Updated dividend drop-off estimate of theta

Draft Report for the Energy Networks Association

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1. Executive summary

Background and context

1. In the Australian regulatory setting, the regulator requires an estimate of a parameter that reflects the implied market value of dividend imputation tax (or "franking") credits at the time those credits are created by the payment of corporate tax. This parameter is known as "gamma." Gamma, in turn, is a function of two other parameters. One of these is the implied market value of imputation credits at the time they are distributed to shareholders – a parameter known as "theta."

2. One method of estimating theta is known as "dividend drop-off analysis." This is an econometric (statistical) technique that estimates the value of distributed imputation credits (theta) by observing the change in stock prices around ex-dividend events (days when the dividend and imputation credit separate from the share).

3. In a recent case, the Australian Competition Tribunal (the **Tribunal**) directed that a "state of the art" dividend drop-off study should be performed to assist with its deliberations. That study was performed by SFG Consulting (**SFG**) and concluded that the best estimate of theta was 0.35. The Tribunal endorsed and adopted that estimate. In all subsequent decisions, the AER has set theta to 0.35.

Instructions

4. SFG has now been retained by the Energy Networks Association (**ENA**) to update the "state-of-the-art" dividend drop-off estimate of theta. We have applied the same econometric methodologies and applied the same statistical, diagnostic and robustness tests as in the study performed for the Tribunal. We have updated our data set from September 2010 to October 2012.

Summary of conclusions

5. In our 2011 study we 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.[1]

6. In our view, the conclusions from our earlier study remain valid when tested against the updated data set.

[1] SFG (2011), Paragraph 3.

2. Background and context

Effect of dividend imputation tax credits and the role of gamma

7. In a dividend imputation tax system, such as has operated in Australia since 1987, dividends paid by Australian companies out of profits that have been taxed in Australia have tax credits attached to them. For example, a company that earns a profit of $100 and pays $30 corporate tax and then distributes the remaining $70 as a dividend to shareholders, can attach $30 of dividend imputation tax credits to the $70 dividend. Those tax credits can be used by resident investors to reduce their personal tax obligations by $30, but cannot be used by non-resident investors under the dividend imputation legislation.

8. The "gamma" parameter has an important effect on the grossing up for corporate tax. Continuing the example above, suppose a regulator determines that shareholders require a return of $70. In the absence of dividend imputation, a pre-tax profit of $100 would be required. The firm would then pay $30 in corporate tax and distribute the remaining $70, as required.

9. In an imputation system, however, the $70 dividend comes with $30 of tax credits attached to it. The gamma parameter effectively acknowledges that those tax credits have a potential value. This is a market value, that is, how much the market price of a share will increase as a result of the credits attached to the dividend stream. Suppose, for example, that the regulator determines that the $30 of tax credits have a value of $7.50.[2] In that case, the shareholders would have received a $70 cash dividend and tax credits with a value of $7.50, and would therefore have been over-compensated.

10. In this case, the firm's pre-tax revenue requirement should have been set at $90.32, in which case the firm would pay tax of $27.10 (30%) and pay a cash dividend of $63.23 (its after tax profit). Attached to that cash dividend would be $27.10 of tax credits (equal to the amount of corporate tax paid), which we continue to assume are valued by the regulator at 25% of face value – $6.77. The total of the cash dividend ($63.23) and the assumed value of the tax credits ($6.77) provides shareholders with the $70 return that they require.[3]

Estimation

11. In the regulatory setting, gamma is estimated as the product of two components:

$$\gamma = F \times \theta$$

where F is the distribution ratio (the proportion of created imputation credits that are distributed to shareholders) and θ is the value of a distributed credit. Imputation credits are created whenever a firm pays a dollar of Australian corporate tax. But to distribute all of the imputation credits it creates, a firm would have to distribute 100% of its (Australian) profits as dividends. The average firm does not do this, because it retains some profits to finance future capital expenditure.

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[2] That is, imputation credits are assumed to be valued at 25% of face value.

[3] The revenue requirement is calculated by back-solving from the return requirement. Let the revenue requirement be X. For a corporate tax rate of 30%, the cash dividend that can be paid out of pre-tax profit of X is X(1-0.30). The amount of imputation credits that are created by the payment of corporate tax is 0.30X. At 25% of their face value, these imputation credits are valued at 0.25(0.30)X. The sum of the cash dividend and the imputation credit must provide shareholders with the $70 they require. Hence: $X(1-0.30)+0.25(0.30)X=70$, and the implied value of X is 90.32.

12. If firms distribute 70% of the imputation credits they create and if those credits are each valued at 35% of face value, then gamma would be:

$$\gamma = F \times \theta = 0.7 \times 0.35 = 0.25.$$

13. This would mean that 25% of the corporate tax that the firm pays is assumed to flow back to shareholders, so the grossing up for corporate tax would be reduced accordingly, as in the example above.

14. In summary, the regulatory setting requires estimates of the distribution ratio (F) and the value of a distributed credit (θ).

Australian Competition Tribunal review – background

15. Prior to the last process for setting the AER's Statement of Regulatory Intent (**SoRI**), the long-standing regulatory precedent was to set gamma equal to 0.5. In its SoRI in May 2009, the AER set gamma to 0.65. This estimate was based on:

    a) Setting F to 100%. The AER's consultant on this issue proposed that F should be set on the basis of theoretical assumption rather than market evidence; and

    b) Setting θ to 0.65 as the mid-point of two estimates:

        i) A dividend drop-off estimate of 0.57 whereby one compares the prices of shares immediately before the ex-dividend date with the prices of the same shares immediately after, as a means of inferring the implied value of dividends and the tax credits that are attached to them[4]; and

        ii) An estimate based on ATO tax statistics about the proportion of imputation credits that are redeemed.[5]

16. The first three businesses to be regulated under the AER's SoRI estimate of 0.65 were ENERGEX, Ergon Energy and ETSA Utilities, all of whom sought a review by the Australian Competition Tribunal (the **Tribunal**). This review took place under the National Electricity (Distribution) Rules and has become known as the *Gamma Case*.

Issues and Tribunal findings

Estimating the distribution rate

17. Recall that the distribution rate (*F*) is the ratio of (a) the total amount of franking credits distributed to shareholders in a given year, to (b) the total amount of franking credits created in a given year. In the Gamma Case, the AER abandoned its contention that F should be set to 100% before the Tribunal hearing. In its submissions to the Tribunal prior to the hearing, the AER then acknowledged that an estimate above 0.7 was unsupportable, as there was no evidence for it, and therefore that the

[4] Beggs, D.J., and C.L. Skeels, 2006. "Market arbitrage of cash dividends and franking credits," *The Economic Record,* 82 (258), 239 – 252.

[5] Handley, J.C., and K. Maheswaran, 2008. "A measure of the efficacy of the Australian imputation tax system," *The Economic Record,* 84 (264), 82 – 94.

distribution rate should be set to 0.7. In summarising the AER's position on this issue, the Tribunal stated that:

> The AER accepts that on the material presently before the Tribunal, there is no empirical data that is capable of supporting an estimated distribution ratio higher than 0.7. The AER therefore accepts that it is open to the Tribunal to adopt a substitute distribution ratio of 0.7.[6]

18. The Tribunal then concluded and ordered that:

> In light of these submissions and the material before the Tribunal, the Tribunal concludes that the distribution ratio is 0.7 for the calculation of gamma.[7]

Estimating Theta

19. The theta parameter estimates the value, to the relevant shareholder, of a dollar of franking credits that has been distributed to them. Different shareholders will place a different value on the franking credits that are distributed to them. Resident shareholders can use franking credits to reduce their personal tax obligations, whereas non-resident shareholders obtain no benefit from franking credits. Theta represents the extent to which trading among all market participants results in some value in relation to franking credits being impounded into the stock price.

20. Two techniques for empirically estimating theta were considered by the Tribunal:

    a) Tax statistics about the proportion of distributed imputation tax credits that had been redeemed by shareholders, obtained from the Australian Taxation Office (**ATO**); and

    b) Dividend drop-off analysis, whereby the implied value of imputation tax credits is inferred from the price change that occurs over ex-dividend days.

21. The Tribunal held that the ATO tax statistic approach did not produce an estimate of market value and that the AER was wrong to have interpreted tax statistic estimates in that way. In particular, the Tribunal held that the ATO tax statistic approach provides no more than an upper bound check on estimates of theta obtained from the analysis of market prices, and that the AER was wrong to have interpreted such an estimate as a point estimate rather than as an upper bound:

> The AER accepted that utilisation rates derived from tax statistics provide an upper bound on possible values of theta. Setting aside the manner in which the AER derived a value from the tax statistics study, it correctly considered that information from a tax statistics study was relevant. However, its relevance could only be related to the fact that it was an upper bound. No estimate that exceeded a genuine upper bound could be correct. Thus the appropriate way to use the tax statistics figure was as a check.[8]

22. The Tribunal also held that the AER was wrong to take upper bound estimates from two different sub-periods and then interpret their average as a point estimate:

[6] Australian Competition Tribunal [2010] ACompT 9, Paragraph 2.
[7] Australian Competition Tribunal [2010] ACompT 9, Paragraph 4.
[8] Australian Competition Tribunal [2010] ACompT 7, Paragraph 91.

> But this simple averaging adjustment has no logic to it and fails to accord each Handley and Maheswaran (2008) estimate its correct interpretation as an upper bound applying to a period…[9]

and that:

> …any downward adjustment to a properly derived upper bound would be inappropriate as a means of deriving an estimate of theta.[10]

23. This left the Tribunal with dividend drop-off analysis. On this point, the AER had sought to rely entirely on a single study by Beggs and Skeels (2006). The Tribunal held 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.[11] 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."[12]

24. In summary, the Tribunal ruled that:

    a) The AER had erred in using tax statistics estimates for any purpose other than as an upper bound;

    b) The AER had erred in its reliance on the Beggs and Skeels (2006) dividend drop-off estimate of theta; and

    c) SFG should be retained to prepare a state-of-the-art dividend drop-off analysis with terms of reference to be agreed with the AER.

The SFG state-of-the-art dividend drop-off study

25. After a number of meetings and telephone conferences and circulation of several draft versions of proposed Terms of Reference, agreement on several matters could not be reached. This required a further hearing before the Tribunal on those matters that were in dispute. In particular the matters in dispute concerned:

    a) The specific econometric specification of the tests that were to be performed. SFG had proposed four variations of the econometric specification of dividend drop-off analysis, drawn from the literature and the AER had proposed slight variations on two of these specifications; and

    b) Whether results should be reported for certain sub-periods of the full sample period. SFG had proposed that the results for the full updated period would be the most reliable results available as they would include the most timely data that was available and would be based on the largest sample available. The AER had proposed that results should also be reported for an earlier sub-period that ended in 2004, commensurate with the Beggs and Skeels (2006) study.

[9] Australian Competition Tribunal [2010] ACompT 7, Paragraph 95.
[10] Australian Competition Tribunal [2010] ACompT 7, Paragraph 95.
[11] Australian Competition Tribunal [2010] ACompT 7, Paragraph 146.
[12] Australian Competition Tribunal [2010] ACompT 7, Paragraph 147.

26. At the completion of this hearing, the Tribunal made an immediate ruling, finding against the AER on both of these matters. The Terms of Reference were duly finalised in accordance with the Tribunal's ruling.

27. SFG then conducted the state-of-the-art 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 provided detailed comments on the draft report and these were taken into account in a revised report that was provided to all parties and to the Tribunal.

28. At the final hearing, the AER submitted that the SFG study had departed from the Terms of Reference, could be criticised on numerous other grounds, and should therefore be afforded little weight. The Tribunal rejected these submissions entirely concluding that:

> It is not necessary to set out the details of the eight issues, since they raise no important or significant questions of principle…Calling them "major compliance issues" is unnecessarily pejorative.
>
> Whether or not the terms of reference have been departed from, what is important is whether the concerns raised by the AER with the construction of the database cast doubt on the value of SFG's analysis, requiring the Tribunal to give it less weight than it otherwise would. In the Tribunal's view, they do not.
>
> 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.[13]

29. The Tribunal then accepted the estimates from the SFG state-of-the-art study:

> 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. [14]

30. 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.[15]

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.[16]

[13] Australian Competition Tribunal [2011] ACompT 9, Paragraphs 18-19.
[14] Australian Competition Tribunal [2011] ACompT 9, Paragraph 22.
[15] Australian Competition Tribunal [2011] ACompT 9, Paragraph 29.
[16] Australian Competition Tribunal [2011] ACompT 9, Paragraph 38.

Final estimate of Gamma

31. Having determined that the appropriate distribution rate is 70% and that the best dividend drop-off estimate of theta is 0.35, the Tribunal had no more work to do other than to multiply these two estimates together to obtain a gamma estimate of 0.25:

> Taking the values of the distribution ratio and of theta that the Tribunal has concluded should be used, viz 0.7 and 0.35, respectively, the Tribunal determines that the value of gamma is 0.25.[17]

32. In every subsequent case where the AER has had to determine a value for gamma, it has adopted a value of 0.25.

[17] Australian Competition Tribunal [2011] ACompT 9, Paragraph 42.

3. Compilation of data

Initial data set

33. We begin with the sample of ex-dividend events that was used in our Final Report for the Tribunal.[18] This sample consists of 3,107 observations from the period of July 2001 to September 2010. The construction of the sample is explained in detail in our previous report.

Extend sample of ex-dividend events

34. We extend the sample of ex-dividend events from September 2010 to October 2012. To do this, we begin by identifying all ex-dividend events in each of two independent data bases – DatAnalysis and Thompson Reuters Tick History (**TRTH**). DatAnalysis is operated by Aspect Huntley, which is a wholly-owned subsidiary of Morningstar Inc. It is commonly used as the basis for papers published in the academic and practitioner literature relating to empirical finance. The TRTH database is compiled by Reuters and made available by the Securities Industry Research Centre of Asia-Pacific (**SIRCA**). This data is also commonly used as the basis for papers published in the academic and practitioner literature relating to empirical finance.

35. From each data base, we obtain records of all ex-dividend events for all firms listed on the Australian Securities Exchange (**ASX**). Information obtained includes the following fields:

    a) Company name;

    b) ASX ticker symbol (three digit code used by the ASX);

    c) Dividend amount;

    d) Currency in which the dividend was paid;

    e) Franking percentage (the proportion of the dividend that was franked);

    f) Ex-dividend date; and

    g) Type of dividend:

        i) Ordinary (interim, final, quarterly, or monthly);

        ii) Special-cash;

        iii) Special-scrip; or

        iv) Return of capital.

Apply preliminary screens and conversions

36. We then apply a number of preliminary screens, as follows:

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[18] See SFG (2011), Table 1, p. 14.

a) We eliminate observations where the dividend amount is missing (or set to zero) or where the ex-date is missing;

b) We eliminate observations for which the ticker symbol has more than three letters, as this indicates that the security is not an ordinary share;

c) We eliminate dividends that are defined to be a capital return or a special scrip dividend;

d) We eliminate dividends with a currency defined to be "PCT." This indicates "per cent" rather than a currency and is used for in specie distributions rather than cash dividends;

e) We eliminate all duplicate records. The TRTH database in particular contains a number of duplicated observations; and

f) We eliminate all observations for which there was a corporate event/capitalisation change (such as a rights or bonus issue or other issuance or cancellation of shares) within five days of the ex-dividend event identified in the DatAnalysis Corporate Events file.

37. We convert all foreign currency dividends into Australian dollars using exchange rates provided by the Reserve Bank of Australia. We retain a record of the dividend currency so that the drop-off analysis can be applied to samples that include, and exclude, foreign currency dividends.

38. In cases where a database indicates that the same company paid two different dividends with the same ex-date, we add those dividends to obtain a single record for each ex-date for each company. For example, if a company paid a 15 cent fully franked dividend and a 5 cent unfranked special dividend with the same ex-date, a single record is retained with:

a) Dividend amount set to 20 cents; and

b) Franking percentage set to $\frac{15}{20}\times 100+\frac{5}{20}\times 0=75$.

39. We retain a record of observations that have been summed in this manner so that the drop-off analysis can be applied to samples that include, and exclude, these summed observations.

Match ex-dividend events across databases

40. We then seek to match ex-dividend events from the two data bases on the following four fields:

a) ASX ticker symbol/company identifier;

b) Ex-dividend date;

c) Australian dollar dividend amount; and

d) Franking percentage.

41. A number of observations match on ASX ticker symbol, ex-dividend date and dividend amount, but not franking percentage. In most of these cases, the franking percentage is missing in one of the databases. In these cases, we manually checked the ASX web site and company annual reports for

franking percentage information. In cases where we were able to find two independent sources that agreed on the franking percentage, we treated the observation as a match.

42. Those observations that matched across databases were allocated to our "Matched" sample. Other observations were allocated to the "Unmatched DatAnalysis" or the "Unmatched TRTH" samples if data is available on the following fields:

a) ASX ticker symbol/company identifier;

b) Ex-dividend date;

c) Australian dollar dividend amount; and

d) Franking percentage,

otherwise they are eliminated from the sample.

Add ASX share price data

43. All observations in all three subsamples were then supplemented with additional data sourced from Datastream, which is commonly used as the basis for papers published in the academic and practitioner literature relating to empirical finance. The following data items were added to each observation:

a) The closing cum-dividend day stock price;

b) The closing cum-dividend day trading volume;

c) The closing ex-dividend day stock price;

d) The closing ex-dividend day trading volume;

e) The total return on the All Ordinaries Accumulation Index over the ex-dividend day;

f) The market capitalisation for the firm on the ex-dividend day;

g) The total market capitalisation for the All Ordinaries index on the ex-dividend day;

h) The mean of the daily excess returns (total stock return less All Ordinaries Accumulation Index return) computed over the year ending six trading days before the ex-dividend day; and

i) The standard deviation of the daily excess returns (total stock return less All Ordinaries Accumulation Index return) computed over the year ending six trading days before the ex-dividend day.

44. The mean and standard deviation of daily excess returns were calculated in the same way as in our 2011 report:

a) **Mean excess return**: We use a period of one year, ending six days prior to the ex-dividend date, so that the historical period does not overlap with the ±5 day window around the ex-dividend date. The mean excess stock return was measured over the trading days beginning one year and six days prior to the ex-dividend day and ending six days prior to the ex-dividend day. The excess stock return for each day is defined as the stock return for a particular company *i* less the return on the All Ordinaries index. Formally, the mean excess stock return for company *i* at time *t* is defined as:

$$\overline{er}_{i,t} = \frac{1}{N}\sum_{j=1}^{N} er_{i,t-5-j}$$

where

$$er_{i,t} = r_{i,t} - r_{m,t},$$

and N represents the number of trading days over the relevant year-long period.

b) **Standard deviation of excess returns**: The volatility of excess stock returns was computed as the standard deviation of the excess stock return, measured over the same period. Formally, the volatility of excess stock returns for company *i* at time *t* is defined as:

$$\sigma_{i,t} = \sqrt{\frac{1}{N}\sum_{j=1}^{N}\left(er_{i,t-5-j} - \overline{er}_{i,t}\right)^2}.$$

Add other data fields

45. We then augment each observation with the following fields:

a) An indicator of whether the dividend was an ordinary or special dividend. In cases where a company paid an ordinary and special dividend with the same ex-date, the dividend is classified as special;

b) An indicator of whether the company made any announcement to the ASX on the cum-dividend day or the ex-dividend day that was classified as price sensitive. We obtain information about announcements and the classification of price sensitivity from the SIRCA company announcement file, which is a direct feed from the ASX;

c) A field that indicates whether the ASX classifies the security as:

i) ordinary shares of company;

ii) a listed fund;

iii) a real estate investment trust (REIT); or

iv) a stapled security; and

d) A field that indicates whether there was any capitalisation change for the firm within five days of the ex-dividend date, sourced from the SIRCA "dilutions" (capitalisation change) file.

4. Econometric methods

Primary data set

46. Our primary data set is compiled as follows:

a) We begin with our matched sample – a set of ex-dividend events for which all relevant items are consistent across the two independent data bases;

b) We eliminated observations where the stock did not trade on the cum-dividend day or the ex-dividend day;

c) We eliminated observations where there was a capitalisation change within five days of the ex-dividend date;

d) We eliminated observations where the company made an announcement that was classified as price sensitive on the cum-dividend day or the ex-dividend day;

e) We eliminated observations where the company in question had a market capitalisation that was less than 0.03% of the market capitalisation of the All Ordinaries index at the time of the ex-dividend date; and

f) We eliminated observations where the security in question falls into any one of the following categories: stapled securities; shares whose primary listing is overseas; CHESS depositary interests; CHESS units of foreign securities; or exchange-traded funds.

Robustness tests and sensitivity analysis

47. In addition to our primary data set, we also examined the following variations:

a) Different definitions of stock return volatility (variance and standard deviation) for the purposes of GLS estimation;

b) Including and excluding dividends paid in a foreign currency;

c) Including and excluding observations where the firm made an announcement that was classified as being price sensitive;

d) Including and excluding observations that appear in the DatAnalysis sample but did not match the TRTH sample (and which pass the other requirements set out above); and

e) Including and excluding observations that appear in the TRTH sample but did not match the DatAnalysis sample (and which pass the other requirements set out above).

Econometric models

48. As in our 2011 study (and in accordance with Paragraph 12 of the 2011 Terms of Reference of that study) we estimated the parameters of the following model:

$$\frac{P_{i,t-1} - P_{i,t}^{*}}{D_i} = \delta + \theta \frac{FC_i}{D_i} + \varepsilon_i \quad (1)$$

where $P_{i,t-1}$ is the cum-dividend stock price for observation i; $P_{i,t}^{*} = \frac{P_{i,t}}{1+r_{m,t}}$ is the market-adjusted ex-dividend stock price (where $r_{m,t}$ is the return on the All Ordinaries index on day *t*); D_i is the amount of the dividend for observation i; and FC_i is the amount of franking credits associated with observation *i*.

49. The two parameters to be estimated are δ and θ where:

a) δ represents the estimated market value of cash dividends as a proportion of their face value; and

b) θ represents the estimated market value of distributed franking credits as a proportion of their face value.

50. The econometric model in Equation (1) was estimated using regression analysis applied to the final sample (and subsequently to the samples used for the purposes of robustness checks and sensitivity analysis). It was estimated using ordinary least squares, generalised least squares and robust regression methods.

51. Generalised least squares estimation involves multiplying all terms in the original econometric model by the same variable. This would be done if the researcher was concerned about a potential relationship between the variance of the residuals (ε_i) and a particular variable. Suppose, for example, that there is a potential relationship between the variance of the residuals in Equation (1) and dividend yield, $\frac{D_i}{P_{i,t-1}}$, such that the variance of residuals is inversely related to dividend yield. This would be the case if the model in Equation (1) provided a closer fit to the data and generally smaller residuals for observations with a higher dividend yield. If this were actually the case, the coefficient estimates in Equation (1) would be consistent and unbiased, but the usual procedures for conducting statistical inference (e.g., *t*-statistics) may be inaccurate.

52. Generalised least squares estimation is designed to eliminate any relationship between the variance of residuals and the variable in question. This is done by scaling every term in the original model by the variable in question. If, for example, all terms in Equation (1) are multiplied by dividend yield, $\frac{D_i}{P_{i,t-1}}$, then Equation (1) becomes:

$$\frac{P_{i,t-1} - P_{i,t}^{*}}{D_i} \times \frac{D_i}{P_{i,t-1}} = \delta \times \frac{D_i}{P_{i,t-1}} + \theta \frac{FC_i}{D_i} \times \frac{D_i}{P_{i,t-1}} + \varepsilon_i \times \frac{D_i}{P_{i,t-1}}$$

which is equivalent to:

$$\frac{P_{i,t-1} - P_{i,t}^{*}}{P_{i,t-1}} = \delta' \frac{D_i}{P_{i,t-1}} + \theta' \frac{FC_i}{P_{i,t-1}} + \varepsilon_i'. \quad (2)$$

53. The idea behind generalised least squares estimation in this example is that if the variance of the original residuals (ε_i) is inversely related to dividend yield, the scaled residuals (ε_i') are not related to

the dividend yield, and standard statistical inference can be performed (i.e., the *t*-statistics will be correct).

54. Consequently, Equation (2) can be thought of as GLS estimation of Equation (1), where the scaling variable is dividend yield, or as OLS estimation of a model in which the percentage stock return is regressed on dividend yield and franking credit yield.

55. The prior literature (e.g., Michaely, 1991; Bellamy and Gray, 2004) identifies dividend yield and stock return volatility as variables that might be related to the variance of the residuals in Equation (1) and we are not aware of any dividend drop-off analysis that uses GLS scaling variables other than dividend yield and stock return volatility. Other things equal, the magnitude of the residuals may be greater for high-volatility stocks because stock price changes tend to be greater for these stocks. In this case, the relevant GLS adjustment would be to scale by the inverse of the volatility of stock returns for the company in question. This adjustment would produce the following econometric specification:

$$\frac{P_{i,t-1} - P^*_{i,t}}{D_i \sigma_i} = \delta'' \frac{1}{\sigma_i} + \theta'' \frac{FC_i}{D_i \sigma_i} + \varepsilon''_i \,. \qquad (3)$$

56. If both GLS adjustments are applied, the econometric specification is:

$$\frac{P_{i,t-1} - P^*_{i,t}}{P_{i,t-1} \sigma_i} = \delta''' \frac{D_i}{P_{i,t-1} \sigma_i} + \theta''' \frac{FC_i}{P_{i,t-1} \sigma_i} + \varepsilon'''_i \,. \qquad (4)$$

57. In accordance with the Terms of Reference for our 2011 study (Paragraphs 12 and 14), we estimate the four model specifications set out in Equations (1) to (4) above using OLS regression analysis, noting that the models in Equations (2) to (4) can be thought of as GLS estimates (with different scaling adjustments) of the basic model in Equation (1). In summary, we estimate each of the four models that are set out in Table 1 below. Even though we refer to the four specifications as "Models" 1 to 4 for convenience, we note that they are actually just different econometric specifications of the one model in which cash dividends and franking credits are posited as the only systematic factors in driving the ex-dividend day change in stock prices.

Table 1
Econometric models to be estimated

Model	Specification	Interpretation
Model 1	$\frac{P_{i,t-1}-P^{*}_{i,t}}{D_i}=\delta+\theta\frac{FC_i}{D_i}+\varepsilon_i$	Basic model.
Model 2	$\frac{P_{i,t-1}-P^{*}_{i,t}}{P_{i,t-1}}=\delta'\frac{D_i}{P_{i,t-1}}+\theta'\frac{FC_i}{P_{i,t-1}}+\varepsilon'_i$	GLS estimation of (1) with weighting variable dividend yield, $\frac{D_i}{P_{i,t-1}}$.
Model 3	$\frac{P_{i,t-1}-P^{*}_{i,t}}{D_i\sigma_i}=\delta''\frac{1}{\sigma_i}+\theta''\frac{FC_i}{D_i\sigma_i}+\varepsilon''_i$	GLS estimation of (1) with weighting variable inverse stock return volatility, $\frac{1}{\sigma_i}$.
Model 4	$\frac{P_{i,t-1}-P^{*}_{i,t}}{P_{i,t-1}\sigma_i}=\delta'''\frac{D_i}{P_{i,t-1}\sigma_i}+\theta'''\frac{FC_i}{P_{i,t-1}\sigma_i}+\varepsilon'''_i$	GLS estimation of (1) with weighting variables dividend yield, and inverse stock return volatility.

Estimation results

58. The results of our estimations are set out in Table 2 below. The key results are:

a) The point estimate of the value of a dollar of cash dividends ranges from 81 cents to 91 cents;

b) The point estimate of the value of a dollar of imputation credits ranges from 14 cents to 38 cents; and

c) The point estimate of the value of the package of a one dollar cash dividend and the associated 43 cent franking credit ranges from 87 cents to 104 cents.

59. We use two methods to estimate standard errors:

a) The White method for computing heteroscedasticity-consistent standard errors (which allows for unspecified heteroscedasticity in the residuals); and

b) A method that allows for clustering at the firm level (i.e., allows for the variance of residuals to differ by firms).[19]

60. The two methods produce standard error estimates that are similar in magnitude and generally indicate that the estimates of the value of cash dividends are significantly less than one and franking credits are significantly greater than zero. The standard errors for the estimated value of a fully-franked dividend (i.e., the package of cash dividend and the associated franking credit) are considerably lower than the standard errors for the estimated values of cash or franking credits

[19] As mentioned previously we have reason to believe that standard errors vary systematically with firm characteristics, namely higher standard errors for volatile stocks with low dividend yields. We observe a number of firms appearing multiple times in examination of outliers. Hence, this is our preferred technique for estimating standard errors but we present White's (1984) adjusted standard errors for completeness. For a review of estimation techniques for standard errors refer to Petersen (2009).

separately, meaning there is reliable evidence that the value of one dollar of a fully-franked dividend is approximately one dollar.

61. The R^2 statistics measure how much of the variation in the dependent variable is explained by variation in the independent variables. For Models (2) and (4), the R^2 statistics are substantial – 59% and 71% (respectively) of the variation in the ex-day percentage price change can be explained by variation in the cash dividend and franking credit.[20]

62. For Models (1) and (3), however, the explanatory power of the cash dividend is moved from the right-hand side of the regression to the left-hand side – the cash dividend appears only on the left-hand side as part of the dependent variable. For these models, the R^2 statistic must be interpreted as a measure of the extent to which the franking percentage is able to explain the ex-day price change – beyond that which can be explained by the cash dividend.

63. That is, for Models (2) and (4) the R^2 statistic measures the combined explanatory power of the cash dividend and the franking credit. For Models (1) and (3) it measures only the incremental explanatory power of the franking credits – the cash dividend is effectively given full opportunity to explain whatever it can of the ex-day price change and the R^2 statistic measures only what the franking credit can explain beyond this. Consequently, it would be wrong to compare R^2 statistics across models or to use them as a basis for selecting a preferred model.

[20] We refer to the *R*-squared statistic throughout, rather than the adjusted *R*-squared statistic, because the robust regression analysis considered later only generates an *R*-squared statistic and we want to present explanatory power on a consistent basis throughout.

Table 2
Estimation results: OLS/GLS estimation

Model 1			
	Estimate	**Std Err (White)**	**Std Err (Firm clustering)**
Cash	0.8133	0.0580	0.0729
Franking credits	0.1405	0.1546	0.1912
Package	0.8735	0.0298	0.0288
R-squared	0.0002		
Adjusted R-Squared	0.0000		
N	3,642		
Model 2			
	Estimate	**Std Err (White)**	**Std Err (Firm clustering)**
Cash	0.8193	0.0261	0.0311
Franking credits	0.3815	0.0704	0.0868
Package	0.9828	0.0164	0.0195
R-squared	0.5971		
Adjusted R-Squared	0.5968		
N	3,642		
Model 3			
	Estimate	**Std Err (White)**	**Std Err (Firm clustering)**
Cash	0.9098	0.0399	0.0480
Franking credits	0.1381	0.1080	0.1263
Package	0.9690	0.0200	0.0206
R-squared	0.0004		
Adjusted R-Squared	0.0002		
N	3,642		
Model 4			
	Estimate	**Std Err (White)**	**Std Err (Firm clustering)**
Cash	0.9136	0.0203	0.0209
Franking credits	0.3044	0.0557	0.0645
Package	1.0440	0.0139	0.0157
R-squared	0.7193		
Adjusted R-Squared	0.7192		
N	3,642		

Cash represents the estimated value of a one dollar cash dividend; *Franking credits* represents the estimated value of a one dollar franking credit; *Package* represents the estimated combined value of a one dollar cash dividend plus the associated 43 cent franking credit. The *package* value is estimated as the sum of the *cash* coefficient and 0.43 times the *franking credits* coefficient. The standard error for the *package* estimate is computed as a function of the standard errors of the *cash* and *franking credits* coefficients, and the correlation between them.

Robust regression estimates

64. In accordance with the Terms of Reference (Paragraphs 12 and 14) for our 2011 study, we also estimate the four models set out in Equations (1) to (4) above using robust regression analysis. Robust regression analysis uses automated statistical adjustments to down-weight the influence of extreme data points or outliers. We use the SAS procedure ROBUSTREG to implement the MM robust regression method. The MM method was developed by Yohai (1987) and accounts for imprecision in the dependent and independent variables. Of the four alternative techniques available

in the ROBUSTREG procedure it provides the most comprehensive analysis of outliers. The application of these methods in the SAS package is explained in detail in Chen (2002).

65. When implementing the MM robust regression method in SAS, the user is able to over-ride default values and impose values for certain parameters. For example, the INEST option allows the user to impose a prior expectation for the values of the regression coefficients, rather than using values from a first stage estimation procedure. In our implementation, we use the default (neutral) values for all options.

66. The results of our estimation using the ROBUSTREG-MM procedure are summarised in Table 3 below. The estimates of theta for Models 2 and 4 are very similar to those reported in Table 2 above. The robust regression estimates of theta for Models 1 and 3 are higher than the estimates in Table 2, and more consistent with the estimates from Models 2 and 4.

67. The ROBUSTREG procedure available in SAS does not permit the calculation of White heteroscedastic-consistent standard errors or standard errors based on firm clustering. The procedure only allows for estimates of the standard covariance matrix of parameters. The result is that the "regular" standard errors in Table 3 are lower than the heteroscedastic-consistent and firm clustering standard errors reported in Table 2. This should not be seen as an improvement in the precision of estimates, but rather that a different definition of standard error is being reported.

Table 3
Estimation results: Robust regression

Model 1		
	Estimate	**Std Err**
Cash	0.8747	0.0309
Franking credits	0.2876	0.0820
Package	0.9980	0.0159
R-squared	0.0021	
N	3,642	
Model 2		
	Estimate	**Std Err**
Cash	0.8932	0.0234
Franking credits	0.3488	0.0630
Package	1.0427	0.0131
R-squared	0.5218	
N	3,642	
Model 3		
	Estimate	**Std Err**
Cash	0.9111	0.0213
Franking credits	0.2418	0.0580
Package	1.0147	0.0124
R-squared	0.0023	
N	3,642	
Model 4		
	Estimate	**Std Err**
Cash	0.9297	0.0150
Franking credits	0.3516	0.0420
Package	1.0804	0.0093
R-squared	0.6567	
N	3,642	

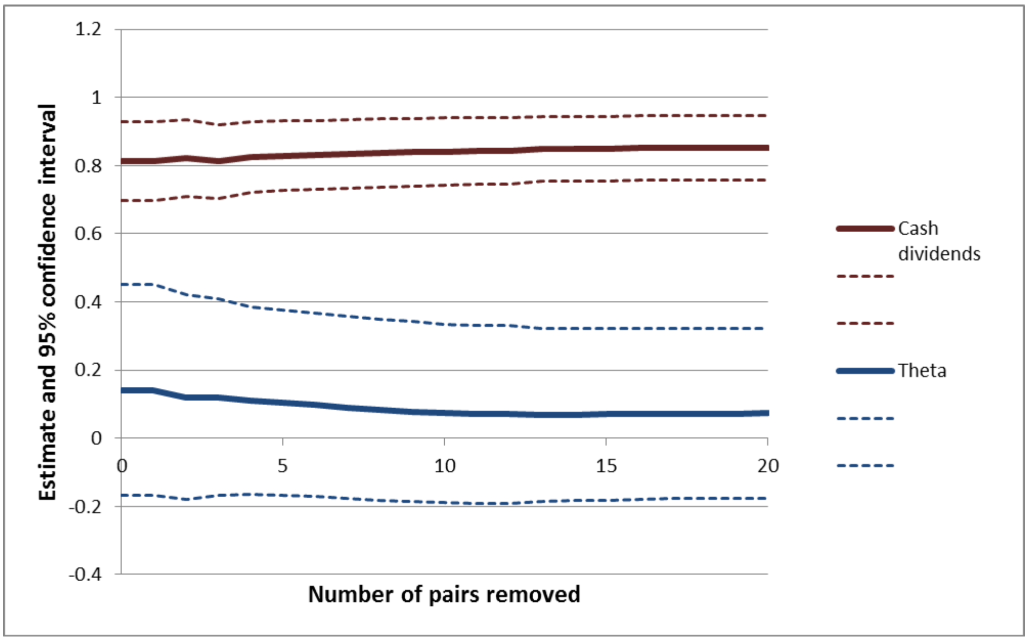
Cash represents the estimated value of a one dollar cash dividend; *Franking credits* represents the estimated value of a one dollar franking credit; *Package* represents the estimated value of a one dollar cash dividend plus the associated 43 cent franking credit.

Stability analysis: Robustness to influential observations

68. Our data compilation methods (e.g., eliminating from the sample very small firms or firms that do not trade on the cum-dividend and ex-dividend dates) are designed to eliminate outlier data points that are erroneous in some respect and which are likely to have a disproportionate influence on the estimate of theta. Even after having performed this screening and checking process, it is inevitable that some of the remaining data points will be more influential than others. Consequently, we have quantified the sensitivity of our estimates of theta to influential observations by conducting a stability analysis. We do this by first determining which single observation, if removed, would result in the greatest increase in our estimate of theta. We then determine which single observation, if removed, would result in the greatest decrease in our estimate of theta. We then remove both observations and re-estimate theta. We then repeat this process by removing another pair of observations. We continue in this manner, removing pairs of observations, until 20 pairs have been removed.

69. The results of applying this process to Model 1 are summarised in Figure 1. The solid lines represent the estimates of the value of cash dividends and theta, as indicated. In each case, the corresponding dashed lines represent the 95% confidence interval around the point estimate.

Figure 1
Sensitivity to removal of influential observations: Model 1



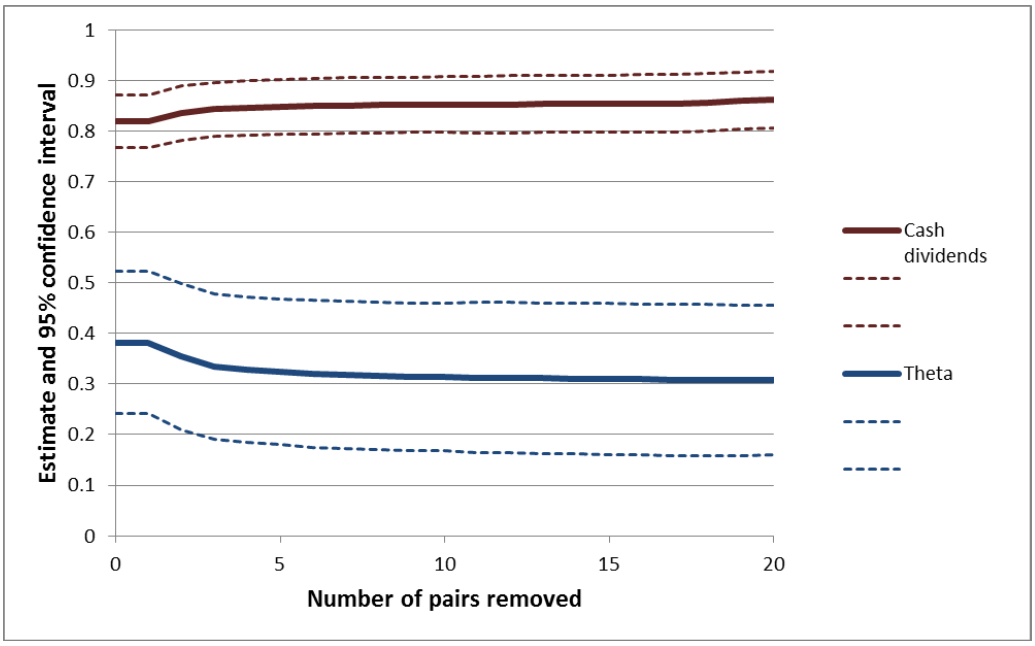
70. Figure 1 shows that the original point estimate of theta from Model 1 was 0.14. When the first pair of observations (i.e., one observation that would maximally increase the estimate of theta and one that would maximally decrease the estimate of theta) is removed, there is a negligible change in the point estimate of theta. As further pairs of observations are removed, the point estimate of theta falls marginally before levelling off at approximately 0.07.

71. The point estimates of the value of cash dividends move in the opposite direction. As pairs of influential observations are removed, the estimate increases slightly before settling at approximately 0.86.

72. The combined value of dividend plus franking credit is stable throughout, taking a constant value (between 0.873 and 0.883) whether the influential observations are included or excluded.

73. The result of applying the same process of removing pairs of influential observations to Model 2 is summarised in Figure 2 below. These results are similar to those for Model 1 above. The point estimate of theta falls slightly as the first pairs of influential observations are removed before stabilising at a constant level – approximately 0.31 in this case.

Figure 2
Sensitivity to removal of influential observations: Model 2



74. The stability analysis for Models 3 and 4 are set out in Figure 3 and Figure 4 respectively.

Figure 3
Sensitivity to removal of influential observations: Model 3

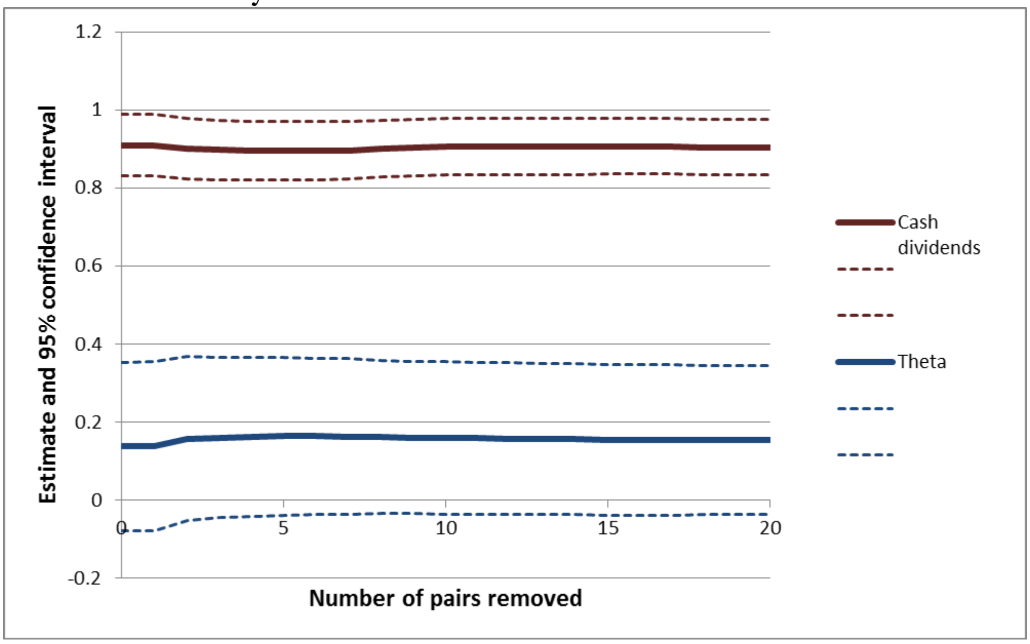
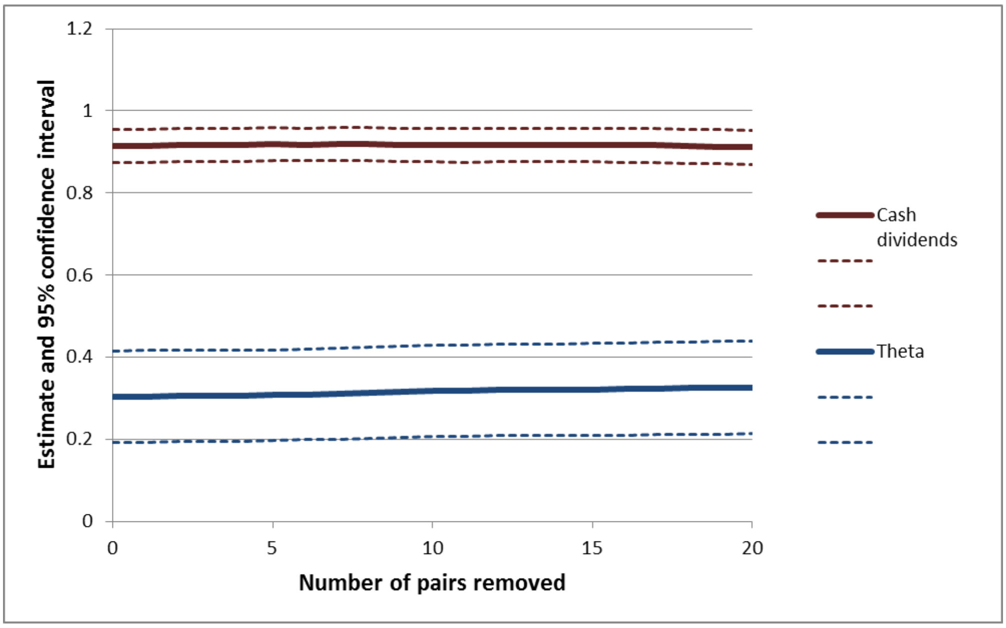


Figure 4
Sensitivity to removal of influential observations: Model 4



75. The stability analysis for Model 4, in Figure 4 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. That is, the estimates from Model Specification 4 are less sensitive to the effects of influential observations.

76. In summary, the stability analyses demonstrate that the estimates of theta are either maintained or slightly lowered when pairs of influential observations are removed from the data set.

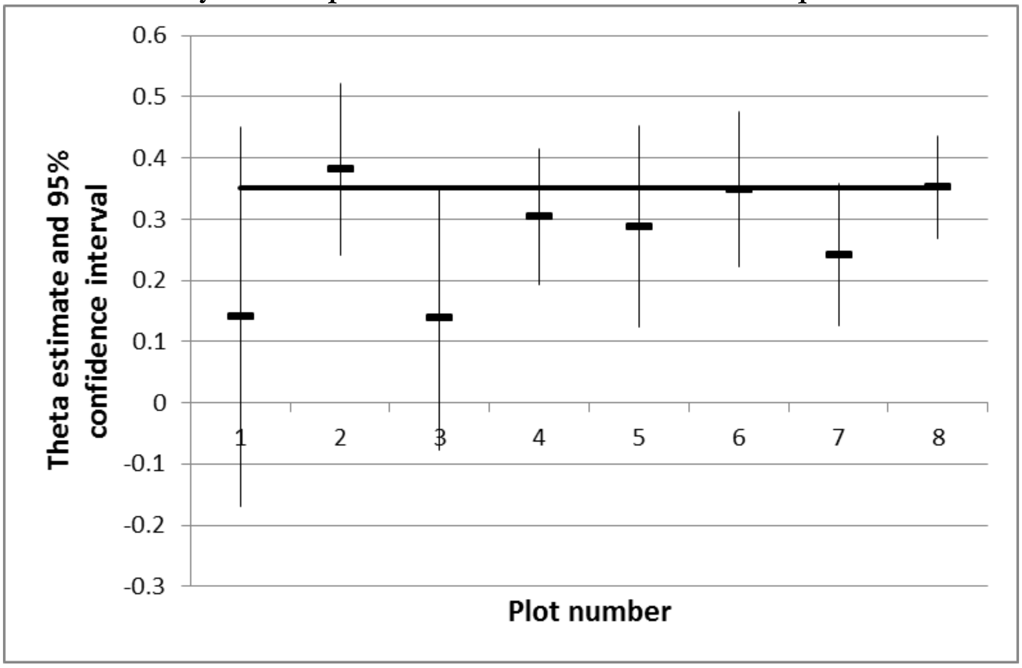
Sensitivity analysis

77. In this section, we examine the sensitivity of the results to variations in the model specifications, estimation methods, and construction of the data sets. In each case, we compare the theta estimate of 0.35 from our 2011 study with the updated results.

0.35 is consistent with results from different model specifications and estimation techniques

78. We note that 0.35 lies within the standard statistical 95% confidence interval for all the estimations we have performed. We illustrate this in Figure 5 below, which shows that our previous estimate of 0.35 is within the 95% confidence interval for every estimation. Figure 5 plots estimates for Model Specifications 1-4 estimated by OLS/GLS (Plots 1-4 in the figure) and then the corresponding robust regression estimates (Plots 5-8 in the figure). For none of these estimations can the proposed estimate of 0.35 be statistically rejected.

Figure 5
Summary of point estimates and confidence intervals for theta by model specification and estimation technique



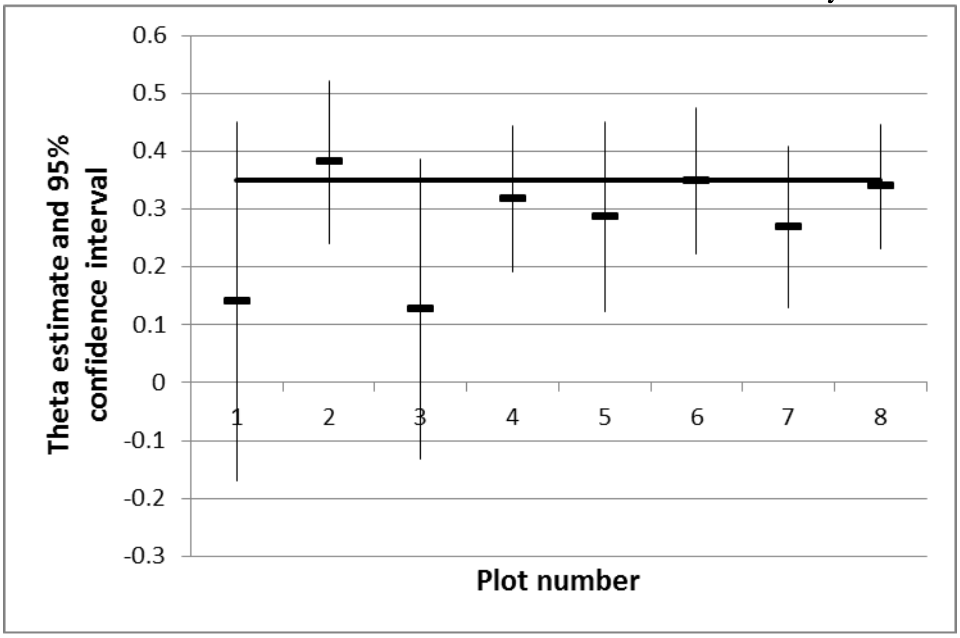
For each estimate, the narrow line represents the 95% confidence interval for theta and the solid black marker represents the point estimate. The solid black horizontal line represents the recommended point estimate of 0.35.

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.

0.35 is consistent with results from different measures of volatility

79. Model specifications 3 and 4 involve scaling by stock return volatility as part of the GLS estimation methodology. Volatility can be defined in terms of the standard deviation of stock returns or the variance of stock returns. Figure 6 shows that the estimates of theta are largely insensitive to the definition of volatility that is used – the estimates of theta from a particular model are immaterially different across definitions of volatility.

Figure 6
Summary of point estimates and confidence intervals for theta based on different definitions of stock return volatility

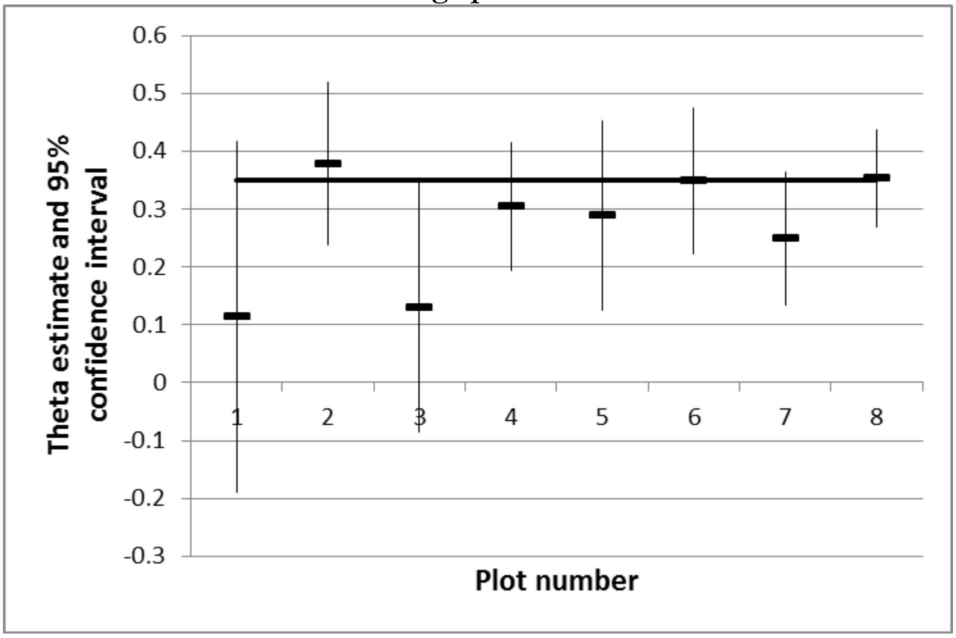


For each estimate, the narrow line represents the 95% confidence interval for theta and the solid black marker represents the point estimate. The solid black horizontal line represents the recommended point estimate of 0.35. For all models, all observations for which the firm made a "market sensitive" announcement are removed.
Plot 1: Model specification 3, OLS, variance; Plot 2: Model specification 4, OLS variance;
Plot 3: Model specification 3, OLS standard deviation; Plot 4: Model specification 4, OLS, standard deviation;
Plot 5: Model specification 3, RR, variance; Plot 6: Model specification 4, RR, variance;
Plot 7: Model specification 3, RR standard deviation; Plot 8: Model specification 4, RR, standard deviation.

0.35 is consistent with results when special dividends are omitted

80. In our view, there is no conceptual reason to omit special dividends from the analysis, however the AER has previously expressed concern about their inclusion. Figure 7 shows that the estimates of theta are largely insensitive to the inclusion or exclusion of special dividends.

Figure 7
Summary of point estimates and confidence intervals for theta after omitting special dividends

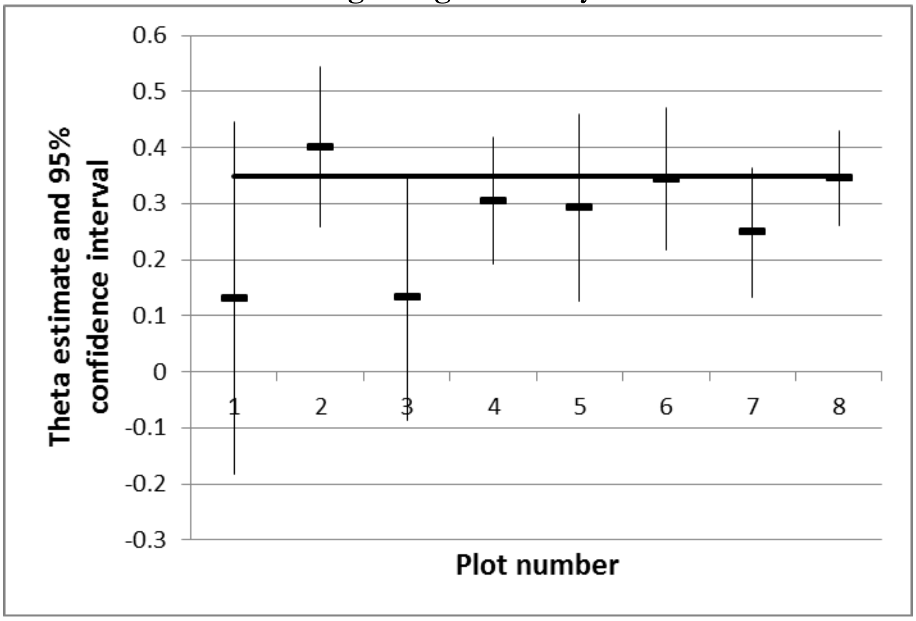


For each estimate, the narrow line represents the 95% confidence interval for theta and the solid black marker represents the point estimate. The solid black horizontal line represents the recommended point estimate of 0.35.
Plot 1: Model specification 1, OLS estimation; Plot 2: Model specification 2,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

0.35 is consistent with results when foreign currency dividends are omitted

81. Figure 8 shows that the estimates of theta are largely insensitive to the inclusion or exclusion of foreign currency dividends. The exclusion of 56 foreign currency dividends has no material effect on the estimates of theta.

Figure 8
Summary of point estimates and confidence intervals for theta after omitting foreign currency dividends



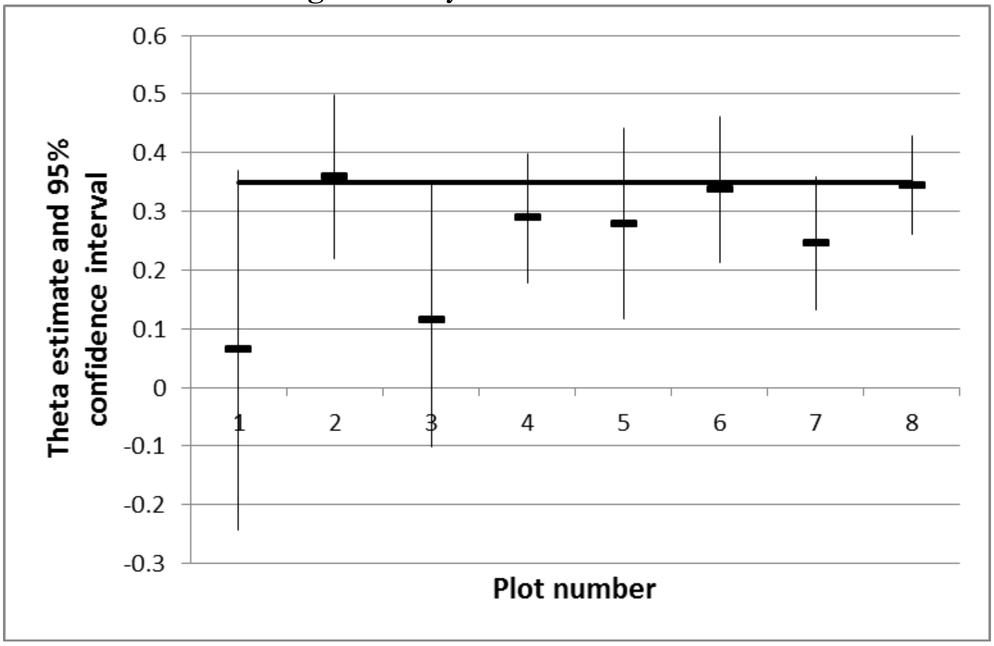
For each estimate, the narrow line represents the 95% confidence interval for theta and the solid black marker represents the point estimate. The solid black horizontal line represents the recommended point estimate of 0.35.

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.

0.35 is consistent with results when unmatched DatAnalysis dividend events are included

82. To ensure that the results are robust to the process used to identify ex-dividend events, we perform an analysis that includes the dividend events that appear in the DatAnalysis database, but which do not match a dividend event in the TRTH database. The inclusion of these 80 observations has no material effect on the results. Figure 9 shows that the estimates of theta are largely insensitive to the inclusion or exclusion of unmatched DatAnalysis dividend events.

Figure 9
Summary of point estimates and confidence intervals for theta including DatAnalysis unmatched dividends

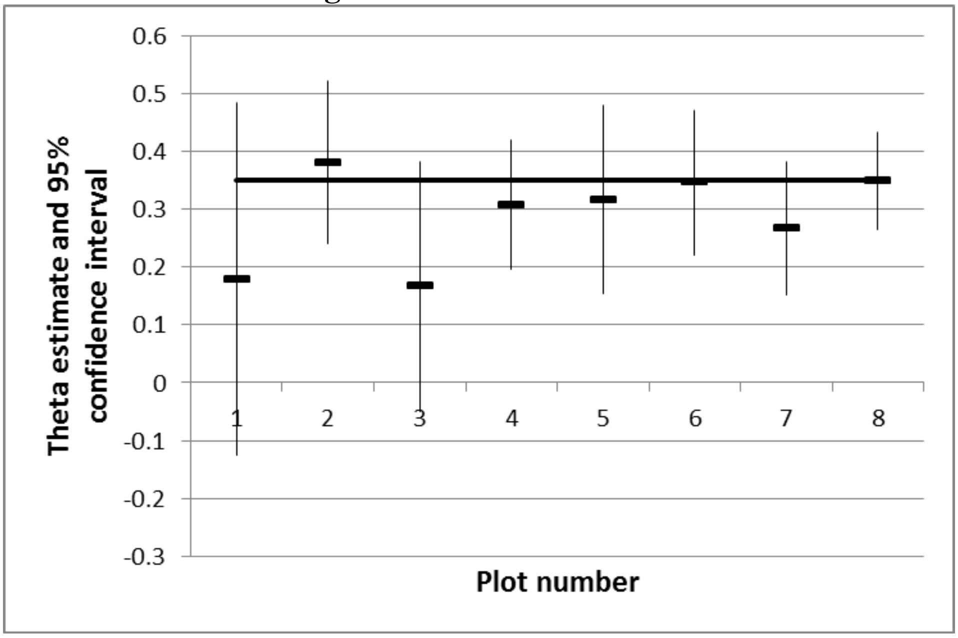


For each estimate, the narrow line represents the 95% confidence interval for theta and the solid black marker represents the point estimate. The solid black horizontal line represents the recommended point estimate of 0.35.
Plot 1: Model specification 1, OLS estimation; Plot 2: Model specification 2,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

0.35 is consistent with results when unmatched TRTH dividend events are included

83. To ensure further that the results are robust to the process used to identify ex-dividend events, we also perform an analysis that includes the dividend events that appear in the TRTH database, but which do not match a dividend event in the DatAnalysis database. The inclusion of these 113 observations has no material effect on the results. Figure 9 shows that the estimates of theta are largely insensitive to the inclusion or exclusion of unmatched TRTH dividend events.

Figure 10
Summary of point estimates and confidence intervals for theta including TRTH unmatched dividends

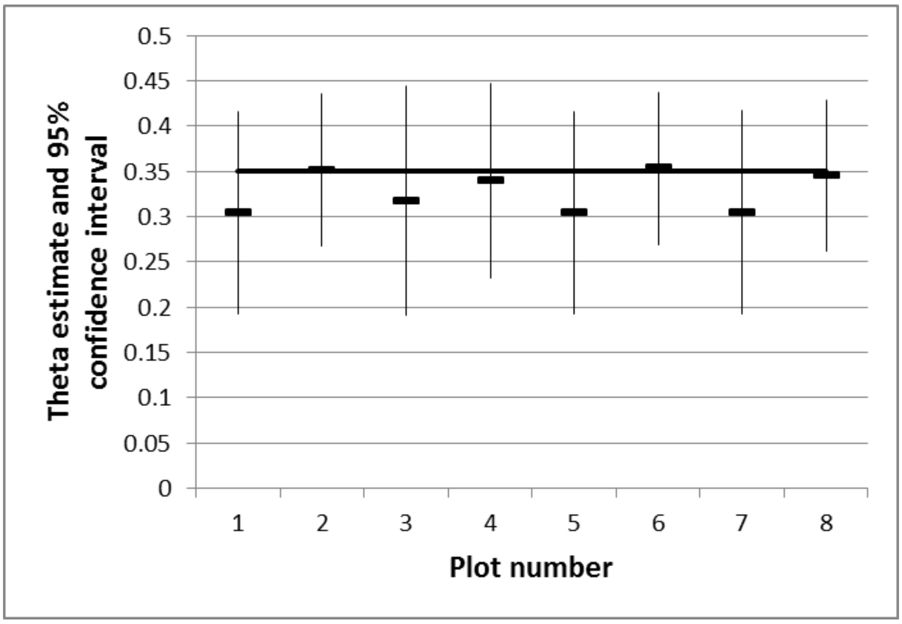


For each estimate, the narrow line represents the 95% confidence interval for theta and the solid black marker represents the point estimate. The solid black horizontal line represents the recommended point estimate of 0.35.
Plot 1: Model specification 1, OLS estimation; Plot 2: Model specification 2,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

0.35 is consistent with results for Model 4

84. In our 2011 report, we noted that the theta estimates from Model 4 tended to be the most stable across different sensitivity analyses and to have relatively smaller standard errors. Consequently, we collated those estimates into a single figure (Figure 11 in our 2011 report). We follow that same practice with our updated data set and display the results in Figure 11 below, which shows that the proposed estimate of 0.35 is squarely within the confidence interval, and close to the point estimate of theta, in all cases.

Figure 11
Summary of point estimates and confidence intervals for theta for Model 4



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: Base case, OLS estimation; Plot 2: Base case, RR estimation;
Plot 3: Vol=Standard deviation, OLS estimation; Plot 4: Vol=Standard deviation, RR estimation;
Plot 5: No specials, OLS estimation; Plot 6: No specials, RR estimation;
Plot 7: No foreign currency dividends, OLS estimation; Plot 8: No foreign currency dividends, RR estimation.

5. Conclusions

85. In our 2011 study we 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.[21]

86. In our view, the conclusions from our earlier study remain valid when tested against the updated data set.

[21] SFG (2011), Paragraph 3.

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