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Asset Beta

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1 Executive summary

1. In this report we have updated the Commission's 2010 asset beta sample and estimated monthly, weekly and daily asset betas. We have also tested this sample to see if there is any discernible difference between asset betas for firms subject to price cap vs revenue cap (referred to as revenues 'decoupled' from volumes in US regulatory proceedings).

2. We independently identified 36 decoupled firms based on a list of US states that implement "Decoupling Policies".[1] Table 1summarise the comparison of estimated betas for firms with revenue caps/decoupling and those with price caps. It can be seen that asset beta for the "price cap" group is marginally lower for the recent 5-year period. There is no discernible difference between alternative regulatory forms for the previous 5-year or the recent 10-year period.

Table 1: Revenue vs price cap summary

	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)	Number of firms
Revenue cap/decoupled	0.38	0.37	0.39	39
Price cap	0.36	0.34	0.36	25
Grand Total	0.38	0.36	0.37	64

Bloomberg data, CEG analysis

3. There is no statistically reliable difference between estimated asset betas for price cap and revenue cap/decoupled businesses.

4. Our results on the average level of beta are summarised in Table 2 and Table 3 below (Table 2 reports asset betas ending May 2010/2015 in order for comparison to the Commission's 2010 estimates while Table 3 has more up to date estimates ending in November 2010/2015).

[1] As set out at in Morgan, A Decade of Decoupling for US Energy Utilities: Rate Impacts, Designs, and Observations, p.3 and also at this link http://www.c2es.org/us-states-regions/policy-maps/decoupling

Table 2: Asset beta results ending on 31th May

Asset beta (average of all definitions)	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)
Monthly	0.35	0.30	0.34
Weekly	0.38	0.36	0.38
Daily	0.40	0.41	0.40
Average	**0.38**	**0.36**	**0.38**

Bloomberg data, CEG analysis

Table 3: Asset beta results ending on 30th November

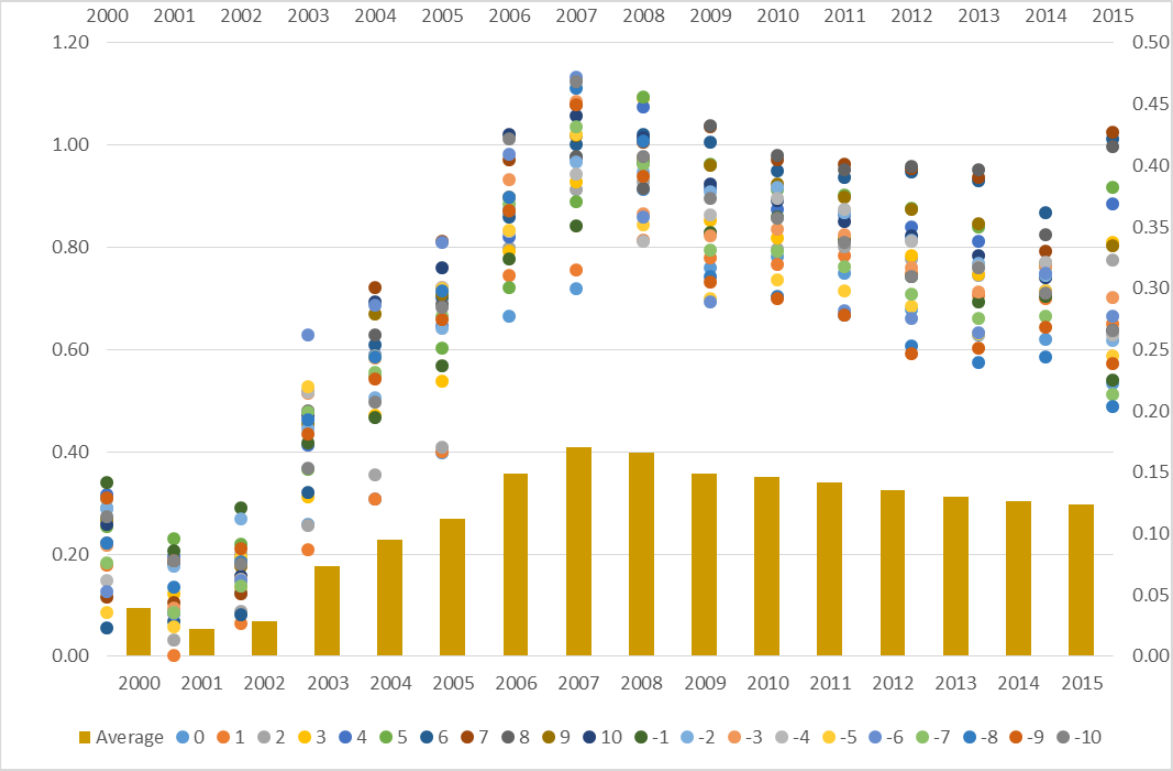
Asset beta (average of all definitions)	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)
Monthly	0.35	0.30	0.33
Weekly	0.38	0.36	0.37
Daily	0.39	0.40	0.40
Average	**0.37**	**0.35**	**0.37**

5. We note that the current IM asset beta estimate of 0.34 lower than most of the beta estimates in the above tables with the exception of monthly betas over the last 5 years and the last 10 years ending 30th November (which at 0.30/0.33 are modestly below 0.34).

6. We have followed the Commission's methodology closely with one important alteration. Instead of estimating only one monthly/weekly asset beta for each firm we have estimated 21/5 monthly/weekly asset betas for each firm; with each one corresponding to a different trading day within the month that defines the end/beginning of the return sampling period. For example, we have estimated five weekly betas – with the sampling period for each beta estimate ending on a different weekday (week ended Monday, Tuesday etc.). Similarly, we have estimated 21 different monthly asset betas (i.e., with returns measured to the last trading day in a month and to every trading day ±10 days from the last trading day).

7. Figure 1 illustrates why we have found this necessary. It shows the estimated 5-year monthly asset beta rolling on a yearly basis from 2000 to 2015, each based on the 21 different definitions of a 'month'. Average monthly betas for each year are represented by the bar plots (left vertical axis); while monthly asset betas from different definition are the scatter plots (right vertical axis).

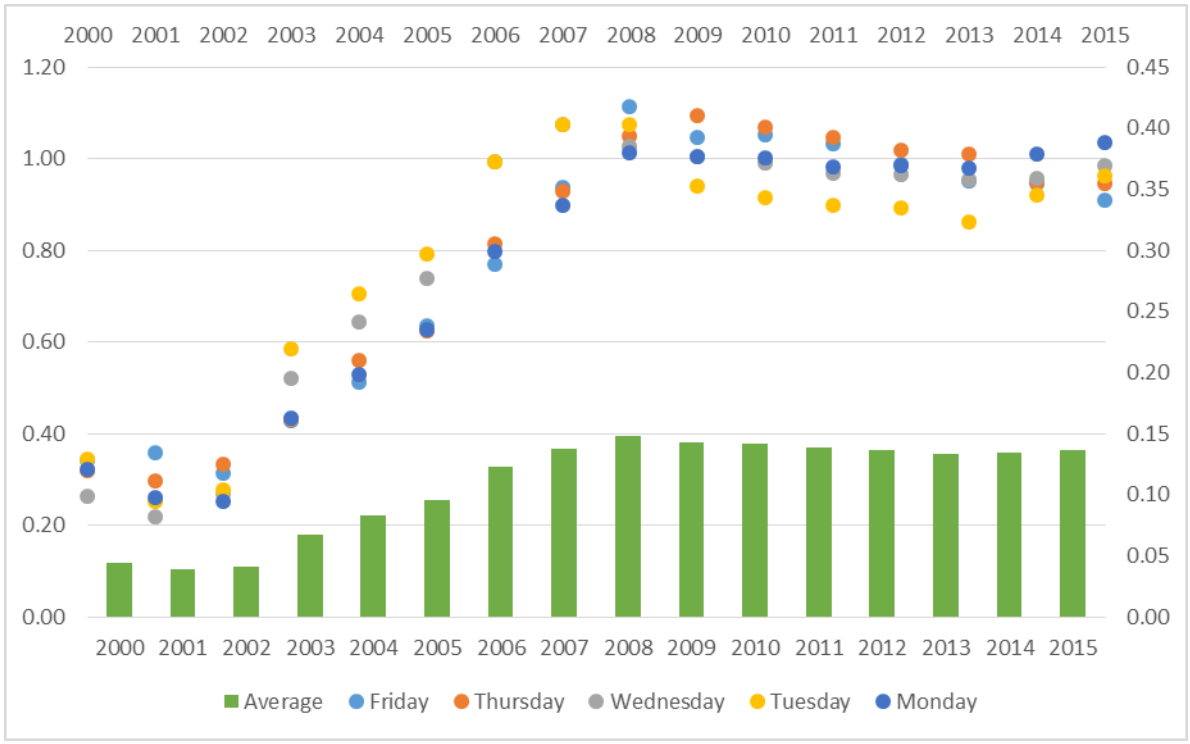
Figure 1: 5-year monthly asset beta based on 21 versions of a 'month' (ending on -10th, -9th...last...1st, 2nd ...10th trading day in each month)



Bloomberg data, CEG analysis

8. It can be seen that the monthly beta estimate is highly sensitive to the day that is defined as the beginning/end of the month. While the average of these for the 2015 estimates is only 0.30 the range of results extends from 0.20 to 0.43. In light of this, we consider that the use of a single 'monthly' asset beta estimate will be very unstable and reliance on such an estimate is likely to lead to error. Variability in weekly betas exists but the range of weekly betas is much smaller (see Figure 2 below) because the larger number of observations in a 5 year weekly beta estimate (260) as compared to a monthly beta estimate (60) make it less likely that small changes in the measurement period can produce large changes in the measured beta.

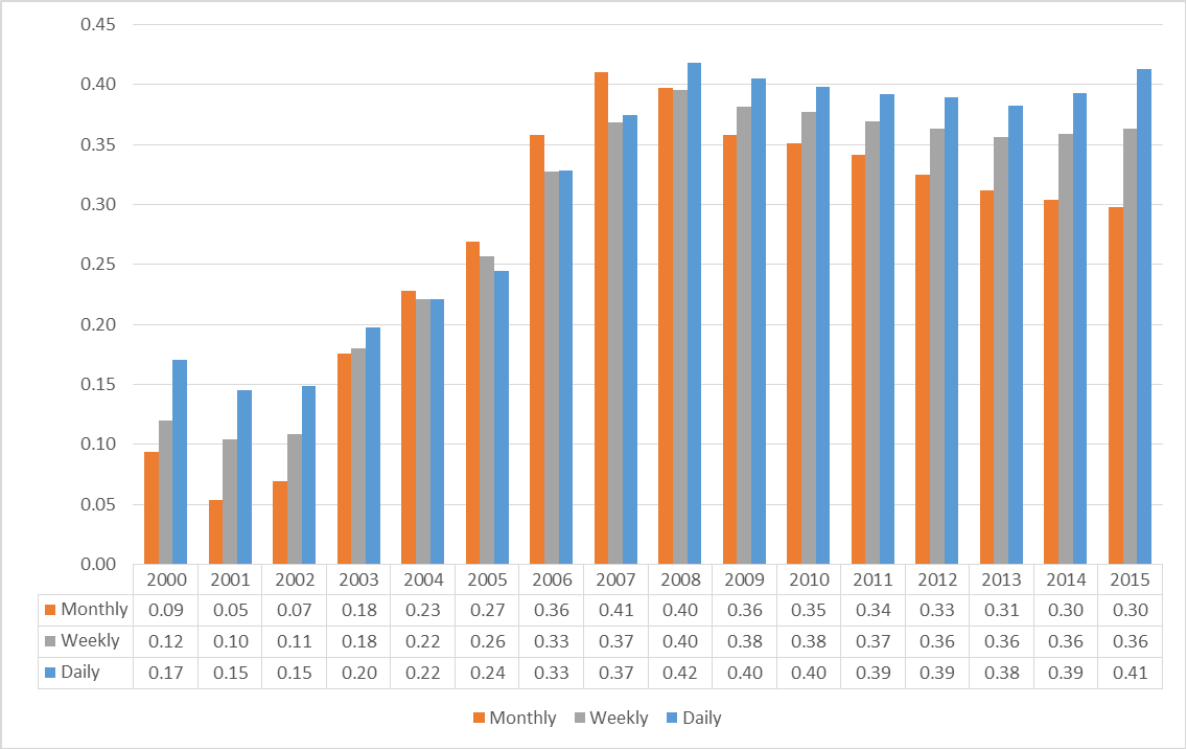
Figure 2: 5-year weekly asset beta based on 5 versions of a 'week' (ending on Friday, Thursday... Monday in each week)



Bloomberg data, CEG analysis

9. We note that daily beta estimate do not suffer from the same source of variability because there is only one definition of a day. Figure 3 below shows that, that the average 5 year monthly beta has fallen materially since 2010, the average 5 year weekly betas have not fallen anywhere like to the same extent and daily betas have actually risen. This highlights the statistical noise associated with estimating beta.

Figure 3: Average 5-year monthly, weekly and daily asset beta rolling on a yearly basis

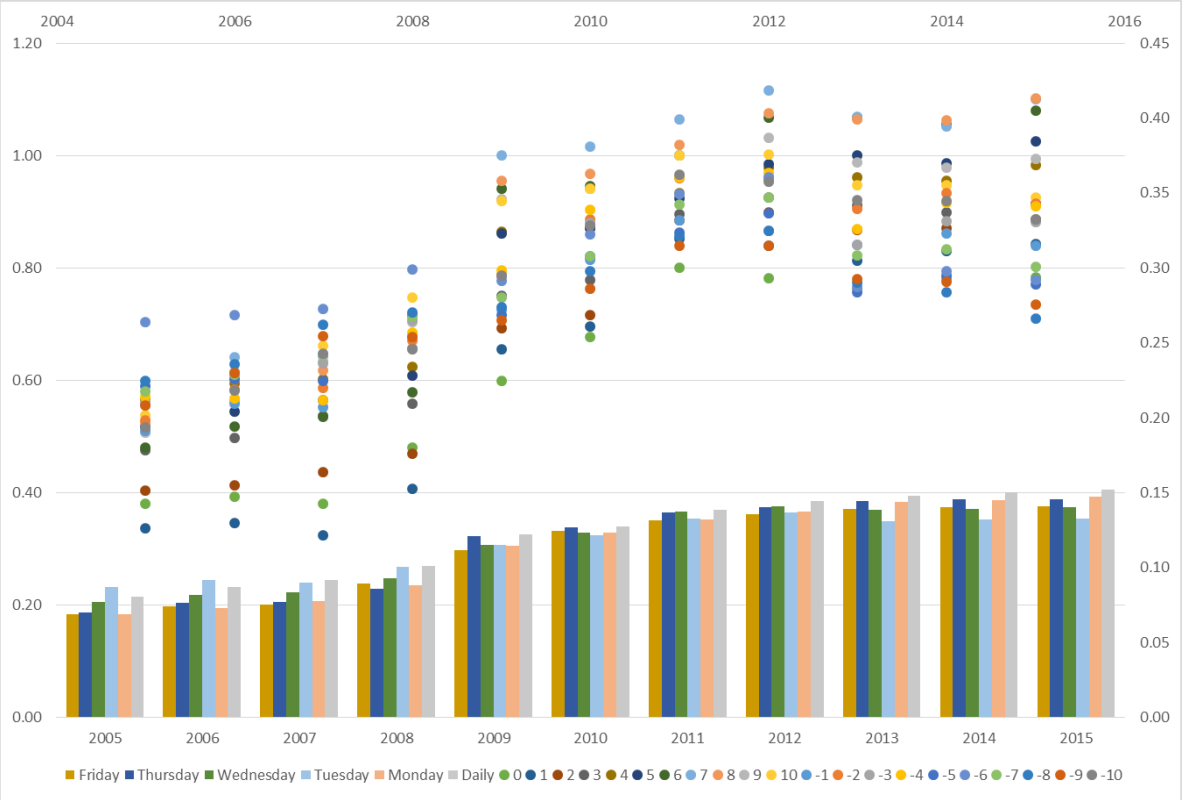


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Monthly	0.09	0.05	0.07	0.18	0.23	0.27	0.36	0.41	0.40	0.36	0.35	0.34	0.33	0.31	0.30	0.30
Weekly	0.12	0.10	0.11	0.18	0.22	0.26	0.33	0.37	0.40	0.38	0.38	0.37	0.36	0.36	0.36	0.36
Daily	0.17	0.15	0.15	0.20	0.22	0.24	0.33	0.37	0.42	0.40	0.40	0.39	0.39	0.38	0.39	0.41

Bloomberg data, CEG analysis

10. We have also estimated 10 year asset betas. It should be noted that the 10-year asset beta is not equivalent to a simple average of the asset betas obtained from the two proceeding five-year periods (i.e. 2005-2010 and 2010-2015). Figure 4 below combines average 10-year monthly and weekly betas under different definitions of a month/week, as well as daily betas, into a single chart. Weekly and daily asset betas are represented by the bar plots (left vertical axis); while monthly asset betas are the scatter plots (right vertical axis).

Figure 4: 10-year monthly/weekly asset beta based on 21 versions of a 'month' and 5 versions of a 'week'



Bloomberg data, CEG analysis

11. As per Table 2 and Table 3 above the 10 year asset beta over the last 10 years is higher than the average of the two most recent 5 year asset beta estimates.

2 Introduction

12. CEG has been engaged by the New Zealand ENA to prepare an expert report which provides an update of, and suggested modifications to, the Commission's 2010 asset beta estimates for regulated energy infrastructure businesses. We have also been asked to consider whether there is any evidence that a change in the form of control will effect asset betas and, if so, how?

13. The remainder of this report is structured as follows:

    - **Section 3** provides our asset beta analysis including:
        - sample selection;
        - estimation methodology;
        - beta estimates.
    - **Section 4** provides our assessment of the impact on estimated betas of differences in the form of control.

14. I have made all inquiries that I believe are desirable and appropriate to answer the questions put to me. No matters of significance that I regard as relevant have to my knowledge been withheld. I have been assisted in the preparation of this report by Yanjun Liu in CEG's Sydney office. However, the opinions set out in this report are my own.

Thomas Nicholas Hird

3 Asset beta analysis

3.1 Update of comparators (sample selection)

15. We have used the Commerce Commission's original sample, which consists of 79 listed utility companies, from its 2010 decision[2] to estimate asset beta.

16. Since that decision, the sample has been affected by acquisition with: Progress Energy acquired by Duke Energy Corporation in 3rd July 2012; Nicor Inc acquired by AGL Resources in 13th December 2011. Both Duke Energy and AGL Resources were included in the original sample. There is a separate ticker for Progress energy (PREX US Equity).

17. Three stocks (HED, PREX and Nicor prior to acquisition) are excluded due to data issues. HED NZ Equity and PREX US Equity are too illiquid for a reliable beta to be estimated (HED NZ Equity was delisted on 28th July 2015). These are summarised in Table 4 below.

Table 4: Change in CC's original sample or tickers

Issue	Company name	Old Ticker	New Ticker
Illiquid stock	Horizon Energy Distribution	HED NZ Equity	-
	Progress energy	PGN US Equity	PREX US Equity
Renamed	Northeast Utilities	NU US Equity	ES US Equity
	AGL Resources	AGL US Equity	GAS US Equity
	SP AusNet	SPN AU Equity	AST AU Equity
Acquired	Progress energy (by DUKE US Equity)	PGN US Equity	PREX US Equity
	Nicor Inc (by AGL Resources)	0111145D US Equity	-

Bloomberg data, CEG analysis

18. Our final sample consists of 6 firms from Australia, 1 firm from New Zealand, 1 firm from UK and 68 firms from US. The full list of our sample and illustration for illiquidity of excluded stocks are included in Appendix A.

[2] Commerce Commission, Input methodologies (electricity distribution and gas pipeline services) reasons paper, December 2010

3.2 Estimation methodology

3.2.1 Elements of the regression

19. Table 5 shows the four benchmark indices used to estimate equity betas for each of the firms in our sample.

Table 5: Market indices to estimate equity beta[3]

Market	Benchmark indices (BB ticker)	Number of individual stocks in sample
AU	AS51 Index	6
NZ	NZSEG Index	1
UK	TUKXG Index	1
US	SPXT Index	68

Bloomberg data, CEG analysis

20. According to the capital asset pricing model (CAPM), equity beta can be calculated as the slope coefficient of a simple regression where market return is the independent variable and stock return is the dependent variable.

21. To obtain asset beta from equity beta, we have adopted the following formula:

$$Asset\ beta = leverage * debt\ beta + (1 - leverage) * equity\ beta$$

22. If, as is the Commission's practice, debt beta is assumed to be zero the above equation becomes :

$$Asset\ beta = (1 - leverage) * equity\ beta$$

23. The leverage of a firm at any date can be calculated as:

$$\frac{net\ debt}{net\ debt + market\ capitalisation}$$

24. Both historical net debt and market cap can be collected from Bloomberg using the "NET_DEBT" and "HISTORICAL_MARKET_CAP" fields on a daily basis. In order to consistently estimate monthly/weekly asset betas, monthly/weekly leverages are also calculated as the average of daily leverage[4] in the same period where monthly/weekly returns are derived.

[3] An additional 12 firms that were delisted during the recent 5 years are excluded for the most recent five and ten year beta estimates, see details in Appendix A.

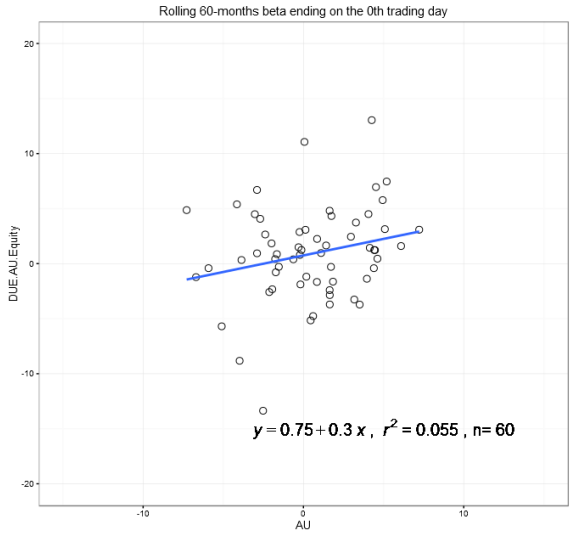
[4] Net figures are generally only available biannually while market capitalisation figures are available annually. We have interpolated the former to arrive at daily leverage values.

3.2.2 Definition of a month/week

25. As CEG noted in submissions to the last IM process, the Commission's use of a single 'monthly' asset beta estimate (measured based on the return from the first to last day of each month) is likely to lead to error. This is because there are actually 20 or so different estimates of a monthly asset beta (e.g. from the 2nd of one month to the 2nd of the next etc.). These different measures can result in very different monthly betas – even when averaged across a large sample. The same is true of weekly betas which can be measured to Monday, Tuesday, Wednesday, Thursday or Friday (the Commission's past practice appears to have been to measure to Friday).

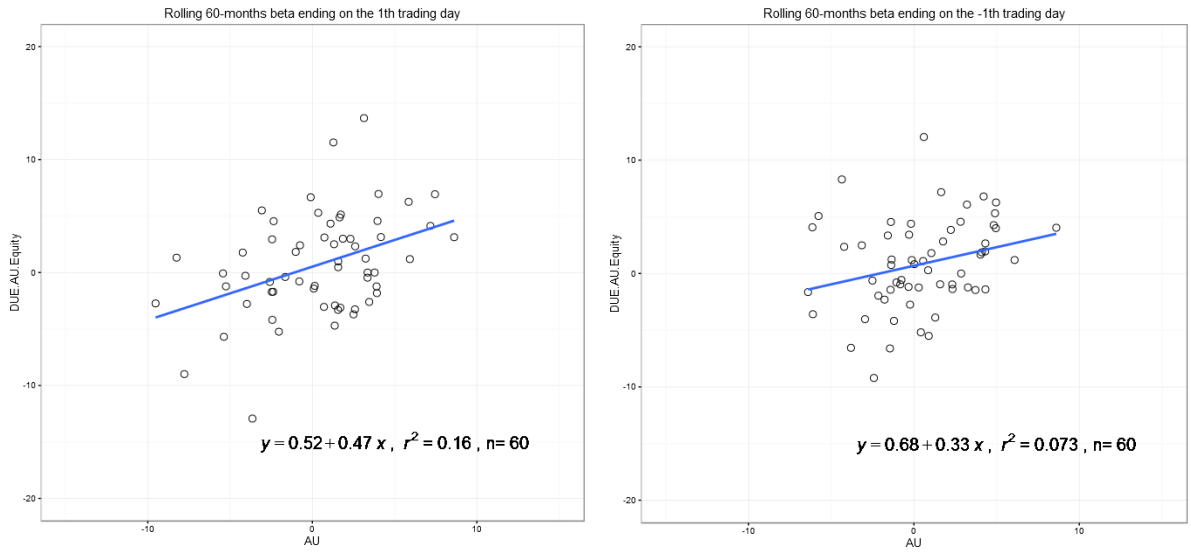
26. To illustrate, we have estimated the 5-year monthly equity beta of the stock "DUE AU Equity" for the period from 31th May 2010 to 31th May 2015. Figure 5 shows that the monthly equity beta is 0.3 based on the returns from the last trading days of each month. However, Figure 6 shows that the equity beta changes significantly to 0.47/0.33 if returns are calculated as the percentage change in price from the first/second last trading days of each month.

Figure 5: Equity beta based on the returns from the last trading day of the each month (the Commission's practice)



Bloomberg data, CEG analysis

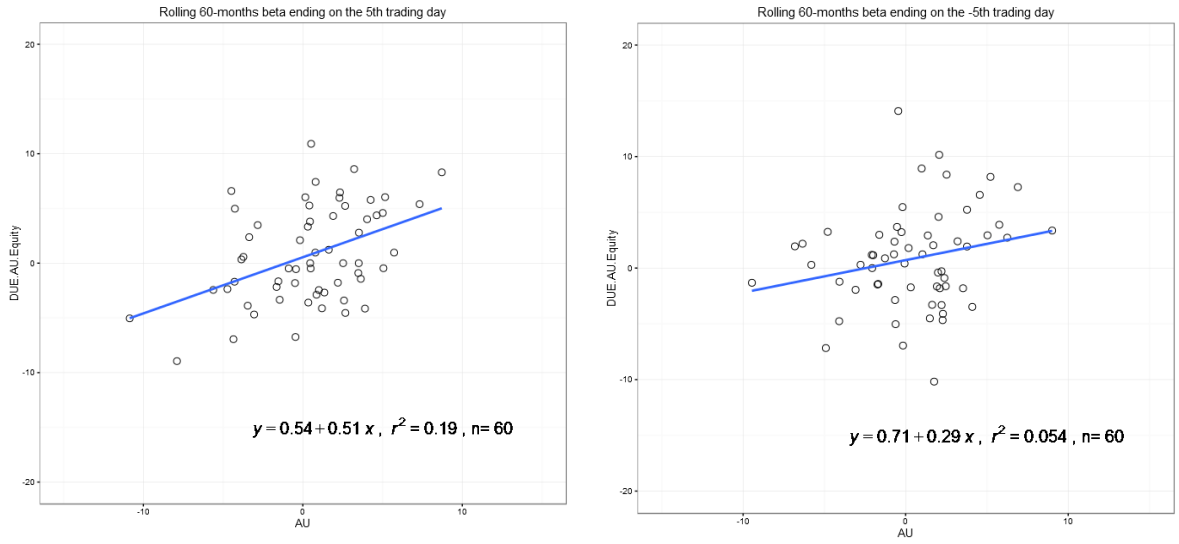
Figure 6: Equity beta based on the returns from the ±1st trading day of the each month



Bloomberg data, CEG analysis

27. Furthermore, Figure 7 shows that the monthly equity beta is around 0.5 based on returns from the 5th trading day of each month, but is 0.29 if measured from the fifth last trading day of each month.

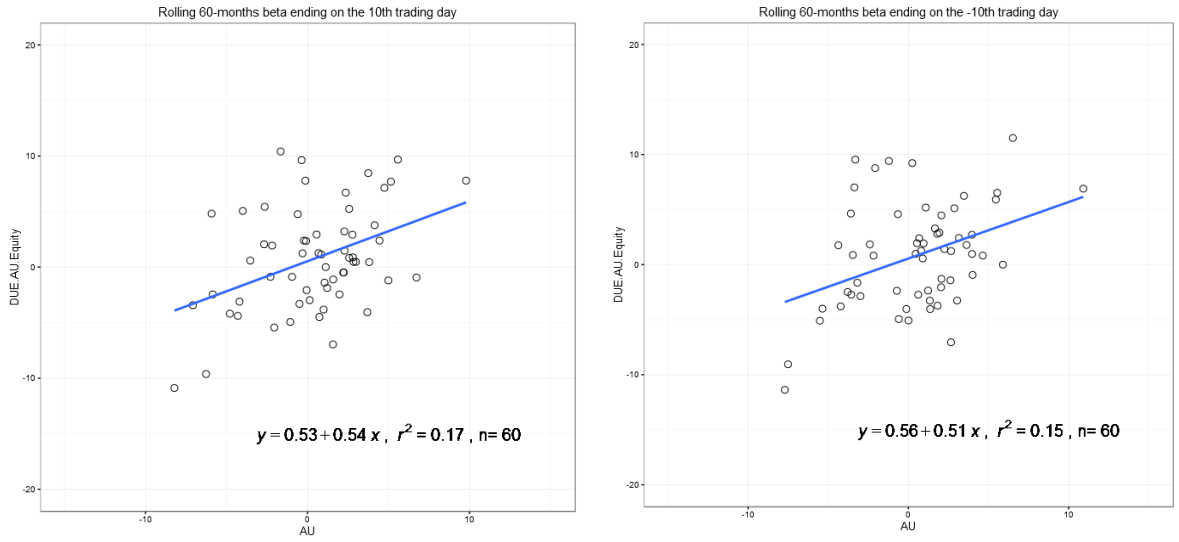
Figure 7: Equity beta based on the returns from the ±5th trading day of the each month



Bloomberg data, CEG analysis

28. Figure 8 shows that equity beta is over 0.5 based on measuring returns from the ±10th trading day of the each month.

Figure 8: Equity beta based on the returns from the ±10th trading day of the each month



Bloomberg data, CEG analysis

29. Table 6 below collects the estimated 5-year monthly equity beta for 'DUE AU Equity' under 7 different definitions of a 'month'. It can been seen that the average of the 7 estimate, 0.42, is materially above the estimates obtained using just the last day of the month(0.3).

Table 6: DUE AU Equity monthly equity beta summary

Monthly end date	5-year Monthly equity beta
0 (last trading day)	0.30
1 (first trading day)	0.47
-1 (second last trading day)	0.33
5 (5th trading day)	0.51
-5 (4th last trading day)	0.29
10 (10th trading day)	0.54
-10 (9th last trading day)	0.51
Average	**0.42**

Bloomberg data, CEG analysis

30. It can be shown that monthly/weekly betas for other stocks would have the same problem. For this reason we estimate betas for:

- 21 different monthly betas with each definition of a monthly beta measuring returns between the 'same' trading day of each month; where that trading day is defined by where it sits relative to the last trading day of the month. For example,
  - One beta is estimated using returns measured between the last trading day of each month;
  - Other betas are estimated using returns measured between the second last trading day of each month, the 3rd last trading day of each month,..., the 11th last trading day of each month. We refer to these beta estimates as 'count back' estimates;
  - Other betas are estimated using returns measured between the first trading day of each month, the 2nd trading day of each month... the 10th trading day of each month. We refer to these beta estimates as 'count forward' estimates;
- 5 different weekly betas corresponding to definitions of a week ending Monday, Tuesday, Wednesday, Thursday or Friday (or the nearest trading day if that day is not a trading day);
- One daily beta.

3.2.3 Return interval

31. There are essentially two trade-offs when selecting the length of the return interval (monthly/weekly/daily). The shorter the return interval the more observations and the lower confidence interval around a beta estimate.[5] However, the shorter the return interval the more likely that relatively less heavily traded stocks (such as utilities) estimated beta will be biased down as a result of thin trading.

32. This is an effect whereby some shocks, such as a shift in the equity discount rate, hits the market and is quickly reflected in the largest most heavily traded stocks causing the market to move in a particular direction on the same day. However, the shock might only be fully reflected in less heavily traded stocks' prices the next day. This will cause the daily beta for these less heavily traded stocks' to be biased downward – because these stocks' prices only fully respond to prices over more than a day; causing measured daily betas to only pick up less than 100% of the true sensitivity of the stocks to systematic shocks.

33. Damodaran notes precisely this:[6]

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5 Although these confidence intervals must be interpreted carefully – they are the confidence intervals that apply if market conditions are the same as market conditions over the period the beta was estimated. They are not the confidence interval around the value that beta can be expected to take in future market conditions.

6 Damodaran, Discussion Issues and Derivations, available at http://people.stern.nyu.edu/adamodar/New_Home_Page/AppldCF/derivn/ch4deriv.html

> *There are two estimation decisions the analyst must make in setting up the regression described above. …. The second estimation issue relates to the return interval. Returns on stocks are available on an annual, monthly, weekly, daily and even on a intra-day basis. Using daily or intra-day returns will increase the number of observations in the regression, but it exposes the estimation process to a significant bias in beta estimates related to non-trading. For instance, the betas estimated for small firms, which are more likely to suffer from non-trading, are biased downwards when daily returns are used. Using weekly or monthly returns can reduce the non-trading bias significantly. To illustrate, the beta for America Online, a small information services firm, was 1.20 using daily returns from 1990 and 1994, while it was 1.80 using monthly returns. The latter is a much more reliable estimate of the firm's beta.*

34. Utility stocks are typically relatively small. The largest firm in our sample is Duke Energy which has a weight of around 0.32% in the S&P 500. It is the 70th largest stock in the S&P 500 but the larger firms in the S&P 500 have 56% weight - grouping the largest utility with the bottom half (by weight) of the index. By contrast the bottom 70 firms in the S&P500 include Pepco Holdings, AES Corporation, NiSource, Chesapeak Energy, NRG Energy. Consequently, if anything, daily beta estimates are likely to be downward biased estimates of the true beta for utility stocks.

35. Following the logic set out above we consider that the only reason not to give daily betas the same weight as monthly and weekly betas would be if one considered that daily betas were biased down by the above effect. Even then, are techniques for estimating beta that attempt to remove such bias.

3.2.4 Estimation period

36. In its recent review for UCLL and UBA pricing, the commission noted[7]:

> *In arriving at an asset beta of 0.43 for this decision, we have placed primary weight on the five-year monthly asset beta estimates for the two preceding five-year periods, but also paid some attention to other beta estimates.*

37. We have followed the Commission's focus in performing our beta analysis although we do report beta estimates from earlier periods. In the following sections, we have provided the 5-year beta estimates for the two most recent preceding five-year periods, as well as the corresponding ten-year beta estimates.

7 Commerce Commission, Cost of Capital for the UCLL and UBA pricing reviews, 15 December 2015, p. 39

38. We note that the Commission's focus on the last ten years is consistent with the trade-off identified by Damodaran in the same document that the previous quote was taken: [8]

> *There are two estimation decisions the analyst must make in setting up the regression described above. The first concerns the length of the estimation period. Most estimates of betas, including those by Value Line and Standard and Poors, use five years of data, while Bloomberg uses two years of data. The trade-off is simple: A longer estimation period provides more data, but the firm itself might have changed in its risk characteristics over the time period. For instance, using data from 1985 to 1994 to estimate betas for Microsoft might increase the amount of data available, but it will lead to a beta estimate that is much higher than the true beta, since Microsoft was a smaller and riskier firm in 1985 than it was in 1994.*

3.3 Results

3.3.1 Results summary

39. Table 7 below shows the results of our estimates for the monthly, weekly and daily asset betas using data from the most recent 10 year period (ending on 31th May). All results assume a zero debt beta irrespective of the level of leverage.

Table 7: Asset beta results ending on 31th May

Asset beta (average of all definitions)	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)
Monthly	0.35	0.30	0.34
Weekly	0.38	0.36	0.38
Daily	0.40	0.41	0.40
Average	**0.38**	**0.36**	**0.38**

Bloomberg data, CEG analysis

40. We have used 31 May as a cut off in order to aid comparison with the betas in the Commission's last IM decision which also had a 31 May 2010 cut-off date. However, we also report below the results using data to November 2010 and November 2015. Our November cut-off results are summarised in Table 8 below and more detailed results for the November cut-off are reported in Appendix B (the body of the report focuses on the May cut-off).

8 Damodaran, Discussion Issues and Derivations, available at http://people.stern.nyu.edu/adamodar/New_Home_Page/AppldCF/derivn/ch4deriv.html

Table 8: Asset beta results summary, ending on 30th November

	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)
Monthly	0.35	0.30	0.33
Weekly	0.38	0.36	0.37
Daily	0.39	0.40	0.40
Average	**0.37**	**0.35**	**0.37**

41. We note that the current IM asset beta estimate of 0.34 is the same as, or lower than, all of the beta estimates in the above tables with the exception of monthly betas over the last 5 years.

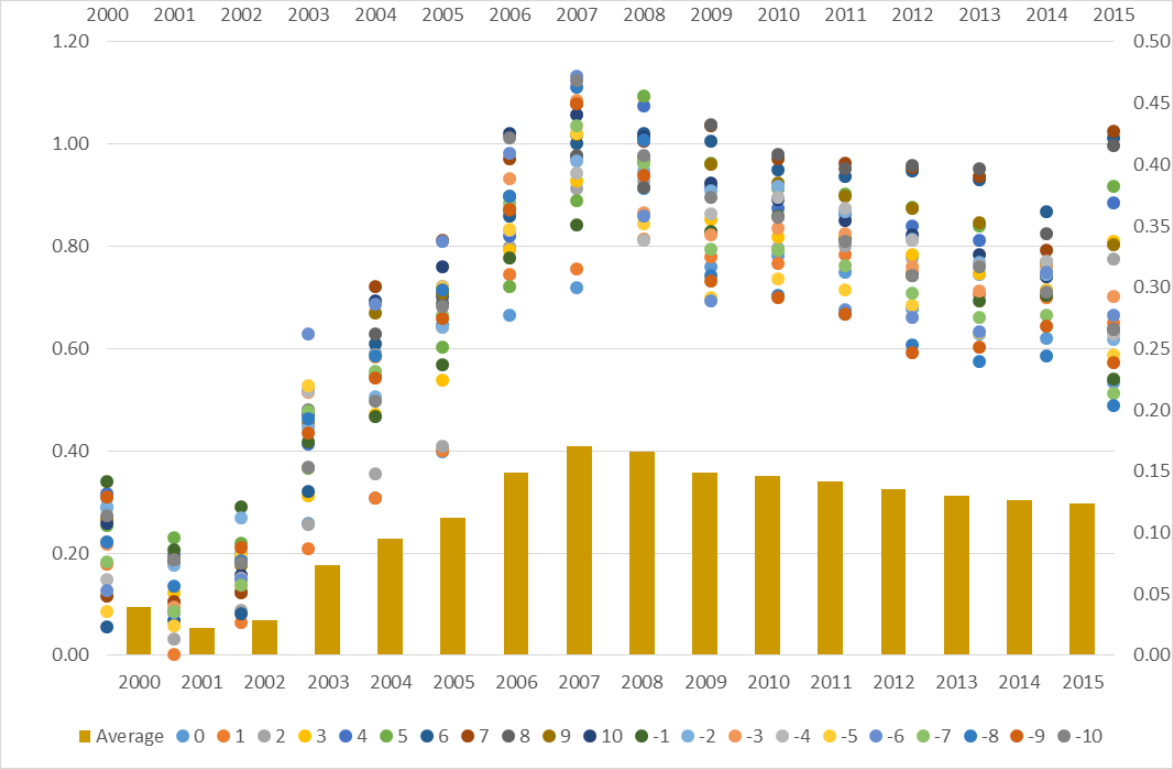
42. As noted in section 3.2.2 above, our monthly beta estimates are averages across 21 different definitions of a month (e.g. from the 2nd of one month to the 2nd of the next etc.). Details of the sensitivity of monthly and weekly betas to the definition of a month/week, even when averaged across the sample, can be found in the following sections[9].

3.3.2 Monthly/weekly asset betas

43. Figure 9 below shows the estimated 5-year monthly asset beta rolling on a yearly basis from 2000 to 2015, each based on the 21 different definitions of a 'month'. Average monthly betas for each year are represented by the bar plots (left vertical axis); while monthly asset betas from different definition are the scatter plots (right vertical axis).

9 We have focused on data ending on 31th May in the main body of this report. However, detailed results for data ending on 30th can be found in Appendix B.

Figure 9: Average 5-year monthly asset beta based on 21 versions of a 'month' (ending on -10th, -9th...last...1st, 2nd ...10th trading day in each month)



Bloomberg data, CEG analysis

44. It can be seen that monthly beta is highly sensitive to the count forward/backward days. While the average of these for the 2015 estimates is only 0.30 the range of results extends from 0.20 to 0.43.

45. Table 9 below shows each of the 21 2015 betas charted in the above figure.

Table 9: Average 5-year monthly asset beta for 2015 under different definition of a 'month'

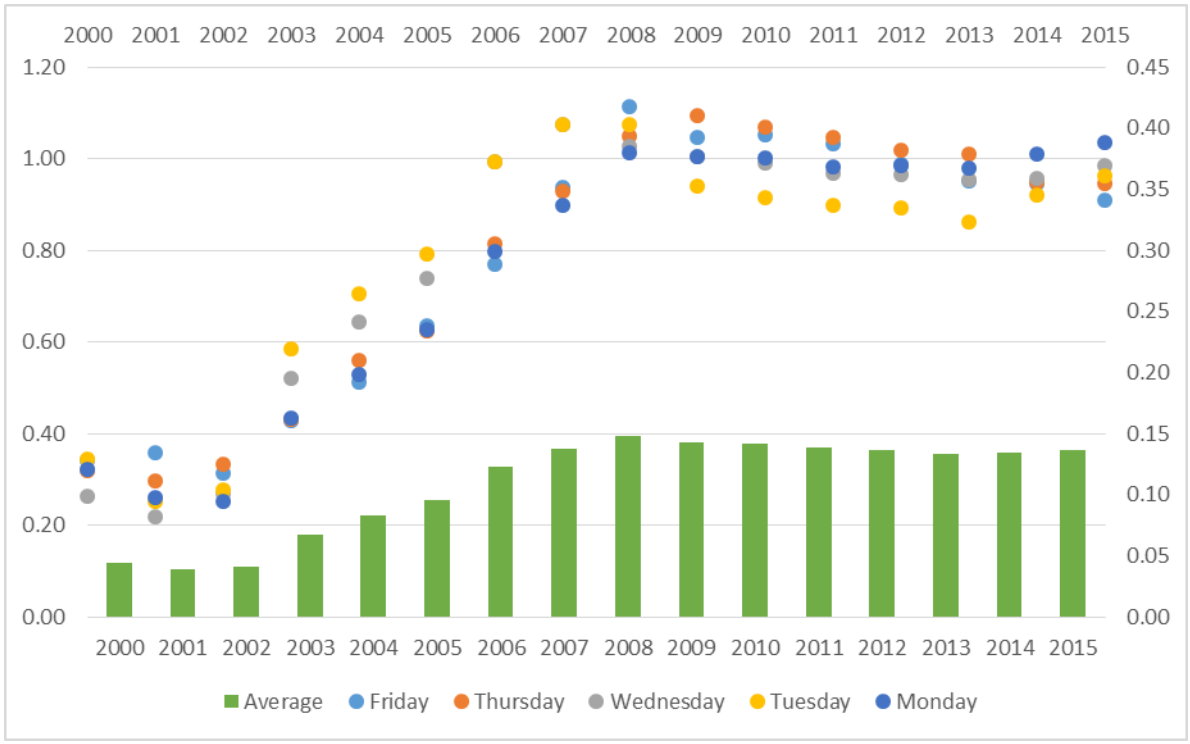
Counting forward	beta	Counting back	beta
0	0.22		-
1	0.27	-1	0.23
2	0.32	-2	0.26
3	0.34	-3	0.29
4	0.37	-4	0.26
5	0.38	-5	0.24
6	0.42	-6	0.28
7	0.43	-7	0.21
8	0.42	-8	0.20
9	0.34	-9	0.24
10	0.27	-10	0.27
Average		**0.30**	

Bloomberg data, CEG analysis

46. In light of this, we reiterate that the use of a single 'monthly' asset beta estimate will be very unstable and reliance on such an estimate is likely to lead to error.

47. Similarly, Figure 10 shows the estimated 5-year weekly asset beta ending on 31st May and rolling on a yearly basis from 2000. There is, again, material variability between weekly betas obtained based on different definition of a 'week'. However, the variability is smaller than for monthly betas. This reflects, in part, the larger number of observations when using weekly betas (260 weekly observations in a 5 year period vs 60 monthly observations).

Figure 10: Average 5-year weekly asset beta based on 5 versions of a 'week' (ending on Friday, Thursday... Monday in each week)



Bloomberg data, CEG analysis

48. Comparing Table 9 above and Table 10 below shows that the difference between weekly betas obtained under different definitions of a 'week' for 2015 is relatively narrowed.

Table 10: Average 5-year weekly asset beta for 2015 under different definition of a 'week'

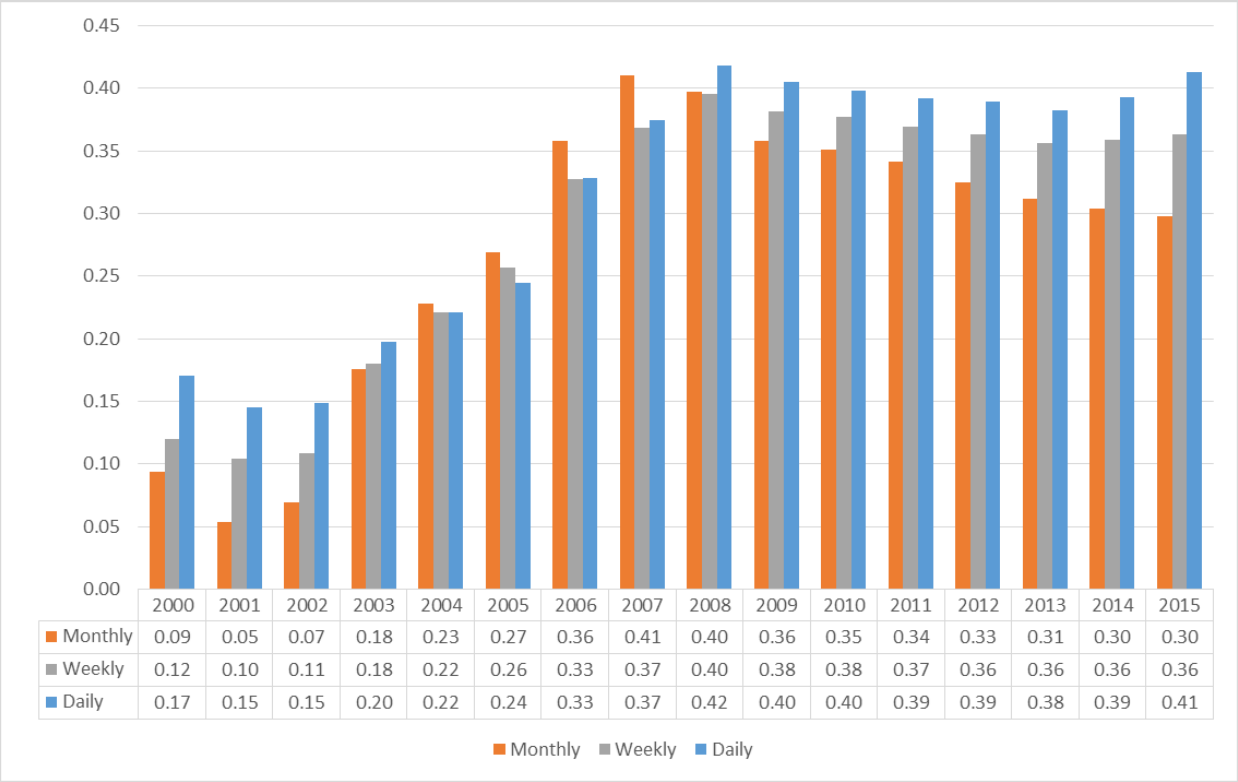
Counting forward	5-year weekly asset beta
0 (Friday)	0.34
1 (Thursday)	0.35
2 (Wednesday)	0.37
3 (Tuesday)	0.36
4 (Monday)	0.39
Average	**0.36**

Bloomberg data, CEG analysis

3.3.3 Daily beta

49. We note that daily beta estimate do not suffer from the same source of variability because there is only one definition of a day. Figure 11 below shows that, that the average 5 year monthly beta has fallen materially since 2010, the average 5 year weekly betas have not fallen anywhere like to the same extent and daily betas have actually risen. This highlights the statistical noise associated with estimating beta.

Figure 11: Average 5-year monthly, weekly and daily asset beta rolling on a yearly basis



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Monthly	0.09	0.05	0.07	0.18	0.23	0.27	0.36	0.41	0.40	0.36	0.35	0.34	0.33	0.31	0.30	0.30
Weekly	0.12	0.10	0.11	0.18	0.22	0.26	0.33	0.37	0.40	0.38	0.38	0.37	0.36	0.36	0.36	0.36
Daily	0.17	0.15	0.15	0.20	0.22	0.24	0.33	0.37	0.42	0.40	0.40	0.39	0.39	0.38	0.39	0.41

Bloomberg data, CEG analysis

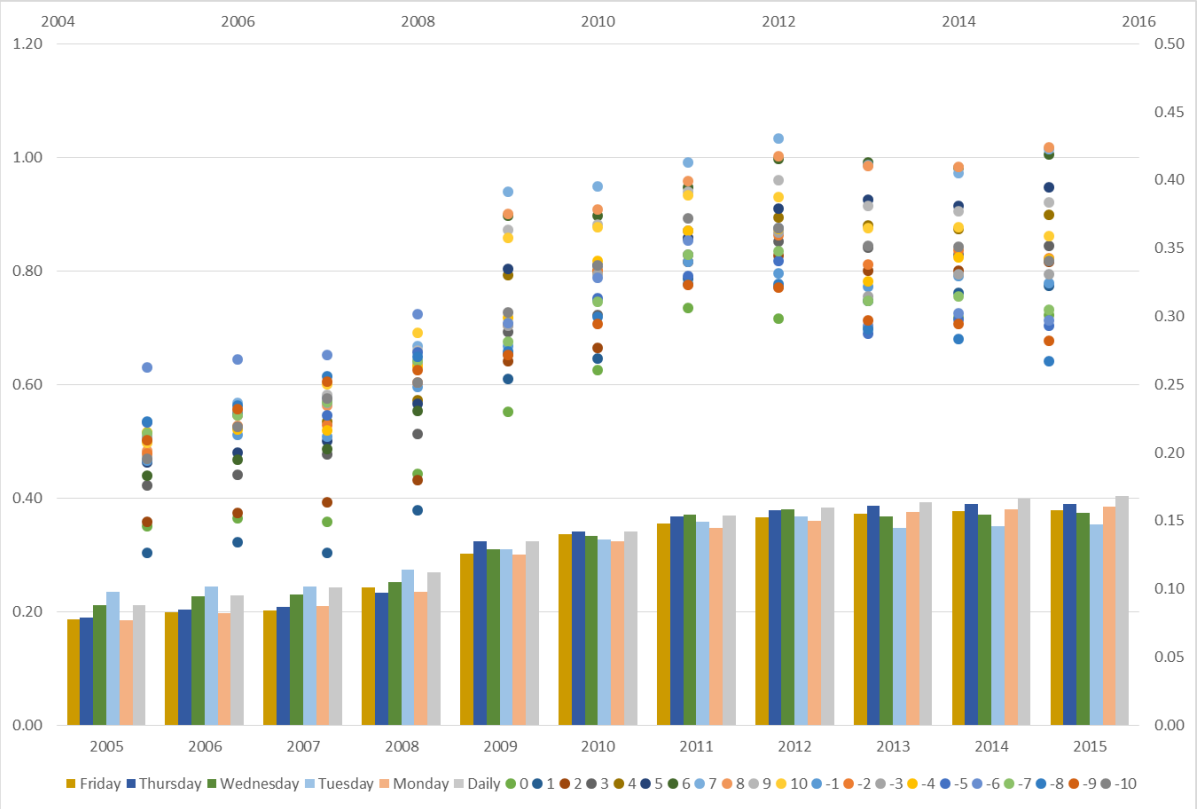
3.3.4 10 year asset beta

50. It should be noted that the 10-year asset beta is not equivalent to a simple average of the assets betas obtained from two proceeding five-year periods (i.e. 2005-2010 and 2010-2015). This is because the 10 year asset beta looks at the relationship between a company's stock returns and market returns across the pooled dataset while each 5 year beta looks only at the relationship within each 5 year period. The relationship across a pooled dataset need not be an average of the relationships across subsets of the dataset. This is especially likely to be the case the smaller the number of observations in the subset – because the smaller the observations in the subsets the more volatile will be the measured beta in each period and the greater the potential

for a spurious relationship to be measured in those periods that is not present in the pooled dataset.

51. Figure 12 below combines that average 10-year monthly and weekly betas under different definitions of a month/week, as well as daily betas, into a single chart. Weekly and daily asset betas are represented by the bar plots (left vertical axis); while monthly asset betas are the scatter plots (right vertical axis).

Figure 12: Average 10-year monthly/weekly asset beta based on 21 versions of a 'month' and 5 versions of a 'week'



Bloomberg data, CEG analysis

52. Table 11, Table 12 and Table 13 below compare the estimated 5-year and 10 year monthly/weekly/daily asset betas under different definitions as specified in section 3.2.2. It is obvious that figures in the fourth column (10-year beta) are not equivalent to the average of the second and third columns. It is notable that the average 10 year

- monthly beta (0.34) is much closer to the five year monthly beta ending 2010 (0.35) than the five year monthly beta ending 2015 (0.30); and
- daily beta is (fractionally) above both the 2010 and 2015 5 year beta estimates.

Table 11: Average 10-year and 5-year monthly asset beta under 21 versions of a 'month' (31 May cut-off)

Monthly asset beta	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)
0	0.33	0.22	0.29
1	0.32	0.27	0.32
2	0.33	0.32	0.33
3	0.34	0.34	0.34
4	0.36	0.37	0.37
5	0.38	0.38	0.38
6	0.40	0.42	0.40
7	0.40	0.43	0.41
8	0.41	0.42	0.41
9	0.39	0.34	0.37
10	0.37	0.27	0.35
-1	0.36	0.23	0.31
-2	0.38	0.26	0.34
-3	0.35	0.29	0.33
-4	0.37	0.26	0.34
-5	0.31	0.24	0.29
-6	0.29	0.28	0.29
-7	0.33	0.21	0.30
-8	0.29	0.20	0.27
-9	0.29	0.24	0.28
-10	0.36	0.27	0.33
Average	**0.35**	**0.30**	**0.34**

Bloomberg data, CEG analysis

Table 12: Average 10-year and 5-year weekly asset beta under 5 versions of a 'week' (31 May cut-off)

Weekly asset beta	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)
0	0.39	0.34	0.38
1	0.40	0.35	0.39
2	0.37	0.37	0.37
3	0.34	0.36	0.35
4	0.38	0.39	0.39
Average	**0.38**	**0.36**	**0.38**

Bloomberg data, CEG analysis

Table 13: Average 10-year and 5-year daily asset beta (31 May cut-off)

Daily asset beta	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)
Average	0.40	0.41	0.40

Bloomberg data, CEG analysis

3.4 Summary and conclusion

53. Table 14 summarises the average asset betas estimated in this section.

Table 14: Asset beta results summary

Asset beta (average of all definitions)	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)
Monthly	0.35	0.30	0.34
Weekly	0.38	0.36	0.38
Daily	0.40	0.41	0.40
Average	**0.38**	**0.36**	**0.38**

Bloomberg data, CEG analysis.

54. Based on these results there is contradictory evidence relating to the movement in asset betas since 2010 and the level of asset beta estimates relative to the current IM value of 0.34. Measured average 5 year monthly betas have fallen the most and the most recent five year estimate is below 0.34 (0.30). However, average weekly and daily asset betas remain above 0.34 (as do all 5 year beta estimates to 2010). Moreover, beta estimates derived from pooling the last 10 years of data are all at or above 0.34 – including monthly beta estimates. In our view the weight of this evidence suggests that the best estimate of beta over the last 10 years is above 0.34. This is before any adjustment for the low beta bias in the standard CAPM (discussed in our companion report).

55. However, we note that evidence is noisy – as illustrated in the above table but also as illustrated by comparing the differences in beta estimates within monthly and weekly betas themselves (as shown in Figure 9).

4 Asset beta and form of regulation

56. It has been claimed that differences in regulatory regimes could, in theory, give rise to materially different levels of systematic risk for utility companies. Alexander, Mayer and Weeds found that high-powered incentive schemes such as price cap regulation resulted in higher risks relative to low-powered incentive schemes such as rate-of-return regulation (but as discussed below, we do not):[10]

> *The results show a clear pattern at the level of individual utility sectors and for regulatory regimes as a whole. Regimes with low-powered incentives tend to co-exist with low asset beta values, while high-powered incentives imply a significantly higher beta values. These results, in accordance with existing comparisons of regulatory regimes, seem to imply that companies under RPI-X regulation are exposed to much higher levels of systematic risk in comparison with those under rate-of-return regulation, and that the cost of capital for these forms is therefore likely to be higher.*

57. The findings of Alexander et al. are referred to approvingly by the New Zealand Commerce Commission's adviser Dr Lally, who noted that[11]:

> *Firms subject to "rate of return regulation" (price regulation with frequent resetting of prices) should have low sensitivity to real GNP shocks, because the regulatory process is geared towards achieving a fixed rate of return.*

58. Dr Lally recommended an upward adjustment to account for the incentive based regulatory regime in New Zealand and the length of time between price resets when he estimated betas in 2005 for electricity distribution businesses and in 2004 and 2008 for gas pipeline businesses.[12]

59. However, the Commerce Commission, in its 2010 Input Methodologies Paper, concluded that there was insufficient empirical evidence necessary to make an adjustment to the asset beta estimate to account for different levels of systematic difference due to regulatory policy.[13]

> *In theory, regulatory regimes can allocate risks between regulated suppliers and consumers differently, such that a regulatory regime can*

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10 Alexander, Mayer & Weeds (1996) *Regulatory structure and risk: An international comparison,* The World Bank.

11 Lally (2005) *The weighted average cost of capital for electricity lines businesses,* Victoria University of Wellington, p. 37

12 New Zealand Commerce Commission (2010) *EDB and GPB Input Methodologies Reasons Paper,* p. 531

13 New Zealand Commerce Commission (2010) *EDB and GPB Input Methodologies Reasons Paper*, p. 541-542

> *either insulate the regulated supplier from more risk or expose the regulated supplier to more risk. Consequently, the regulatory regime can affect the asset beta that should be set and differences in regulatory regimes should in principle be taken into account.*
>
> *Previous research suggests that US electricity utilities were subject to less risk than UK electricity utilities and that this was a function of the different regulatory regimes. The Commission notes that the results from research by Buckland and Fraser questions the results of the previous research.*
>
> *The Commission does not consider that it has any recent empirical evidence that demonstrates different regulatory regimes affect or reduce the level of systematic risk in any material way. The empirical evidence considered by the Commission has not shown a significant difference between the systematic risks associated with regulated US and UK entities or for regulated US entities subject to different regulatory regimes.*

60. The Commission's 2010 position was not to *raise* the asset beta unless there was solid empirical evidence that US regulated businesses had *lower* asset betas than NZ regulated businesses by virtue of being subject to 'rate of return regulation' – i.e., regulation where prices can be reset to reflect cost changes without having to wait until the end of a predefined regulatory period ('incentive regulation').

61. Applying a consistent approach, the Commission would require robust empirical evidence to determine that the asset beta derived from US firms should be *reduced* to reflect a hypothetical lower risk associated with revenue than price caps. We consider that such evidence will be unlikely to be available both because:

- we don't believe that there is a strong theoretical case to expect that revenue capped businesses would have lower risks;
- many of the firms in the US sample (which dominates the Commission's sample) are best described as revenue capped; and
- there is no discernible difference between estimated asset betas for revenue and price capped businesses.

62. In relation to the first point, it is very difficult to determine from first principles what the effect of a change in the form of control would be on measured asset betas. Relative to a revenue cap, under a price cap a business tends to outperform when the regulator underestimates volume growth and *vice versa*. We understand that most volume-related variability in energy demand is weather related and it is difficult to tell a clear story as to why, for example, a positive exposure to cold winters creates systematic risk that would show up in higher betas for price-capped businesses.

63. We note that in the US and Australia, as in New Zealand, there are differences in the form of control for businesses and there is currently very little distinguishing by regulators between these businesses on either the cost of equity or debt allowance.

That is, it is very rare for regulators to adopt a different cost of equity allowance based on whether a firm is subject to a price cap or a revenue cap (or something in between).

64. On the measurement point, we note that it is very hard to find an effect of the form of regulation on measured asset betas. Recent research by Gaggero concludes:[14]

> *This paper tests empirically whether regulation characterized by high incentives implies more risk to firms than regulation characterized by low incentives. Using a worldwide panel of 170 regulated companies operating in electricity, gas, water, telecommunication and transportation sectors during the period 1995–2004, I find that different regulatory regimes do not result in different levels of risk to their regulated firms.*

65. In 2013 CEG performed a statistical analysis of the impact of different forms of regulation on asset betas within the US. In order to test any relationship between incentive regulation and the estimated betas in our sample, we used Kwoka's[15] work to classify each of the potential US comparators as operating under incentive regulation, non-incentive regulation or both.

66. While Kwoka's categorisation did not explicitly distinguish between revenue and price caps, at a first approximation non-incentive regulation can be treated as more like a revenue cap while incentive regulation can be treated as more like a price cap. This is because the key difference between the two forms of regulation is that the former does not have a strictly defined regulatory period – such that prices can be reset whenever they become materially inconsistent with costs.

67. Consequently, if a revenue cap is hypothesised to have lower risk (e.g., because revenues are less likely to depart from costs for a prolonged period) then non-incentive regulation can be expected to have the same or lower risk. Therefore, a failure to detect differences in risk between non-incentive and incentive regulated firms is evidence against a view that revenue caps are lower risk than price caps.

68. In our US study[16], most companies operated in more than one state. If a company is subject to both incentive and non-incentive regulation (determined by the state that they operate in), it was classified as 'both'. I note that this is the same approach used by the Commerce Commission Input Methodologies Paper[17].

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14 Gaggero, A., Bulletin of Economic Research 64:2, 2010.

15 Kwoka, J. (2009) *Investment adequacy under incentive regulation,* Northeastern University pp 24-25

16 CEG, *Information on equity beta from US companies*, June 2013

17 New Zealand Commerce Commission (2010) *EDB and GPB Input Methodologies Reasons Paper,* p. 516

69. Table 15 and Table 16 summarise the number of companies (i) exposed to some form of incentive regulation in all states where it operates under the regulation of a public utility commission, (ii) not exposed to incentive regulation anywhere it operates under a public utility commission and (iii) exposed to both incentive and non-incentive regulation in the states where it operates under the regulation of a public utility commission.

70. The only difference between Table 15 and Table 16 is that the former relies on a 'mostly regulated' sample and the latter on 'highly regulated' sample (defined by CEG in our 2013 report as greater than 50%/80% regulated assets).

Table 15: Type of regulation (mostly regulated companies)

Type of regulation	Number of companies	Average CAPM asset beta	Standard deviation	Average FFM relative risk	Standard variation
Incentive only	22	0.35	0.09	0.36	0.13
Non-incentive only	12	0.33	0.07	0.37	0.13
Both	19	0.35	0.07	0.35	0.16

Source: Bloomberg, Kwoka, CEG analysis

Table 16: Type of regulation (highly regulated companies)

Type of regulation	Number of companies	Average CAPM asset beta	Standard deviation	Average FFM relative risk	Standard variation
Incentive only	15	0.34	0.06	0.36	0.10
Non-incentive only	9	0.32	0.07	0.37	0.12
Both	9	0.35	0.08	0.40	0.16

Source: Bloomberg, Kwoka, CEG analysis

71. These results are consistent with there being no statistical difference in predicted relative risk associated with the type of regulation the company is exposed to. This is confirmed by formal statistical analysis. Applying Welch's t-test to the CAPM asset betas we find that there is no statistically reliable difference between the 'incentive only' and 'non-incentive only' samples for the wider mostly regulated sample of businesses.

72. We have extended this analysis to specifically look at the impact of the form of control on measured asset betas. In doing so we also update the beta estimates to include those that are the focus of this report (various beta estimates over the last 10 years).

73. Table 17 summarises the average betas for companies exposed to different types of regulation (incentive, non-incentive or both). Our classification is largely based on Table H17 from the Commerce Commission Input Methodologies Paper. However,

we have also referred to our US study for firms that are not classified (i.e. left blank) by the Commission.

Table 17: Updated type of regulation summary,

	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)	Number of firms[18]
Both	0.38	0.36	0.39	20
Incentive	0.36	0.34	0.35	28
Non-incentive	0.37	0.37	0.38	13
Grand average/total	0.37	0.35	0.37	61

Bloomberg data, CEG analysis. The reported asset beta is the reported figures are the simple average of monthly, weekly and daily betas (where monthly/weekly betas are themselves the average of 21/5 definitions for monthly/weekly asset betas).

74. Table 18 decomposes Table 17 to show the monthly, weekly and daily average beta for alternative forms of regulation.

[18] Firms delisted during the recent 5 years are, nonetheless, included for the purpose of comparison. This applies to all of the analysis in this section.

Table 18: Updated type of regulation summary – distinguishing between monthly, weekly and daily asset betas

	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)	Number of firms
Monthly				
Both	0.35	0.29	0.34	20
Incentive	0.32	0.29	0.31	28
Non-incentive	0.36	0.30	0.35	13
Grand average/total	0.34	0.29	0.33	61
Weekly				
Both	0.38	0.37	0.42	20
Incentive	0.36	0.34	0.35	28
Non-incentive	0.38	0.38	0.40	13
Grand average/total	0.37	0.36	0.38	61
Daily				
Both	0.40	0.42	0.41	20
Incentive	0.39	0.39	0.39	28
Non-incentive	0.38	0.42	0.40	13
Grand average/total	0.39	0.41	0.40	61

Bloomberg data, CEG analysis

75. Results from and Table 17 do not provide evidence that there is a material difference in asset betas between firms subject to incentive or non-incentive regulation in each of the three estimation periods.

76. In order to attempt to distinguish between estimated betas for businesses with revenue versus price cap form of control we have primarily relied on the distinction made in the US between what was historically the standard 'price cap' form of control (where utilities marginal revenues directly corresponded to the price structure that customers faced) and what is termed in the US 'decoupling'. As described by Morgan:[19]

> *Decoupling is a regulatory tool that first appeared in the 1980s as a means of helping utilities overcome the throughput incentive; i.e., the contribution to gross income that occurs with every energy unit sold because the unit (variable) price recovers some of a utility's fixed costs. A decoupling mechanism separates a utility's revenues from its unit sales volumes without affecting the design of customer rates.1 In other words, utility customers continue to pay for service primarily according to the amount of*

[19] Morgan, A Decade of Decoupling for US Energy Utilities: Rate Impacts, Designs, and Observations, p. 2.

energy they use. The utility's revenue is based on a formula approved by its regulator.

77. This decoupling need not necessarily take the form of a pure revenue cap (with revenues fixed irrespective of volumes). However, it is clear that a primary purpose of the policy is to reduce marginal incentives for throughput to below those associated with a price cap. Consistent with this, the US Center for Climate and Energy Solutions describes decoupling in the following manner.[20]

> *Under the present rate structures in U.S. energy markets, utilities' revenues depend on the amount of energy they produce and deliver to consumers. This type of system makes utilities averse to conservation and efficiency measures because their implementation ultimately cuts into profits by decreasing sales and therefore revenues. "Decoupling" removes the pressures placed on utilities to sell as much energy as possible by eliminating the relationship between revenues and sales volume. Under such a compensation scheme, revenues are "decoupled" from sales and are instead allowed to adjust so that utilities receive fair compensation regardless of fluctuations in sales. Decoupling policies are in place in many states for both electric and gas utilities.*

And

> *Under decoupling policies, a state regulatory commission determines the revenue requirement for a given utility based on a "test year" using traditional regulatory methods; but in a departure from traditional regulation the utility is then allowed to collect that revenue regardless of actual sales volume. One approach is to connect revenue to the number of customers instead of quantity of sales: revenue per customer is fixed and an automatic adjustment to the revenue requirement occurs with any new or departing customers. Periodic adjustments are made to ensure that the utility is not under- or over-collecting. Thus utilities are no longer incentivized to maximize sales volume and those that reduce costs (fixed or variable) through efficiency measures will see an increase in short-term profits because the revenue stream is largely fixed.*

78. We have independently identified 36 decoupled firms based on a list of US states that implement "Decoupling Policies".[21] A detailed list of decoupled US firms can be found in Appendix C. Table 19 and Table 20 summarise the comparison of estimated betas for firms with revenue caps/decoupling and those with price caps. It can be seen that asset beta for the "price cap" group is marginally lower for the recent 5-year period.

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[20] http://www.c2es.org/us-states-regions/policy-maps/decoupling/detail

[21] As set out at in Morgan, A Decade of Decoupling for US Energy Utilities: Rate Impacts, Designs, and Observations, p.3 and also at this link http://www.c2es.org/us-states-regions/policy-maps/decoupling

There is no discernible difference between alternative regulatory forms for the previous 5-year or the recent 10-year period.

Table 19: Revenue vs price cap summary

	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)	Number of firms
Revenue cap/decoupled	0.38	0.37	0.39	39
Price cap	0.36	0.34	0.36	25
Grand Total	0.38	0.36	0.37	64

Bloomberg data, CEG analysis

79. There is no statistically reliable difference between estimated asset betas for price cap and revenue cap/decoupled businesses.

Table 20: Revenue vs price cap - distinguishing between monthly, weekly and daily asset betas

	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)	Number of firms
Monthly				
Decoupled/Revenue cap	0.35	0.30	0.33	39
Price cap	0.36	0.30	0.34	25
Grand average/total	0.35	0.30	0.34	64
Weekly				
Decoupled/Revenue cap	0.39	0.37	0.40	39
Price cap	0.36	0.35	0.35	25
Grand average/total	0.38	0.36	0.38	64
Daily				
Decoupled/Revenue cap	0.41	0.43	0.42	39
Price cap	0.37	0.39	0.38	25
Grand average/total	0.40	0.41	0.40	64

Bloomberg data, CEG analysis

80. These results indicate that there is not sufficient evidence that "price cap" regulation (or incentive regulation) attracts higher risk, as measured by higher asset beta, than "revenue cap" regulation (or non-incentive regulation) in our sample.

Appendix A CEG Sample

81. Three firms are excluded due to missing data/illiquidity from Bloomberg. Figure 13 below shows the Bloomberg description for these stocks. It can be seen that Horizon Energy Distribution was delisted and Nicor Inc was acquired.

Figure 13: Excluded stocks description

Bloomberg data

82. Figure 14 shows the Bloomberg historical price for HED NZ Equity and PREX US Equity. It can be seen that that the variability of prices for both of these stocks are limited due to illiquidity[22].

Figure 14: Illiquid stocks historical price

Bloomberg data

83. Except for the three firms above, our final sample includes all of the firms in the Commission's original sample for the 10 year estimates and 5 year estimates prior to May 2010; an additional 12 firms are excluded for the most recent 5 year estimates as they were delisted during the period.

[22] Over the period from 2010 to 2015, HED NZ Equity has only 16% has only of the trading days with positive trade volumes; while the average trading volume for PREX US Equity in the same period is less than 1% of the average trading volume for the total sample.

Table 21: CEG final sample (excluded/delisted stocks highlighted in red, name change highlighted in yellow)

Index	stock	CC ticker	BB ticker	industry	financial year end
NZ	Horizon Energy Distribution	HED	HED NZ Equity	electricity distribution	March
NZ	Vector	VCT	VCT NZ Equity	electricity & gas distribution	June
AU	DUET Group	DUE	DUE AU Equity	electricity distribution	June
AU	Spark Infrastructure	SKI	SKI AU Equity	electricity business	December
AU	SP AusNet	SPN	AST AU Equity	electricity distribution	March
AU	APA Group	APA	APA AU Equity	gas transmission	June
AU	Envestra	ENV	ENV AU Equity	gas transmission	June
AU	Hastings Diversified Utilities Fund	HDF	HDF AU Equity	gas business	December
UK	National Grid	NG	NG UK Equity	electricity transmission	March
US	Allegheny Energy	AYE	AYE US Equity	electricity - integrated	December
US	Allete	ALE	ALE US Equity	electricity - integrated	December
US	Alliant Energy	LNT	LNT US Equity	electricity - integrated	December
US	Ameren Corp	AEE	AEE US Equity	electricity - integrated	December
US	American Electric Power Company	AEP	AEP US Equity	electricity - integrated	December
US	Avista Corp	AVA	AVA US Equity	electricity - integrated	December
US	Black Hills Corp	BKH	BKH US Equity	electricity - integrated	December
US	Central Vermont Public Service Corporation	CV	CV US Equity	electricity - integrated	December
US	CH Energy Group	CHG	CHG US Equity	electricity - integrated	December
US	Cleco Corp	CNL	CNL US Equity	electricity - integrated	December
US	CMS Energy Corp	CMS	CMS US Equity	electricity - integrated	December
US	Consolidated Edison	ED	ED US Equity	electricity - integrated	December
US	Constellation Energy Group	CEG	CEG US Equity	electricity - integrated	December
US	Dominion Resources	D	D US Equity	electricity - integrated	December
US	DPL	DPL	DPL US Equity	electricity - integrated	December
US	DTE Energy	DTE	DTE US Equity	electricity - integrated	December
US	Duke Energy Corp	DUK	DUK US Equity	electricity - integrated	December
US	Edison International	EIX	EIX US Equity	electricity - integrated	December
US	El Paso Electric Co	EE	EE US Equity	electricity - integrated	December
US	Empire District Electric Co	EDE	EDE US Equity	electricity - integrated	December

US	Entergy Corporation	ETR	ETR US Equity	electricity - integrated	December
US	Exelon Corporation	EXC	EXC US Equity	electricity - integrated	December
US	FirstEnergy Corp	FE	FE US Equity	electricity - integrated	December
US	Great Plains Energy	GXP	GXP US Equity	electricity - integrated	December
US	Hawaiian Electric	HE	HE US Equity	electricity - integrated	December
US	Idacorp	IDA	IDA US Equity	electricity - integrated	December
US	Integrys Energy Group	TEG	TEG US Equity	electricity - integrated	December
US	ITC Holdings	ITC	ITC US Equity	electricity - integrated	December
US	MGE Energy	MGE	MGEE US Equity	electricity - integrated	December
US	NextEra Energy [formerly FPL Group]	NEE	NEE US Equity	electricity - integrated	December
US	Northeast Utilities	NU	ES US Equity	electricity - integrated	December
US	Northwestern Corp	NWE	NWE US Equity	electricity - integrated	December
US	NSTAR	NST	NST US Equity	electricity - integrated	December
US	NV Energy	NVE	NVE US Equity	electricity - integrated	December
US	OGE Energy Corp	OGE	OGE US Equity	electricity - integrated	December
US	Pepco Holdings	POM	POM US Equity	electricity - integrated	December
US	PG&E Corp	PCG	PCG US Equity	electricity - integrated	December
US	Pinnacle West Capital	PNW	PNW US Equity	electricity - integrated	December
US	PNM Resources	PNM	PNM US Equity	electricity - integrated	December
US	PPL Corporation	PPL	PPL US Equity	electricity - integrated	December
US	Progress Energy	PGN	PGN US Equity	electricity - integrated	December
US	Public Service Enterprise	PEG	PEG US Equity	electricity - integrated	December
US	Scana Corp	SCG	SCG US Equity	electricity - integrated	December
US	Southern Corp	SO	SO US Equity	electricity - integrated	December
US	Teco Energy	TE	TE US Equity	electricity - integrated	December
US	UIL Holdings Corp	UIL	UIL US Equity	electricity - integrated	December
US	Unisource Energy Corp	UNS	UNS US Equity	electricity - integrated	December
US	Unitil Corp	UTL	UTL US Equity	electricity - integrated	December
US	Westar Energy	WR	WR US Equity	electricity - integrated	December
US	Wisconsin Energy	WEC	WEC US Equity	electricity - integrated	December
US	Xcel Energy	XEL	XEL US Equity	electricity - integrated	December
US	AGL Resources	GAS	GAS US Equity	gas distribution	December (September up to 2001)
US	Atmos Energy Corp	ATO	ATO US Equity	gas distribution	September

US	Centerpoint Energy	CNP	CNP US Equity	gas distribution	December
US	Chesapeake Utilities Corp	CPK	CPK US Equity	gas distribution	December
US	Laclede Group	LG	LG US Equity	gas distribution	September
US	National Fuel Gas Co	NFG	NFG US Equity	gas distribution	September
US	New Jersey Resources Corp	NJR	NJR US Equity	gas distribution	September
US	Nicor Inc	GAS	0111145D US Equity	gas distribution	December
US	Nisource Inc	NI	NI US Equity	gas distribution	December
US	Northwest Natural Gas Co	NWN	NWN US Equity	gas distribution	December
US	Oneok Inc	OKE	OKE US Equity	pipelines	December
US	Piedmont Natural Gas Co	PNY	PNY US Equity	gas distribution	October
US	Sempra Energy	SRE	SRE US Equity	gas distribution	December
US	South Jersey Industries	SJI	SJI US Equity	gas distribution	December
US	Southwest Gas Corp	SWX	SWX US Equity	gas distribution	December
US	Spectra Energy Corp	SE	SE US Equity	pipelines	December
US	UGI Corp	UGI	UGI US Equity	gas distribution	September
US	Vectren Corp	VVC	VVC US Equity	gas distribution	December
US	WGL Holdings Inc	WGL	WGL US Equity	gas distribution	September

Bloomberg data, CEG analysis

Table 22: Firms delisted during 2010-2015

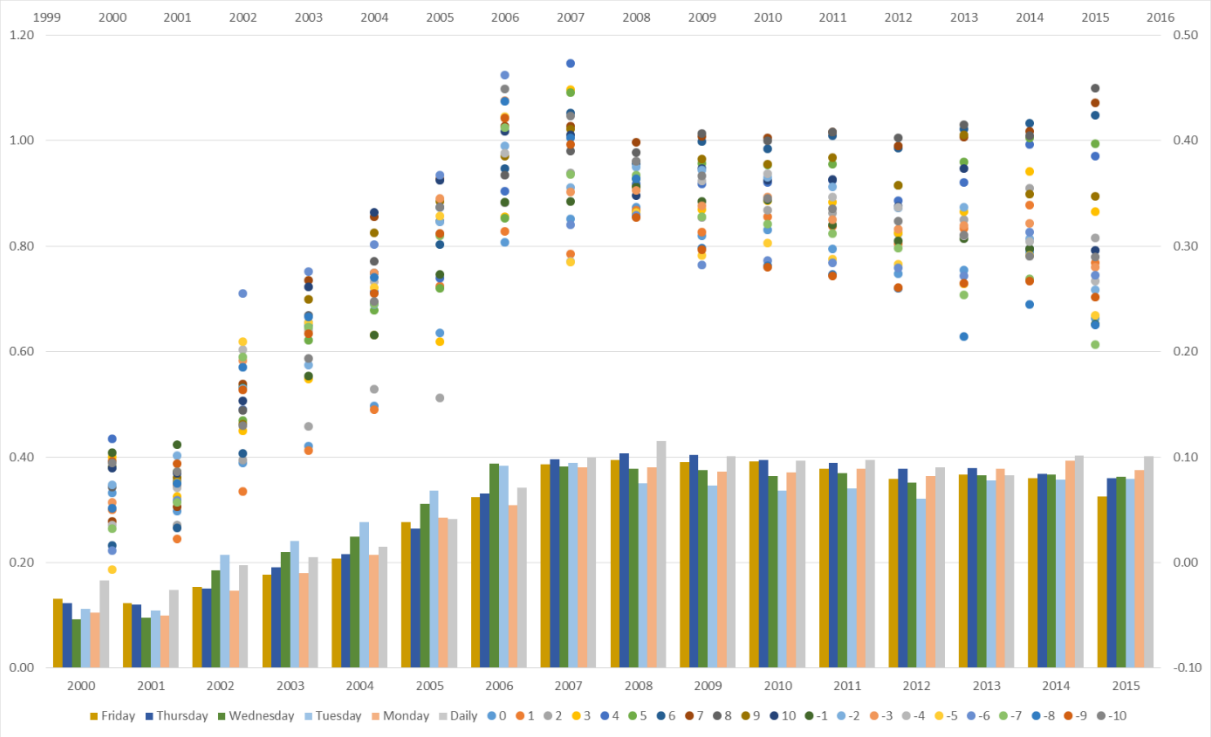
last price available date	BB ticker	Firm	Market
23-Jun-15	HED NZ Equity	Horizon Energy Distribution	NZ
12-Sep-14	ENV AU Equity	Envestra	AU
23-Nov-12	HDF AU Equity	Hastings Diversified Utilities Fund	AU
25-Feb-11	AYE US Equity	Allegheny Energy	US
27-Jun-12	CV US Equity	Central Vermont Public Service Corporation	US
27-Jun-13	CHG US Equity	CH Energy Group	US
12-Mar-12	CEG US Equity	Constellation Energy Group	US
25-Nov-11	DPL US Equity	DPL	US
29-Jun-15	TEG US Equity	Integrys Energy Group	US
9-Apr-12	NST US Equity	NSTAR	US
19-Dec-13	NVE US Equity	NV Energy	US
16-Dec-15	UIL US Equity	UIL Holdings Corp	US
15-Aug-14	UNS US Equity	Unisource Energy Corp	US

Bloomberg data, CEG analysis

Appendix B Detailed results for data ending on 30th November

84. Figure 15 below combines that average 5-year monthly and weekly betas under different definitions of a month/week, as well as daily betas, into a single chart. Weekly and daily asset betas are represented by the bar plots (left vertical axis); while monthly asset betas are the scatter plots (right vertical axis).

Figure 15: Average 5-year monthly/weekly asset beta based on 21 versions of a 'month' and 5 versions of a 'week'



Bloomberg data, CEG analysis

85. Table 23, Table 24 and Table 25below compare the estimated 5-year and 10 year monthly/weekly/daily asset betas under different definitions as specified in section 3.2.2.

Table 23: Average 10-year and 5-year monthly asset beta under 21 versions of a 'month'

Monthly asset beta	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)
0	0.32	0.23	0.29
1	0.34	0.28	0.32
2	0.35	0.31	0.33
3	0.36	0.33	0.34
4	0.37	0.39	0.37
5	0.39	0.40	0.39
6	0.41	0.42	0.40
7	0.42	0.44	0.41
8	0.42	0.45	0.42
9	0.39	0.35	0.37
10	0.38	0.30	0.35
-1	0.35	0.23	0.31
-2	0.37	0.26	0.33
-3	0.35	0.28	0.33
-4	0.37	0.27	0.34
-5	0.31	0.23	0.28
-6	0.30	0.27	0.29
-7	0.33	0.21	0.29
-8	0.29	0.23	0.26
-9	0.29	0.25	0.27
-10	0.36	0.29	0.33
Average	**0.35**	**0.30**	**0.33**

Bloomberg data, CEG analysis

Table 24: Average 10-year and 5-year weekly asset beta under 5 versions of a 'week'

Weekly asset beta	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)
0	0.39	0.33	0.38
1	0.40	0.36	0.39
2	0.37	0.36	0.37
3	0.34	0.36	0.35
4	0.38	0.38	0.38
Average	**0.38**	**0.36**	**0.37**

Bloomberg data, CEG analysis

Table 25: Average 10-year and 5-year daily asset beta

Daily asset beta	Previous 5 year beta (2010)	Last 5 year beta (2015)	Last 10 year beta (2015)
	0.39	0.40	0.40

Bloomberg data, CEG analysis

Appendix C US Decoupled firms

Table 26: list of US decoupled firms

BB ticker	States of electric rate cases	States of natural gas rate cases	Overall states with rate cases
ALE US Equity	MN	-	MN
LNT US Equity	MN, IA, WI	IA, WI	MN, IA, WI
AEE US Equity	IL, MO	IL, MO	IL, MO
AEP US Equity	AR, IN, KY, LA, MI, OH, OK, TN, TX, VA, WV	-	AR, IN, KY, LA, MI, OH, OK, TN, TX, VA, WV
AVA US Equity	ID, WA	ID, OR, WA	ID, OR, WA
CHG US Equity	NY	NY	NY
CMS US Equity	MI	MI	MI
ED US Equity	NY, NJ	NY	NY, NJ
D US Equity	VA, NC	OH, WV	VA, NC, OH, WV
DTE US Equity	MI	MI	MI
DUK US Equity	IN, KY, OH, FL, NC, SC	KY, OH	IN, KY, OH, FL, NC, SC
EIX US Equity	CA	-	CA
EXC US Equity	IL, MD, PA	MD, PA	IL, MD, PA
FE US Equity	OH, VA, WV, MD, NJ, PA	-	OH, VA, WV, MD, NJ, PA
IDA US Equity	ID, OR	-	ID, OR
TEG US Equity	MI, WI	IL, MI, MN, WI	IL, MI, MN, WI
MGEE US Equity	WI	WI	WI
ES US Equity	NH, MA, CT	CT, MA	NH, MA, CT
NVE US Equity	CA, NV	NV	CA, NV
POM US Equity	DE, MD, NJ, DC	DE	DE, MD, NJ, DC
PCG US Equity	CA	CA	CA
PNW US Equity	AZ	AZ	AZ
PPL US Equity	KY, VA, PA	KY	KY, VA, PA
PEG US Equity	NJ	NJ	NJ
SCG US Equity	SC	NC, SC	NC, SC
UIL US Equity	CT	CT, MA	CT, MA
UNS US Equity	AZ	AZ	AZ
UTL US Equity	NH, MA	MA, ME, NH	MA, ME, NH
WEC US Equity	MI, WI	WI	MI, WI
XEL US Equity	TX, MN, CO, SD, NM, WI, ND	CO, MN, ND, WI	TX, MN, CO, SD, NM, WI, ND
GAS US Equity	-	FL, GA, IL, NJ, TN, VA	FL, GA, IL, NJ, TN, VA
CNP US Equity	TX	AR, LA, MN, OK, TX	TX, AR, LA, MN, OK
CPK US Equity	FL	DE, FL, MD	DE, FL, MD
NFG US Equity	-	NY, PA	NY, PA

NJR US Equity	-	NJ	NJ
NI US Equity	IN	IN, KY, MA, OH, PA, VA	IN, KY, MA, OH, PA, VA
NWN US Equity	-	OR, WA	OR, WA
PNY US Equity	-	NC, SC, TN	NC, SC, TN
SRE US Equity	CA	AL, CA	AL, CA
SJI US Equity	-	NJ	NJ
SWX US Equity	-	AZ, CA, NV	AZ, CA, NV
SE US Equity	NH, MA, CT	CT, MA	NH, MA, CT
VVC US Equity	IN	IN, OH	IN, OH
WGL US Equity	-	DC, MD, VA	DC, MD, VA

SNL data, CEG analysis