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Feedback on Quantonomics phase 2 report on econometric opex cost functions

Jemena Electricity Networks (Vic) Ltd (**JEN**) welcomes the opportunity to provide feedback on Quantonomics' phase 2 report, which explores model specifications to address monotonicity violations and non-convergence issues impacting operating expenditure (**opex**) cost functions.

During the phase 1 consultation, we encouraged the Australian Energy Regulator (**AER**) to consider models that allow efficiency to vary over time, rather than relying solely on alternative time trends across jurisdictional groupings (Australia, New Zealand and Ontario). We are therefore pleased to see this feedback reflected in the phase 2 analysis and we support the overall direction of the phase 2 work.

Quantonomics has undertaken a comprehensive assessment of model specifications with time-varying efficiency. Overall, we support the introduction of model specifications that better reflect how Australian Distribution Network Service Providers' (**DNSP**) efficiency has changed over time.

Our submission focuses on the following four key points:

1. **Inclusion of Stochastic Frontier Analysis (SFA) time-varying efficiency models -** We support the inclusion of the two SFA time-varying efficiency models recommended by Quantonomics (SFA-BC95-JTT-HN and SFA-Kumb90-JTT-HN) in the benchmarking suite. We recommend that these models should supplement rather than replace the existing models as they are more parameter-intensive and may face convergence or stability issues over time. A larger model set also reduces the risk of benchmarking results being unduly influenced by the inclusion or exclusion of individual models in any given year.

2. **Continued use of the benchmarking roll-forward approach -** We support Quantonomics' recommendation to continue using the benchmarking roll-forward model to assess base year opex efficiency because the base year typically lies outside the estimation period of econometric models and it cannot be directly assessed.

3. **Non-inclusion of Least Squares Estimation (LSE) time-varying efficiency models -** While we support adopting time-varying efficiency models in principle, we do not support the inclusion of the LSE time-varying specifications recommended by Quantonomics (LSE-AJTT-GTC). These model specifications produce efficiency patterns inconsistent with observed outcomes, the AJTT specification exposes Australian results to unrelated Ontario DNSPs opex movements and the GTC specification makes technical change highly sensitive to single-year opex movements.

4. **Discontinue use of short-period econometric models** - The long-period time-varying specifications directly estimate year-by-year efficiency changes, making short-period models redundant. Additionally, the short-period models are more prone to convergence issues and risk overstating technical change during periods of strong efficiency catch-up. These models should therefore be discontinued.

We have set out our detailed reasoning and supporting analysis in the ***Annexure*** to this letter. We would appreciate more clarity on this consultation process from the AER – next steps and timelines. Please contact [redacted] if you would like to discuss this submission further.

Yours sincerely

[redacted]

Sandeep Kumar
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Annexure

1. Inclusion of SFA time-varying models

The econometric models considered in Quantonomics' Phase 1 report and the ones currently in use assume that efficiency is constant over time. This assumption is far from reality and risks conflating two distinct drivers of opex change:

- Technical change, reflecting movement of the efficiency frontier
- Efficiency catch-up, reflecting firms moving closer to the frontier

Jemena's submission to Quantonomics' phase 1 report provides a detailed analysis of how the existing time-invariant specifications fail to recognise efficiency catch-up and may misinterpret it as frontier shift, leading to biased estimates of both efficiency and technical change[1].

Quantonomics' Phase 2 analysis demonstrates that time-varying efficiency models materially reduce the risk by explicitly separating efficiency catch-up from frontier shift. On the basis of this analysis, Quantonomics recommended three time-varying specifications for inclusion in the AER's benchmarking assessment:

- SFA-BC95-JTT-HN
- SFA-Kumb90-JTT-HN
- LSE-AJTT-GTC

Of these we support the inclusion of the two SFA time varying specifications as they demonstrate stronger alignment with economic theory, statistically significant coefficients with expected signs and substantially fewer monotonicity violations.

While these SFA models are an improvement on existing specifications, they are more parameter-intensive and may still be prone to convergence or stability issues in future. From time to time, when estimating average efficiency across models, individual models may need to be excluded due to these issues. We therefore consider that the new SFA models should supplement rather than replace the existing model set.

A broader model set reduces the risk of large year-on-year movements in benchmarking outcomes driven by inclusion/exclusion of models. At a minimum, the AER should use both sets of models, existing and new, till it is fully satisfied with the performance of new models over time.

2. Continued use of the roll-forward approach

The AER's assessment of base year opex during a DNSP's Price Reset relies on econometric models estimated using data prior to the base year. As a result, time-varying efficiency models, just like existing models, cannot directly estimate the base-year benchmark efficient opex.

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[1] JEN, *Submission to refinements to opex cost functions - February 2025, Pg. 3-7*

We support Quantonomics recommendation to continue using the benchmarking roll-forward model (**BRFM**) to roll forward efficient opex from the midpoint of the estimation period to the base year. This will also allow the AER to continue to assess base-year opex efficiency by averaging rolled-forward opex across the full set of available models.

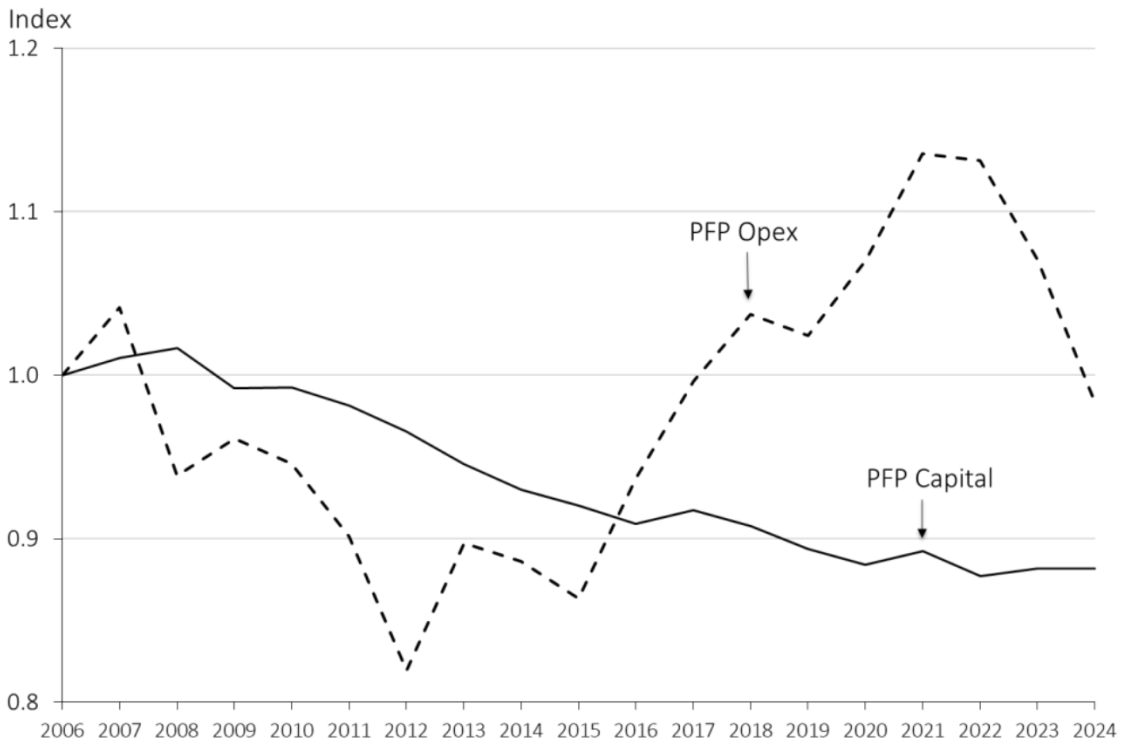
3. Issues with the LSE time-varying models

While we support the use of SFA time-varying models in Quantonomics analysis we do not support the use of the LSE-based specifications. This is because these models introduce material misspecification risks resulting in unreliable efficiency estimates for Australian DNSPs and errors in regulatory decision making.

Assumption of a constant rate of efficiency change

The LSE specification assumes that efficiency improves at a constant rate over time. This assumption is inconsistent with observed efficiency patterns and with the results produced by both opex multilateral partial factor productivity (**MPFP**) analysis and SFA time-varying models. The decline in efficiency prior to 2012 and the subsequent improvement is evident in the opex PFP results in Quantonomics' 2025 benchmarking report, as illustrated in the dotted line in Figure 1.

Figure 1: Opex and Capital PFP index



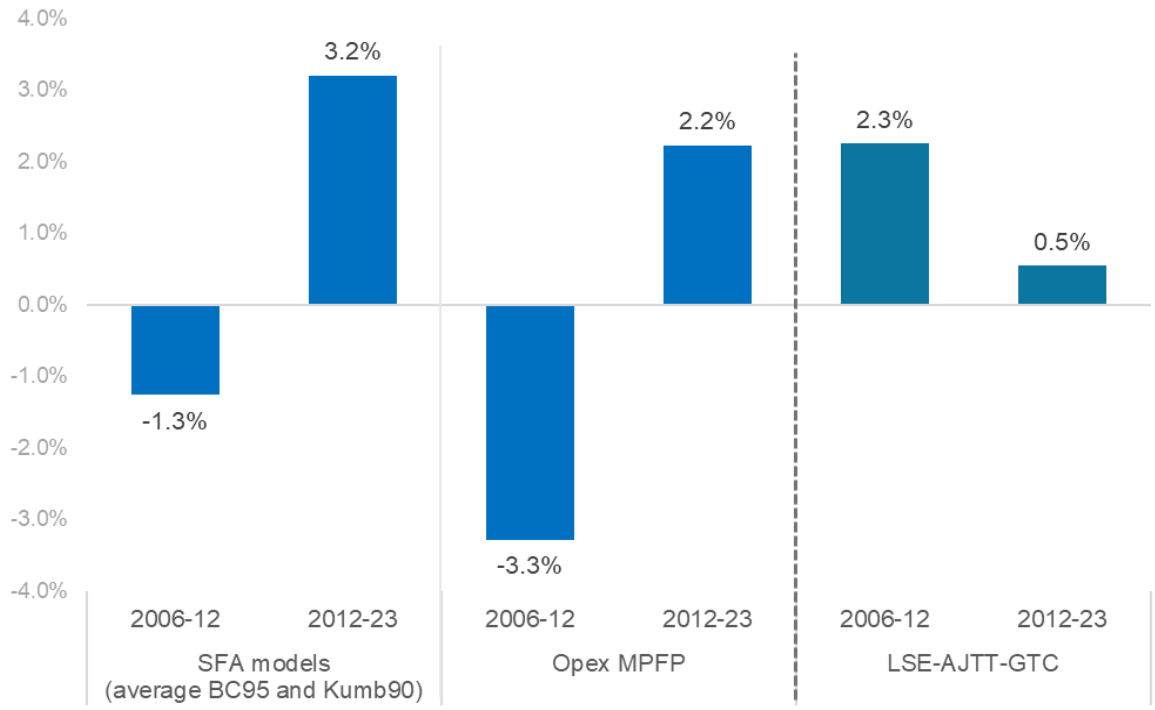
Source: Quantonomics 2025 Benchmarking Report (Page 17)

As shown in Figure 2 below, Quantonomics' opex MPFP analysis and the two SFA time-varying efficiency models[2] consistently indicate the following trends across Australian DNSPs:

- 2006-12: decline or broadly flat efficiency
- 2012-23: stronger efficiency improvements

In contrast, the LSE-AJTT-GTC specification produces the opposite pattern of relatively strong efficiency improvement prior to 2012 (2.3% per annum) and much weaker improvement thereafter (0.5% per annum). This result contradicts both the Opex MPFP and SFA evidence and does not reflect the observed patterns of DNSP efficiency changes.

Figure 2: Annualised change in productivity and efficiency scores across models



Note:
(1) Sourced from the supporting files of Quantonomics' phase 2 report and the 2025 Annual Benchmarking Report.
(2) For econometric models, the annualised efficiency change is calculated as the average annualised change across all Australian DNSPs and across both Cobb-Douglas and Translog specifications. For opex MPFP, the measure shown is the average annualised change in productivity across all Australian DNSPs.

The reason for LSE models to produce misleading trends and therefore unreliable estimates is due to the underlying misspecification constraining the rate of efficiency change to be constant over time. When genuine efficiency movements cannot be captured, the LSE models are forced to absorb them into other parts of the regression distorting the estimated relationships between opex, outputs and time trends.

[2] SFA-BC95-JTT-HN and SFA-Kumb90-JTT-HN

Issues with Australian Jurisdictional Time Trend (AJTT)

The LSE-AJTT specification assumes that the Ontario time trend represents Australian DNSPs' underlying rate of technical change (frontier shift). Quantonomics describes this assumption as follows[3]:

> *If we wish to decompose the productivity changes of Australian DNSPs into technical change and efficiency change, then we can assume that the general (ie, Ontario) time trend represents the underlying rate of technical change.*

In our view, this assumption results in high risk of misspecification for the following two reasons:

1. The Ontario time trend captures both technical change and efficiency catch-up by Ontario DNSPs. Where efficiency catch-ups of Ontario DNSPs are present the resulting time trend does not represent pure frontier shift and is therefore not an appropriate benchmark for Australian DNSPs.

2. This assumption makes Australian efficiency outcomes highly sensitive to changes in Ontario DNSPs' opex that are unrelated to Australian operating conditions. For example, extreme weather events, jurisdiction-specific regulatory changes or other one-off factors affecting Ontario DNSPs could materially distort the estimated time trend applied to Australian DNSPs through the BRFM.

The AJTT related misspecification risk is specific to the LSE specifications. These risks do not arise in the SFA specifications which have technical change and catch-up efficiency change estimated separately for all jurisdictions.

Issues with General Technical Change (GTC)

GTC is a way of modelling technical change (frontier shift) over time. Instead of assuming a constant rate of technical change over time, GTC allows the rate of technical change to vary every three years.[4]

Under the BRFM approach, the movement between the average GTCs[5] and the final three-year GTC block is used to calculate the rate of technical change from mid-point of the sample period to the base year.[6] This rate of technical change is one of the key parameters for rolling forward the efficient opex to the base year.

However, because the GTC is estimated in three-year blocks, the final block may contain fewer than three years of data. For example, if a sample has 10 years of data, it is divided into three sets of three-year blocks and only one year in the final block. Where the final block includes only a single year, the estimated rate of technical change becomes highly sensitive to one-off movements in opex in that year.

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3 Quantonomics - Electricity Distribution Benchmarking Opex Model Development – 26 November 2025, Pg 72

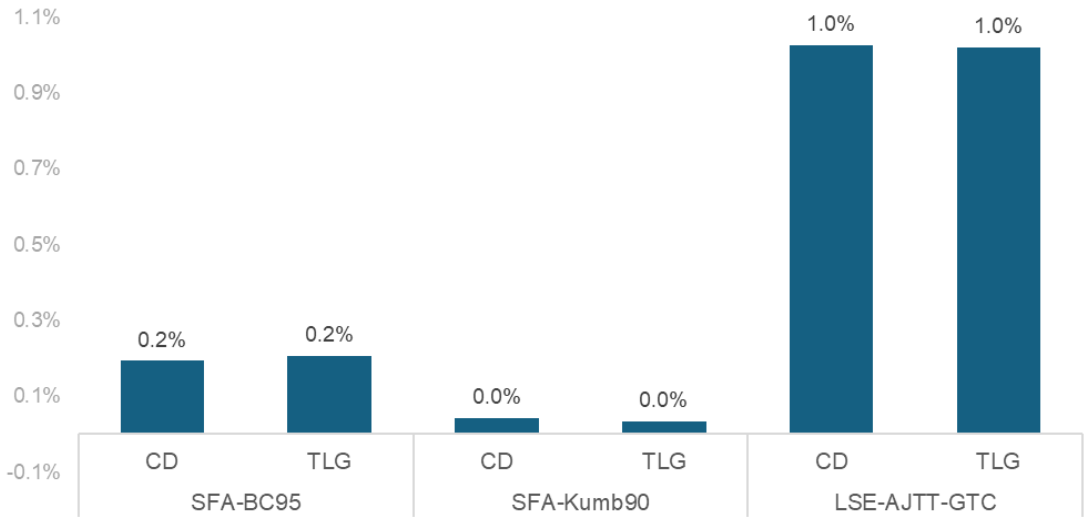
4 This is estimated by separating the full sample period into three-year blocks, and use dummy variables for each GTC block: 2006–2008, 2009–2011, 2012–2014, 2015–2017, 2018–2020, 2021–2023, etc.

5 Calculated as a simple average of all time trend coefficients over the whole sample period

6 This calculation is provided in Quantonomics' phase 2 report supporting file 'BRFM – Time Varying Models.xlsx' sheet 'Opex Forecast – LSE-AJTT-GTC'.

We illustrate this issue using the LSE-AJTT-GTC specification on the 2006-24 dataset. In this sample, the final GTC block contains only one year of data (2024). When we increase the Ontario DNSPs' opex in that single year by 20%, holding all other inputs unchanged, the time trend increases significantly in the LSE model by 1% per annum, as shown in Figure 3. On the other hand, the SFA models are largely unaffected with changes of between 0.0% and 0.2% per annum.

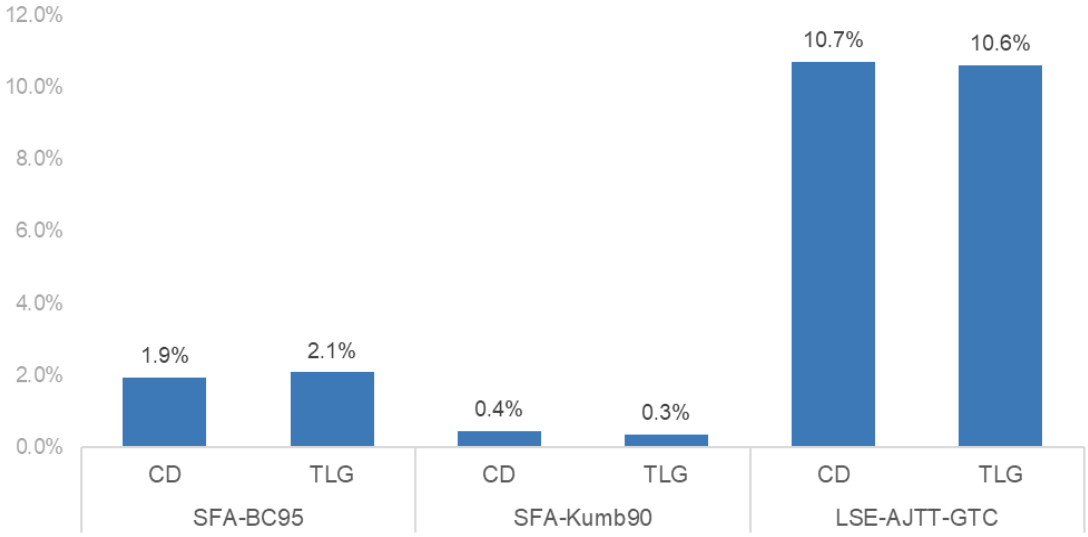
Figure 3: Change in time trend for Australian DNSPs



Note: To make the time trend coefficients comparable between SFA and LSE-AJTT-GTC specifications, the annualised time trend for LSE-AJTT-GTC is derived based on the method in Quantonomics' supporting files: (1) calculate the change between the average GTCs and the last GTC; (2) convert this cumulative change from mid-point to the last year into an annualised change.

This results in an average increase of 10.6%-10.7% in rolled-forward benchmark opex for the LSE model across all Australian DNSPs as shown in Figure 4. By contrast, the two SFA models show only marginal impacts of between 0.3% and 2.1%.

Figure 4: Average impact on 2024 rolled-forward opex across Australian DNSPs



This highlights the issue that under the LSE specification, a single-year change in Ontario DNSPs opex alone can inadvertently and materially impact the roll-forward efficient opex estimates for Australian DNSPs.

Overall assessment of LSE time varying models

In summary, the assumption of a constant rate of efficiency change produces efficiency patterns inconsistent with observed outcomes, the AJTT specification exposes Australian results to unrelated Ontario DNSPs opex movements, and the GTC specification makes the rate of technical change highly sensitive to single-year opex movements.

If the AER remains minded to include an LSE-based time-varying model, the LSE-ADTT specification[7] may partially mitigate some of the issues associated with the AJTT and GTC assumptions by applying a general time trend across all DNSPs, as it reduces sensitivity to single-year movements under GTC and dependence on Ontario data under AJTT. However, it does not address the fundamental misspecification caused by assuming a constant rate of efficiency change over time. It continues to estimate stronger efficiency improvements prior to 2012 and weaker improvements thereafter, in a manner that is inconsistent with observed outcomes.

Based on our assessment we do not consider the LSE specifications to be suitable for inclusion in the AER's benchmarking assessment of Australian DNSPs.

4. Short-period econometric models are redundant

The introduction of time-varying efficiency models provides an opportunity to reconsider the ongoing role of short-period econometric models that largely provided a useful mechanism to understand near term efficiency movements. The use of time-varying efficiency specifications (estimated using long samples) makes the existing short-period models redundant. Quantonomics noted that the short period time varying models fail to converge as shorter data series is unable to support the large number of parameters required.

The existing short period models are also problematic. As shown in Figure 1, the post-2012 period is characterised by materially stronger efficiency catch-up by Australian DNSPs but the existing short period models assume that efficiency is constant over time. When applied to a period of strong efficiency improvement the models are forced to attribute observed opex reductions to other components of the regression, resulting in:

- overstating technical change (frontier shift), and/or
- distorting the estimated relationship between opex and outputs, leading to implausible coefficients or monotonicity violations.

While the constant efficiency assumption impacts the existing long-period models, their effect is largely mitigated due to longer sample having offsetting periods of weak and strong efficiency. We therefore recommend that all short-period econometric models (existing and time varying) be discontinued while the existing long period models can continue to be used.

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[7] Quantonomics noted that the LSE-ADTT specification exhibits substantially higher Variance Inflation Factor (**VIF**) (a statistical test for multicollinearity) than the LSE-AJTT variants and cited this as one of the key reasons for not recommending LSE-ADTT. We note that the high VIFs in the LSE-ADTT arise from the firm-specific time trends not being demeaned in the data generation process. Once these time trends are demeaned, the VIFs for the AJTT and ADTT specifications are comparable.