Estimating gamma

Report for Aurizon Network

6 March 2014

SFG CONSULTING
Level 1, South Bank House
Cnr. Ernest and Little Stanley St
South Bank, QLD 4101

PO Box 29
South Bank, QLD 4101

Email: s.gray@sfgconsulting.com.au
Office: +61 7 3844 0684
Phone: +61 419 752 260

Contents

1. Background and conclusions

Overview and instructions

1. SFG Consulting (**SFG**) has been retained by Aurizon Network (**Aurizon**) to provide our views on issues relating to the estimation of the gamma parameter. In particular, we have been asked to address issues relating to the stability of dividend drop-off estimates of the value of distributed imputation credits, raised by Vo, Gellard and Mero (2013) and Lally (2013).

Summary of conclusions

2. Our main conclusions are set out below.

Estimation approach

3. We agree with the QCA's general approach (which is consistent with regulatory practice and the submissions of stakeholders) of estimating gamma as the product of:

    a) The imputation credit distribution rate, *F*; and

    b) The value of distributed imputation credits, θ or "theta."

4. Our view is that the QCA's current estimate of the imputation credit distribution rate, 80%, is inconsistent with Australian regulatory practice, the submissions of all stakeholders and the available empirical evidence. We recommend that the distribution rate should be set to 70%.

5. Our view is that the value of distributed imputation credits must be determined using empirical estimation. The most prominent approach for empirically estimating the value of distributed imputation credits is dividend drop-off analysis.

Dividend drop-off analysis

6. Two current dividend drop-off estimates of the value of distributed imputation credits are available:

    a) A point estimate of 0.35 from SFG (2011) and SFG (2013); and

    b) A range of 0.35 to 0.55 from its own study, Vo et al (2013).

7. In our view, there are a number of reasons to prefer the SFG studies to the ERA study:

    a) The SFG approach has been subjected to an unusual amount of scrutiny. All data and computer code was supplied to the AER. All issues that the AER has identified have been considered by the Tribunal. And the Tribunal has endorsed and adopted the results. By contrast, the ERA study has not been subjected to such scrutiny;[1]

    b) The SFG studies employ the standard, Tribunal-approved and AER-approved approach of correcting prices for market movements over the ex-dividend day; and

[1] We understand that the ERA study has been submitted to an academic journal for publication. If this is the case, the ERA could release the referee report and editorial decision to document the degree of scrutiny to which its study has been subjected.

c) The SFG theta estimates have been shown to be stable and reliable in the face of a battery of stability and robustness checks, whereas Vo et al (2013) express concerns about the stability and reliability of their own results.

8. In any event, there is little evidence to support the Vo et al (2013) mid-point estimate of 0.45 from within the range of 0.35 to 0.55:

   a) The Vo et al estimates are overwhelmingly below 0.45 (see Figure 1 and Figure 3 above), and a significant proportion of those estimates are below 0.35;

   b) Vo et al reports a theta estimate of 0.34 when the standard ex-day market correction is applied;

   c) The Vo et al estimate increases only to 0.4 when the standard ex-day market correction is removed;

   d) The SFG (2013) estimates indicate that, if anything, the 0.35 estimate is towards the upper end of the reasonable range.

9. In our view, there is no reasonable basis for adopting a dividend drop-off estimate of theta above 0.35.

2. QCA approach

Gamma to be estimated as the product of two components

10. The practice of the QCA has always been to estimate gamma as the product of:

    a) The imputation credit distribution rate, *F*; and

    b) The value of distributed imputation credits, θ or "theta." [2]

11. This approach is consistent with prior regulatory practice, with stakeholder submissions, and with the approach that has been adopted by all other Australian regulators. In our view, this approach is uncontroversial and we agree with it.

Distribution rate set to 80%

12. The QCA currently uses a gamma value of 0.5 based on:

    a) A distribution rate of 0.8; and

    b) A value of distributed credits of 0.625.[3]

13. In the Australian regulatory context, the widely-accepted value for the distribution rate is now 0.7.[4] McKenzie and Partington (2013) state that the distribution rate "can be measured reasonably well from taxation statistics and a value of 70% is widely accepted."[5] The value of 0.7 was also proposed by the QRC.[6]

14. Moreover, in its Final Guideline, the ERA proposes to use an estimate of 70% for the distribution rate, or "payout ratio" as the ERA refers to it.[7] The ERA notes that this estimate has been adopted by the Australian Competition Tribunal and is consistent with the most recent empirical evidence.[8] We also note that the AER has also recently adopted a distribution rate of 70% based on its assessment of the relevant empirical evidence.[9]

15. In our view, there is no basis for the QCA maintaining its current estimate of 80% and a value of 70% should be adopted.

Market value of distributed credits to be estimated using empirical methods

16. The original basis for the QCA's estimate of 0.625 for the value of distributed credits (which the QCA has adopted in every one of its decisions) is explained in the QCA's 2001 Electricity Distribution Final Decision. In particular, the 0.625 was originally based on the empirical estimates from the unpublished working paper of Hathaway and Officer (1999).[10]

---

[2] See, for example, DBCT Draft Decision 2004, Footnote 22, p. 176 and p. 178.
[3] See, for example, DBCT Draft Decision 2004, Footnote 22, p. 176 and p. 178.
[4] AER (2013), Draft Cost of Capital Guideline, p. 24.
[5] McKenzie and Partington (2013), p. 31.
[6] QRC WACC Submission, p. 20.
[7] ERA, Final Guideline, p. 9.
[8] ERA, Explanatory Statement, Paragraphs 926-928.
[9] AER, Final Guideline, p. 23.
[10] QCA 2001 Electricity Distribution Final Decision, pp. 100-103.

17. Section 5 of our report of 16 January 2014 establishes in some detail why the value of distributed imputation credits must be determined using empirical estimation rather than on the basis of theoretical reasoning.[11]

18. The most prominent approach for empirically estimating the value of distributed imputation credits is dividend drop-off analysis, which is the focus of this report. The subsequent section examines the dividend drop-off analyses that are available for consideration by the QCA and discusses the relative merits of each.

[11] SFG, 2014, *An appropriate regulatory estimate of gamma*.

3. Dividend drop-off analysis

Current dividend drop-off estimates of theta

19. Three dividend drop-off analyses are currently available for consideration:

    a) The SFG (2011) study that was accepted by the Tribunal in the *Gamma* case;[12]

    b) An updated study performed by SFG (2013) and recently submitted to the AER;[13] and

    c) A drop-off analysis performed by ERA staff.[14]

20. The SFG study that was accepted by the Tribunal and the updated version of that study both recommend a point estimate of 0.35 from within a range of point estimates around 0.35.

21. The ERA study performed by Vo et al (2013) concludes that:

> The appropriate range suggested by this study is between 0.35 and 0.55.[15]

22. In summary, the QCA faces two dividend drop-off estimates – 0.35 and a range of 0.35 to 0.55. The key question surrounds the relative weights to be applied to each study. In the subsequent sub-sections we set out evidence that is relevant to the relative weights to be applied to these studies.

The merits of the SFG studies

23. The SFG studies arose out of a direction from the Australian Competition Tribunal in what has become known as the *Gamma* Case. In that case, the AER had sought to rely on a dividend drop-off study by Beggs and Skeels (2006)[16]. The Tribunal held[17] that the AER was wrong to rely on an out-dated and methodologically unsound dividend drop-off study. The Tribunal then directed that a "state-of-the-art" dividend drop-off study should be conducted to assist the Tribunal.[18] The Tribunal also directed that the dividend drop-off study to be performed by SFG "should employ the approach that is agreed upon by SFG and the AER as best in the circumstances."[19]

24. After agreement could not be reached between the parties, the Tribunal ruled that:

    a) The four variations of the econometric specification of dividend drop-off analysis drawn by SFG from the literature should be used; and

    b) The results for the full updated period should be used rather than a number of sub-periods.

25. SFG then conducted the dividend drop-off study and circulated a draft report to all parties. The AER and the regulated businesses that were parties to the *Gamma Case*[20] provided detailed comments on the

[12] Application by Energex Limited (Gamma) (No 5) [2011] ACompT 9 (12 May 2011), Paragraph 29.
[13] SFG (2013), Updated dividend drop-off estimate of theta, 7 June 2013.
[14] Vo et al (2013).
[15] Vo et al (2013), Abstract.
[16] Beggs, D. J. and Skeels, C.L., (2006), "Market arbitrage of cash dividends and franking credits," *Economic Record*, 82 (258), 239 – 252.
[17] Application by Energex Limited (No 2) [2010] ACompT 7 (13 October 2010), Paragraphs 66, 145.
[18] Application by Energex Limited (No 2) [2010] ACompT 7 (13 October 2010), Paragraph 146.
[19] Application by Energex Limited (No 2) [2010] ACompT 7 (13 October 2010), Paragraph 147.
[20] Application by Energex Limited (No 2) [2010] ACompT 7 (13 October 2010).

draft report and these were taken into account in a revised report that was provided to all parties and to the Tribunal.

26. Although the AER submitted[21] that the SFG study had departed from the Terms of Reference, the Tribunal disagreed and accepted the estimates from the SFG dividend drop-off study:

> The Tribunal is satisfied that the procedures used to select and filter the data were appropriate and do not give rise to any significant bias in the results obtained from the analysis. Nor was that suggested by the AER.[22]
>
> In respect of the model specification and estimation procedure, the Tribunal is persuaded by SFG's reasoning in reaching its conclusions. Indeed, the careful scrutiny to which SFG's report has been subjected, and SFG's comprehensive response, gives the Tribunal confidence in those conclusions.[23]

27. The Tribunal went on to conclude that:

> The Tribunal is satisfied that SFG's March 2011 report is the best dividend drop-off study currently available for the purpose of estimating gamma in terms of the Rules.[24]

and

> The Tribunal finds itself in a position where it has one estimate of theta before it (the SFG's March 2011 report value of 0.35) in which it has confidence, given the dividend drop-off methodology. No other dividend drop-off study estimate has any claims to be given weight vis-à-vis the SFG report value.[25]

28. The SFG study concluded that:

> For the reasons set out in detail in this report, we conclude that the appropriate estimate of theta from the dividend drop-off analysis that we have performed is 0.35 and that this estimate is paired with an estimate of the value of cash dividends in the range of 0.85 to 0.90.[26]

29. The SFG (2013) study employs the same methodology as the SFG (2011) study, but extends the data set through to the end of 2012. The conclusion from that study is that:

> the conclusions from that earlier study remain valid when tested against the updated data set.[27]

Problems with the Vo et al (2013) approach

30. Vo, Gellard and Mero (2013) from the Economic Regulation Authority of Western Australia (**ERA**) have recently produced a drop-off study that essentially follows the methodology of the SFG studies. One important deviation from the SFG methodology is that Vo et al also present results that are

[21] Application by Energex Limited (Gamma) (No 5) [2011] ACompT 9 (12 May 2011), Paragraph 16.
[22] Application by Energex Limited (Gamma) (No 5) [2011] ACompT 9 (12 May 2011), Paragraphs 18-19.
[23] Application by Energex Limited (Gamma) (No 5) [2011] ACompT 9 (12 May 2011), Paragraph 22.
[24] Application by Energex Limited (Gamma) (No 5) [2011] ACompT 9 (12 May 2011), Paragraph 29.
[25] Application by Energex Limited (Gamma) (No 5) [2011] ACompT 9 (12 May 2011), Paragraph 38.
[26] SFG (2011), Paragraph 3.
[27] SFG (2013), Paragraph 6.

based on analysis that omits the standard market adjustment. The standard approach in dividend drop-off studies is to assume that, but for the dividend, the stock price would have followed the movement in the broad market over the ex-dividend day. That is, if the broad market index increases by 2% over the ex-dividend day, it is assumed that, but for the dividend, the particular stock would also have increased by 2%.

31. We are unaware of any recent paper in a peer-reviewed journal that does not make such an adjustment. It is not surprising, therefore, that Vo et al would have to make the adjustment to "enable a comparison of results to those from other studies." [28]

32. However, Vo et al (2013) also report results in the absence of this standard market adjustment on the basis that, but for the dividend, a particular stock price might have moved (over the ex-dividend day) by somewhat more or less than the market. For example, it is possible that when the broad market increases by 2%, a particular stock might have moved (but for the dividend) by 1.8% or by 2.2%.

33. Omitting the market adjustment entirely is certain to be an inferior estimate on average. Whereas individual stocks might have moved by somewhat more or less than the broad market, on average stocks will move exactly in accordance with the market index, by definition.[29] That is, the standard market adjustment produces estimates of "but for the dividend" stock price movements that are unbiased on average – in the sense that it is equally likely that (but for the dividend) the stock might have moved somewhat more or somewhat less than the broad market index. Omitting the market adjustment entirely is to assume that (but for the dividend) the stock price would not have moved at all. Such an omission creates a bias. If the broad market increased by 2% over the ex-dividend day, the assumption that the stock price would have been 0% is clearly likely to be a material under-estimate, on average.

34. The reason Vo et al (2013) provide for reporting results that omit the standard market correction is that "applying the market correction is an unnecessary complication to an already complex econometric task." [30] However, the correction is necessary to produce unbiased and reliable estimates and it is *not* difficult to implement. Indeed Vo et al have already implemented the standard approach in their own study. In fact, the only new information provided by the Vo et al study is to also show how the results would have looked if a non-standard and inferior methodology had been employed. For these reasons, our view is that the subset of the results in the Vo et al paper that are based on analysis that omits the standard market adjustment should receive no weight.

35. When the standard market adjustment is performed, the Vo et al (2013) study confirms the results from the SFG studies. In particular, the SFG studies conclude that an appropriate value for theta is 0.35. Vo et al report that, when the standard market correction is applied, the average estimate of theta is 0.34. The estimate using robust regression and Model Specification 4 (which the ERA considers to be the most reliable estimate) is 0.33.[31]

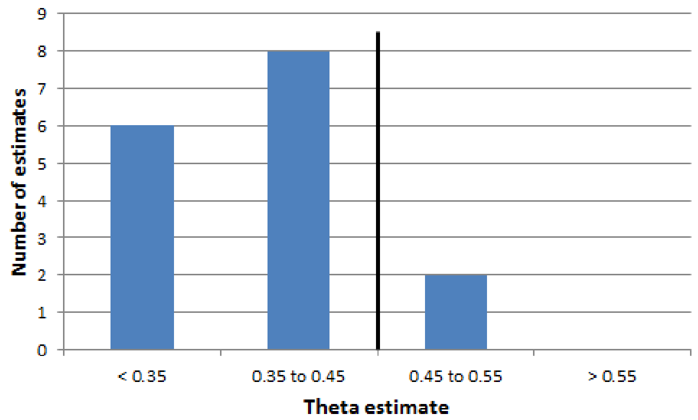
36. Even when no market correction is applied, Vo et al (2013) report an average theta estimate of 0.40 and a robust regression estimate from Model Specification 4 of 0.32.

37. In fact, there is very little evidence to support the Vo et al (2013) mid-point estimate of 0.45 at all. The Vo et al estimates of theta are summarised in Figure 1 below. This figure summarises the point estimates for all different model specifications and estimation methodologies (with and without the standard ex-day market correction) except for the OLS estimates, which Vo et al deem to be

[28] Explanatory Statement, Paragraph 956.
[29] This is because the market portfolio is an average taken over all stocks.
[30] Vo, Gellard and Mero (2013), p. 32.
[31] Vo, Gellard and Mero (2013), Table 5.

inappropriate.[32] The figure shows that the vast majority of estimates fall below the mid-point estimate (marked as a line). Moreover, whereas a material number of estimates fall below the bottom of the range (less than 0.35) there are no estimates above the top end of the range (0.55).

Figure 1. Distribution of ERA theta estimates



Source: Vo et al (2013), Table 5.

38. In summary, our view is that the Vo et al (2013) study errs in omitting the standard market adjustment that is applied in dividend drop-off studies. Moreover, even setting aside this problem, the results that are presented do not support the range of 0.35 to 0.55 that is adopted.

Issues raised by Lally (2013)

39. Lally (2013) raises questions about the general reliability of dividend drop-off analysis by pointing to apparent differences between the results from the SFG (2011,2013) and Vo et al (2013) studies:

> despite using the same methodology and data filtering rules to data from an almost identical period (July 2001 to July 2012 versus July 2001 to October 2012), Vo et al (2013) and SFG (2013a) generate some quite dramatic differences in results.[33]

40. However, this conclusion appears to be at odds with the facts. SFG (2013) adopt a theta estimate of 0.35. Vo et al (2013) report a mean theta estimate of 0.34.[34] Vo et al also report a theta estimated using robust regression applied to model specification 4 (the specification that was afforded most weight by SFG) of 0.33. The difference between these estimates is statistically and economically insignificant. Indeed, Lally (2013) also recognises the equivalence of the main results:

> In respect of SFG's preferred approach involving model 4 and "robust regression", SFG estimate *U* at 0.38 (SFG, 2013a, Table 3) whilst Vo et al (2013, Table 5) estimate it at 0.36.[35]

41. The only point of difference between the two studies appears to be in relation to the OLS estimates. On this point, Lally (2013) notes that the SFG OLS estimate is in accordance with estimates from other methods, but the Vo et al OLS estimate is an implausible outlier:

---

[32] Vo et al (2013), p. 9.
[33] Lally (2013), p. 21.
[34] Vo et al (2013), Table 5, p. 24.
[35] Lally (2013), p. 21, where the theta estimates reported by SFG and Vo et al have been converted into estimates of Lally's *U*. The main point here is not the numerical values, but the equivalence across the two studies.

> However, using OLS, SFG's estimate is 0.33 (SFG, 2013a, Table 2) whilst Vo et al (2013, Table 5) estimate it at -0.08. [36]

42. Vo et al (2013) also recognise the implausibility of their own OLS estimates and conclude that they are so unreliable that they should be disregarded. In this regard, Vo et al state that:

> OLS regression is not appropriate,[37]

and the OLS estimates are not included in the averages that are computed when the results are tabulated.

43. One possible reason for the problems with the Vo et al OLS results is that the data has not been subjected to the same scrutiny and cross-checking that was performed for the SFG studies. This could result in the Vo et al sample containing errors and/or extreme values. Of course, we cannot confirm this as we do not have access to the Vo et al data. However, Lally (2013) makes an observation that is consistent with data sample issues affecting the Vo et al results:

> Vo et al's standard errors on the franking credit coefficient are on average 50% larger than SFG's.[38]

44. In summary, the Vo et al results generally corroborate the SFG results. The only exception is for the OLS estimates, where the SFG estimates are reasonable and consistent with estimates from other methods, and the Vo et al results are dismissed as being implausible and inappropriate by Vo et al themselves.

Stability of theta estimates

45. Another issue raised by Lally (2013) is the stability of the estimates, or the sensitivity of estimates to the removal of influential outliers:

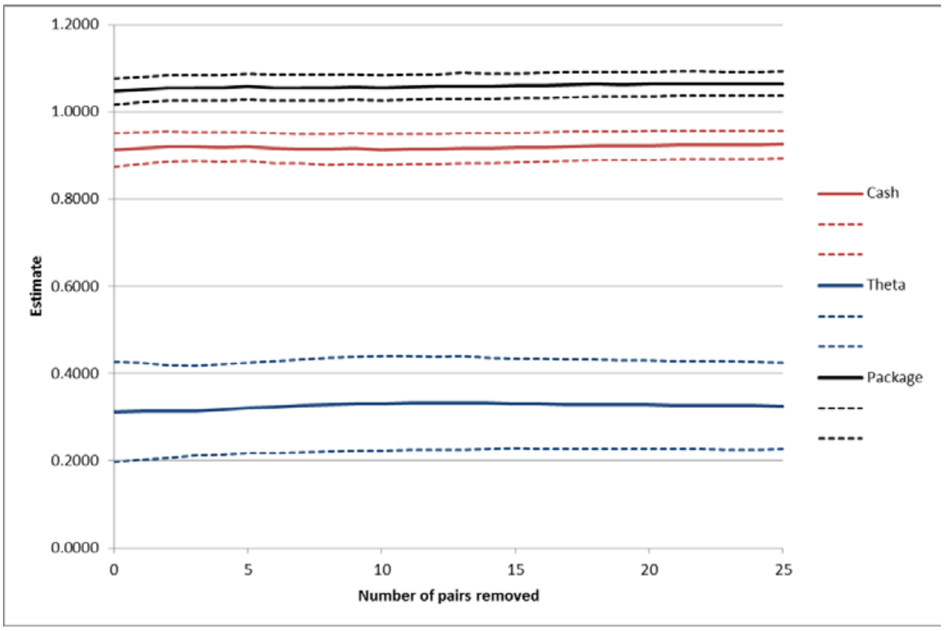
> …using different (but reasonable) approaches to investigating the effect of removing outliers, the effect on the parameter estimates is quite different. For example, in respect of SFG's preferred approach involving model 4 and "robust regression", the effect on Vo et al's estimate of the franking credit coefficient from progressively removing the 30 most extreme observations (in absolute terms), and rerunning the model after each deletion, is to generate estimates of this coefficient that (largely) progressively increase from 0.32 to 0.53 (Vo et al, 2013, Table 8 and Figure 15). The associated coefficients on cash dividends are not given but it could be presumed that the estimate for *U* would also have almost doubled. Importantly, these 30 observations represent less than 1% of the total set of observations. By contrast, SFG progressively remove the 20 most extreme pairs of observations (the one that exerts the most upward effect on the franking credit coefficient and the one exerting the most downward effect) and find only trivial effect on the coefficient (SFG, 2013a, Figure 4).[39]

[36] Lally (2013), p. 21.
[37] Vo et al (2013), p. 9.
[38] Lally (2013), p. 21.
[39] Lally (2013), pp. 21-22.

46. In our view, it is always useful to consider the stability of estimates and to consider how the estimates might have been affected by influential observations. We note that Lally (2013) considers that the sensitivity analyses applied by SFG (2011, 2013) and Vo et al (2013) are both "reasonable approaches," so we examine these approaches below.

47. The SFG (2011) study contained an extensive section on stability analysis[40] whereby observations are removed in pairs consisting of the observations that have the most influential upward and downward effects on the estimate of theta, respectively. As pairs of observations are removed, theta is re-estimated to determine the sensitivity of the theta estimate to influential observations. The result is a figure such as that replicated below for Model Specification 4.[41]

Figure 2. SFG stability analysis



Source: SFG (2011), Figure 8, p. 31.

48. SFG (2011) conclude, on the basis of this stability analysis, that:

> The stability analysis for Model 4, in Figure 8 above, shows that the estimates of the value of cash dividends, the value of theta, and the value of the combined package are very stable and robust to the removal of pairs of influential data points…In summary, the stability analyses demonstrate that the estimates of theta are either maintained or lowered when pairs of influential observations are removed from the data set.[42]

49. SFG (2013) conduct a similar stability analysis for the updated data set and reach the same conclusion.

50. Vo et al (2013) implement a stability analysis known as the DFBETAS approach. This approach differs from the SFG stability analysis in two primary ways:

   a) Influential observations are removed one at a time, rather than in pairs; and

[40] SFG (2011), pp. 28-32.
[41] This appeared as Figure 8, p. 31 in SFG (2011).
[42] SFG (2011), p. 31.

b) The stability analysis is only applied in relation to the non-standard approach whereby prices are not corrected for market movements over the ex-dividend day.

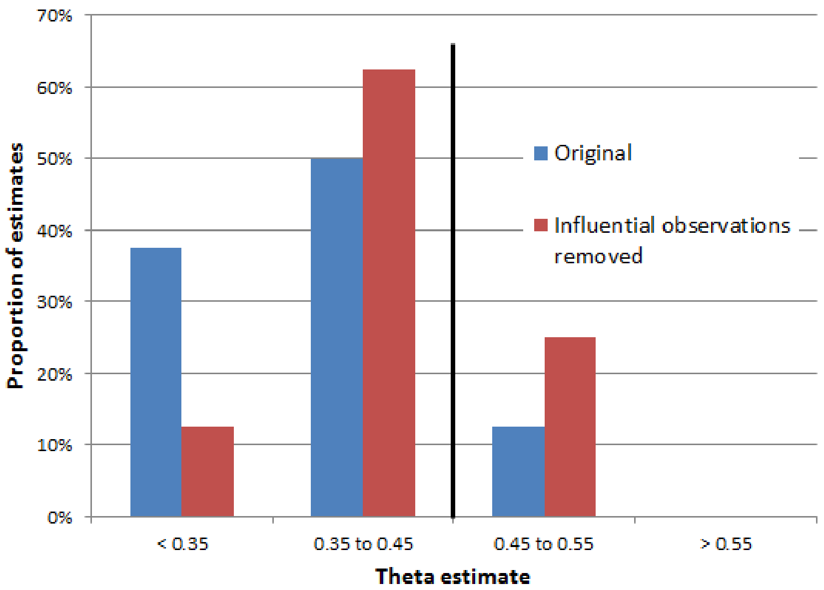
51. For the reasons set out Paragraphs 30 to 37, the results based on the ERA's non-standard approach are likely to be more variable and less reliable than standard estimates and this may be manifest in the stability analysis.

52. Indeed Vo et al (2013) report that:

> The results of the DFBETAS analysis confirm that the estimate of theta is highly sensitive to the choice of the underlying sample of dividend events. Removing just 30 observations from a sample of 3309 can result in a dramatically different estimate of theta. In the course of this process, the value of theta can vary between 0.3 to 0.55. It is important to note that these points represent less than 1% of the entire dividend sample. Whilst by design the removed dividend event has the most extreme impact on the estimate of theta it is undesirable for the estimate to be vulnerable to the removal of observations.[43]

53. Vo et al (2013) report the results of their stability analysis in their Table 8. In particular, Table 8 sets out the revised estimates of theta as the 30 most influential observations are removed from the data set. The results reported in Table 8 do not support the conclusion that the ERA's theta estimates are unstable. In particular, the average mean estimate of theta reported in Table 8 Column 5 is 0.42 and the average median (Column 6) is 0.43. Indeed the distribution of theta estimates is not at all dissimilar to the distribution of the original theta estimates, as summarised in Figure 3 below. Moreover, it is likely that the two sets of results would be even more similar of the stability analysis had been applied to estimates computed using the standard market correction.

Figure 3. ERA theta estimates before and after removal of influential observations



Source: Vo et al (2013), Table 5 and Table 8.

[43] Vo et al (2013), p. 30.

54. In their Table 8, Vo et al (2013) also report the minimum and maximum estimate of theta as influential observations are eliminated. For example, Lally (2013) provides the example of the MM estimate of model specification 4 ranging between 0.32 (after 1 observation is removed) and 0.53 (after 27 observations are removed). This example has the widest range of all of the non-OLS estimates. The average range for the other estimates is the mean ±0.05, which is economically very small. Again, this range is likely to be even narrower if the standard market correction had been applied.

55. We also note that for 50% of the estimates, the lower end of the range is below 0.35 whereas none of the estimates has an upper bound above 0.55. That is, even taking these figures at face value would not seem to justify the adoption of a range of 0.35 to 0.55.

56. In Appendix 2 to their study, Vo et al (2013) graph the changes in their estimates of theta as influential observations are removed from the sample. The figures that demonstrate the most pronounced variation in theta estimates pertain to the OLS estimates. However, Vo et al have previously concluded that "OLS regression is not appropriate"[44] and the OLS estimates are not included in the averages that are computed when the results are tabulated. Consequently, it is not clear that anything can be made of the OLS stability analysis, or even why that analysis was performed on the OLS estimates.

57. In summary, Vo et al (2013) conclude that their estimates of theta lack stability and can vary materially if a relatively small number of influential observations are removed from the data set. In our view:

    a) This conclusion is not supported by the results that are reported in the study; and

    b) If the Vo et al themselves suggest that their results are unstable and unreliable, there would be even more reason to place material weight on the SFG studies for which there is no suggestion of instability or unreliability.

Additional SFG stability analyses

Overview

58. Given that:

    a) The stability of theta estimates is clearly a key issue for Vo et al (2013), as noted by Lally (2013); and

    b) The only stability analysis performed by Vo et al (2013) is in relation to the non-standard approach of making no correction for market movements over the ex-dividend day,

    we apply two additional types of stability analysis using the standard Tribunal-approved methodology and the updated SFG (2103) data set.

Application of the Vo et al (2013) stability analysis

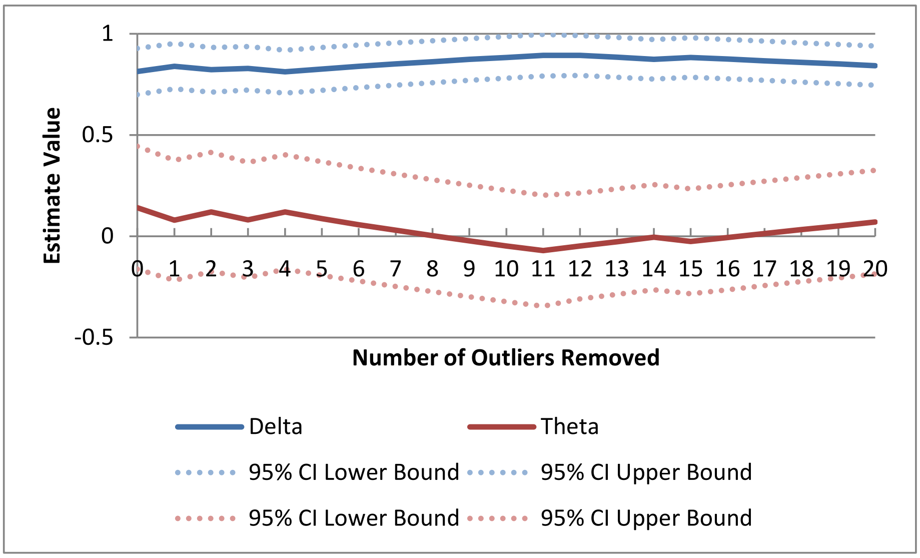
59. First, we apply the one-at-a-time influential observation (DFBETAS) approach that Vo et al (2013) employed, but using the standard ex-day market correction and our updated data set.

[44] Vo et al (2013), p. 9.

60. In general, we conclude that the estimates of theta are robust to the removal of influential observations – particularly in relation to Model Specification 4, which we consider to produce the most reliable estimates.

61. Figure 4 below shows that the estimates of delta (the market value of cash dividends) and theta from Model 1 (basic model estimated via OLS) are relatively insensitive to the removal of influential observations. Even with the removal of the twenty most influential observations the estimates do not deviate markedly from their original values.

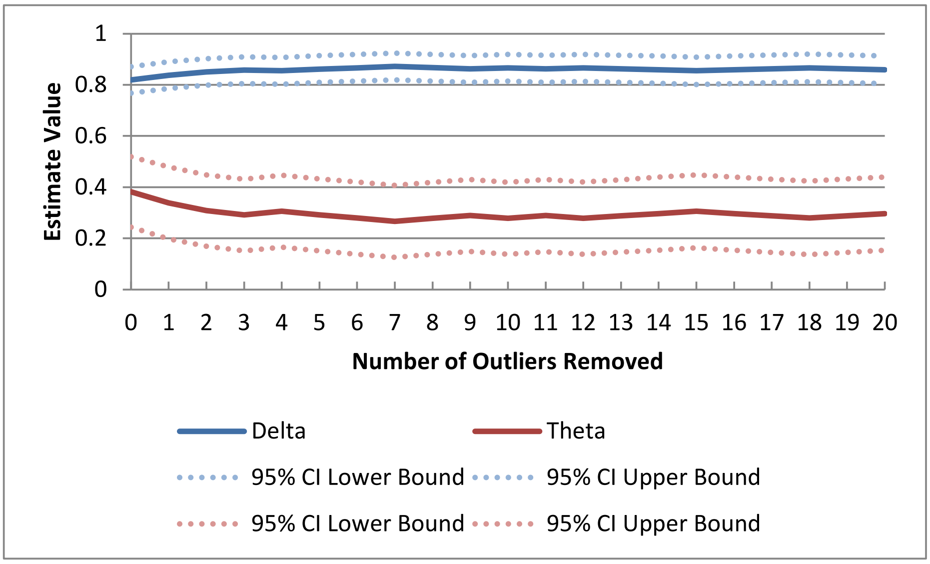
Figure 4. Sensitivity of Model 1 Delta and Theta estimates to the removal of influential observations



Source: SFG Consulting.

62. Next we examine the sensitivity of Model 2 (basic model estimated with GLS with dividend yield as the weighting variable) to the removal of the most influential observations. Again, we remove the most influential observation one at a time. Figure 5 below shows that the estimate of theta does not alter materially, although it does decline slightly.

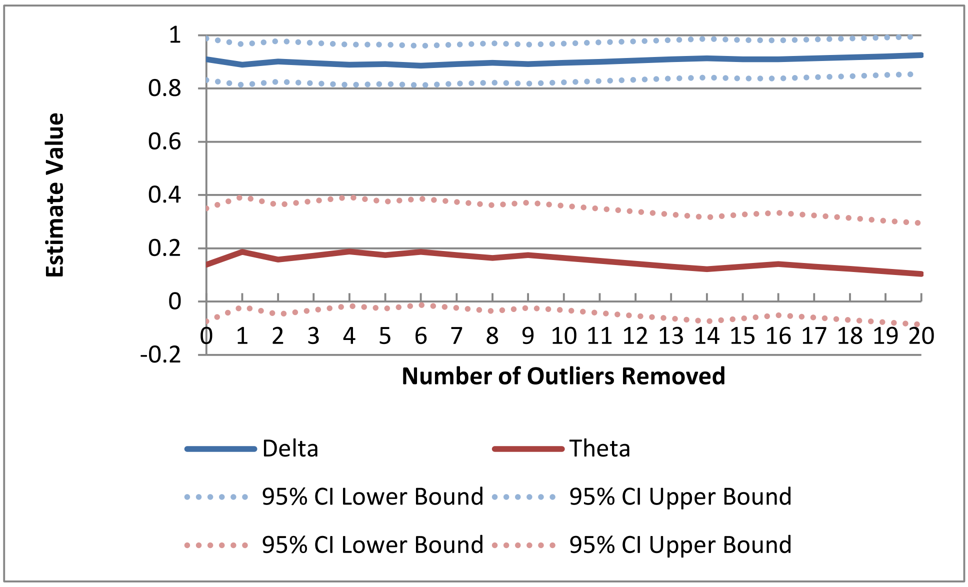
Figure 5. Sensitivity of Model 2 Delta and Theta estimates to the removal of influential observations



Source: SFG Consulting.

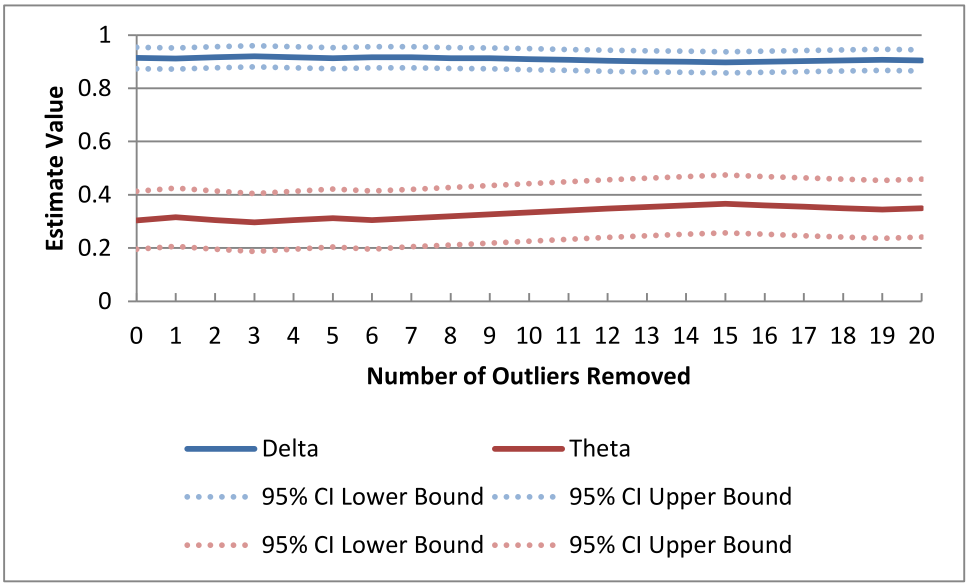
63. Next we examine the sensitivity of Model 3 (the basic model estimated with GLS with inverse stock return volatility used as the weighting variable) estimates to the removal of influential observations using the same procedure as before. Figure 6 shows, consistent with the findings for the other models, that the estimates of theta remain relatively stable.

Figure 6. Sensitivity of Model 3 Delta and Theta estimates to the removal of influential observations



64. Finally, we examine the sensitivity of Model 4 (the basic model estimated with GLS with dividend yield and inverse stock return volatility used as the weighting variables) to the removal of the influential observations. Again, we find that the estimates are not materially affected by the removal of the influential observations, as illustrated in Figure 7.

Figure 7. Sensitivity of Model 4 Delta and Theta estimates to the removal of influential observations



65. One important result that comes from the sensitivity analysis is that none of the theta estimates (for any model specification or for any number of outliers removed) reaches the 0.45 mid-point of the Vo et al (2013) range of 0.35-0.55. Overall, the estimates are stable and do not deviate markedly from the estimates prior to the removal of any influential observations. In our view, these results confirm our earlier conclusion that 0.35 represents the best available dividend drop-off estimate of theta.

Bootstrap removal of 5% of data set

66. To further test the stability of the SFG (2013) theta estimates, we conduct a randomised bootstrapping analysis. To do this, we randomly eliminate five per cent of the sample and re-estimate each of the models using the remaining data. We then repeat this procedure (on the original full sample) another 999 times, yielding 1,000 estimates of theta – each computed after a different 5% of the sample has been removed. This analysis is designed to show how sensitive the estimate of theta might be to removal of 5% of the sample observations.

67. The results from this procedure also lead us to conclude that the SFG estimates of theta are stable and robust to the removal of even 5% of the sample observations. In all cases, the 90% confidence interval is relatively narrow and close to, or below, the SFG point estimate of 0.35. Again, this is particularly the case for model specification 4, which we consider to be the most reliable.

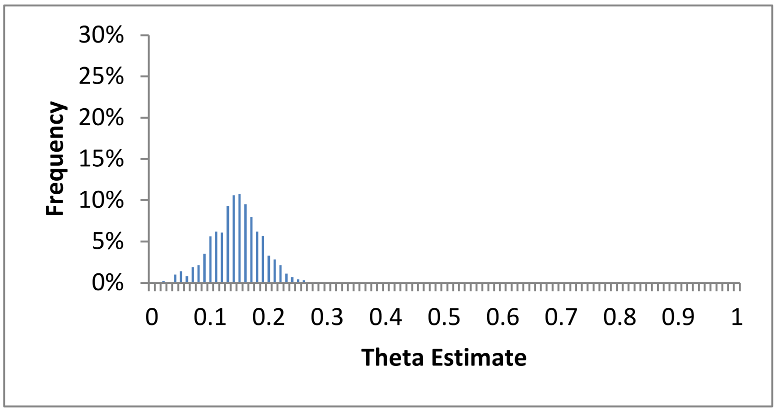
68. The results of this bootstrap test for Model 1 are set out in Table 1 below. The average theta estimate of 0.14 is consistent with the estimate when model specification 1 is applied to the full sample. The 90% confidence interval is from 0.7 to 0.21.

Table 1. Bootstrap re-sampling summary statistics for Model 1

Statistic	Theta Estimate
Average	0.140
Minimum	-0.018
Maximum	0.288
5th Percentile	0.067
95th Percentile	0.208

Source: SFG calculations

Figure 8. Histogram of theta estimates from simulation of Model 1



Source: SFG calculations

69. Figure 8 above shows that even under the relative extreme procedure of removing 5% of the sample there tends to be relatively little deviation from the mean theta estimate of 0.14.

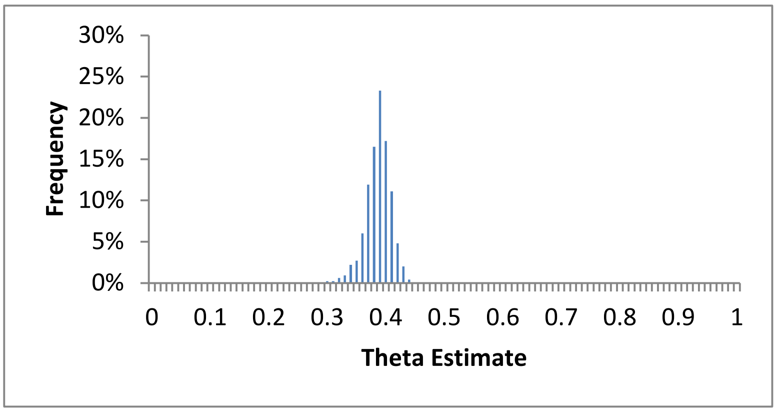
70. The results from running the bootstrap analysis for Model 2 are set out in Table 2 below. The mean estimate is 0.38 within a narrow 90% confidence interval of 0.35 to 0.41.

Table 2. Bootstrap re-sampling summary statistics for Model 2

Statistic	Theta Estimate
Average	0.382
Minimum	0.293
Maximum	0.440
5th Percentile	0.346
95th Percentile	0.413

Source: SFG calculations

Figure 9. Histogram of theta estimates from simulation of Model 2



Source: SFG calculations

71. Figure 9 above shows the narrow distribution of theta estimates for Model Specification 2.

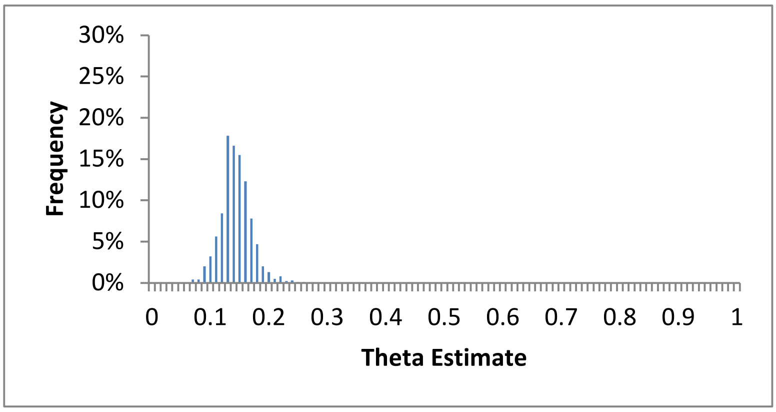
72. The results of the bootstrap re-sampling procedure for Model 3 are set out in Table 3 below. The mean estimate of 0.14 is from a 90% confidence interval of 0.10 to 0.18.

Table 3. Bootstrap re-sampling summary statistics for Model 3

Statistic	Theta Estimate
Average	0.139
Minimum	0.062
Maximum	0.252
5th Percentile	0.097
95th Percentile	0.181

Source: SFG calculations

Figure 10. Histogram of theta estimates from simulation of Model 3



Source: SFG calculations

73. Figure 10 above shows that the range of estimates is similar to that for Model Specification 1, which is similar in its specification to Model 3.

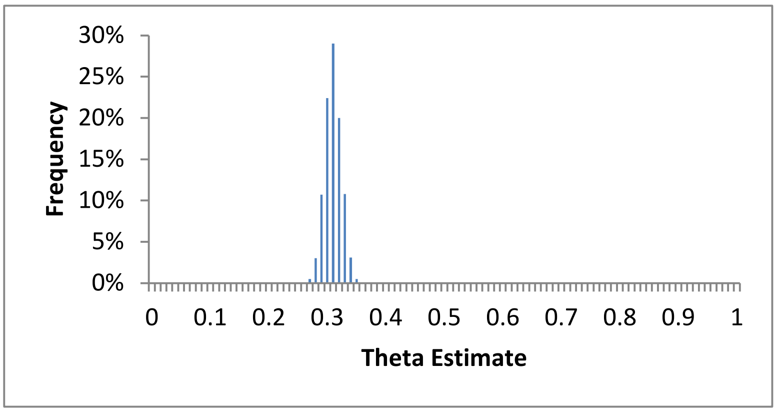
74. The results of the bootstrap re-sampling procedure for Model 4 are set out in Table 4 below. The mean estimate of 0.31 is from a 90% confidence interval of 0.28 to 0.33.

Table 4. Bootstrap re-sampling summary statistics for Model 4

Statistic	Theta Estimate
Average	0.305
Minimum	0.262
Maximum	0.344
5th Percentile	0.282
95th Percentile	0.328

Source: SFG calculations

Figure 11. Histogram of theta estimates from simulation of Model 4



Source: SFG calculations

75. Figure 11 above shows a tightly clustered group of theta estimates centred on 0.30. The simulations provide evidence that the theta estimate from Model Specification 4 is insensitive to the removal of even 5% of the data sample.

76. As with the results obtained from the one-at-a-time removal of the most influential observations, the estimates from the resampling procedure are very stable and do not deviate materially from the estimates from the full sample. Again, as with the one-at-a-time removal, *none* of the models has an estimate value for *any* of the 1,000 simulations that is above the 0.45 mid-point of the Vo et al (2013) range of 0.35-0.55.

Conclusions in relation to SFG stability analysis

77. The additional stability analyses corroborate the results form SFG (2011) and SFG (2013) – the SFG estimates of theta are stable and robust to the removal of influential outliers and even to the removal of up to 5% of the data sample.

Conclusions in relation to dividend drop-off analysis

78. In our view, there are a number of reasons to prefer the SFG (2011, 2013) studies to the Vo et al (2013) study:

    a) The SFG approach has been subjected to an unusual amount of scrutiny. All data and computer code was supplied to the AER. All issues that the AER has identified have been considered by the Tribunal. And the Tribunal has endorsed and adopted the results. By contrast, the ERA study has not been subjected to such scrutiny;[45]

    b) The SFG studies employ the standard, Tribunal-approved and AER-approved approach of correcting prices for market movements over the ex-dividend day; and

    c) The SFG theta estimates have been shown to be stable and reliable in the face of a battery of stability and robustness checks, whereas the ERA expresses concerns about the stability and reliability of its own results.

79. In any event, there is little evidence to support the Vo et al (2013) mid-point estimate of 0.45 from within its range of 0.35 to 0.55:

    a) The estimates reported by Vo et al are overwhelmingly below 0.45 (see Figure 1 and Figure 3 above), and a significant proportion of those estimates are below 0.35;

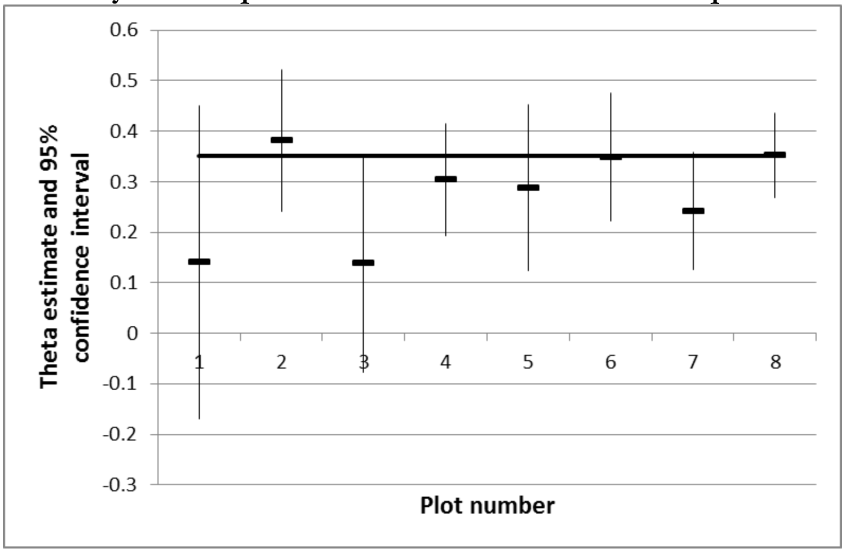
    b) The Vo et al study reports a theta estimate of 0.34 when the standard ex-day market correction is applied;

    c) The Vo et al estimate increases only to 0.4 when the standard ex-day market correction is removed; and

    d) The SFG (2013) estimates indicate that, if anything, the 0.35 estimate is towards the upper end of the reasonable range. See for example Figure 12 below, which is reproduced from SFG (2013), Figure 5.

[45] We understand that the ERA study has been submitted to an academic journal for publication. If this is the case, the ERA could release the referee report and editorial decision to document the degree of scrutiny to which its study has been subjected.

Figure 12
Summary of point estimates and confidence intervals for theta by model specification and estimation technique



For each estimate, the narrow line represents the 95% confidence interval for theta and the solid black marker represents the point estimate. The solid black horizontal line represents the recommended point estimate of 0.35.
Plot 1: Model specification 1, OLS estimation; Plot 2: Model specification 2, OLS estimation;
Plot 3: Model specification 3, OLS estimation; Plot 4: Model specification 4, OLS estimation;
Plot 5: Model specification 1, RR estimation; Plot 6: Model specification 2, RR estimation;
Plot 7: Model specification 3, RR estimation; Plot 8: Model specification 4, RR estimation.

80. In our view, there is no reasonable basis for adopting a dividend drop-off estimate of theta above 0.35.

References

Australian Competition Tribunal, 2011, Application by Energex Limited (Gamma) (No 5) [2011] ACompT 9, 12 May.

Australian Competition Tribunal, 2010, Application by Energex Limited (Distribution Ratio (Gamma)) (No 3) [2010] ACompT 9, 24 December.

Australian Competition Tribunal, 2010, Application by Energex Limited (No 2) [2010] ACompT 7, 13 October.

Australian Energy Regulator, 2013, *Rate of return guideline – Explanatory Statement*, December.

Beggs, D.J., and C.L. Skeels, 2006, "Ownership of Australian equities and corporate bonds," *The Economic Record,* 82 (258), 239 – 252.

Economic Regulation Authority of Western Australia, 2013, *Final Rate of Return Guideline*, 16 December.

Economic Regulation Authority of Western Australia, 2013, *Final Rate of Return Guideline: Explanatory Statement*, 16 December.

Economic Regulation Authority of Western Australia, 2013, *Final Rate of Return Guideline: Appendices*, 16 December.

Lally, M., 2013, *Estimating Gamma*, Report for the QCA, 25 November.

McKenzie, M. and G. Partington, 2013, *Review of Aurizon Network's draft access undertaking*, Report for the Queensland Resources Council, 5 October.

Queensland Competition Authority, 2001, *Regulation of electricity distribution: Final determination*, May.

Queensland Competition Authority, 2004, *Dalrymple Bay Coal Terminal draft access undertaking: Draft Decision*, October.

Queensland Competition Authority, 2005, *Regulation of electricity distribution: Final determination*, April.

Queensland Competition Authority, 2009, *QR Network draft access undertaking: Draft Decision*, December.

SFG Consulting, 2014, *An appropriate regulatory estimate of gamma.*

SFG Consulting, 2013, *Updated dividend drop-off estimate of theta*, Report prepared for the Energy Networks Association, 7 June.

SFG Consulting, 2011, *Dividend drop-off estimate of theta*, Report prepared for the Australian Competition Tribunal.

Vo, D., B. Gellard and S. Mero, 2013, *Estimating the market value of franking credits: Empirical evidence from Australia*, Working paper.