Review of Oxera debt beta analysis

Dr. Tom Hird
Dr Ker Zhang

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1 Introduction

1. This report provides a critique of Oxera's 19 September submission on debt betas "Oxera response to CEG's cross-submission: the debt beta for gas pipeline businesses".

2. The report has only one section with the following structure:

   ▪ Section 2.1 summarises Oxera's conclusions;

   ▪ Section 2.2 critiques Oxera's proposition that debt beta should be capped at 0.2 for a 90% geared firm and shows the effect of altering this cap to 0.5;

   ▪ Section 2.3 notes that even if one accepted Oxera's assumptions regarding debt beta, those assumptions still have a material impact on the percentage difference (as opposed to absolute difference) in asset betas between gas only and electricity only firms; and

   ▪ Section 2.4 critiques Oxera's advice that the Commission should not be concerned by the fact that Oxera's estimates imply a material negative relationship between asset beta and gearing.

3. Finally, in recognition that it is simply not possible to have a reliable estimate of debt betas for firms in the Commission's sample, Appendix A summarises the impact of a range of other assumptions that could be made.

4. The key message from this analysis remains the same as in our previous advice. The Commission should be wary of analysis of differences in asset beta within its sample that involve comparisons across firms with different levels of gearing. These comparisons are not reliable without a reliable estimate of debt betas for the firms involved.

2 Analysis

2.1 Oxera's analysis

5. Oxera's analysis advances three main propositions:

    i. That CEG's modelling of the relationship between debt beta and gearing gave rise to implausible results because:

        a. CEG's imposition of a 0.30 maximum cap on debt beta at gearing of 50% and above is unreasonably high. Oxera instead impose a value of debt beta of 0.2 at 90% gearing;

        b. CEG imposed an implausibly steep increase in debt beta at gearing levels above 30%. Oxera instead model a linear increase in debt beta starting at 0 for 0% gearing and increasing to 0.2 at 90% gearing.

    ii. That when Oxera's assumptions are adopted the difference in estimated asset beta's is very similar to that estimated with a zero debt beta and, therefore, the analysis that has been based on zero debt beta does not need to be revised;

    iii. That the Commission should not be concerned that there remains, under Oxera's assumptions, a strong negative relationship between gearing an asset betas. This is because Oxera asserts that this reflects the fact that high asset beta firms will tend to borrow less than low asset beta firms.

6. This report critiques each of these propositions.

2.2 Oxera's assumed relationship between debt beta and gearing

7. Oxera supports its adoption of a 0.2 maximum debt beta on the basis that:[1]

    While Brealey and Myers (2012) state that large firms would typically have a debt beta of 0.1 to 0.3, it is likely that a debt beta of 0.3 is applicable only for firms with low credit rating.

8. There is no statement in Brealey and Myers to this affect but Oxera infers this from another study (Schaefer and Strebulaev (2008)) which Oxera reports as concluding:

    "…the size of the positive debt betas tends to increase as credit quality declines."

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[1]   Oxera, 19 September 2016, p. 3

9. We, naturally, agree with the assumption that debt betas rise as debt becomes more risky. It, therefore, does follow that debt betas will tend to increase with gearing. However, this provides no basis for assuming that debt betas of 0.3 are unreasonable for the most highly geared firms in the Commission's sample (which is the basis of CEG's assumptions).

10. More importantly, Oxera portrays its debt beta assumptions as consistent with the advice of Brealey and Myers once it is recognised that "*a debt beta of 0.3 is applicable only for firms with low credit rating*". However, this is at odds with Oxera's actual application – which sets the debt beta a 90% geared firm at 0.2.

    For the purpose of illustration, Oxera has assumed that debt beta varies linearly between 0 and 0.2 for firms with gearing of 0% to 90%.

11. In our view, a 90% geared firm will be, almost by definition, have a "low credit rating". It is, therefore, unclear why Oxera assigns that firm a debt beta of less than 0.3. Indeed, given that most large firms have gearing much less than 90%, implementing Brealey and Myers' advice would require adoption of a debt beta well in excess of 0.3 at 90% gearing.

12. For the purpose of comparison we retain Oxera's assumption that debt betas increase linearly with gearing (and have a zero value at zero gearing). However, simply vary the debt beta that is assumed to apply at 90% gearing. Specifically, we compare results where debt beta at 90% gearing is:

    ▪ 0.0 (i.e., debt beta equals zero at all levels of gearing);

    ▪ 0.2 (i.e., Oxera's assumption);

    ▪ 0.5 (an alternative assumption consistent with Brealey and Myers advice and, also, with the logic of Oxera's stated position).

13. The percentage of firms in the Commission's sample with debt betas in the Brealey and Myers' range of 0.1 to 0.3 is provided in the last column of the below table. It can be seen that only 24% of firms have debt betas that are in that range if Oxera's assumptions are adopted. By contrast, 94% of firms have debt betas in that range in the alternative approach we postulate.

Table 1: Comparison of three different assumptions about debt beta's linear relationship to gearing

Asset beta at 90% gearing	Average of weekly and 4 weekly asset betas	Daily asset betas	% of debt betas between 0.1 and 0.3 for all firms
Difference b/w gas and electricity asset betas			
0.0	0.15	0.12	0%
0.2	0.13	0.11	24%
0.5	0.11	0.08	94%
Above difference divided by average electric asset beta			
0.0	52%	34%	As above
0.2	40%	26%	As above
0.5	27%	17%	As above

Source: Bloomberg, Commerce Commission, CEG analysis

14.   It can be seen that the alternative assumption reduces the absolute difference by around one third (compared to an assumed uniformly zero asset beta) and reduces the percentage difference by around a half.

15.   Oxera also argues for low debt betas on the basis of regulatory precedent. However, this is irrelevant in the context where the regulator was estimating average asset betas for a sample of firms and re-levering the asset beta to the gearing of the average firm. In that context, it is common ground that the choice of debt beta is largely irrelevant to the final cost of equity estimated (so long as the same debt beta is used to de-lever and re-lever betas). However, that is not the context here were we are comparing asset betas across firms with different gearing.[2]

16.   Oxera also refers to its own empirical estimates of debt betas which it summarised in a report to the Commission in the UCLL/UBA context. However, Oxera's methodology is only summarised at a very high level and we note that illiquidity in corporate debt markets is a major constraint on accurately estimating debt betas – and tends to result in underestimation due to the failure of measured bond prices to respond to market news at the same speed as equity prices.

2.3   Oxera reports absolute differences in asset betas not percentage differences

17.   Oxera states that:

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[2]   In any event, we note that Oxera's survey of regulatory precedent is incomplete and that materially higher debt betas have been used by regulators. For example, the QCA adopted an estimate of 0.28 for the debt beta. This was derived based on the observed debt risk premium relative to the risk free rate. QCA, Final Decision, Regulation of Electricity Distribution, May 2001, p. 11.

In contrast, Oxera's analysis of debt betas shows that the differential in the asset betas of gas pipeline businesses and electricity networks would reduce only marginally, by around 0.01-0.02.

18. However, this is a less than full presentation of the effect on asset betas. This is because, even adopting Oxera's very low asset beta assumptions, the average asset beta of all the firms in the Commission's sample rises materially. This means that even a small reduction in the *absolute* difference can be associated with a large reduction in the *percentage* difference.

19. An observed absolute difference in asset betas is less economically material if the absolute value of all asset betas is higher. When the comparison is performed on a percentage difference basis Oxera's debt beta assumptions actually causes this metric to decline by over 20% (i.e., from Table 1 above (52%-40%)/52%=0.23% decline and (34%-26%)/34% = 24% decline).

2.4 Oxera argues that negative relationship between estimated asset beta and gearing is not problematic

20. If we apply Oxera's debt beta assumptions we estimate the following relationship between asset beta and gearing in the Commission's sample.

Figure 1: Asset beta vs debt beta using daily betas (Oxera assumptions, daily data)
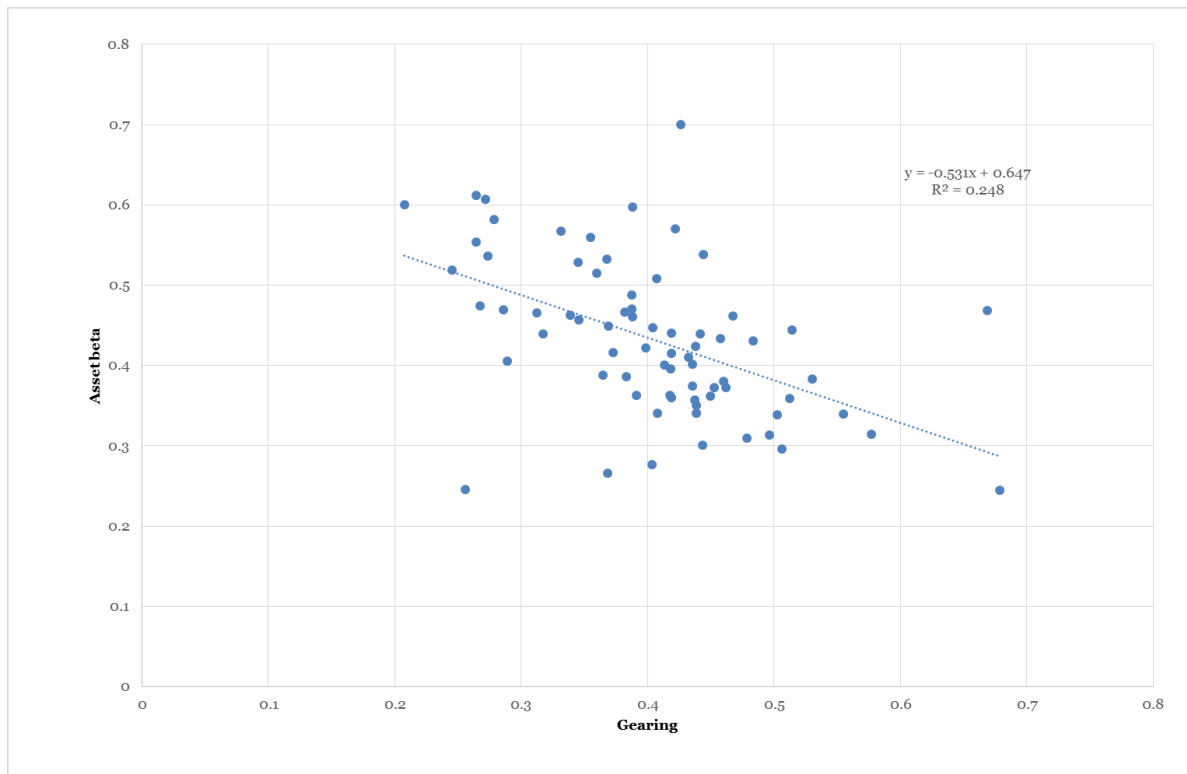
21. This shows a strong negative relationship between asset beta and gearing. Such a relationship should not exist because asset beta is, in theory, independent of gearing.

22. Oxera advises the Commission that it should not be concerned about the existence of this strong negative relationship. The basis for this advice is that Oxera posits an assumption that higher risk firms tend to borrow less. Consequently, Oxera argues that we should expect to see a negative relationship between asset beta and gearing.

23. Oxera's explanation is highly speculative and no evidence is provided in support of the assumption. Given that gas only businesses happen to have lower than average gearing, Oxera's position amounts to assuming the answer rather than deriving the answer.

24. However, there is a test that can be applied to Oxera's assumption. The only justification that Oxera provides for there being differences in risk within the Commission's sample is that US gas only businesses are higher risk than other US businesses. This suggests that we can test Oxera's proposition by excluding gas only businesses. If doing so has the effect of removing any relationship between asset beta and gearing in the remaining firms in the Commission's sample then this will be evidence in support of Oxera's proposition. If not, it will be evidence against Oxera's proposition.

25.   Figure 2 below shows the results of such an exclusion. It can be seen that the negative relationship remains very strong (-0.49 coefficient on gearing vs -0.53) and the R^2 increases materially (from 0.25 to 0.30). In both scenarios, the slope coefficient is significant at above 99.99% confidence levels.

Figure 2: Asset beta vs debt beta using daily betas and excluding gas only firms (Oxera assumptions, daily data)
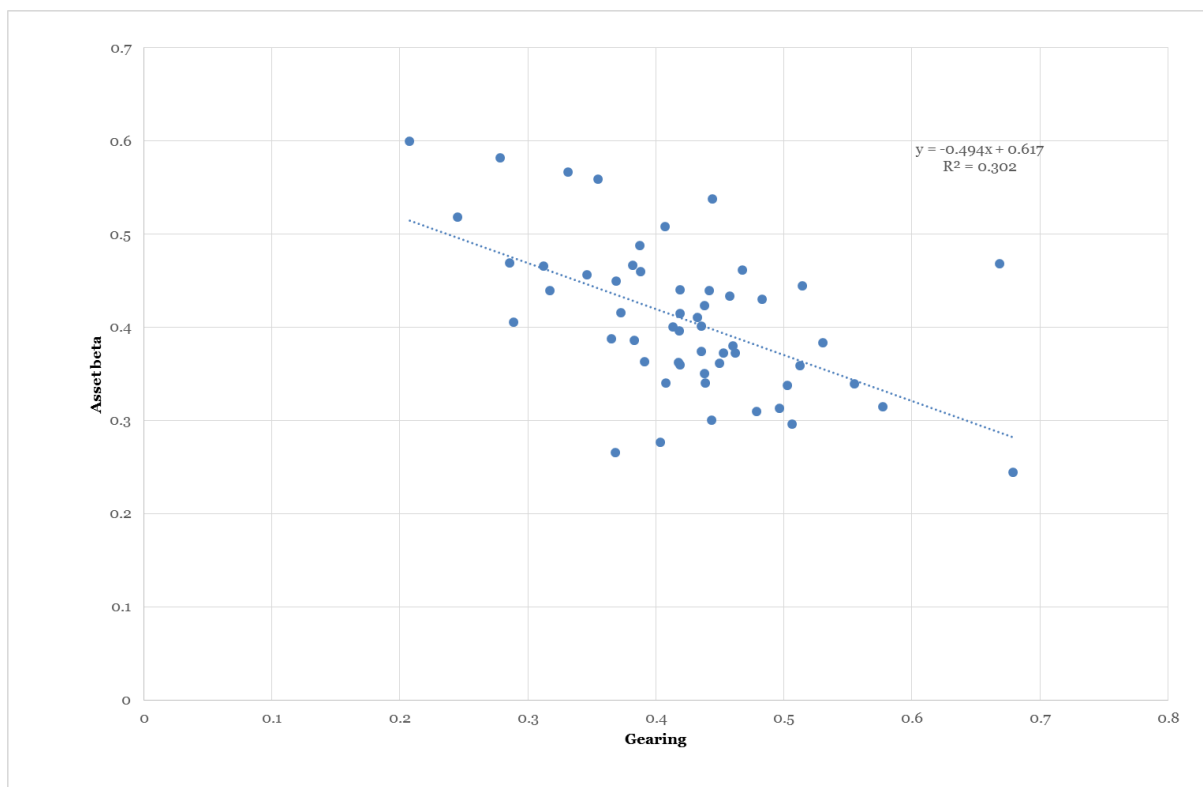
26.   This is compelling evidence:

- against the proposition that it is higher risk of 'gas only' firms that is driving the observed negative relationship; and

- in favour of the proposition that the observed relationship reflects the fact that Oxera's assumed debt beta is too low at high levels of gearing.

27.   It is also relevant to note that in the above sample the firm with the highest asset beta, MGEE, also has the lowest gearing. Similarly, the firm with the lowest asset beta, DUET, has the highest gearing. Examination of these firms reveals apparently very similar activities. Both are integrated gas and electric distribution/transmission businesses. There is no reason to expect that MGEE is materially higher risk than DUET. Rather, there is every reason to believe that their extreme positions in the distribution of asset betas is due to a failure to use a sufficiently higher debt beta assumption when deriving the asset beta for DUET

28.   In this regard, we note that out alternative linear debt beta relationship with gearing (assuming a 0.5 debt beta at 90% gearing) results in a materially lower slope coefficient (-0.20) and R^2 (0.064). This is illustrated in Figure 3 below.

Figure 3: Asset beta vs debt beta using daily betas and excluding gas only firms (CEG alternative linear assumptions, daily data)
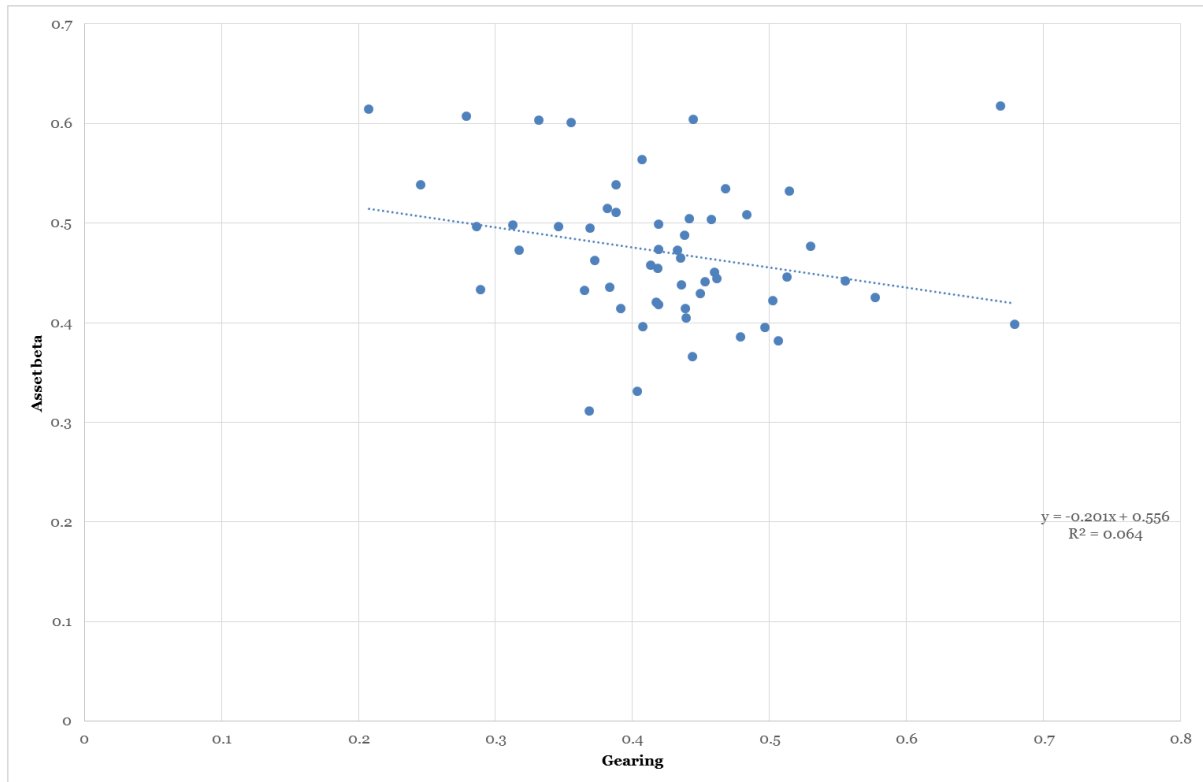
29.   It can be seen that while the negative slope is reduced it is not eliminated. This suggests that a more positively sloped relationship between debt beta and gearing may be appropriate. It is notable that the difference between MGGE and DUET's estimated asset beta is compressed materially. However, MGEE continues to have one of the highest (second highest) estimated asset beta while DUET's estimated asset beta is now closer to the middle of the pack.

Appendix A   Other sensitivities

30.   Oxera reports only a single alternative to CEG's debt beta assumptions. In section 2 we focus on a single variation to Oxera's assumptions. In this section we report a more varied set of sensitives.   The 'take home message' of these is that any assumptions about debt beta:

- that substantially reduce the estimated negative relationship between asset beta and gearing; also

- substantially reduce the estimated difference between gas only asset betas and electricity asset betas.

31.   The data covers the gas only, electric only and integrated firms, except Jersey Electricity and National Fuel Gas for period from 2011 March 31st to 2016 March 31st. Equity beta is estimated using daily returns for daily, weekly for different days of the week, and monthly based on different days of the month.

32.   Asset beta is calculated based on several assumptions on the relationships between debt betas and gearing. The first section presents the result for the model presented in the original CEG report. The next section presents the result based on the linear approach published by Oxera. The third section presents the result based on other alternatives.
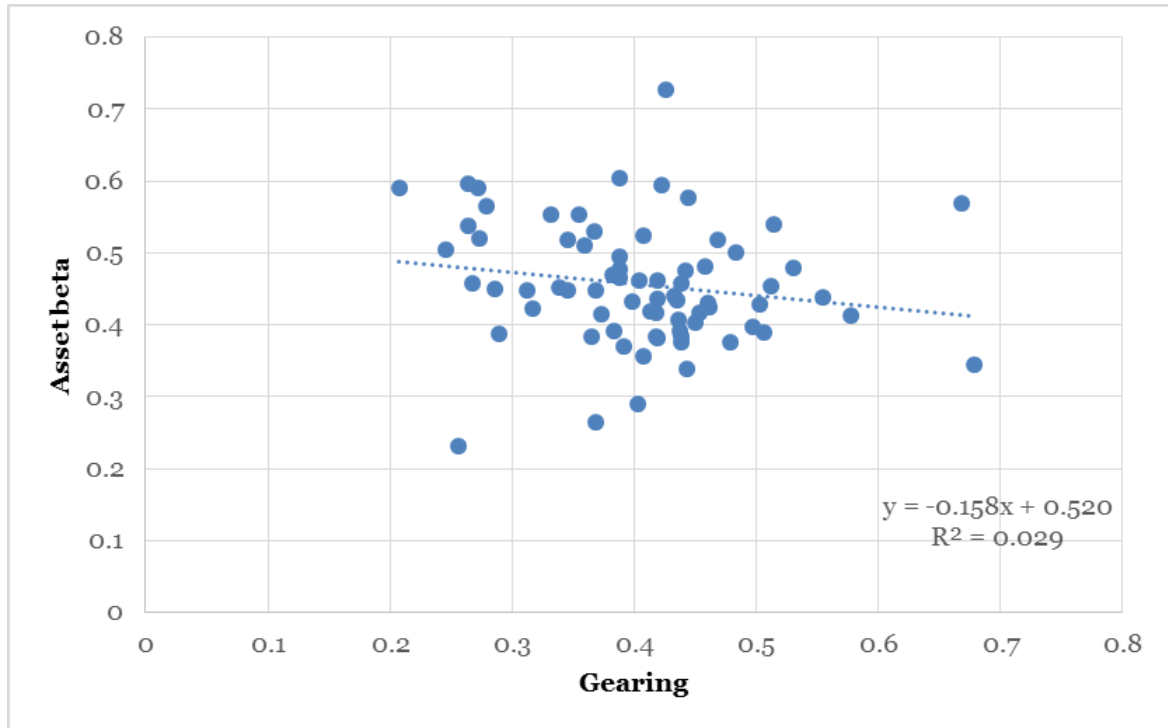
A.1   Original CEG report

33. $Debt\ Beta = \ \min\left(\max\left(0, \frac{0.5}{1-gearing} - \frac{0.5}{1-0.3}\right), 0.3\right)$

Figure 4: Debt Beta Curve (CEG original report model)
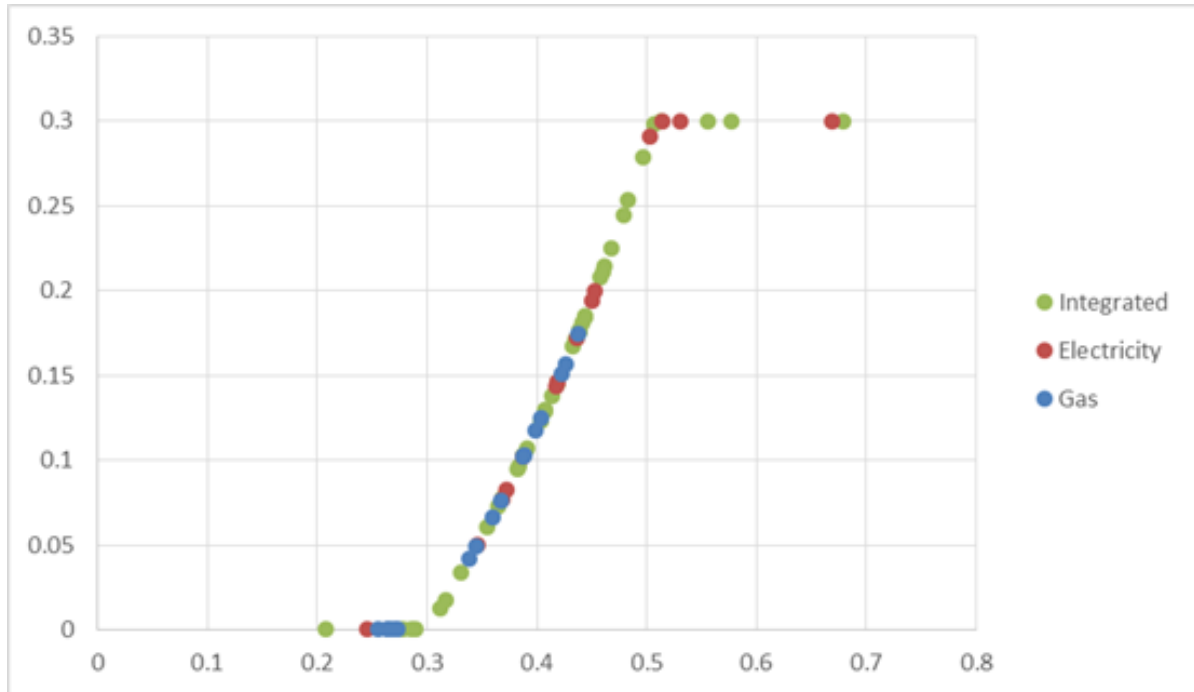
Source: CEG analysis using Bloomberg data

Figure 5: Asset beta vs debt beta using daily betas (CEG original report model)
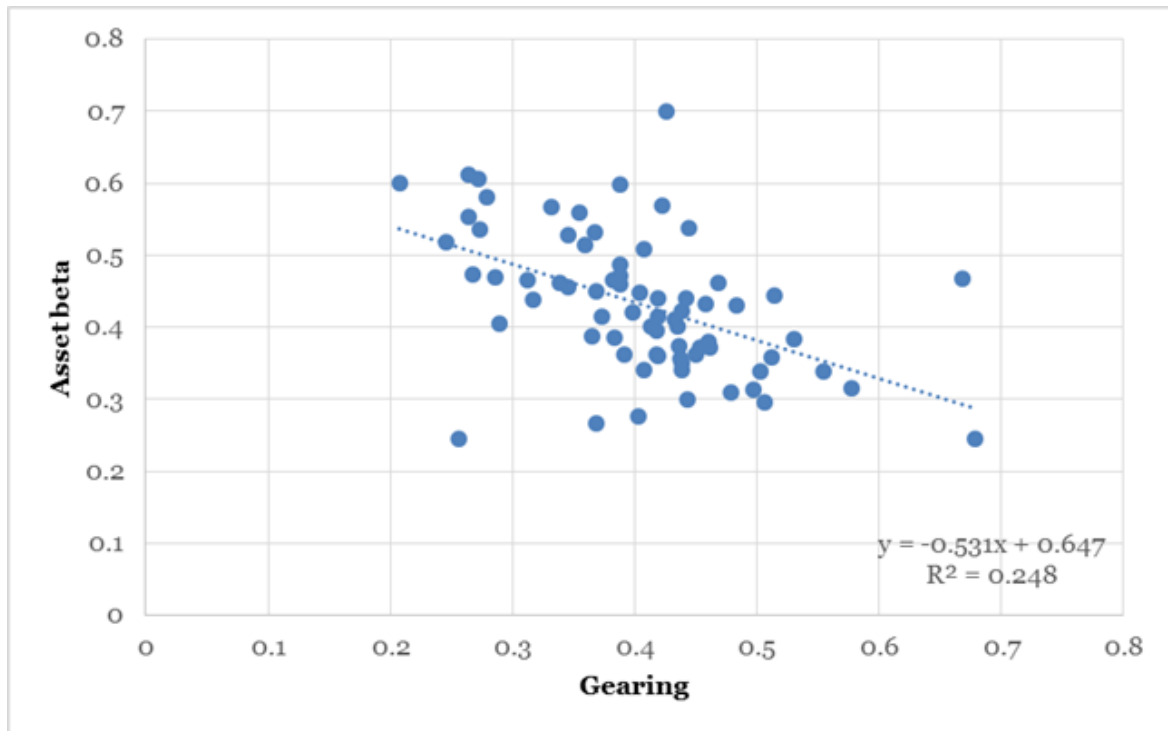

Source: CEG analysis using Bloomberg data

Table 2: Comparison of assumptions about debt beta's relationship to gearing (CEG original report model)

	Assuming zero debt beta		Assuming non-zero debt beta		
	Range for absolute difference (daily, weekly and four-weekly over 2011-2016)	Average of weekly and four-weekly estimates over 2011-2016	Range for absolute difference (daily, weekly and four-weekly over 2011-2016)	Average of weekly and four weekly estimates over 2011-2016	% of debt betas between 0.1 and 0.3 for all firms
Difference b/w gas and electricity asset betas	0.12-0.15	0.15	0.07-0.10	0.10	64%
Above difference divided by average electric asset beta	34%-54%	52%	16%-27%	26%	As Above

Source: Bloomberg, Commerce Commission, CEG analysis
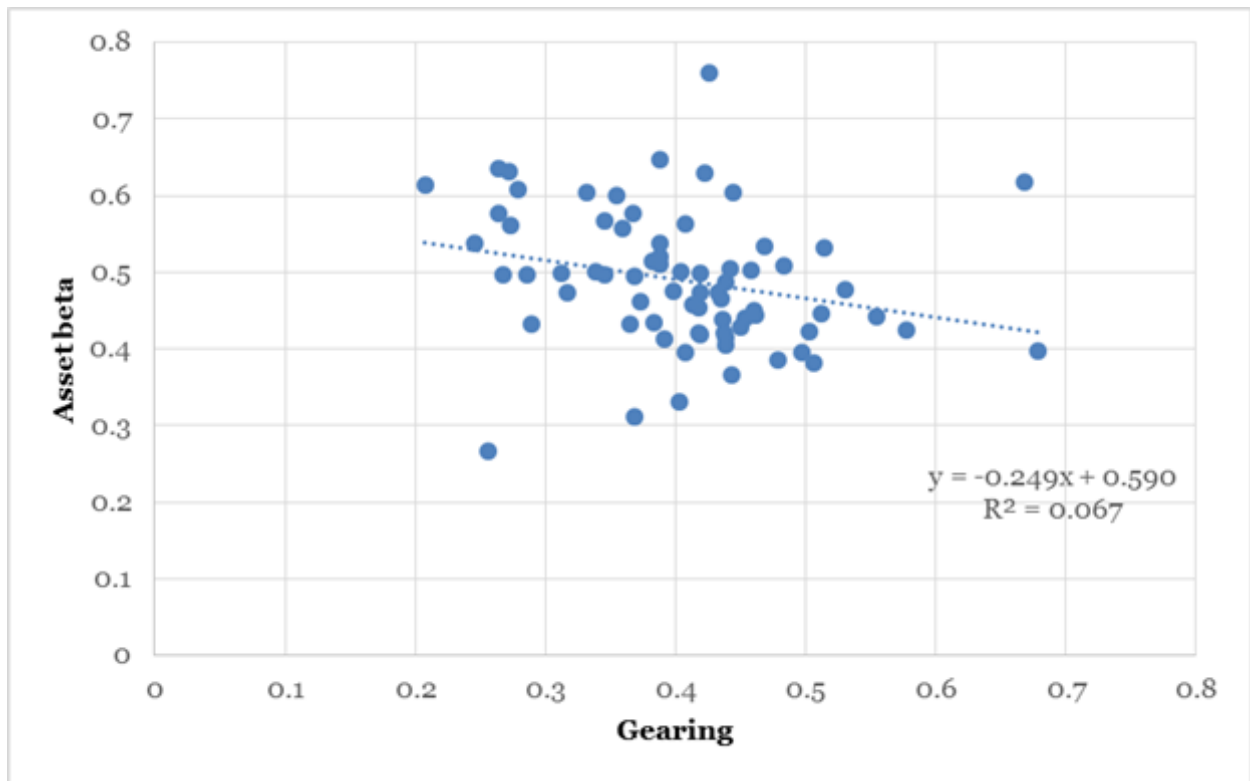
A.2 Linear approaches

Figure 6: Asset beta vs debt beta using daily betas (Oxera assumption, linear with 90% geared firms having 0.2 debt beta, all firms)

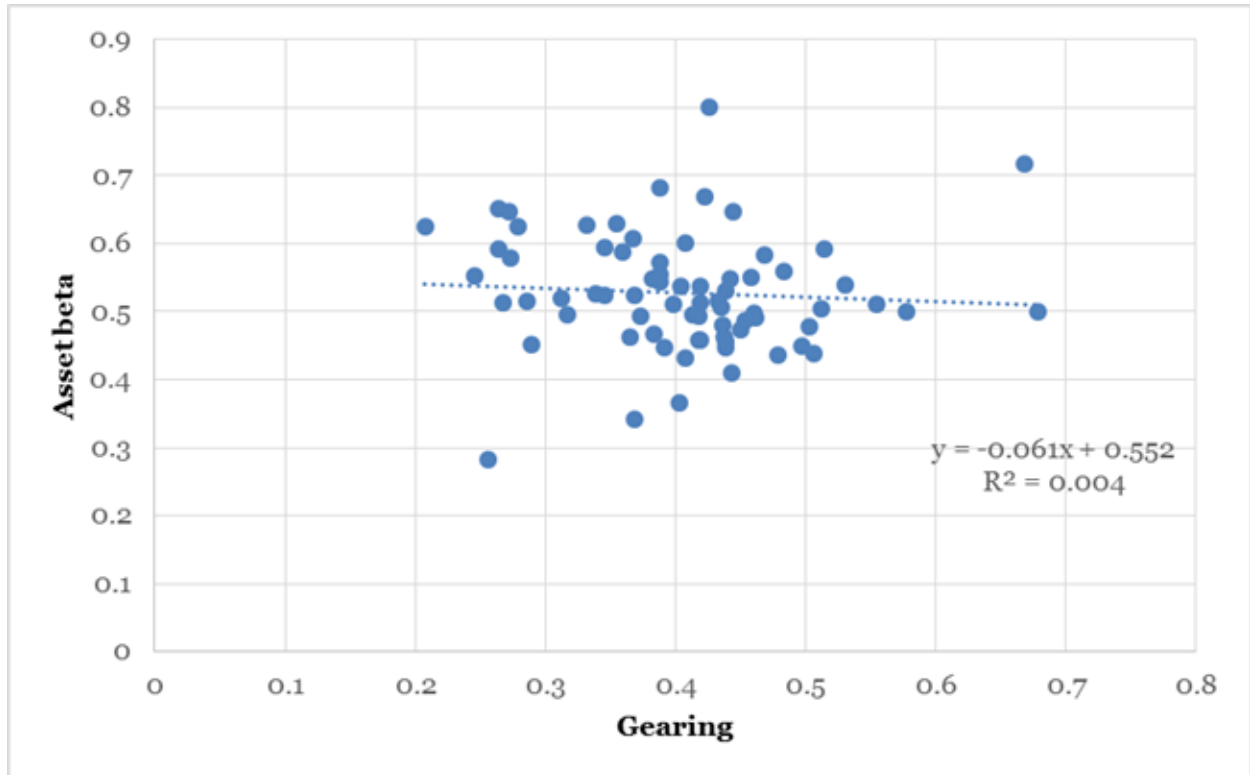*Source: CEG analysis using Bloomberg data*

Figure 7: Asset beta vs debt beta using daily betas (90% geared firms has 0.5 debt beta, all firms)

Source: CEG analysis using Bloomberg data

Figure 8: Asset beta vs debt beta using daily betas (90% geared firms has 0.7 debt beta, all firms)

Source: CEG analysis using Bloomberg data

Table 3: Comparison of four different assumptions about debt beta's linear relationship to gearing

| Asset beta at 90% gearing	Average of weekly and 4 weekly asset betas	Daily asset betas	% of debt betas between 0.1 and 0.3 for all firms
Difference b/w gas and electricity asset betas			
0.0	0.15	0.12	0%
0.2	0.13	0.11	24%
0.5	0.11	0.08	94%
0.7	0.09	0.06	36%
Above difference divided by average electric asset beta			
0.0	52%	34%	As above
0.2	40%	26%	As above
0.5	27%	17%	As above
0.7	21%	13%	As above

Source: Bloomberg, Commerce Commission, CEG analysis

A.3   Other non-linear assumptions about debt beta
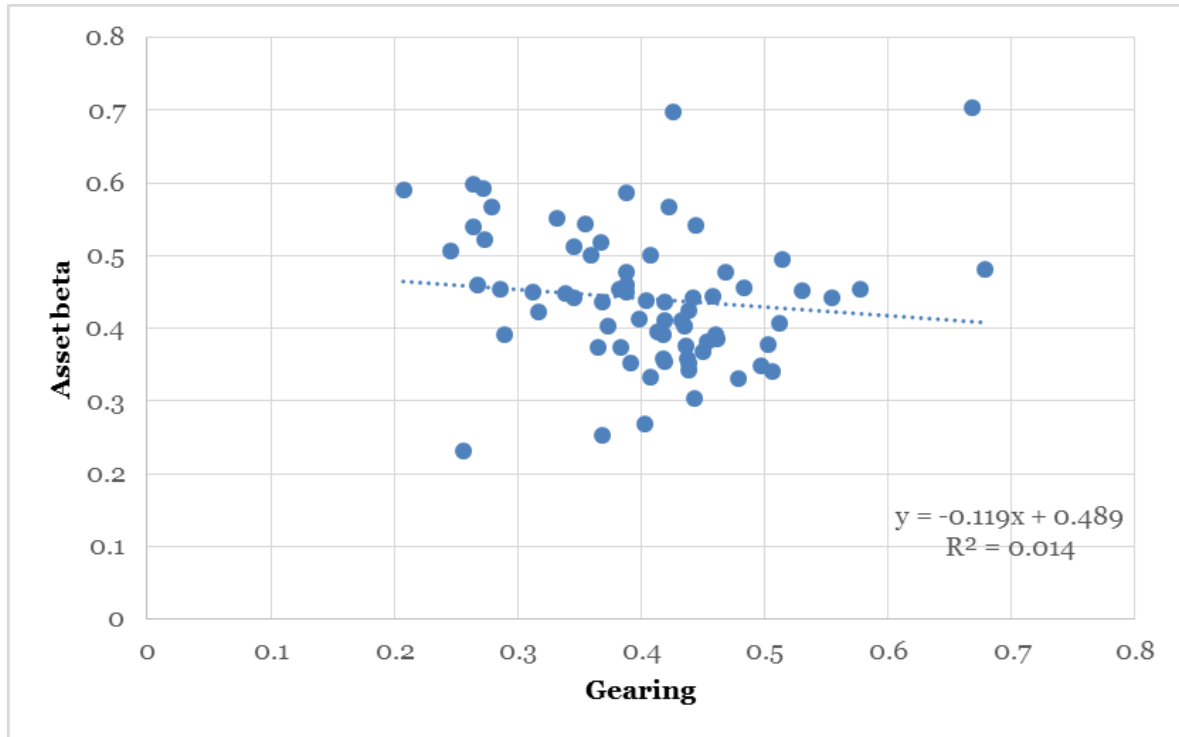
A.3.1   Non-linear alternative 1

34. $Debt\ Beta = \min\left(\max\left(0, \frac{gearing^2}{1-gearing} - \frac{gearing^2}{1-0.2}\right), 0.5\right)$

Figure 9: Debt Beta Curve, non-linear alternative 1
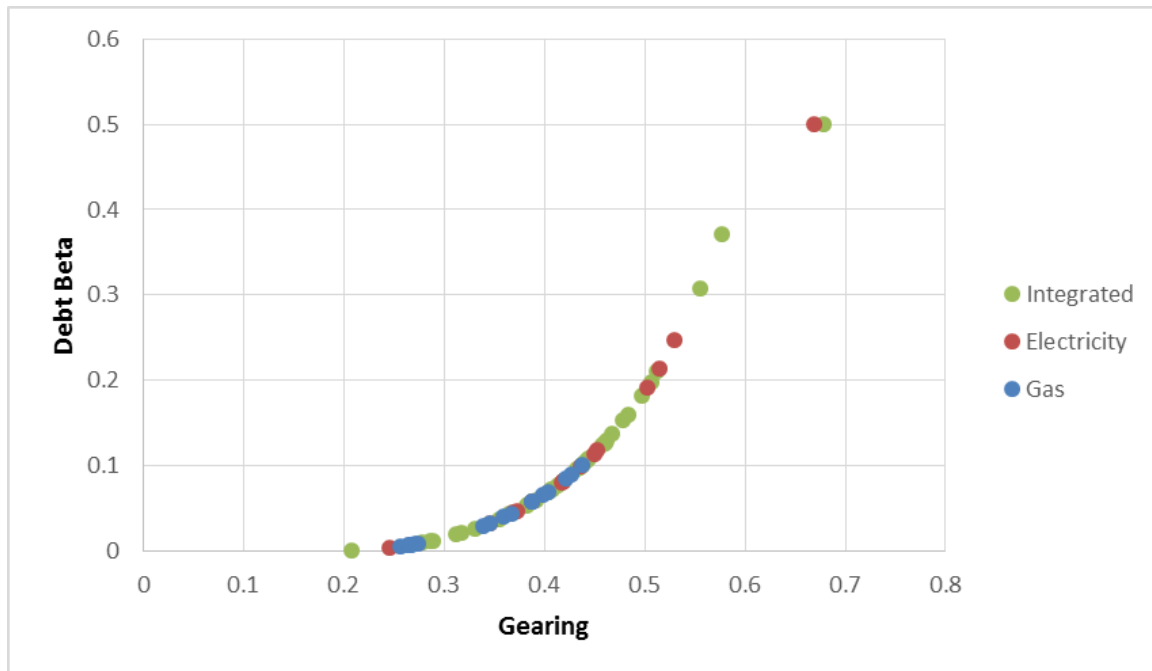
Source: CEG analysis using Bloomberg data

Figure 10: Asset Beta vs gearing, non-linear alternative 1

The chart shows a scatter plot with regression line:
$$y = -0.119x + 0.489$$
$$R^2 = 0.014$$

Source: CEG analysis using Bloomberg data

Table 4: Differences in asset beta (non-linear alternative 1)

	Assuming zero debt beta		Assuming non-zero debt beta		
	Range for absolute difference (daily, weekly and four-weekly over 2011-2016)	Average of weekly and four-weekly estimates over 2011-2016	Range for absolute difference (daily, weekly and four-weekly over 2011-2016)	Average of weekly and four weekly estimates over 2011-2016	% of debt betas between 0.1 and 0.3 for all firms
Difference b/w gas and electricity asset betas	0.12-0.15	0.15	0.07-0.10	0.10	29%
Above difference divided by average electric asset beta	34%-54%	52%	17%-29%	28%	As Above

Source: Bloomberg, Commerce Commission, CEG analysis

A.3.2 Non-linear alternative 2

35. $Debt\ Beta = \min\left(\max\left(0, \frac{gearing}{1-gearing} - \frac{gearing}{1-0.2}\right), 0.4\right)$

Figure 11: Debt Beta Curve, non-linear alternative 2

Source: CEG analysis using Bloomberg data

Figure 12: Asset Beta vs gearing, non-linear alternative 2

Source: CEG analysis using Bloomberg data

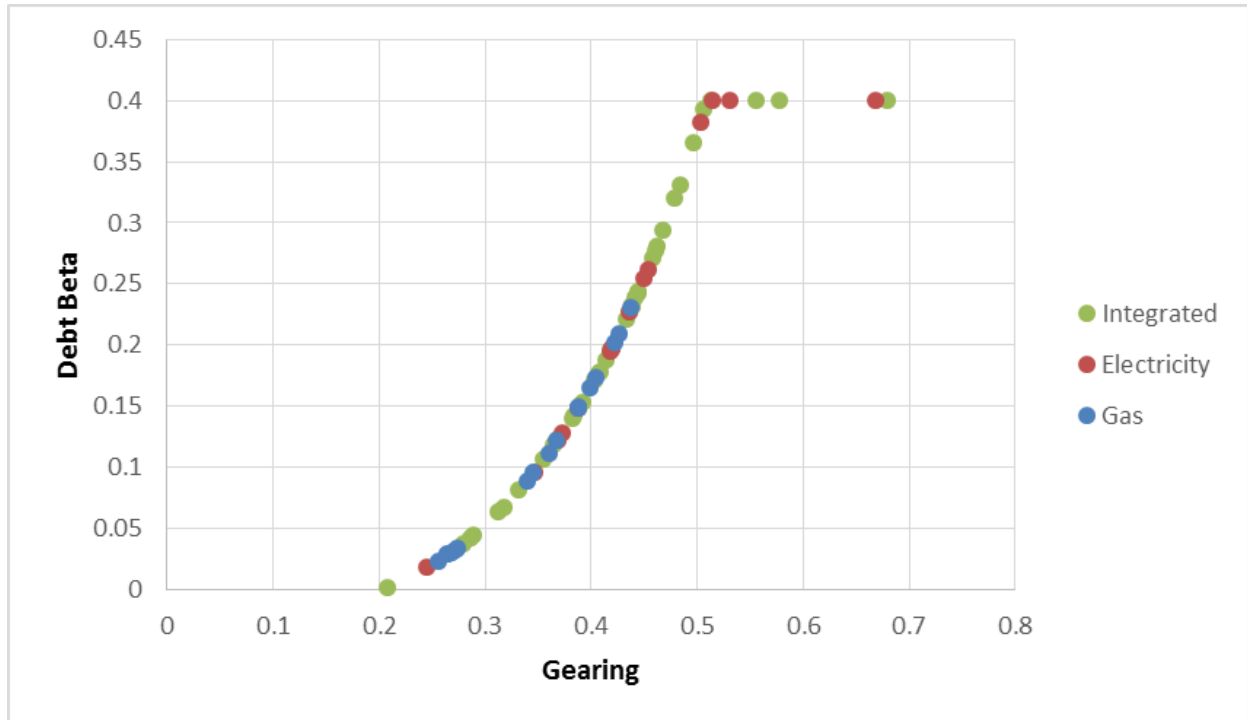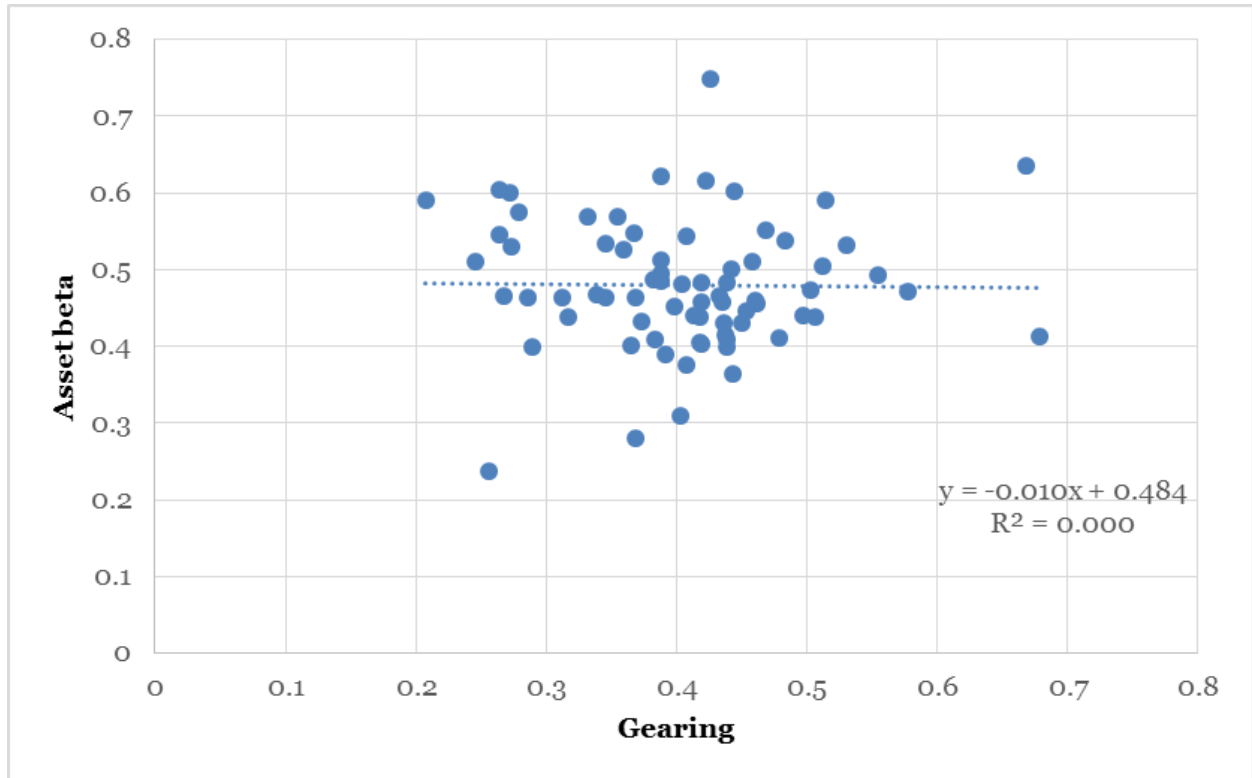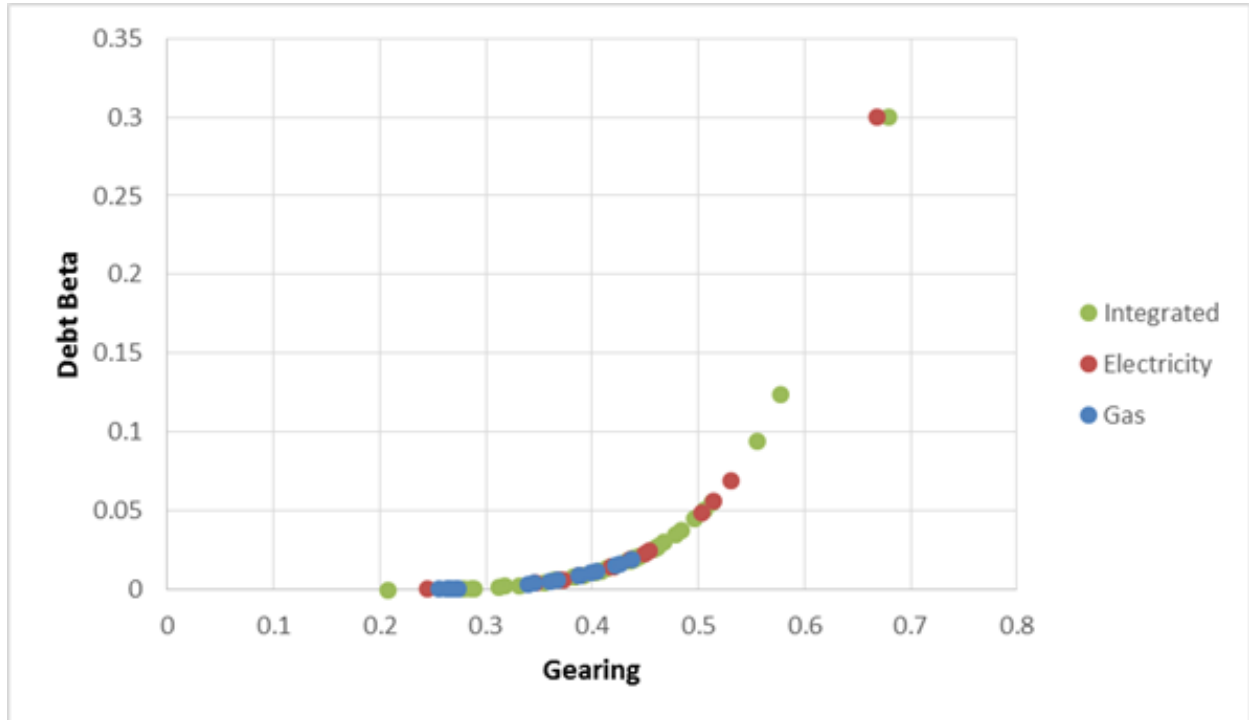**Table 5: Differences in asset betas, non-linear alternative 2**

	Assuming zero debt beta		Assuming non-zero debt beta		
	Range for absolute difference (daily, weekly and four-weekly over 2011-2016)	Average of weekly and four-weekly estimates over 2011-2016	Range for absolute difference (daily, weekly and four-weekly over 2011-2016)	Average of weekly and four weekly estimates over 2011-2016	% of debt betas between 0.1 and 0.3 for all firms
Difference b/w gas and electricity asset betas	0.12-0.15	0.15	0.06-0.08	0.08	60%
Above difference divided by average electric asset beta	34%-54%	52%	12%-21%	21%	As Above

Source: Bloomberg, Commerce Commission, CEG analysis
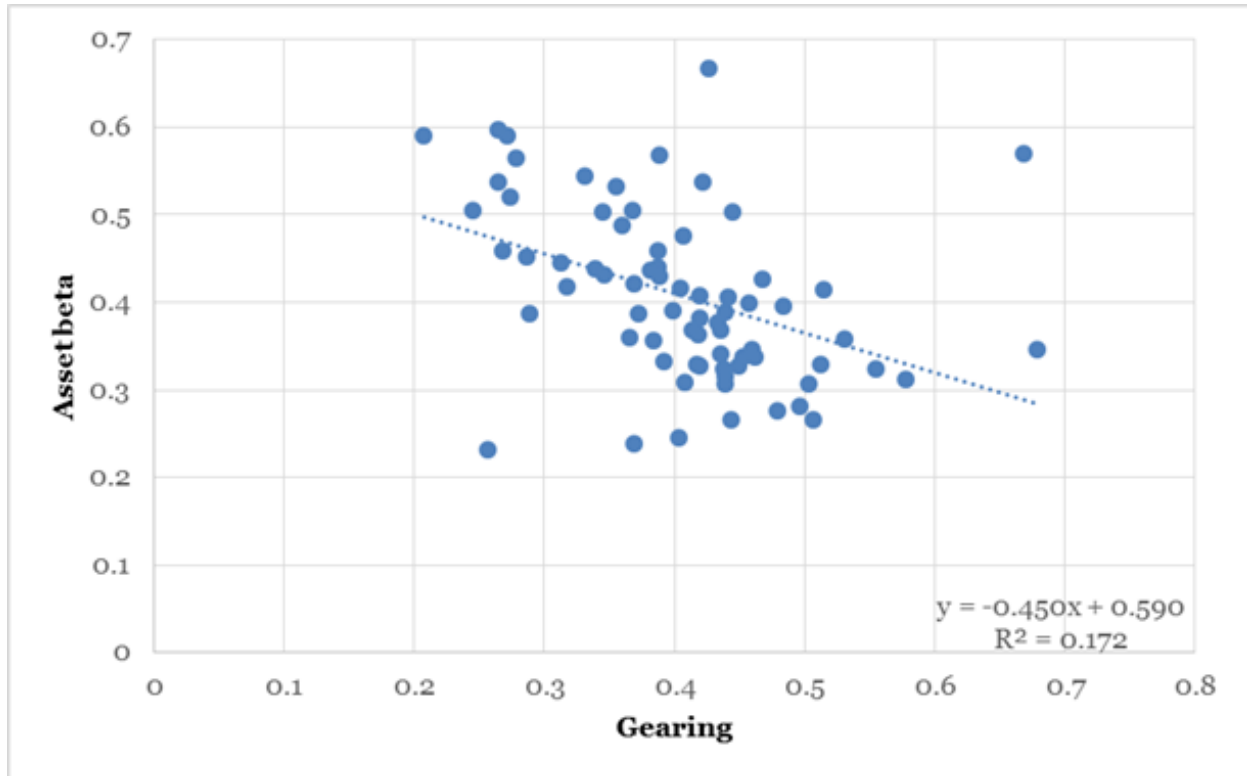
A.3.3   Non-linear alternative 3

36. $Debt\ Beta = \min\left(\max\left(0, \frac{gearing^4}{1-gearing} - \frac{gearing^4}{1-0.2}\right), 0.3\right)$

Figure 13: Debt Beta Curve

Source: CEG analysis using Bloomberg data

Figure 14: Asset Beta vs gearing, non-linear alternative 3

Source: CEG analysis using Bloomberg data

Table 6: Differences in asset beta, non-linear alternative 3

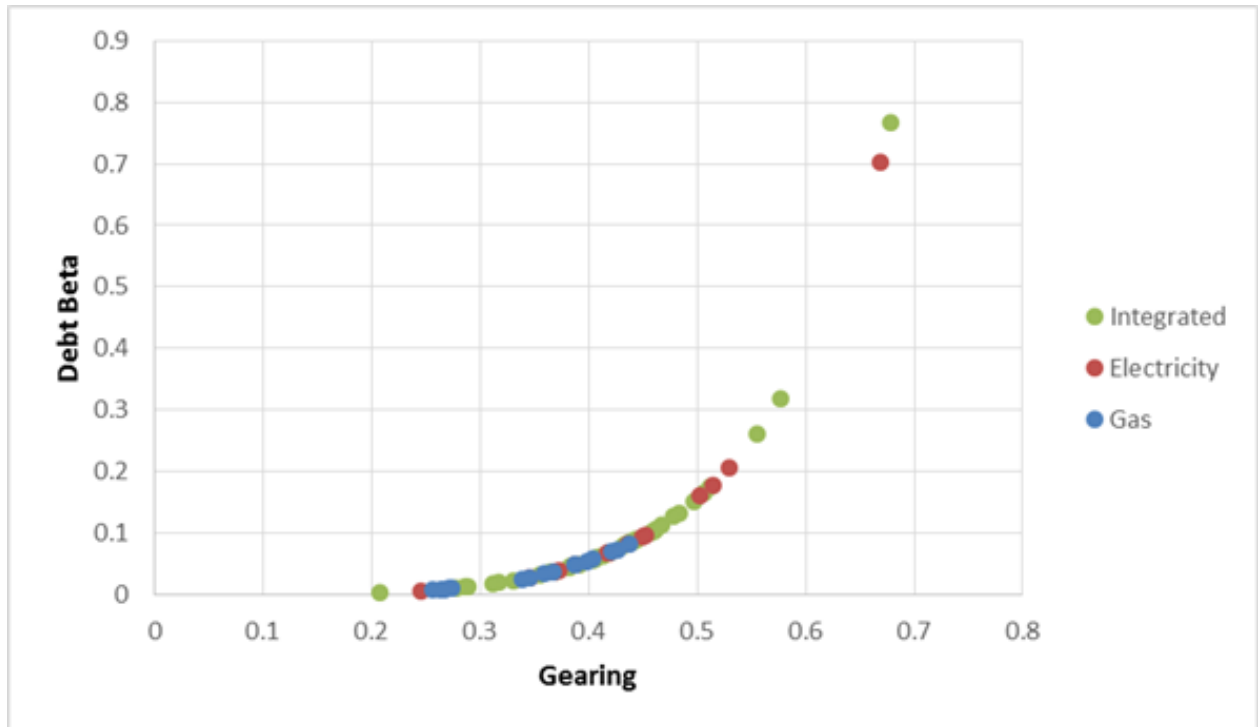|	Assuming zero debt beta		Assuming non-zero debt beta		
	Range for absolute difference (daily, weekly and four-weekly over 2011-2016)	Average of weekly and four-weekly estimates over 2011-2016	Range for absolute difference (daily, weekly and four-weekly over 2011-2016)	Average of weekly and four weekly estimates over 2011-2016	% of debt betas between 0.1 and 0.3 for all firms
Difference b/w gas and electricity asset betas	0.12-0.15	0.15	0.10-0.13	0.13	4%
Above difference divided by average electric asset beta	34%-54%	52%	27%-43%	42%	As Above

Source: Bloomberg, Commerce Commission, CEG analysis
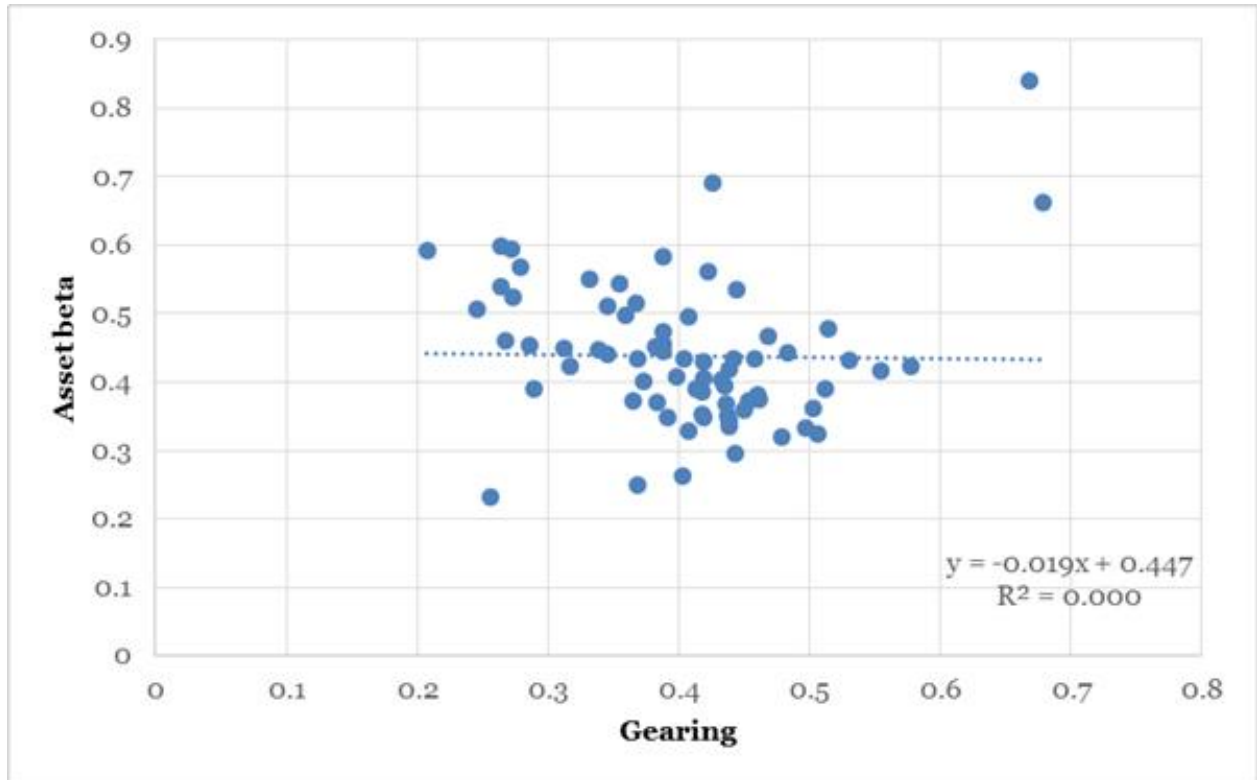
A.3.4 Non-linear alternative 4

37. $Debt\ Beta = \min\left(\max\left(0, \frac{gearing^4}{1-gearing} - \frac{gearing^4}{1-3}\right), 1\right)$

Figure 15: Debt Beta Curve, non-linear alternative 4

Source: CEG analysis using Bloomberg data

Figure 16: Asset Beta vs gearing, non-linear alternative 4

Source: CEG analysis using Bloomberg data

Table 7: Differences in asset beta, non-linear alternative 4

	Assuming zero debt beta		Assuming non-zero debt beta		
	Range for absolute difference (daily, weekly and four-weekly over 2011-2016)	Average of weekly and four-weekly estimates over 2011-2016	Range for absolute difference (daily, weekly and four-weekly over 2011-2016)	Average of weekly and four weekly estimates over 2011-2016	% of debt betas between 0.1 and 0.3 for all firms
Difference b/w gas and electricity asset betas	0.12-0.15	0.15	0.07-0.10	0.09	18%
Above difference divided by average electric asset beta	34%-54%	52%	16%-28%	27%	As Above

Source: Bloomberg, Commerce Commission, CEG analysis