSO dynamic efficiency.

Qualifications, assumptions and limiting conditionsQualifications, assumptions and limiting conditions

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