DTCS FAD further consultation

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1 Overview

1.1 Introduction

1. Optus has commissioned CEG to review a report by Economic Insights (EI), *Domestic Transmission Capacity Services Benchmarking Mode: Testing Further Specifications*, 16 December 2015.[1] EI were commissioned by the Australian Competition and Consumer Commission (ACCC) as part of its enquiry into making a final access determination (FAD) for the domestic transmission capacity service (DTCS).

2. We welcome the analysis of the predicted prices in the model selection process included in EI's most recent report. However, we have a number of reservations with the approach as set out in the report. Specifically, we do not agree that a comparison of actual and predicted prices on regulated routes should be discounted, as material changes in regulated prices would likely not be in the long-term interests of end-users.

3. We also consider that the comparison of the change in average prices should not be the sole basis for comparing actual and predicted prices as it over-weights the effect of changes in the price of high-value services. In addition, we identify what we consider to be errors in EI's predictions for tail end services in model 4 and 5. We also identify a seemingly undocumented change in the approach for classifying tail end services which results in a material increase in the predicted price. When these issues are reconsidered, the predicted prices from model 4b appear to be at least as good as model 1b and model 1c for exempt services and superior for 2Mbps services.

4. We consider that EI's rejection of the stochastic frontier analysis (model 7) is based on a misunderstanding of the specification of the model. Specifically, the inclusion of "Provider" dummies in model 7 creates a price frontier for each provider such that the choice of default provider (Provider [CI]) in the predicted price includes a premium over the efficient pricing frontier for all providers.

5. It can be observed that predicted prices from the random effects model (model 1b) based on lower priced providers (e.g. Provider [CI] or Provider [CI]) would yield similar outcome to the SFA model specification (model 7 with Provider [CI] as the default for predicted prices). This further supports the proposition that no additional premium is warranted as the prices from model 7 are higher than the average prices for lower (more efficient) price providers in model 1b. That is, the prices would be consistent with the commercial interests of efficient providers of the DTCS.

[1] Referred to as "Economic Insights report".

6. In our view when a number of errors are corrected model 4b and potentially model 7b are more appropriate alternative to EI's currently preferred model 1b and model 1c (with price predicted based on Provider [CI]).

1.2 Relevance of predictions for the regulated market

7. EI has incorrectly discounted the predicted prices on regulated routes as a basis of model selection. In reaching its conclusion, EI has failed to take into account:

- the historic use of negotiate/arbitrate regulation which supports a view that current prices are not below cost, as both the provider and the customer had the option to seek cost-based determinations from ACCC in the past; and perhaps more importantly,
- the likelihood that price instability for regulated services will be contrary to efficient investment incentives as access seekers and final users have sunk capital on the basis of current prices - it is notable that the ACCC has historically considered this to be an important consideration in regulating fixed line services.

8. We note that the observed prices in the regulated dataset are, on average, much lower than that what the DAA 2012 benchmarking formula would have predicted. This may be because many of the contracts negotiated before 2012 has not expired since the previous FAD. Moreover, we would generally not expect that prices would be set below the regulated price cap predicted by the model for the DTCS given the purpose of regulation is to constrain the market power of providers on routes with insufficient competition. That is, it would be relatively unusual circumstances for a firm with such market power not to exercise it, whether it is directly through the pricing of the DTCS or higher overall prices when the DTCS is bundled with other services.

1.3 Errors in EI's prediction results

9. There appear to be errors in some of the predictions from EI's model 4 and 5 because all tail end services with 2 Mbps capacity are not treated as 2Mbps service in the Excel spreadsheet used to produce forecasts. Correcting these errors would dissolve EI's concern regarding the over-pricing of tail end services, which is the reason given by EI for rejecting those models.

10. EI has not directly responded to our previous analysis[2] regarding a more accurate method of defining tail end route categories. To the contrary, EI has now adopted a new, even less accurate, method that uses a simple average of the Metro and Regional effects. This new method would result in a significant increase in the

[2] CEG, *Review of the draft decision on DTCS FAD,* October 2015, Appendix B

predicted price for tail end services. We note that the adoption of this method was not (apparent to us) documented in its report.

1.4 Pricing predictions

11. EI's approach to comparing current with predicted prices (based on the change in the average prices) does not give a complete picture of the effect of its model on prices for transmission services. In the context of DTCS regulation, the proportion of services being over/under predicted by the benchmarking model is at least as important as the percentage change in the overall average price.

12. We note that a key purpose of comparing predicted prices with actual prices is to assess the ability of the model to predict individual prices across the range of service types and classifications rather than assess the models ability to provide a similar level of revenue (average price) across all services. To assist in comparing models we include in this report density plots that compare the distribution of actual and predicted monthly charges for both the exempt and regulated dataset (including tail end services).

1.5 Stochastic Frontier Analysis

13. EI reject SFA on the basis that:

- it does not provide an improved fit relative to model 1 when comparing full sample R^2 for the two models;
- it is inappropriate in the context where "the deregulated market is considered to be competitive on average and an average competitive price is considered to be the most suitable benchmark"; and
- it requires a premium be added to ensure prices are sufficient to cover investment costs (and there is no obvious method for estimating such a premium).

14. We find EI's objections to SFA to be on the whole groundless. First, the improvement of SFA cannot be assessed using R squares because residuals from SFA would have a different distribution to a Random Effects model. As a result, the MAE from the SFA model is not comparable to that from other models - the same logic applies to R squares. We show that the SFA forecasts are much closer to the majority of the regulated services, including services that share the common price points.

15. Second, the notion that the deregulated market (or any market for that matter) is "competitive on average" has not clear economic interpretation and does not provide a basis for adopting a benchmark of the average competitive price. The exempt routes are not regulated because the ACCC has determined that competition

is sufficiently developed that regulation is not in the interest of consumers. There are good reasons to believe that prices are not being driven down to efficient cost in the supply of transmission services on exempt routes. These reasons include the inability in the models to explain large variances in prices, the existence of common price points across both regulated and deregulated routes and the strength of the provider effects in the model. Moreover, the significant transaction costs associated with switching providers (due to sunk costs associated with interfaces and the location of services) means that despite reasonably effective competition there will be a wedge between prices and efficient costs in the services provided.

16. Third, EI's claim of the need of an SFA premium is unwarranted and based on an apparent misunderstanding of the specification of model 7, in particular the retention of the "Provider" dummies. The effect of including these dummies in the SFA specification is for the model to fit a different pricing frontier for each provider. In addition, as the predicted prices are based on the default provider (Provider [CI]) the price includes a premium to reflect higher prices that provider charges relative to the efficient pricing frontier for all providers.

17. It can be observed that predicted prices from the random effects model (model 1b) based on lower priced providers (e.g. Provider [CI] or Provider [CI]) would yield similar outcome to the SFA model specification (model 7 with Provider [CI] as the default for predicted prices). This further supports the proposition that no additional premium is warranted as the prices from model 7 are higher than the average prices for lower price (more efficient) providers in model 1b. That is, the prices would be consistent with the commercial interests of efficient providers making investment in providing the DTCS.

1.6 Structure of this report

18. This report is structured as follows:

- section 2 discusses issues with EI's prediction results, identifies and corrects a number of errors, and proposes additional criteria for assessing models;
- section 3 discusses discuses stochastic frontier analysis and responds to the objections raised by EI.

19. At this stage, we have not been asked by Optus to consider other elements of the EI report including its approach to outliers and robust regressions.

2 EI's prediction results

20. We welcome the analysis of the predicted prices in the model selection process included in EI's most recent report. However, we have a number of reservations with the approach as set out in the report. These are discussed in this section.

2.1 Over-prediction to the regulated services is of significant consequence

21. EI has claimed that predictions for the regulated market are less important for the benchmarking exercise because commercial negotiation can be expected when the predicted prices are deemed too high. EI state:[3]

> *If the new models provide lower predictions for the regulated market than the DAA 2012 model but these predictions are not good predictors of the actual prices in the regulated market that is of little consequence because commercial negotiation can lead to actual prices in the regulated market that are less than the regulated prices.*

22. We disagree. It is unlikely in our view that prices would (on average) be negotiated systematically under the level predicted by the final pricing model. This is because the purpose of regulating the DTCS is to constrain the market power of providers on routes with insufficient competition. It would be relatively unusual circumstances for a firm with such market power not to exercise it, whether it is directly through the pricing of the DTCS or higher overall prices when the DTCS is bundled with other (unregulated) services.

23. We also would caution comparisons with the DAA 2012 model. We note that the observed prices in the regulated dataset are, on average, much lower than that what the DAA 2012 benchmarking formula would have predicted. This may be because many of the contracts negotiated before 2012 has not expired since the previous FAD.

24. In addition, we consider a comparison of predicted prices against actual prices on regulated routes is relevant for two reasons:

    i. historic negotiated/arbitrate form of regulation for the DTCS would be expected, albeit imperfectly, to have constrained prices to an approximation of cost (particularly for services purchased by access seekers with the ability to credibly threaten arbitration);

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3 Economic Insights report, p. 9

ii. access seeker and end-users have made sunk investments based on current prices for the DTCS – significant instability in regulated prices is likely to dampen future incentives to make such investment.

25. These points are discussed briefly below.

26. First, it is relevant to recognise that since the DTCS was regulated in 1997 prices have historically been regulated under a "negotiate-arbitrate" model which constrained prices due to the threat of regulation. In 2004, the ACCC established that transmission prices should be based on the Total Service Long-Run Incremental Cost (TSLRIC) principle.[4]

27. We understand that to date, there have been only a small number of disputes lodged with the ACCC and that these were subsequently withdrawn following commercial negotiation. In 2004, the ACCC stated:[5]

> *Since the domestic transmission capacity service was declared in 1997, there have been two disputes notified to the Commission (by AAPT and Primus, both against Telstra)… Both these disputes occurred several years ago and were subsequently settled commercially between the respective parties, circumventing arbitrated outcomes by the Commission.*

28. The threat of cost-based regulation would be expected over time to constrain the range of regulated prices, albeit imperfectly, to a level that allowed the access provider to recover its legitimate cost. In the event an access seeker was to have sought prices below such a level, the access provider could have lodged a dispute and likely received an arbitrated outcome which allowed (at a minimum) for the recovery of efficient cost. Therefore, there can be some level of presumption that the prices satisfy the access provider's legitimate business interests.

29. In contrast, there may be a presumption that some regulated prices are above a level consistent with efficient costs. This is because the fixed cost of arbitrating disputes is not insignificant and smaller access seekers would have a higher unit cost of arbitrating disputes for the DTCS. In other words, larger access seekers can more credibly threaten a dispute because they could spread the fixed costs of the arbitration over more services.

30. Second, stability in prices for regulated service can be important for access seekers (and end-users) making investments in facilities and services that depend on access to the DTCS. If regulation allows the provider to raise prices substantially this could

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4 ACCC, *Pricing Principles for Declared Transmission Capacity Services – Final Report,* September 2004, p. 24

5 ACCC, *Transmission Capacity Service: Review of the declaration for the Domestic Transmission Capacity Service,* April 2004, p. 39

damage competition through expropriating historic investment decisions of access seekers competing with the provider in downstream markets.

31. For example, an access seeker may compete for a business customer requiring access at all its premise in Australia. In order to win the customer, the access seeker may require access to tail ends to a number of those premises and be required to its own sunk investments (e.g., systems to serve the customer). The business consumers may also need to invest in sunk infrastructure that is dependent on being supplied by the access seeker (using the provider's tail end services).

32. The willingness of access seekers and customers (end-users) to make long-lived investments would depend on predictable prices for the DTCS. As the ACCC is required to have regard to the effect of its decision on efficient investment incentives and the promotion of competition, it is appropriate for it to give weight to the comparison of predicted and actual prices for regulated services.

2.2 EI's calculation of predicted 2 Mbps prices is in error

33. EI proposed three different methods to address the concern that its earlier models performed relatively poorly in predicting the price of 2 Mbps service. These methods include:

- excluding all services that are less than 2.5 Mbps and less than 5 km from the estimation sample, and use the average price[6] of the excluded services as the regulated price for these low capacity/distance services (model 4);
- retaining the original sample, adding a dummy for 2.5 Mbps and less than 5 km (model 5);
- Developing a piecewise regression model with a knot at 2.5 Mbps (model 6).

34. EI assessed each of the models based on the predicted prices for a number of service types. Whilst generally noting that model 4 had improved predictions for exempt services relative to the base model (model 1), EI (incorrectly) rejected model 4 because it predicted higher prices for tail end services. EI stated:[7]

> *However, the model 4 predictions for tail end services* ***are substantially higher*** *for model 1. The model 4 predictions for tail end services range from $[CI] to $[CI] whereas the range for model 1 was $[CI] to $[CI] (Table 2.5).*
>
> *Giving most weight to the predictions of the models for the deregulated routes the model 4 specifications appear to offer a small improvement on*

6 This equals to $323.23

7 Economic Insights report, p. 41

the model 1 specifications but the predictions for tail end services ***may be too high****.*

Although the use of the 2.5 Mbps indicator variable results in a lower price for 2 Mbps services on regulated Metro routes, there is an ***increase*** *in the price for tail-end services. Using Model (5b) the average price for tail-end services is $[CI] per month, and with Model (5c) it is $[CI] per month. [Emphasis added]*

35. EI is obviously in error making the above statements. This is because the only reason that tail end price has increased for model 4 and model 5 is that EI' has **not** treated any tail end services as 2Mbps service in the Excel spreadsheet it uses to produce forecasts. In the case of model 4, EI has used the coefficients from the model estimated excluding services less than 2Mbps to estimate the price of tail end services that are 2Mbps. In the case of model 5, EI have not discounted the price of 2Mbps tail end services to reflect the negative coefficient on the 2Mbps dummy in model 5.

36. Given the majority (85%) of tail end services are 2Mbps and with an average distance of 1.3 km for Metro ESAs and 3.74 km for others according to EI's previous report,[8] we can see no obvious reason not to predict the price of 2Mbps tail end services in the same way in which the prices of other 2Mbps services are predicted in both model 4 and model 5.

37. When this error is corrected we find that predicted prices for tail end services from model 4 ranges from $[CI] to $[CI], which is consistent with the range from model 1 which EI calculate to be between $[CI] to $[CI] (and significantly less than the range it calculated for model 4 of $[CI] to $[CI]). We note that EI's other comparisons of model 1 and model 4 using average predicted and actual prices for other categories of service (e.g., 200Mbps metro and Inter-capital) are not materially affected by this error.

38. In addition, Figure 1 below compares the distribution of actual and predicted (log) monthly charges for both the exempt and the regulated dataset (including tail end services) based on EI's model 1b and model 4b. The spikes in the density curves corresponds to the large amount of 2Mbps services in the regulated (70%) dataset. The cyan spikes both lie to the right of the red spikes, suggesting that many of the 2Mbps services are overpriced by each model.

8 Economics Insight, *Domestic transmission capacity services benchmarking model*, September 2015 , p. 56

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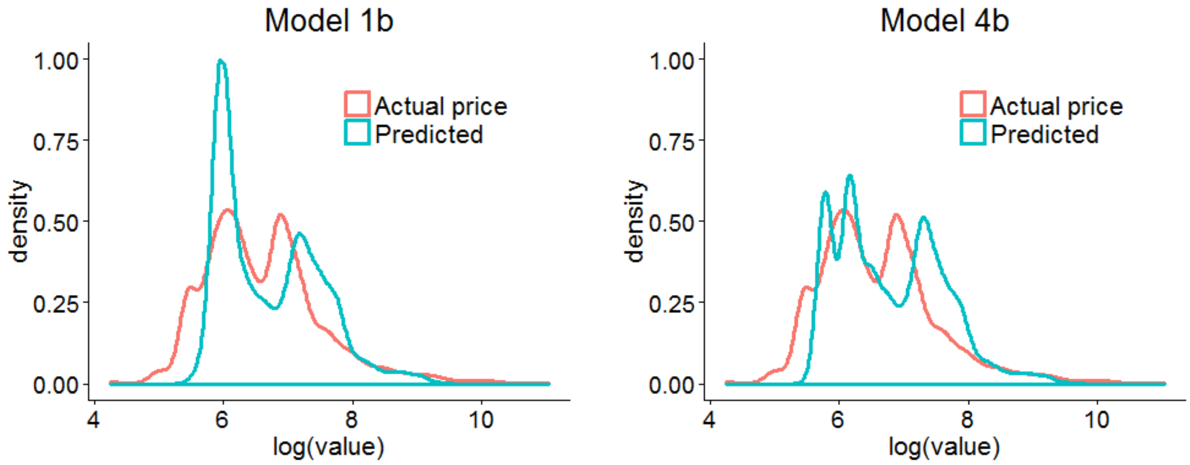
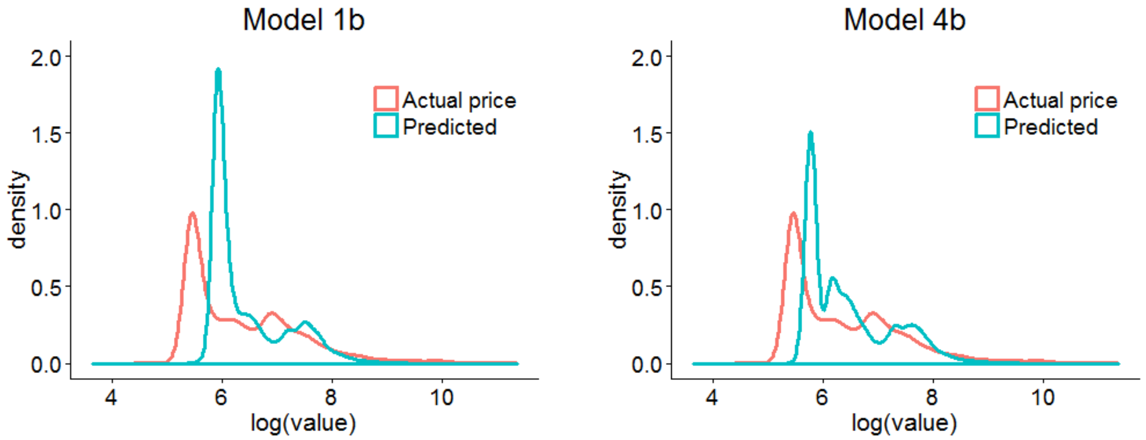
Figure 1: EI’s model 1b and 4b predicted vs. actual price density plot

Exempt



Regulated



Source: ACCC data, CEG analysis

39. In can been seen from above that over-prediction of prices for low capacity/distance services remain an issue for EI’s currently preferred model 1b. In comparison, predictions from model 4b, after correcting the treatment of 2Mbps tail end services, represents a significant improvement from model 1b in terms of providing much closer fit to 2Mbps regulated services.

2.3 Route category effect on tail end services

40. EI has used a simple average the ‘Metro’ and ‘Regional’ effects on tail end services in producing its forecasts. This approach has effectively raised tail end prices by

around $20, on average. We note this additional adjustment was neither explicitly disclosed in the current report nor consistent with EI's previous approach:[9]

> *...it may be appropriate to apply the metro route class effect to ESAs located in capital cities and the regional route class effect to all other ESAs. That is the assumption used in Table 6.1 to calculate the route-class effect for stand-alone tail end services.*

41. In our view, the simple average approach adopted by EI would bias tail end prices upwards as the majority[10] of the tail end services are located in 'Metro' area. To the extent the ACCC regard it necessary to simplify the model, a weighted average of the 'Metro' and 'Regional' dummies should be used for tail end services.[11]

42. In addition, EI has not responded to our previous submission regarding the classification of 'Metro' and 'Regional' categories for tail end services from our October report.[12]

43. We reiterate that EI's current methodology can only identify metropolitan ESAs that are paired with another metropolitan ESA present in the dataset:[13]

> *By definition, Inter-capital and Metro routes have metropolitan ESAs at both ends, so it is possible to identify a set of metropolitan ESAs, but this may not include all of the metropolitan ESAs in the dataset. If we assume that the set of metropolitan ESAs identified in this way is complete, then out of the 409 ESAs with standalone tail-end services, 262 are metropolitan and 147 are regional.*

44. Metropolitan ESAs identified in this way are incomplete because a Metro ESA may be only at one end of a regional routes. Our May 2015 report suggested that most tail-end services are located in metro areas, according to the 'ESA Zone Classification' table from the ACCC website[14]. Tail-end ESAs located in band 1 or 2 zones should be classified as Metropolitan routes. We believe there is value in combining the two methodology. Compared with EI's classification, we have

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9 Economics Insight, *Domestic transmission capacity services benchmarking model*, September 2015 , p. 53

10 74% according to EI's classification and 90% according to CEG's specification as discussed in our October report.

11 Weight being the relative proportion of 'metro' and 'regional' observations for tail end services.

12 CEG, *Review of the draft decision on DTCS FAD,* October 2015, Appendix B

13 Economic Insights, *Domestic Transmission Capacity Services Benchmarking Model: Final Report,* 1 September 2015, p. 56

14 Available at http://www.accc.gov.au/system/files/Appendix%205%20-%20ESA%20Zone%20Classifications.pdf

identified another 73 tail-end ESAs that are located in Metropolitan area, which corresponds to an additional 667 tail end observations that should be re-labelled as 'Metro' rather than 'Regional' services. This is shown in Table 1 below.

Table 1: Route categories for tail-end ESAs

	EI's Route category	CEG's Route category
Metro	263	336
Regional	146	73
Total	409	409

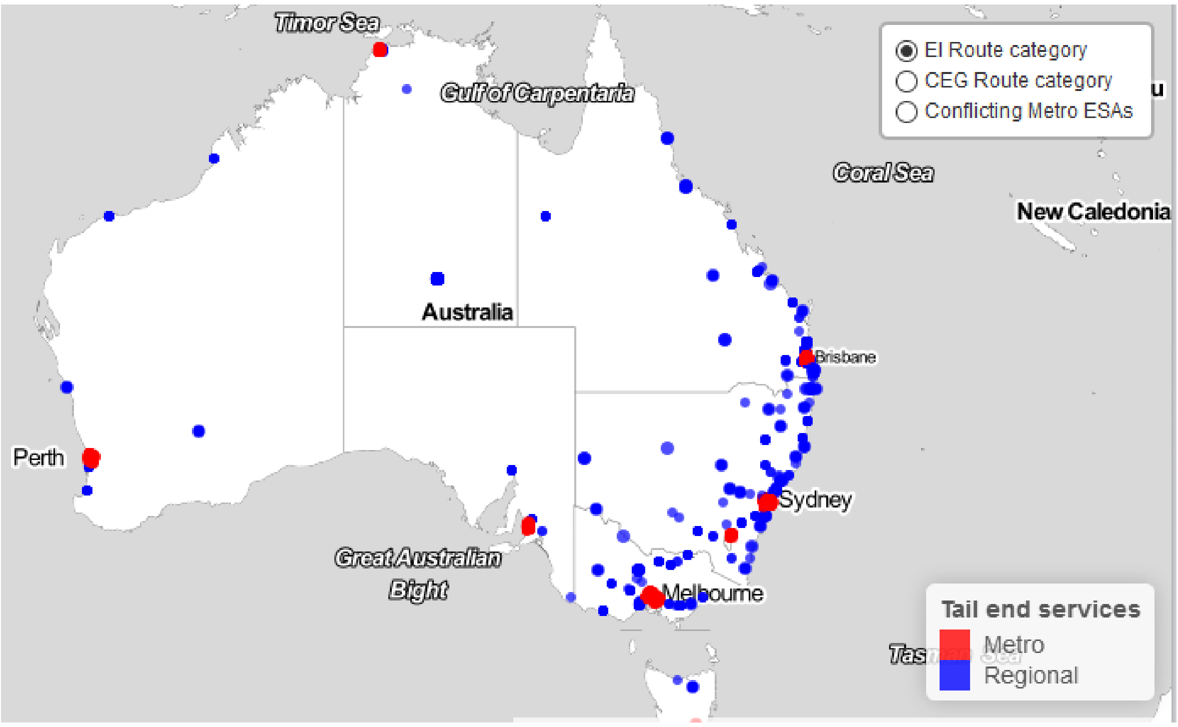
Source: ACCC data, CEG analysis

45. We have identified the geographic location of 406 tail end exchanges based on the National Telephone Exchange database[15]. Figure 2 below shows the location of the tail end services coloured by EI's classification of 'Metro' or 'Regional'. It appears that EI has labelled tail end services as "Metro" only if they are located in one of the capital cities.[16]

15 Available at: http://www.ga.gov.au/corporate_data/74665/NationalTelephoneExchanges.gdb.zip

16 Sydney, Melbourne, Brisbane, Adelaide, Perth and Darwin and Canberra.

Figure 2: Geographic location of tail end exchanges, route category identified by EI



CEG analysis

46. In contrast, using CEG's approach and additional 73 tail end exchanges are identified to be located in a 'Metro' area but not in a capital city. We have provided a list of these additional 'Metro' ESAs in Appendix A. It is notable that EI's approach classifies tail end services in major centres such as the Gold Coast, Geelong, Wollongong, and Newcastle as regional, even though they might be expected to have similar cost characteristics to those in capital cities.

47. We understand that our approach is based on the geographic classifications developed by the ACCC in the context of differentiating the cost of constructing fixed line network across Australia. We would expect this would be a superior method of classification than either of the approaches adopted by EI.

2.4 Criteria to assess predictions

48. We have previously criticised EI's focus on average predicted prices in assessing the impact of the benchmarking on the exempt/regulated services.[17] Because average estimates can be highly influenced by observations from the (right) tail[18] of the

[17] CEG, *Review of the draft decision on DTCS FAD,* October 2015, section 4.1

[18] As Professor Bartels indicated, DTCS pricing exhibits a positively skewed distribution, see section 3.2.1 for details.

distribution, and would overlook the amount of low capacity/distance services that are actually overpriced by the model. We note that the comparison between average predicted and actual prices remains EI's only measure of the impact from the benchmarking in Table 6.4 of its recent report.

49. The drawback of relying solely on average measures can be seen from a side-by-side comparison between Figure 1 and EI's prediction table 2.7. Figure 1 indicates that the predicted (log) price from EI's model 1b is likely to be higher[19] than the actual, on average. However, according to EI's table 2.7, predicted price from model 1b is 34% lower than the actual prices, on average.

50. This seeming anomaly is resolved by seeing that EI has not calculated the percentage change in price for each service, it merely calculates the percentage change in the average price for each group of services. In doing so, information on individual services are masked by the average. The **34%** reduction on average, as calculated by EI, is not representative of the fact that **65%** of the services are currently priced below the predicted price and would face price rises.

51. Essentially, EI's 'percentage difference' is a weighted average of the individual percentage change in prices for each regulated services i:

$$
\begin{aligned}
EI's\ \%\ change &= \%\ difference\ between\ average\ prices \\
&= \frac{[\frac{1}{n} * \sum_{i=1}^{n} predicted_i] - [\frac{1}{n} * \sum_{i=1}^{n} actual_i]}{\frac{1}{n} * \sum_{i=1}^{n} actual_i} \\
&= \frac{\sum_{i=1}^{n}(predicted_i - actual_i)}{\sum_{i=1}^{n} actual_i} \\
&= \sum_{i=1}^{n}\left[\frac{predicted_i - actual_i}{actual_i} * \frac{actual_i}{\sum_{i=1}^{n} actual_i}\right] \\
&= \sum_{i=1}^{n}[\%change\ in\ price_i * w_i], \quad where\ w_i = \frac{actual_i}{\sum_{i=1}^{n} actual_i}
\end{aligned}
$$

52. It can been seen from above that the weight applied to each individual percentage change in EI's averaging is a ratio of the actual price over the sum of all prices. Accordingly, higher priced services would get higher weights while lower prices services get less weight. This explains why the problematic over-prediction of 2 Mbps services is not reflected from EI's prediction tables: they are averaged out by the highly-weighted reduction in prices for 'high-priced services.

53. In the context of DTCS regulation, the proportion of services being over/under predicted by the benchmarking model is, at least, as important as the percentage change in the overall average price. Because the purpose of developing a price

[19] The actual average log price is 6.39, compared with the predicted of 6.44, see Table 2.

formula is for it to be applied to each and every services on the regulated routes, instead of setting a revenue cap for the whole market.

54. Under the current circumstance where the two types of measures, namely the percentage change in average price and the proportion of services being over/under predicted, are pointing at opposite directions, it would be ideal to have another measure that contains the information from both. One suggestion is to amend EI's formula by setting an equal weight on all observations in calculating the 'average percentage change', i.e.:

$$w_i = \frac{1}{n}$$

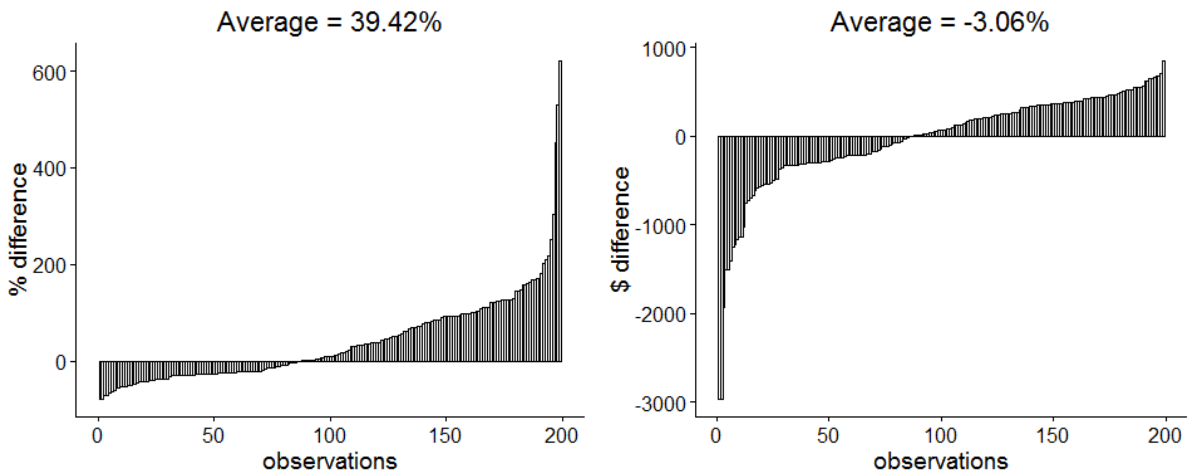
55. The resulted measure has two advantages over EI's formula. Firstly, information on the proportion of services being over/under predicted, especially for 2Mbps services, is (partly) retained because the weight put on each service is no longer determined by price. Secondly, as all of the variables in the model are with log, our measure of "percentage change" is more consistent with the change in the average log prices predicted by the model.

56. To illustrate, Figure 3 below compares the prediction result from Model 1b in terms of the percentage change and the real dollar change for the 144 Inter-capital services below 5 Mbps in the regulated dataset.[20] Observations are aligned in the same order (i.e. from the most negative change to the most positive) because a positive percentage change always corresponds to a positive dollar change, and vice versa. The plot to the left measures the average of percentage change to be 39.42% for the exempt and 16.78% for the regulated dataset; while the plot to the right measures the percentage change in average price to be -3.06% for the exempt and -30.17% for the regulated.

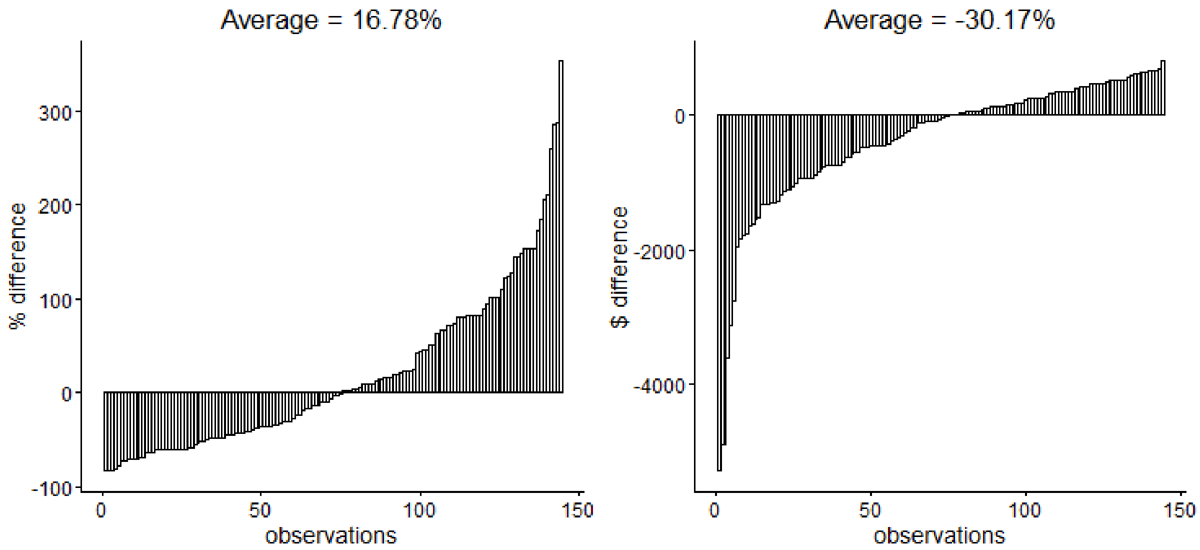
[20] Corresponds to the first category in EI's prediction tables.

Figure 3: Inter-capital service below 5 Mbps prediction result based on Model 1b

Exempt



Regulated



ACCC data, CEG analysis

57. Since observations are aligned in exactly the same order in Figure 3, we can directly compare the percentage and dollar change for the same services. It can be seen that observations associated with higher dollar changes (bars near the left edge of the plot) are typically associated higher prices, because the corresponding percentage changes are small in comparison. In other words, the 'percentage change in average price' as calculated by EI is highly influenced by observations with higher price.

58. This is not to say that the average percentage change measure is, by all accounts, superior. One might equally suggest that such measure would put too much weight on low price services, and overlook the impact on services with higher prices. However, we believe that presenting either of the two measures alone would create

bias in assessing the prediction results. Given that 2 Mbps services presents a significant proportion in the regulated services, the 'average percentage change' measure is a valuable addition to the existing assessment.

59. Table 2 below compares the two alternative measure of 'percentage change' in the regulated dataset from EI's model 1b, 7b and 4b.[21] It can be seen that the 'average percentage change' is more consistent with the difference in predicted and actual log prices and the proportion of services being over-predicted.

Table 2: Percentage change between actual and predicted prices, regulated services

	Actual average price	Predicted average price	Percentage change in average price (EI)	Actual average log of price	Predicted average log of price	Average Percentage change in price (CEG)	Proportion of services being over-predicted
Model 1b	1286.21	848.18	-34%	6.39	6.44	22%	65%
Model 7b	1286.21	488.80	-62%	6.39	5.90	-28%	9%
Model 4b	1286.21	905.86	-30%	6.39	6.46	23%	68%

Source: ACCC data, CEG analysis

60. Table 2 suggests that for the regulated services:

- EI's original model (1b) would result in an average percentage increase of 22%, as oppose to the 34% reduction indicated by the change in average prices;
- EI's SFA model (7b) would result in an average percentage decrease of 28%, compared with the 62% reduction as suggested by the change in average;
- EI' 2 Mbps separate regression (4b) would result in similar average percentage change to 1b, but has improved in predictions for 2 Mbps services (see section 2.1 for detail).

61. We note that predictions for the exempt services exhibits similar pattern. Table 3 below shows that the average percentage change in prices is also much higher than the percentage change in average prices for the exempt services.

21 These three models are chosen because they are more relevant for the discussion in this report.

Table 3: Percentage change between actual and predicted prices, exempt services

	Actual average price	Predicted average price	Percentage change in average price (EI)	Actual average log of price	Predicted average log of price	Average Percentage change in price (CEG)	Proportion of services being over-predicted
Model 1b	1307.01	1161.53	-11%	6.61	6.72	33%	60%
Model 7b	1307.01	703.55	-46%	6.61	6.25	-18%	20%
Model 4b	1307.01	1296.01	-1%	6.61	6.80	45%	64%

Source: ACCC data, CEG analysis

62. Table 2 and Table 3 are extracted from our replication of EI's prediction tables for model 1b, 7b and 4b, which can be found in Appendix B.

3 Stochastic frontier analysis

63. SFA is appropriate in the circumstances when the prices on exempt routes reflect residual market power.

64. We have suggested SFA in our previous reports based on the observation that it is difficult to adequately explain differences in price using variables other than capacity and distance. This result could be the consequence of inefficiency, or lack of competition, in the exempt dataset. Echoing comments from Professor Bartels:[22]

> *Virtually all economic models of pricing indicate that a supplier has no incentive to price services below cost. The fact that there is a large differential in prices for very similar exempt services in the ACCC dataset, and a large spread in the unexplained price residuals after regression), in my view suggests that the* ***prices of at least some services are priced above cost*** *[Emphasis added].*

65. SFA has typically been used to estimate the cost efficiency of firms by modelling an efficient production function. We can apply SFA technic where we estimate a cost-output function for the provision of the DTCS, where the outputs reflect the various characteristics of the service.

3.1 Economic basis for SFA

66. The ACCC has progressively wound back regulation on routes it believes are sufficiently competitive to not warrant regulation[23].

> *The revised methodology requires, as a starting point, that there be a minimum of three independent fibre providers, that is, T+2 fibre providers, at, or within a very close proximity, to a Telstra exchange.*
>
> *Once this initial threshold is met, the ACCC applied a number of additional quantitative and qualitative assessments to determine whether a route should be declared or deregulated.*

67. The threshold for deregulation is not perfect or strong competition. The test is that regulation is not in the long-term interests of end-users. There are good reasons to believe that prices are not being driven down to cost in the supply of transmission services.

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22 Frontier Economics, *Use of ACCC Dataset for DTCS Benchmarking*, April 2015, p. 14

23 ACCC, *Final Report on the review of the declaration for the DTCS,* Marcy 2014, section 3.4

68. The DTCS is used by operators to compete in downstream markets (e.g., broadband, mobile and data service operators use the DTCS in conjunction with their own network equipment to supply services to retail customers). Operators sink their own capital in specific investments that rely on continued access to transmission services. For example:

- operators configure their own network and interconnection points to rely on the interface being supplied by the transmission supplier;
- they locate their mobile towers and other assets based on the location of transmission services.

69. These specific investments give the transmission provider pricing power by virtue of their ability to 'hold-up' the sunk investments of the operator. Even when there are multiple providers of the transmission service to a particular location, the transaction costs in switching provider gives the provider of the transmission service residual pricing power.

70. The positive SDH dummy is apparent evidence of these lock-in effects. The prior understanding (which was noted by EI in its original report and has been ignored in every one of its subsequent reports) is that Ethernet was the new lower cost technology. However, each model ((a), (b) and (c)) in the EI report predicts a higher price for SDH services relative to Ethernet services.

71. The purchase of the DTCS for a particular route is typically part of a large bundled acquisition of providers. This occurs because of the transaction costs of purchasing individual services. The presence of common prices for services that would diverge in the cost of provision is a strong indicator of less than perfect competition. If competition was very strong prices on individual routes would converge to cost and the ability of operators to maintain 'averaged' prices would disappear.

3.2 EI's objection of SFA has no basis

72. EI has implemented SFA using Stata in its December report. However, EI has rejected SFA based on the following reasoning:[24]

> *The full sample R^2 for the stochastic frontier models are very similar to those for Model 1. These results suggest that the stochastic frontier method does not provide a clear improvement over model 1.*
>
> *To ensure prices were sufficient to finance investment and allow for estimation uncertainty, some premium may need to be added, but there is no well define methodology for determining such a premium.*

[24] Economic Insights report, p. 67, p. 74

The concern is that it is not clear the methodology is appropriate if the deregulated market is considered to be competitive on average and an average competitive price is considered to be the most suitable benchmark.

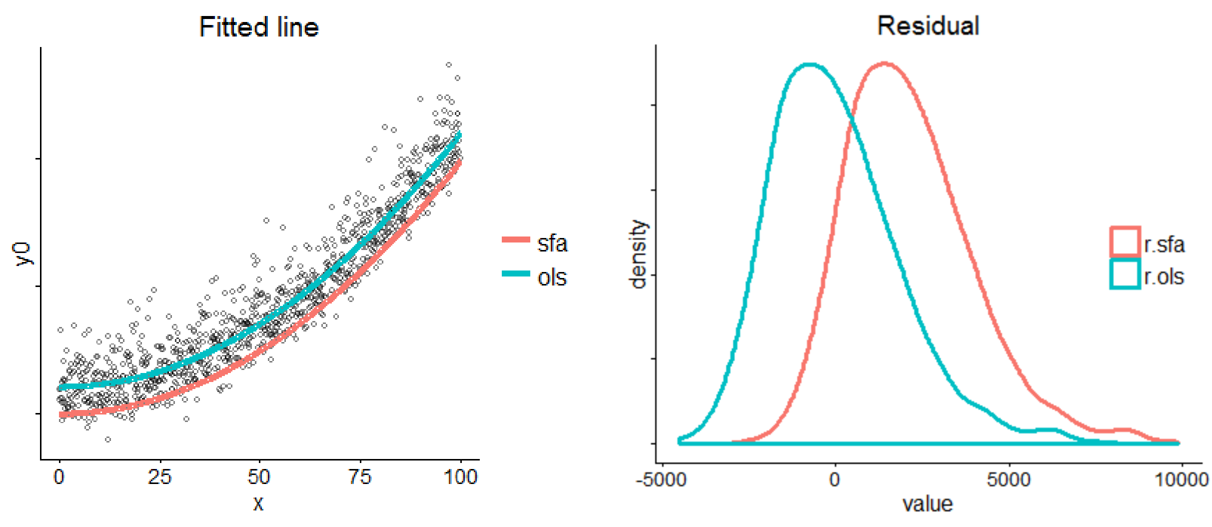
73. In our opinion, the first statement relies on an inappropriate criterion; the second statement is factually incorrect given the parametric form of the SFA model; and the third statement is conceptually incorrect according to the ACCC's competition assessment methodology. We deal with each of the statements in turn.

3.2.1 Improvement over EI's model 1

74. Stochastic Frontier Analysis (SFA) is capable of capturing the lack of competitiveness on price observations by introducing a second (half normally distributed) error term. Since the second error term is non-negative, the combined error term will be positively skewed.

75. To illustrate, Figure 4 below compares the fitted results of SFA[25] and a simple OLS model for 1000 simulated data points[26]. It can be seen that the stochastic frontier (red line) is uniformly below the OLS fitted curve (cyan line) to capture the inefficiency. This is also reflected by the density plot to the right which shows that residuals from the SFA model (red) are not centred around zero, unlike the OLS model.

Figure 4: SFA vs OLS regression scatter and density plot, simulated data



Source: ACCC data, CEG analysis

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[25] Fitted using the sfa() function from the package 'frontier' in R.

[26] y0 <- 2*x^2 + half_normal_error(theta = 0.0005) + normal_error(mean = 0, sd = 1000)

76. Therefore, we agree with EI that either RMSE or MAE would not serve as a valid criterion to assess the SFA model[27]:

> *In the stochastic frontier model…when combined with the ordinary errors, the results will be a highly skewed distribution of residuals. The RMSE's and MAE's calculated from them would* ***not be comparable*** *with those reported for the other models. [Emphasis added]*

77. Nevertheless, we disagree with EI's conclusion that SFA is inferior to the random effects models because 'the full sample R^2 for the stochastic frontier models are very similar to those for Model 1'[28]. As R^2 is essentially a rescaling of MAE[29].

78. We also note that EI has (correctly) excluded the random effects component in calculating the R^2 for various random effects models. However, this does not warrant the use of R^2 to compare against the two types of models. Because in the RE models the route-specific effects are still assumed to be normally distributed around zero.

79. To show this, Figure 5 compares the fitted values and residuals from the SFA and RE[30] models based on EI's specification (b)[31] on the actual exempt dataset. On the left chart, it can be seen that the red dots (SFA prediction) are systematically lower than the blue dots (RE predictions) and mostly fall below the 45 degree line. The density plot on the right shows that the combined error from SFA has a positive average while the error from the RE model is centred around zero[32].

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27 Economic Insights report, p. 74

28 Economic Insights report, p. 74

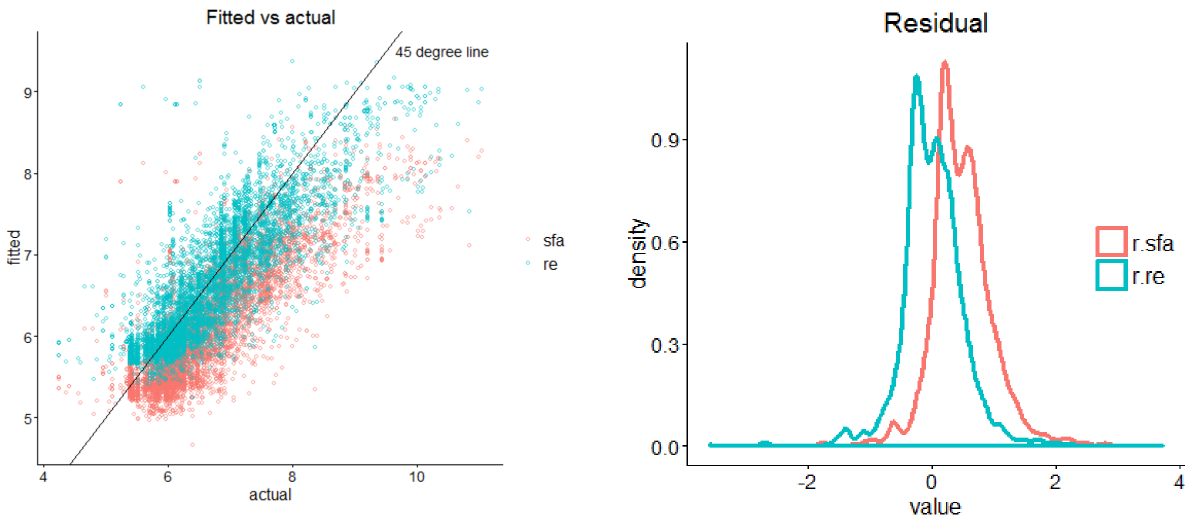
29 Woolridge, *Introductory Econometrics – A Modem Approach*, Chapter 2, pp.38-40

30 Excluding the route-specific random effects.

31 That is, include route and ESA throughput but not contract start date as predictors.

32 Based on ue (as defined by EI), the average is 0.005; while the average of the SFA error is 0.48

Figure 5: SFA vs RE model (b) scatter and density plot, exempt data



Source: ACCC data, CEG analysis

80. It follows that the fit of the model is not an appropriate criterion to assess the stochastic frontier method. We note that Professor Bartels has suggested that SFA is a suitable alternative because the OLS residuals are positively skewed and the SFA prediction for regulated routes are less biased in predictions for services belong to the lower quantile:[33]

> *For a cost function, the (OLS) residuals are expected to be positively skewed. I have conducted the sktest in Stata for this purpose, which confirms that the OLS residuals are positively skewed and that the skewness is statistically highly significant (p-value=0.0000).*
>
> *Table 4 can be compared directly with Table 1. This comparison shows that the SFA predictions have far less bias than either of EI's preferred models.*

81. We have reproduced Professor Bartels' Table 4 based on EI's model 1b (RE) and model 7b (SFA) in Table 4 below. This comparison shows that the SFA predictions are much closer to the actual prices for services with common price points.

33 Bartels, *Review of ACCC's draft benchmarking model,* July 2015, pp. 19-21

Table 4: Comparison of SFA and RE predicted prices for services at common price points on exempt routes

Monthly charge[34] ($)	Number of services	Model 1b average predicted price ($)	Model 1b bias	Model 7b average predicted price ($)	Model 7b bias
[CI]	[CI]	[CI]	64.8%	[CI]	6.0%
[CI]	[CI]	[CI]	67.1%	[CI]	8.2%
[CI]	[CI]	[CI]	48.9%	[CI]	-10.4%
[CI]	[CI]	[CI]	48.8%	[CI]	-9.4%

Source: ACCC data, CEG analysis

82. As indicated in our October report[35], the over prediction of prices for common price points has a material impact on the regulated services. While these services consist of only 7.5% of the exempt services, they represent 34% of the declared services with more than 4000 data points. Table 5 shows the corresponding actual and predicted prices for regulated services that share the top 4 common prices. It can be seen that the SFA predictions are, on average, much closer to the actual price points.

Table 5: Comparison of SFA and RE predicted prices for services at common price points on declared routes

Monthly charge[36] ($)	Number of services	Model 1b average predicted price ($)	Model 1b bias	Model 7b average predicted price ($)	Model 7b bias
[CI]	[CI]	[CI]	67.5%	[CI]	-2.0%
[CI]	[CI]	[CI]	62.9%	[CI]	-4.3%
[CI]	[CI]	[CI]	57.8%	[CI]	-7.1%
[CI]	[CI]	[CI]	54.2%	[CI]	-9.1%

Source: ACCC data, CEG analysis

83. Figure 6 below show compares the distribution of actual and predicted monthly charges for the regulated dataset based on EI's model 1b (RE) and 7b (SFA). The spikes in the density curves correspond to the large amount of 2Mbps services in the regulated ([CI]%) dataset. It can be seen that the SFA model has the advantage of avoiding over-prediction of these 2 Mbps services, including services with the top 4 common price points.

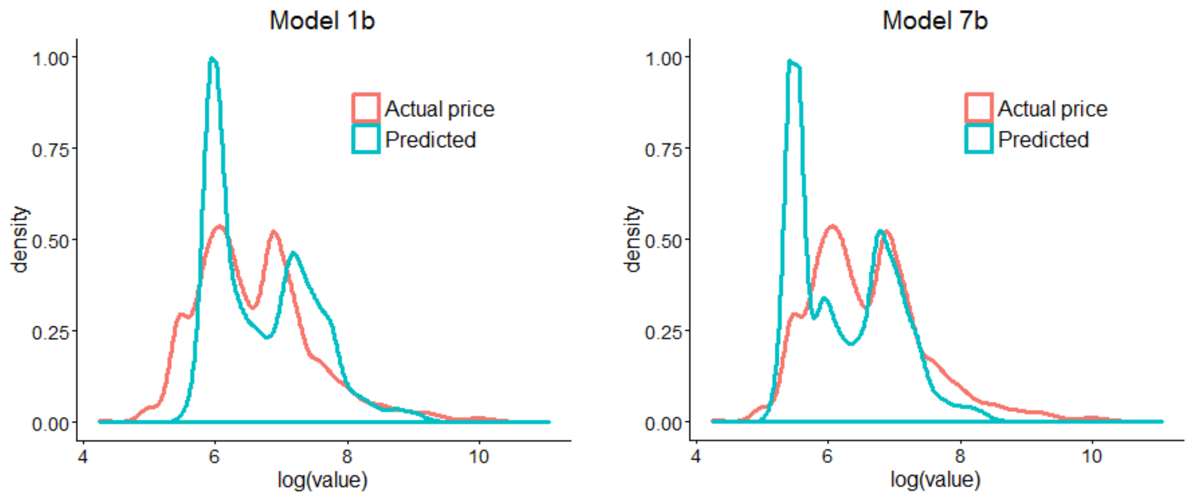
34 The top 4 common prices in this table has been adjusted for GST by the ACCC.

35 CEG, *Review of the draft decision on DTCS FAD,* October 2015, section 4.2

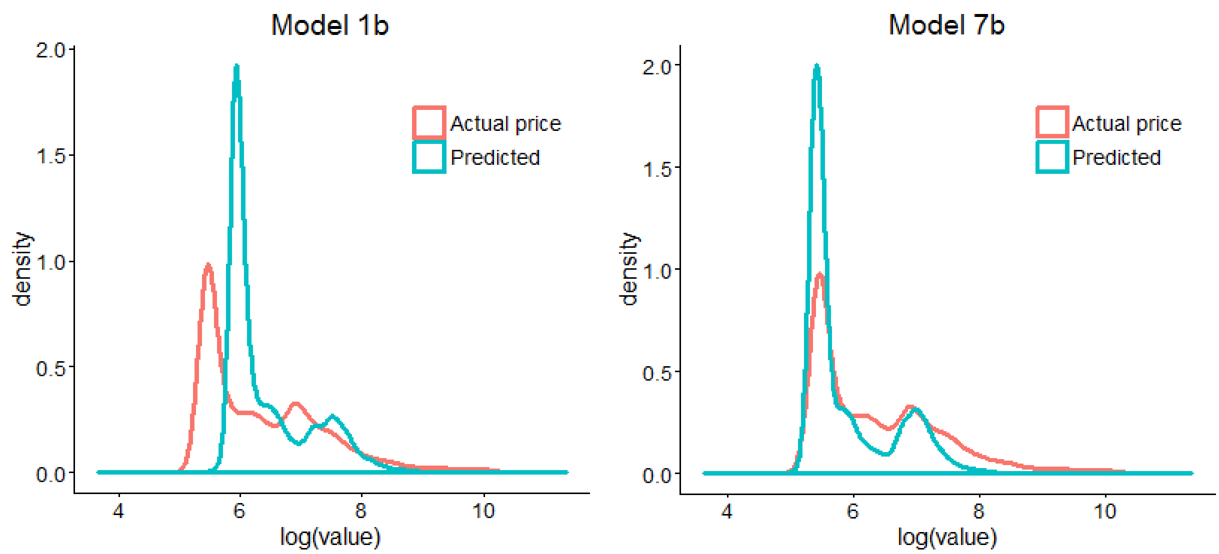
36 The top 4 common prices in this table has been adjusted for GST by the ACCC.

Figure 6: EI's model 1b and 7b predicted vs. actual price density plot

Exempt



Regulated



Source: ACCC data, CEG analysis

84. In this context, it is also notable that the common price points were negotiated some time ago prior to the 2012 FAD. Whilst the basis on which these negotiations occurred are not known to us, it appears obvious that the parties agreed the commercial terms of such prices as adequate to cover costs on both declared and exempt routes.

85. As explained in section **Error! Reference source not found.** and **Error! ference source not found.** in detail, we disagree with EI's opinion that predictions on the actual regulated market is 'of limited consequence'. Regulated services that have been under contract since prior to 2012 have not been set using

the DAA 2012 model. This means that prices that are coming up for renegotiation for the first time in some while will rise significantly. The regulated prices are constraining the pricing of firms with market power, therefore it would be relatively unusual circumstances for a firm with such market power not to exercise it.

3.2.2 The premium for SFA models

86. EI had previously rejected SFA based on the belief that the predicted price would be too low and a premium must be added:[37]

> *A problem with the SFA approach in this context is that it would forecast lower prices based on an efficiency interpretation of the unexplained variation in the data, but given the scope of this variation, a premium would then need to be added to ensure prices were sufficient to finance investment and allow for estimation uncertainty.*
>
> *But it is not clear what the premium should be or how to calculate it.*

87. EI has maintained this view in its recent report:[38]

> *..the stochastic frontier model would predict lower prices than the random effects model…*
>
> *To ensure price were sufficient to finance investment and allow for estimation uncertainty, some premium may need to be added, but there is no well-defined methodology for determining such a premium.*

88. We believe EI's claim is unwarranted. To the extent the purpose of the pricing principle for the DTCS is to replicate the cost efficiency reflected in competitive market prices on declared routes, this will be diluted if an SFA interpretation is not adopted. The ACCC's rationale for using econometric benchmarking highlights the cost efficiency objective:[39]

> *In using the pricing information on those effectively competitive routes to determine the prices on uncompetitive routes, the benchmarking approach is designed to eliminate the possibility of monopoly profits being earned on uncompetitive routes and to* ***mimic the cost efficiency achieved on competitive routes****. [Emphasis added]*

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37 Economic Insights, *Domestic Transmission Capacity Services Benchmarking Model, 1 September 2015*, p. 44

38 Economic Insights report, p. 67

39 ACCC, *Public Inquiry to make a Final Access Determination for the Domestic Transmission Capacity Service,* Draft Decision, page 18.

89. Further to this, we note that the "Provider" dummies are retained in EI's SFA specification. Both CEG[40] and Professor Bartels[41] have previously argued that, while the provider dummies is capturing the average difference in prices charged by different providers, this is a long way from being evidence in the dataset to rule out market power that makes a significant contribution to these price differences.

90. The effect of including these dummies in the SFA specification is for the model to fit a different pricing frontier for each provider. This is referred as the 'true' fixed effects model by Greene (2002).[42]

91. To illustrate, Figure 7 below simulated 1000 points that has a combination of normal and half normal distribution. The plot on the left[43] corresponds to the situation when all providers are equally efficient (same as those simulated for Figure 4); while the plot to the right[44] is when different providers are associated with different level of efficiency. (Provider A being the most efficient firm with lowest prices controlling for the x, etc.)

40 CEG, *Review of the draft decision on DTCS FAD*, October 2015, p.

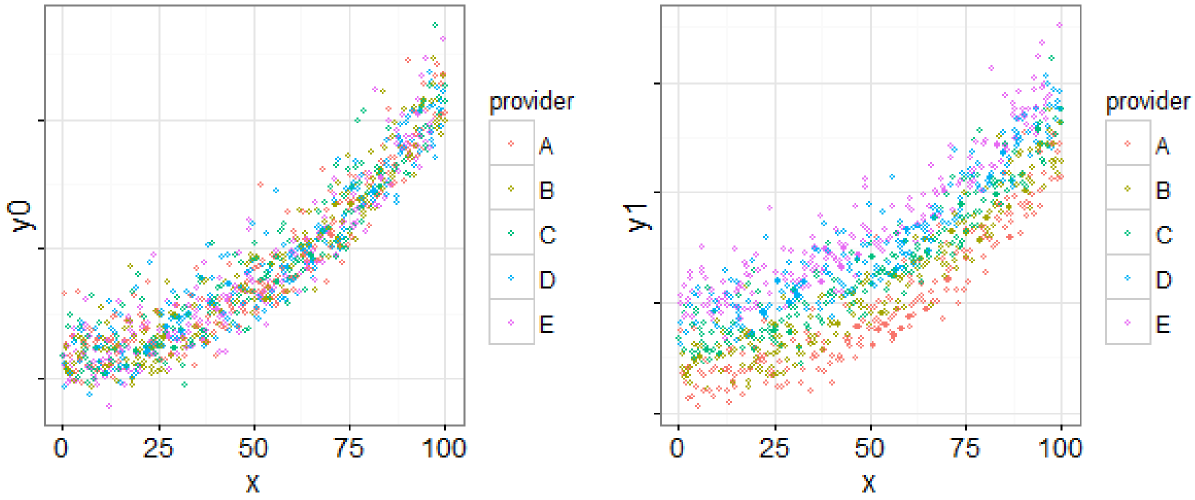
41 VHA, *Submission on the October expert reports of Professor Breusch and CEG,* Dec 2015, section 2

42 Greene, W., *Fixed and Random Effects in Stochastic Frontier Models*, Department of Economics, Stern School of Business, New York University, October, 2002.

43 y0 <- 2*x^2 + half_normal_error(theta = 0.0005) + normal_error(mean = 0, sd = 1000); variable x resides in a range of 1 to 100, the parameter for the normal and half normal distribution (i.e. theta, sd) are chosen such that the scale of the variation in the error terms is comparable to that of x and y0

44 y1 <- provider_effect + 2*x^2 + half_normal_error(theta = 0.0005) + normal_error(mean = 0, sd = 1000); variable x resides in a range of 1 to 100, the parameter for the normal and half normal distribution (i.e. theta, sd) is chosen such that the scale of the variation in the error terms are comparable to that of x and y0

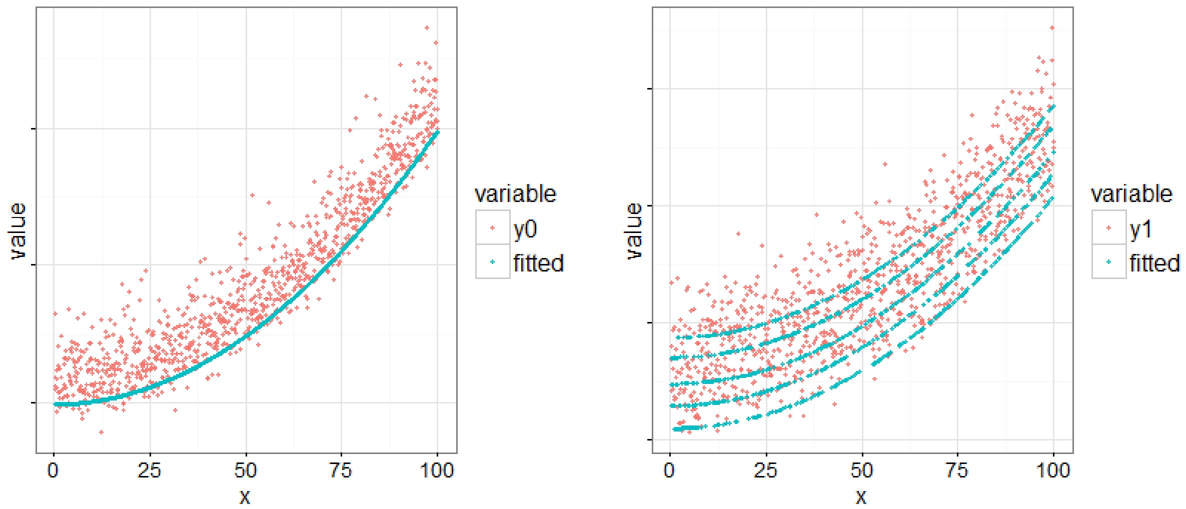
Figure 7: Provider effects scatter plot, simulated data



Source: CEG analysis

92. By including the provider dummies, the stochastic frontier method would seek to estimate a different pricing frontier for each provider. This is shown in Figure 8 below. The plot on the left shows that a single frontier will be fitted at (close to) the bottom of the distribution, as oppose to five different frontiers in the plot to the right.

Figure 8: SFA fitted vs actual scatter plot, simulated data



Source: CEG analysis

93. The pattern shown for the simulated data is indicative of what EI's SFA is modelling for the exempt dataset. It effectively fits a different pricing frontier for each of providers. Figure 9 presents two scatter plots of actual vs. fitted monthly charge[45] based on different providers from EI's SFA model 7b for actual exempt data. The red dots are the actual observed log of monthly charge; and the cyan dots are the fitted values. The plot on the left corresponds to the situation when the largest provider is used to fit the data (the status quo); while the plot to the right is when provider [CI] (with the lowest provider effect) is used.

Figure 9: SFA fitted vs actual based on different provider dummies (Provider [CI] vs Provider [CI]) scatter plot, exempt data

[CI] [CI]

Source: ACCC data, CEG analysis

94. Based on these reasons, we disagree with EI's view that forecast from SFA is 'too low' and 'some premium may need to be added'. To the contrary, EI's current SFA model has already added a premium to all services by adopting the price frontier from the [CI] provider. A similar approach, namely the 'corrected least squares' as proposed by Professor Bartels[46], would result in a lower frontier.

3.2.3 Competitiveness in the currently deregulated routes

95. EI has raised the concern that:

> *…it is not clear the (SFA) methodology is appropriate if the deregulated market is considered to be competitive on average and an average competitive price is considered to be the most suitable benchmark.*

96. However, EI have not provided any evidence to show that the deregulated market is "competitive on average". Not a term with clear economic interpretation. To the contrary, as Professor Bartels has argued, evidence from the deregulated dataset suggests prices on 'exempt' routes exhibit non-competitive characteristics[47]:

> *The prices used for the benchmarking exercise exhibit characteristics that are plainly incompatible with competitive prices. For example, it is widely accepted that bundling transmission services is common when setting prices, a point highlighted by the eJV data. As I have demonstrated in previous reports submitted as part of the review process, this leads to biased estimates of the parameters in the benchmarking model.*

45 with respect to log(Capacity).

46 Frontier Economics, *Use of ACCC Dataset for DTCS Benchmarking*, April 2015, p. 15

47 VHA, *Submission on the October expert reports of Professor Breusch and CEG,* Dec 2015, section 4

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> *Another indication that many of the prices used to estimate the benchmarking model are unlikely to be competitive is the extremely wide range of unexplained variation in the prices. The standard deviation of the prediction error is roughly 70%. In other words, the prices of comparable services have an extremely wide range around their average value with about 1/3 of the prices being at least 70% higher or lower than the average relationship. It would be hard to think of a truly competitive market with mostly large clients having such a wide range of prices for comparable products.*
>
> *This strongly suggests that the dataset used to estimate the benchmarking model is contaminated by non-competitive prices. As I understand it, the objective of the ACCC's benchmarking model is to determine future efficient prices that can be applied to obtain prices on declared routes that are equivalent to the prices that would be negotiated in a competitive market at the time the prices are determined. That is quite a different exercise to determining an overall average relationship.*

97. It should also be noted that criteria for a route being exempt (not declared) is not perfect competition. According to the ACCC's report[48] which describes the methods adopted to assess competition for the DTCS:

> *The revised methodology requires, as a starting point, that there be a minimum of three independent fibre providers, that is, T+2 fibre providers, at, or within a very close proximity, to a Telstra exchange.*
>
> *Once this initial threshold is met, the ACCC applied a number of additional quantitative and qualitative assessments to determine whether a route should be declared or deregulated.*

98. The ACCC regularly updates its criteria to assess competition and there were re-declaration of previously deregulated DTCS routes[49]:

> *During the 2008 Exemption Decision the ACCC also identified additional criteria that it applied to regional and metropolitan routes to test competition.*
>
> *In its 2009 Declaration Decision, the ACCC found that effective competition did not exist in the tail-end market and that the relevant markets for many inter-exchange services (or metropolitan services, as identified by the DTCS FAD) exhibited limited contestability.*

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48 ACCC, *Final Report on the review of the declaration for the DTCS,* Marcy 2014, section 3.4

49 ACCC, *Final Report on the review of declaration for the DTCS,* March 2014, pp. 34, 47

> *In applying the revised competition methodology, the ACCC has identified a total of three routes which are currently deregulated and fail to meet the revised competition methodology.*

99. In light of this, we agree with Professor Bartels that residual market power in the currently deregulated market should not be discounted. Because such residual market power is likely to lead to monopoly pricing above the efficient cost. If the objective of the benchmarking is to estimate cost-based prices that eliminates monopoly profits on declared routes, the ACCC should seriously take into account the SFA interpretation.

3.3 Comparison of the alternatives to SFA

100. As argued in the previous section, the stochastic frontier method is capable of capturing the lack of competitiveness/efficiency on price observations by introducing a second (half normally distributed) error term. The SFA interpretation means that the benchmarking exercise should focus on lower spectrum of the distribution.

101. We note that Professor Bartels had previously suggested a number of alternatives to SFA:[50]

> *a discount of about 17% applied to the QR predictions would bring them to about the same level as the SFA+20% predictions, while a 24% discount would bring them to about the same level as the SFA+10% predictions. For the RE predictions the corresponding discounts are 24% and 31% respectively.*

102. To the extent that the ACCC would not prefer a discount factor, selecting the lower priced providers (e.g. provider [CI] or provider [CI]) as the benchmark[51] for the current model 1b would yield similar outcome.

103. Table 6 below provides a summary of the prediction for the models fitted using the two lower providers on the regulated services. Detailed results can be found in Appendix C.

[50] Frontier, *Review of ACCC's draft benchmarking model*, July 2015, p. 21

[51] We note Professor Barterls had similar suggestion in his recent report.

Table 6: Prediction summary for alternative models to SFA, regulated and exempt services

	Actual average price	Predicted average price	Percentage change in average price (EI)	Actual average log of price	Predicted average log of price	Average Percentage change in price (CEG)	Proportion of services being over-predicted
Regulated							
Model 7b	1286.21	488.80	-62%	6.39	5.90	-28%	9%
Model 1b with provider [CI]	1286.21	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
Model 1b with provider [CI]	1286.21	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
Exempt							
Model 7b	1307.01	703.55	-46%	6.61	6.25	-18%	20%
Model 1b with provider [CI]	1307.01	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
Model 1b with provider [CI]	1307.01	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]

Source: ACCC data, CEG analysis

104. It can be seen that on average, predicted price fitted using Provider [CI] is slightly lower, while it is bit higher under Provider [CI]. This is more obvious from Figure 10 below. Therefore, we believe using EI's model 1b based on either provider [CI] or [CI] will provider similar outcome as the SFA model 7b.

Figure 10: EI's model 1b based on alternative providers predicted vs. actual price density plot

Exempt

[CI]

Regulated

[CI]

Source: ACCC data, CEG analysis

Appendix A EI regional ESAs that should be identified as metro

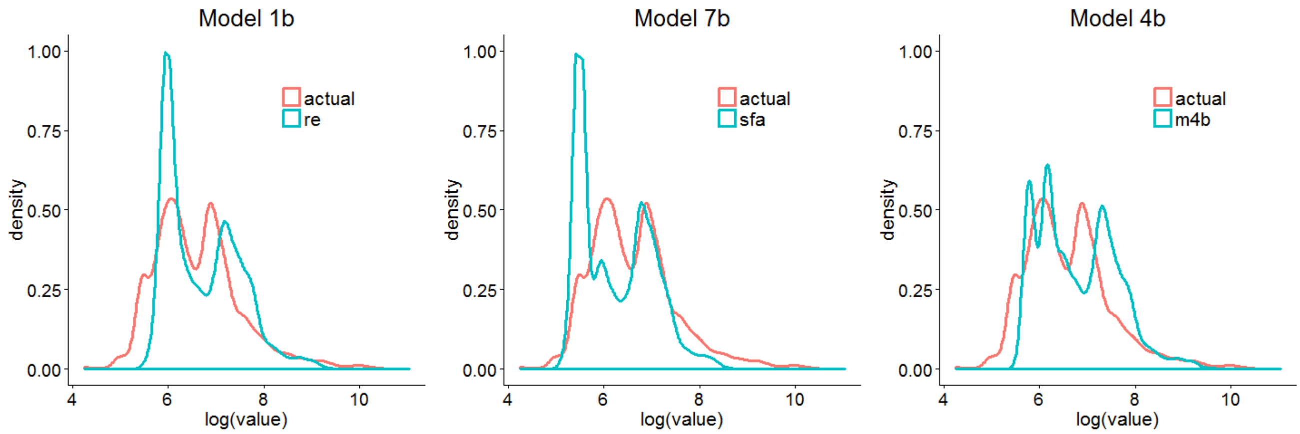
Table 7: List of ESAs located in metro area

ESA names					
Bendigo	Maroochydore	Cleveland	Warilla	Ipswich	Wendouree
Geraldton	Rockingham	Warrnambool	Arundel	Middle Ridge	Wolfe
St John	Southport	Corio	Ashmore	Mildura	Waterford
Ballarat	Surfers Paradise	Orange	Belmont	Moolap	Lismore
Albury	Toowoomba	Beenleigh	Bowral	Merrimac	Ballina
Bundaberg	Wagga Wagga	Loganholme	Caloundra	Mount Hutton	Maitland
Bunbury	Wollongong	Buderim	Coombabah	Port Kembla	Nelson Bay
Coffs Harbour	Wurtulla	Mayfield	Charlestown	Rothwell	Valentine
Cairns	Devonport	North Geelong	Corrimal	Shepparton	
Geelong	Robina	Mooloolaba	Cardiff	Sebastopol	
Gosford	Long Jetty	New Lambton	Currumbin	Tamworth	
Gulliver	Narangba	Caboolture	Frenchville	Townsville	
Mackay	Boolaroo	Burleigh Heads	Hamilton	Transit Hill	

Source: ACCC data, CEG analysis

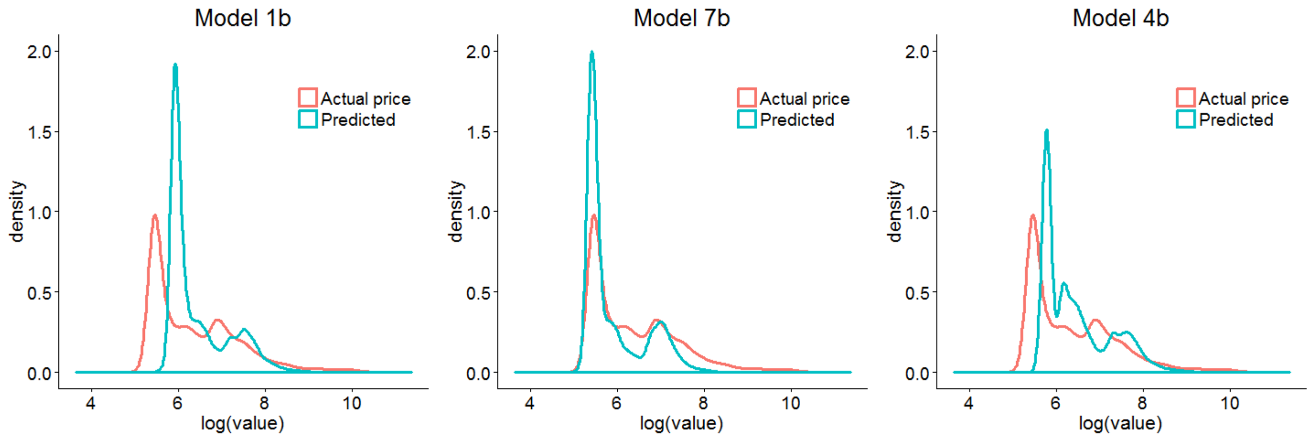
Appendix B Replication of EI's prediction from model 1b, 4b and 7b

Figure 11: EI's model 1b, 4b and 7b Density plot, exempt data



Source: ACCC data, CEG analysis

Figure 12: EI's model 1b, 4b and 7b density plot, regulated data



Source: ACCC data, CEG analysis

Table 8: Model 1b prediction table

Regulated

Capacity.level	Route.category	observed	predicted	CEG.change	EI.change	over	under	count
< 5Mbps	Intercapital	1209	844	17%	-30%	69	75	144
< 5Mbps	Metro	378	395	20%	5%	1834	837	2671
< 5Mbps	Regional	1043	595	-9%	-43%	982	1521	2503
< 5Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
5-50 Mbps	Intercapital	2881	1664	-1%	-42%	33	48	81
5-50 Mbps	Metro	1074	726	-11%	-32%	143	262	405
5-50 Mbps	Regional	3995	1339	-42%	-66%	42	263	305
5-50 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
50-200 Mbps	Intercapital	6677	2552	25%	-62%	52	38	90
50-200 Mbps	Metro	1524	1462	32%	-4%	525	178	703
50-200 Mbps	Regional	6129	2365	25%	-61%	301	285	586
50-200 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
>200 Mbps	Intercapital	11784	4188	36%	-64%	25	28	53
>200 Mbps	Metro	2023	2045	32%	1%	353	147	500
>200 Mbps	Regional	5198	3518	45%	-32%	234	121	355
>200 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
NA	Intercapital	4437	1924	18%	-57%	179	189	368
NA	Metro	824	794	21%	-4%	2855	1424	4279
NA	Regional	2472	1209	-1%	-51%	1559	2190	3749
NA	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
NA	Total	1286	848	22%	-34%	8149	4405	12554

Exempt

Capacity.level	Route.category	observed	predicted	CEG.change	EI.change	over	under	count
< 5Mbps	Intercapital	812	787	39%	-3%	113	86	199
< 5Mbps	Metro	398	387	14%	-3%	1447	1284	2731
< 5Mbps	Regional	504	531	60%	5%	224	108	332
5-50 Mbps	Intercapital	1534	1431	54%	-7%	154	119	273
5-50 Mbps	Metro	859	693	3%	-19%	637	636	1273
5-50 Mbps	Regional	1884	1363	22%	-28%	31	25	56
50-200 Mbps	Intercapital	2432	2482	93%	2%	152	62	214
50-200 Mbps	Metro	1399	1335	33%	-5%	900	319	1219
50-200 Mbps	Regional	3475	2173	30%	-37%	81	50	131
>200 Mbps	Intercapital	7621	5659	238%	-26%	130	137	267
>200 Mbps	Metro	1979	2058	38%	4%	701	183	884
>200 Mbps	Regional	4449	3424	50%	-23%	81	48	129
NA	Intercapital	3290	2717	111%	-17%	549	404	953
NA	Metro	923	882	19%	-4%	3685	2422	6107
NA	Regional	2009	1511	49%	-25%	417	231	648
NA	Total	1307	1162	33%	-11%	4651	3057	7708

Source: ACCC data, CEG analysis

Table 9: Model 7b prediction table

Regulated

Capacity.level	Route.category	observed	predicted	CEG.change	EI.change	over	under	count
< 5Mbps	Intercapital	1209	460	-36%	-62%	25	119	144
< 5Mbps	Metro	378	240	-27%	-36%	249	2422	2671
< 5Mbps	Regional	1043	308	-52%	-70%	90	2413	2503
< 5Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
5-50 Mbps	Intercapital	2881	973	-42%	-66%	7	74	81
5-50 Mbps	Metro	1074	469	-42%	-56%	34	371	405
5-50 Mbps	Regional	3995	719	-68%	-82%	9	296	305
5-50 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
50-200 Mbps	Intercapital	6677	1451	-27%	-78%	37	53	90
50-200 Mbps	Metro	1524	942	-15%	-38%	73	630	703
50-200 Mbps	Regional	6129	1287	-32%	-79%	242	344	586
50-200 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
>200 Mbps	Intercapital	11784	2303	-24%	-80%	21	32	53
>200 Mbps	Metro	2023	1291	-17%	-36%	48	452	500
>200 Mbps	Regional	5198	1833	-22%	-65%	145	210	355
>200 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
NA	Intercapital	4437	1081	-34%	-76%	90	278	368
NA	Metro	824	500	-25%	-39%	404	3875	4279
NA	Regional	2472	639	-47%	-74%	486	3263	3749
NA	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
NA	Total	1286	489	-28%	-62%	1083	11471	12554

Exempt

Capacity.level	Route.category	observed	predicted	CEG.change	EI.change	over	under	count
< 5Mbps	Intercapital	812	431	-24%	-47%	56	143	199
< 5Mbps	Metro	398	239	-29%	-40%	492	2239	2731
< 5Mbps	Regional	504	280	-15%	-44%	57	275	332
5-50 Mbps	Intercapital	1534	833	-10%	-46%	85	188	273
5-50 Mbps	Metro	859	467	-30%	-46%	153	1120	1273
5-50 Mbps	Regional	1884	751	-32%	-60%	13	43	56
50-200 Mbps	Intercapital	2432	1430	12%	-41%	92	122	214
50-200 Mbps	Metro	1399	886	-12%	-37%	212	1007	1219
50-200 Mbps	Regional	3475	1189	-28%	-66%	38	93	131
>200 Mbps	Intercapital	7621	2925	68%	-62%	86	181	267
>200 Mbps	Metro	1979	1328	-10%	-33%	207	677	884
>200 Mbps	Regional	4449	1787	-21%	-60%	52	77	129
NA	Intercapital	3290	1469	14%	-55%	319	634	953
NA	Metro	923	573	-23%	-38%	1064	5043	6107
NA	Regional	2009	804	-20%	-60%	160	488	648
NA	Total	1307	704	-18%	-46%	1543	6165	7708

Source: ACCC data, CEG analysis

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Table 10: Model 4b prediction table

Regulated

Capacity.level	Route.category	observed	predicted	CEG.change	EI.change	over	under	count
< 5Mbps	Intercapital	1209	914	26%	-24%	73	71	144
< 5Mbps	Metro	378	414	23%	10%	1971	700	2671
< 5Mbps	Regional	1043	636	-6%	-39%	1091	1412	2503
< 5Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
5-50 Mbps	Intercapital	2881	1827	8%	-37%	38	43	81
5-50 Mbps	Metro	1074	800	-1%	-26%	165	240	405
5-50 Mbps	Regional	3995	1466	-36%	-63%	54	251	305
5-50 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
50-200 Mbps	Intercapital	6677	2788	35%	-58%	52	38	90
50-200 Mbps	Metro	1524	1571	42%	3%	542	161	703
50-200 Mbps	Regional	6129	2574	35%	-58%	309	277	586
50-200 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
>200 Mbps	Intercapital	11784	4759	51%	-60%	28	25	53
>200 Mbps	Metro	2023	2189	41%	8%	391	109	500
>200 Mbps	Regional	5198	3883	59%	-25%	246	109	355
>200 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
NA	Intercapital	4437	2127	28%	-52%	191	177	368
NA	Metro	824	848	26%	3%	3069	1210	4279
NA	Regional	2472	1314	4%	-47%	1700	2049	3749
NA	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
NA	Total	1286	906	23%	-30%	8528	4026	12554

Exempt

Capacity.level	Route.category	observed	predicted	CEG.change	EI.change	over	under	count
< 5Mbps	Intercapital	812	842	49%	4%	117	82	199
< 5Mbps	Metro	398	402	16%	1%	1401	1330	2731
< 5Mbps	Regional	504	551	64%	9%	225	107	332
5-50 Mbps	Intercapital	1534	1550	66%	1%	173	100	273
5-50 Mbps	Metro	859	825	23%	-4%	831	442	1273
5-50 Mbps	Regional	1884	1494	35%	-21%	33	23	56
50-200 Mbps	Intercapital	2432	2744	111%	13%	158	56	214
50-200 Mbps	Metro	1399	1503	50%	7%	978	241	1219
50-200 Mbps	Regional	3475	2355	41%	-32%	88	43	131
>200 Mbps	Intercapital	7621	6545	292%	-14%	138	129	267
>200 Mbps	Metro	1979	2292	54%	16%	732	152	884
>200 Mbps	Regional	4449	3733	63%	-16%	87	42	129
NA	Intercapital	3290	3070	136%	-7%	586	367	953
NA	Metro	923	984	30%	7%	3942	2165	6107
NA	Regional	2009	1631	57%	-19%	433	215	648
NA	Total	1307	1296	45%	-1%	4961	2747	7708

Source: ACCC data, CEG analysis

Appendix C Prediction results from alternative models to SFA

Figure 13: Alternative models to SFA density plot, exempt data

[CI]

Source: ACCC data, CEG analysis

Figure 14: Alternative models to SFA density plot, regulated data

[CI]

Source: ACCC data, CEG analysis

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Table 11: Model 1b based on Provider [CI]

Regulated

Capacity.level	Route.category	observed	predicted	CEG.change	EI.change	over	under	count
< 5Mbps	Intercapital	1209	461	-36%	-62%	25	119	144
< 5Mbps	Metro	378	215	-34%	-43%	22	2649	2671
< 5Mbps	Regional	1043	325	-51%	-69%	52	2451	2503
< 5Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
5-50 Mbps	Intercapital	2881	908	-46%	-68%	7	74	81
5-50 Mbps	Metro	1074	396	-51%	-63%	17	388	405
5-50 Mbps	Regional	3995	730	-68%	-82%	9	296	305
5-50 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
50-200 Mbps	Intercapital	6677	1392	-32%	-79%	37	53	90
50-200 Mbps	Metro	1524	797	-28%	-48%	44	659	703
50-200 Mbps	Regional	6129	1290	-32%	-79%	222	364	586
50-200 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
>200 Mbps	Intercapital	11784	2285	-26%	-81%	18	35	53
>200 Mbps	Metro	2023	1116	-28%	-45%	23	477	500
>200 Mbps	Regional	5198	1919	-21%	-63%	134	221	355
>200 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
NA	Intercapital	4437	1049	-36%	-76%	87	281	368
NA	Metro	824	433	-34%	-47%	106	4173	4279
NA	Regional	2472	660	-46%	-73%	417	3332	3749
NA	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
NA	Total	1286	463	-33%	-64%	671	11883	12554

Exempt

Capacity.level	Route.category	observed	predicted	CEG.change	EI.change	over	under	count
< 5Mbps	Intercapital	812	429	-24%	-47%	55	144	199
< 5Mbps	Metro	398	211	-38%	-47%	104	2627	2731
< 5Mbps	Regional	504	290	-12%	-43%	58	274	332
5-50 Mbps	Intercapital	1534	781	-16%	-49%	67	206	273
5-50 Mbps	Metro	859	378	-44%	-56%	43	1230	1273
5-50 Mbps	Regional	1884	743	-34%	-61%	9	47	56
50-200 Mbps	Intercapital	2432	1354	5%	-44%	80	134	214
50-200 Mbps	Metro	1399	728	-28%	-48%	116	1103	1219
50-200 Mbps	Regional	3475	1185	-29%	-66%	35	96	131
>200 Mbps	Intercapital	7621	3086	84%	-60%	83	184	267
>200 Mbps	Metro	1979	1123	-25%	-43%	126	758	884
>200 Mbps	Regional	4449	1868	-18%	-58%	53	76	129
NA	Intercapital	3290	1482	15%	-55%	285	668	953
NA	Metro	923	481	-35%	-48%	389	5718	6107
NA	Regional	2009	824	-19%	-59%	155	493	648
NA	Total	1307	634	-28%	-52%	829	6879	7708

Source: ACCC data, CEG analysis

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Table 12: Model 1b based on Provider [CI]

Regulated

Capacity.level	Route.category	observed	predicted	CEG.change	EI.change	over	under	count
< 5Mbps	Intercapital	1209	589	-19%	-51%	45	99	144
< 5Mbps	Metro	378	275	-16%	-27%	940	1731	2671
< 5Mbps	Regional	1043	415	-37%	-60%	403	2100	2503
< 5Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
5-50 Mbps	Intercapital	2881	1161	-31%	-60%	11	70	81
5-50 Mbps	Metro	1074	506	-38%	-53%	47	358	405
5-50 Mbps	Regional	3995	934	-59%	-77%	16	289	305
5-50 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
50-200 Mbps	Intercapital	6677	1780	-13%	-73%	40	50	90
50-200 Mbps	Metro	1524	1020	-8%	-33%	275	428	703
50-200 Mbps	Regional	6129	1650	-13%	-73%	268	318	586
50-200 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
>200 Mbps	Intercapital	11784	2922	-5%	-75%	22	31	53
>200 Mbps	Metro	2023	1427	-8%	-29%	148	352	500
>200 Mbps	Regional	5198	2454	1%	-53%	197	158	355
>200 Mbps	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
NA	Intercapital	4437	1342	-18%	-70%	118	250	368
NA	Metro	824	554	-16%	-33%	1410	2869	4279
NA	Regional	2472	844	-31%	-66%	884	2865	3749
NA	Tail end	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]	[CI]
NA	Total	1286	592	-15%	-54%	5615	6939	12554

Exempt

Capacity.level	Route.category	observed	predicted	CEG.change	EI.change	over	under	count
< 5Mbps	Intercapital	812	549	-3%	-32%	77	122	199
< 5Mbps	Metro	398	270	-21%	-32%	680	2051	2731
< 5Mbps	Regional	504	370	12%	-27%	134	198	332
5-50 Mbps	Intercapital	1534	998	8%	-35%	109	164	273
5-50 Mbps	Metro	859	483	-28%	-44%	158	1115	1273
5-50 Mbps	Regional	1884	951	-15%	-50%	16	40	56
50-200 Mbps	Intercapital	2432	1731	35%	-29%	109	105	214
50-200 Mbps	Metro	1399	931	-7%	-33%	341	878	1219
50-200 Mbps	Regional	3475	1516	-9%	-56%	60	71	131
>200 Mbps	Intercapital	7621	3947	136%	-48%	102	165	267
>200 Mbps	Metro	1979	1436	-4%	-27%	237	647	884
>200 Mbps	Regional	4449	2388	5%	-46%	70	59	129
NA	Intercapital	3290	1895	47%	-42%	397	556	953
NA	Metro	923	615	-17%	-33%	1416	4691	6107
NA	Regional	2009	1054	4%	-48%	280	368	648
NA	Total	1307	810	-7%	-38%	2093	5615	7708

Source: ACCC data, CEG analysis