NERA
ECONOMIC CONSULTING

Estimating Beta Risk at RIIO GD-2

Cadent Gas Limited

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Executive Summary

Cadent commissioned NERA Economic Consulting (NERA) to provide support in responding to Ofgem's recent Framework Consultation document for RIIO-2. Our report focusses on Ofgem's indicative estimates of beta risk, including a critique of analysis set out in a report by CEPA, Ofgem's consultants on the cost of capital, as well as a report by Wright et al commissioned by the UK Regulators' Network (UKRN), similarly on cost of capital estimation for UK utilities.

CEPA's beta range of 0.25 to 40 relies on market evidence during the financial crisis when betas were depressed

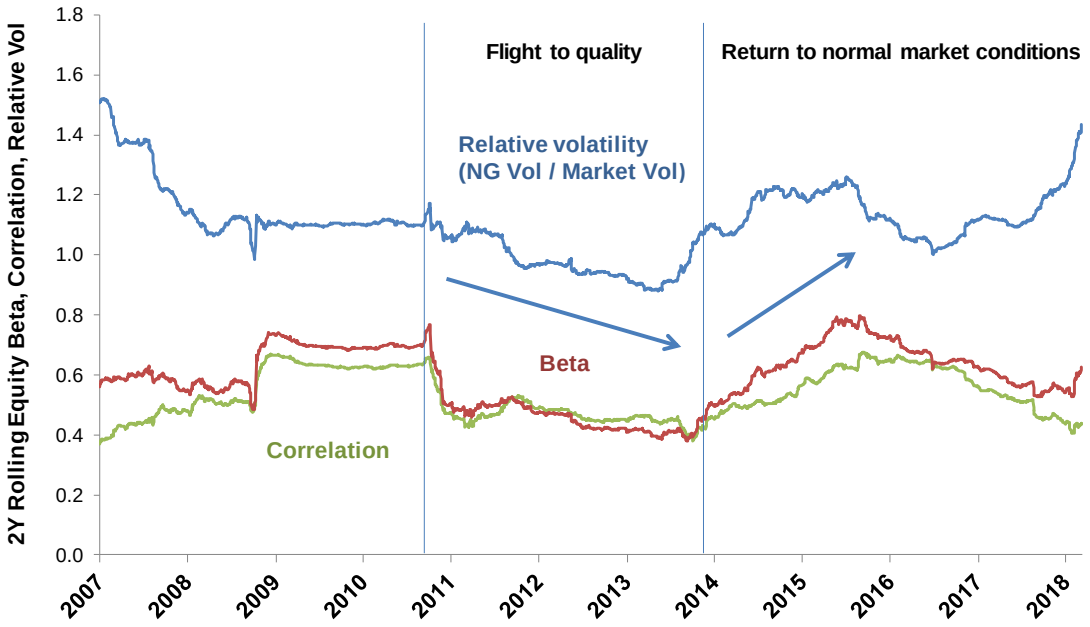
CEPA estimates the asset beta using four UK listed utilities, National Grid (NG) and three UK water companies. CEPA estimates asset betas over time, and calculates a range of 0.25 to 0.40 by taking the overall range in estimates from the global financial crisis onwards. In particular, CEPA places weight on asset beta estimates from the period 2011 to 2014 when UK utility asset betas were at historical lows.

We see no merit in using asset beta estimates from 2011 to 2014 to estimate the asset beta for RIIO-2. In the aftermath of the global financial crisis, the betas for regulated utilities declined as investors became more risk-averse and reallocated their portfolios towards less risky assets. As a result of the "flight to quality", the asset betas declined.

However, this trend has now reversed and beta estimates for UK listed utilities have returned to the pre-crisis level. Decomposing National Grid's asset beta into its constituent elements, the correlation with the market portfolio and relative volatility, we show an increase in both elements since RIIO-1 supporting higher values at RIIO-2 (see Figure 1). By contrast, CEPA's lower bound range of 0.25, which is based on outdated market evidence, is not relevant to RIIO-2.

In addition, we consider that CEPA focuses on a relatively narrow set of UK comparators, and ignores listed European energy networks operating in potentially comparable regimes in Italy, Spain and Portugal.

Figure 1
NG plc's beta has increased as UK has emerged from financial crisis



Updated market evidence shows assets betas in a range of 0.3 to 0.4, with NG towards the upper-end

We show that the latest beta estimates for UK listed utilities lie in the range of 0.3 to 0.4, with NG's latest 2-year asset beta at 0.37. We consider that NG is the most relevant comparator for estimating Cadent's beta risk, as a GB energy network and with a 39 per cent shareholding in Cadent.

CEPA argues that the asset betas for the water companies are as relevant benchmarks for the RIIO-2 asset beta as NG's beta, and CEPA notes that there are certain factors, such as the treatment of pension deficit recovery under the regulatory regimes, which mean energy networks face less risk than water companies.

However, CEPA has not undertaken a complete relative risk analysis of UK energy networks against water companies. Aside from pension deficit recovery, there are other factors for which energy networks may face greater risk than water companies, e.g. cost of debt indexation; capex to RAB. For example, greater capex to RAB ratios increase the company's systematic risk exposure because of the greater fixed costs in the business, which results in greater variance in profits as a result of any demand shocks.

Without considering all these factors, CEPA cannot conclude that UK water companies are appropriate comparators for estimating the asset beta at RIIO-2. Moreover, the empirical asset beta evidence for NG supports a higher asset beta than for water companies.

NG's composite beta reflects lower risk US assets; the implied asset beta for UK energy networks lies in range of 0.43 to 0.47

We have decomposed NG plc's asset beta to determine the beta for its UK regulated operations, given a large segment of its business relates to US energy networks. We find that US energy network betas are lower than NG's asset beta, principally because they are subject to less high-powered incentive regimes, and lower regulatory risk due to established regulatory principles established through the courts. This implies that the asset beta for NG's UK regulated business must be higher than NG plc. Our decomposition analysis suggests that the asset beta for NG's UK regulated business is likely to be in the range of 0.43 to 0.47, above CEPA's overall beta range for RIIO-2 of 0.25 to 0.4.

The use of GARCH techniques per se does not provide lower beta estimates relative to OLS methods

Three of the UKRN report authors, Mason, Pickford and Wright (MPW) recommend estimating betas using a methodology which substantially departs from common regulatory practice. Specifically, they recommend betas should be estimated using very long-run estimation periods going back to 2000; aggregated or low frequency data (e.g. quarterly returns); and statistical models from the GARCH family for estimating betas. On this basis, the authors estimate *equity betas* for United Utilities (UU) and Severn Trent (SVT) between 0.3 and 0.5, substantively lower than the determined equity betas at previous reviews.

We disagree with MPW's recommendations. Estimating betas over long horizons going back to 2000 ignores material changes in companies' business and financial risk, changes in market conditions, as well as changes in the regulatory regime, resulting in beta estimates that fail to reflect regulated companies' risk profile at RIIO-2.

The use of low frequency data requires extending the estimation period to ensure sufficient observations, leading to very long estimation periods that are not relevant in terms of risk profile, as noted above. Even if all available data are used (in case of MPW over the period 2000-2017), the number of quarterly observations is considerably less than the thousands of observations using daily data for the same estimation period. The use of quarterly intervals results in less precise beta estimates, e.g. as measured by the standard errors. Moreover, there are a number of ways aggregating daily returns in lower frequency data, e.g. there are 60 different specifications of quarterly returns depending on which day the starting point of the quarter is defined, which provide varying beta estimates.

In line with standard regulatory practice, beta estimates should draw on high frequency data (e.g. daily) and recent time periods (e.g. two to five years) to ensure precise and relevant estimates. Using high frequency data and recent time periods, we then find that beta estimates for UU and SVT and indeed other UK and European comparators are similar irrespective of whether GARCH or standard OLS statistical models are used. Given the substantial increase in complexity associated with the use of GARCH models, we consider that GARCH methods are less justified compared to standard OLS in the regulatory context.

The use of estimated equity betas, as opposed to re-levered equity betas at notional gearing, is inconsistent with theory and good practice

The UKRN report provides two views on how to estimate the beta for a notionally geared efficient network. The first approach, proposed by MPW, argues that the use of a notional gearing to re-lever the asset beta is incorrect and that the most reliable equity beta is the raw estimation. The second approach, noted by Burns and in line with regulatory practice, involves de-levering the observed equity beta at the actual company gearing and then re-levering the asset beta to the notional gearing, determined by the regulator.

We do not consider the MPW approach has any merit. First, the use of an unadjusted equity beta reflecting companies' actual gearing would be inconsistent with the notional weights used to calculate the weighted average cost of capital. Alternatively, if the regulator were to determine the cost of capital based on listed companies' actual capital structure decisions, this would undermine incentives to optimise capital structure and minimise financing costs, and would tie the sector to the capital structure decisions of the few quoted companies.

Conclusions

Our empirical evidence for UK listed network companies – NG plc, United Utilities, Severn Trent, and Pennon – show that the majority of beta estimates lie in the range of 0.3 to 0.4, with values for NG plc, the most relevant comparator for Cadent, towards the top-end of this range, e.g. NG plc's two-year asset beta is 0.37. Decomposing NG plc's asset beta into UK and US operations, we obtain a range of 0.43 to 0.47 for NG plc's implied UK beta (2Y). Our beta estimates– drawing on high frequency and relevant time periods – are insensitive to the use of GARCH or OLS techniques.

Our results are substantively higher than those set out by CEPA of 0.25 to 0.4, as CEPA's lower bound draws on periods when asset betas were depressed, and it fails to decompose NG's beta to identify UK energy network risk.

1. Introduction

Cadent commissioned NERA Economic Consulting (NERA) to provide support in responding to regulatory finance issues for RIIO-2 set out in Ofgem's recent Framework Consultation document.[1] Our report focusses on Ofgem's indicative estimates of beta risk, including a critique of analysis set out in a report by CEPA, Ofgem's consultants on the cost of capital, as well as a report by Wright et al commissioned by the UK Regulators' Network (UKRN), similarly on cost of capital estimation for UK utilities.[2]

The report is structured as follows:

- Section 2 provides a critical appraisal of CEPA's beta estimates for energy networks at RIIO-2
- Section 3 provides a critical appraisal of the proposed by Wright, an author of the UKRN report, to draw on long run data of quarterly intervals, and to use alternative GARCH techniques, to estimate beta risk
- Section 4 addresses the issue of how to translate raw equity betas to derive asset betas, as discussed in the UKRN commissioned report
- Section 5 draws conclusions on beta risk for Cadent at RIIO-2.

[1] Ofgem (March 2018) RIIO-2 Framework Consultation

[2] CEPA (February 2018), Review of cost of capital ranges for Ofgem's RIIO-2 for onshore networks; Wright et al (2018) Estimating the cost of capital for implementation of price control by UK regulators

2. Critical appraisal of CEPA's beta analysis

In its RIIO-2 Framework Consultation March 2018, Ofgem anticipates that RIIO-2 equity beta could be lower than the 0.9 equity beta implied for RIIO-1. It considers network companies bear a lower degree of non-diversifiable risk than the market (which would imply an equity beta of 1) given the protection given by the regulatory regime.

Ofgem draws on a report commissioned by CEPA, its economic consultants, to inform its indicative equity beta range.[3] Ofgem also notes that it will consider in further detail proposed alternative estimation procedures set out by UKRN. In this section, we assess CEPA's approach to estimating the asset beta for RIIO-2, and we consider UKRN's proposed approach in the following section.

In short, CEPA estimates an asset beta range of 0.25 to 0.40 for energy networks at RIIO-2, where it believes the top end of the range is more appropriate for certain sectors or companies with large investment programmes relative to the size of the asset base.[4] CEPA's estimates are based on the empirical asset beta estimates for four UK listed utilities, including three listed water and sewerage companies.

We have evaluated CEPA's method for estimating the asset beta below, in particular considering whether it is appropriate to use all four UK listed utilities to estimate the asset beta for RIIO-2. Overall, we show that CEPA's recommended range of 0.25 to 0.4 is far lower than empirical estimates for National Grid's asset betas for NG's UK operations, the most relevant comparator for Cadent, which is around 0.43 to 0.47.

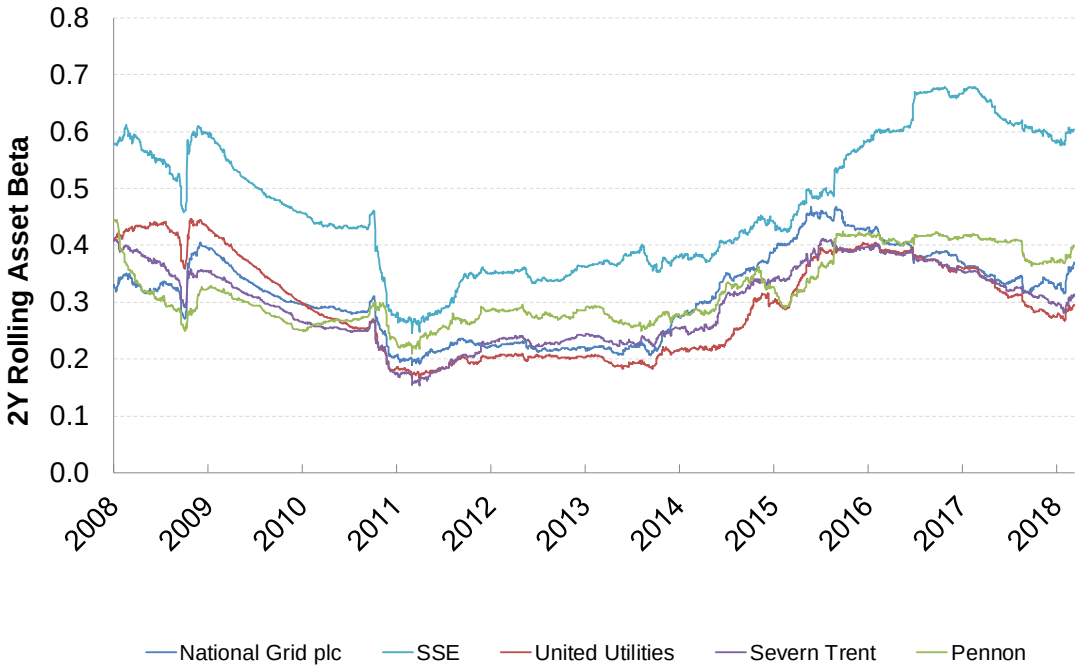
2.1. Empirical evidence from UK networks

Figure 2.1 shows the evolution of asset betas for NG plc and four listed UK network comparators – SSE, UU, Severn Trent and Pennon – over the past 10 years. The asset betas for NG plc and the comparators have increased considerably since the height of the financial crisis in Europe (2011-2012), and the RIIO-1 determination in 2013.

[3] CEPA (February 2018), Review of cost of capital ranges for Ofgem's RIIO-2 for onshore networks

[4] CEPA (February 2018), Review of cost of capital ranges for Ofgem's RIIO-2 for onshore networks, p.54.

Figure 2.1
2Y rolling asset betas for UK utilities have increased since RIIO-1, as a consequence of UK emerging from the financial crisis



Source: Bloomberg, NERA analysis, cut-off: 9 March 2018, daily data, reference index: FTSE All Share

Table 2.1 shows the latest empirical asset betas for UK networks, using 1-year, 2-year, 5-year, and 10-year estimation windows. This evidence shows that in the most part the asset beta estimates lie in the range of 0.3 to 0.4, with the exception of SSE's beta which is higher, reflecting its significant share of generation and supply activities, which are more risky. NG plc's asset beta is at the top-end of the range, excluding SSE.

Table 2.1
With the exception of SSE, most network asset beta lies in the range of 0.3 to 0.4 with NG plc towards the upper-end of the range[5]

	1Y	2Y	5Y
National Grid plc	0.54	0.37	0.39
SSE	0.44	0.60	0.57
United Utilities	0.35	0.30	0.33
Severn Trent	0.37	0.31	0.35
Pennon	0.44	0.40	0.38
Average	0.43	0.40	0.40
Average (excl. SSE)	**0.43**	**0.34**	**0.36**

Source: Bloomberg, NERA analysis, cut-off: 9 March 2018, daily data, reference index: FTSE All Share.

2.1.1. Explaining trend in beta risk over time

We have conducted an empirical analysis of systematic risk, using stock and index return data to estimate betas for NG plc and other listed UK networks.

Figure 2.2 shows NG plc's equity beta (red line) over the period 2007 to 2018, including a decomposition of the beta into its two components, the relative volatility of the stock return to that of the market (blue line) and the correlation of the stock return with the market (green line).

Under the OLS CAPM, the equity beta derived from market data can be decomposed into correlation of the stock return with the market, and relative volatility of the stock return to that of the market:

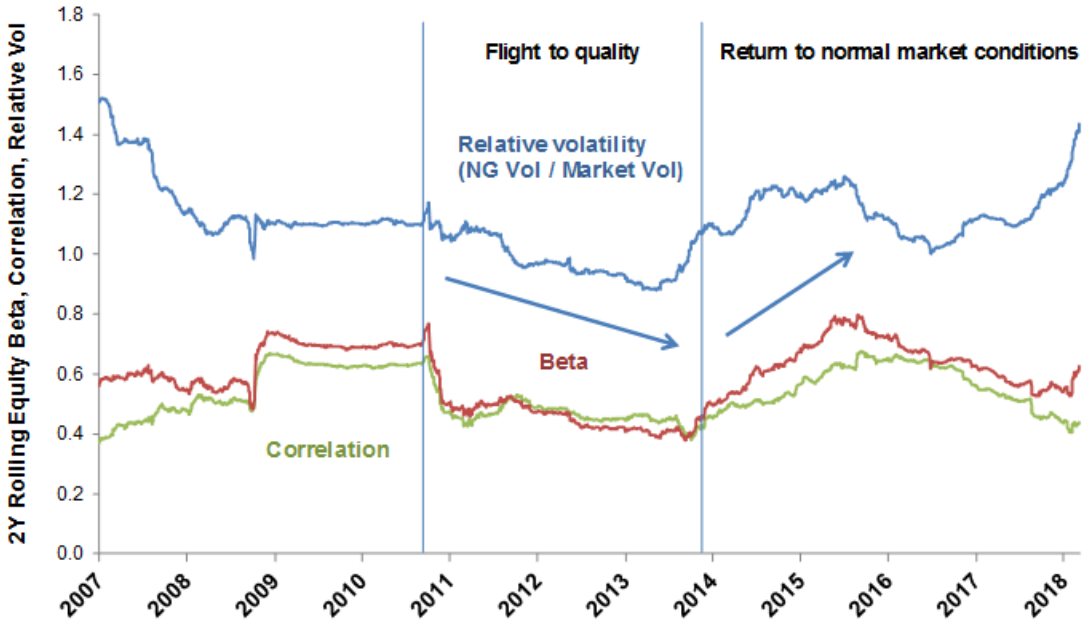
$$equity\ \beta = \rho_{stock,\ market}\ \ x\ \ \frac{\sigma_{stock}}{\sigma_{market}}$$

As with other "defensive" stocks, NG plc's asset beta fell in the aftermath of the financial crisis due to higher market volatility relative to NG plc's volatility, and reduced correlation (which was relatively suppressed due to NG plc being a defensive stock). However, NG plc's beta has returned back to normal market conditions and pre-crisis levels.

Initially, both the correlation component and relative volatility increased, followed by a decrease. In recent months, relative volatility has increased considerably. The trend of higher relative volatility can also be observed for the listed water companies.

[5] Where there is more than one relevant comparator, we draw conclusions based on the average beta estimate for the comparator set, to take into account all relevant information.

Figure 2.2
Increase in NG plc's beta mainly a result of increase in relative volatility

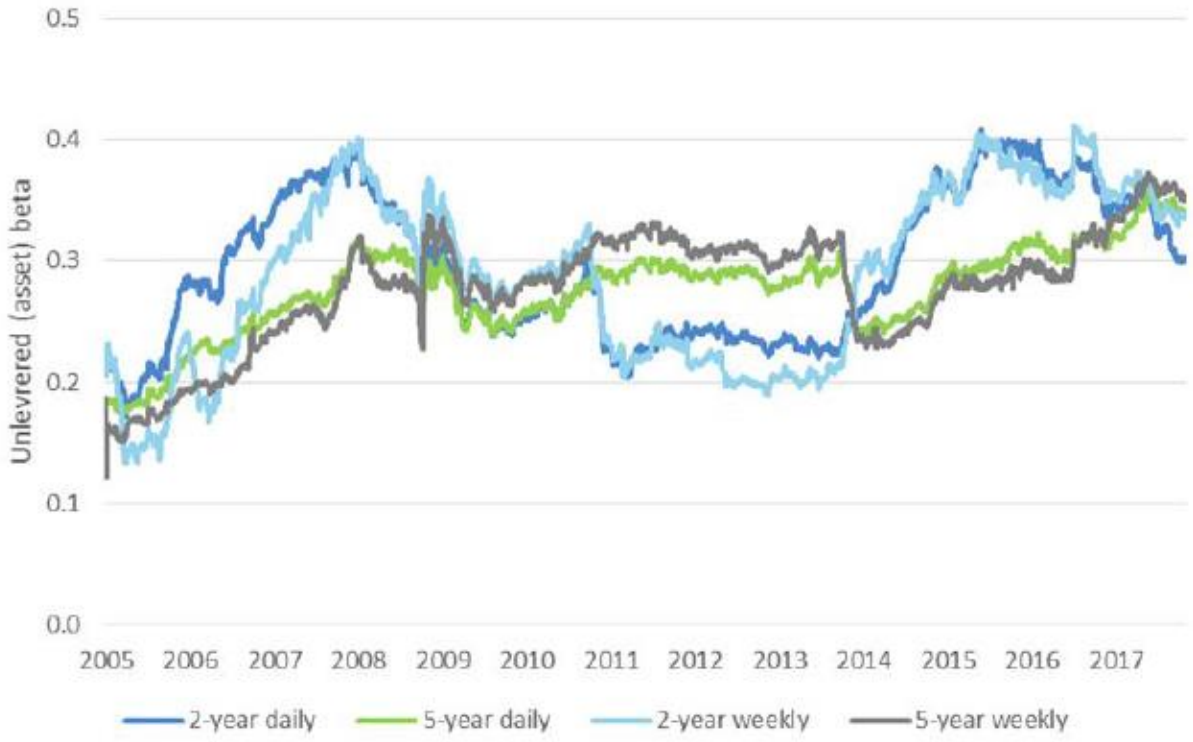


Source: Bloomberg, NERA analysis, cut-off: 9 March 2018, daily data, reference index: FTSE All Share.

2.2. CEPA draws on same comparators but draws on outdated evidence

CEPA presents analysis of the asset beta over time for National Grid, Pennon Group, Severn Trent and United Utilities, which it identifies as the four principal UK listed utilities. CEPA considers a range of different beta estimation approaches, but its final asset beta range of 0.25 to 0.40 appears to be derived from 2-year daily estimates, presented below.

Figure 2.3
CEPA Estimates of Asset Betas for UK Listed Utilities



Source: CEPA (February 2018) op. cit., p.53

Figure 2.3 shows that CEPA's asset beta range of 0.25 to 0.40 is clearly not based on the latest market evidence. As shown in the chart, the asset beta was in the range 0.30 to 0.36 at the end of 2017, well above CEPA's proposed lower bound of 0.25. It appears that CEPA's lower bound places weight on asset beta estimates from the period 2011 to 2014, when asset betas for the four listed utilities were depressed relative to the more recent trend.

We see no merit in using asset beta estimates from 2011 to 2014 to estimate the asset beta for RIIO-2. These asset betas reflect the market's perception of risk facing the companies at that point in time. In the aftermath of the global financial crisis, the betas for regulated utilities declined as investors became more risk-averse and reallocated their portfolios towards less risky assets. As a result of the 'flight to quality', the asset betas declined.

However, the decline in asset betas at RIIO-1 has now reversed. Our decomposition of NG's asset beta into its constituent elements, the correlation with the market portfolio and relative volatility, shows an increase in both elements since RIIO-1 supporting higher values at RIIO-2 (see Figure 2.2).

In addition, we consider that CEPA focuses on a relatively narrow UK set, and ignores potential European comparator networks such as those presented in our critique of GARCH methods in section 3.3.[6]

In conclusion, we do not consider that any weight should be placed on the asset betas from the period 2011 to 2014 as CEPA does, because the estimates from this period are depressed by the temporary flight to quality phenomenon which has since reversed.

2.3. CEPA does not capture differences in relative risk between UK water and energy networks

CEPA argues the "*the energy sector is broadly comparable in (systematic) risk profile to the water sector*".[7] CEPA recognises there may be some differences in the regulatory regime, but believes that these differences will only affect the beta point estimate rather than the range itself.

CEPA asserts that energy networks face less risk relative to water companies from the treatment of pensions under their respective regulatory frameworks. UK water companies were able to recover 50 per cent of deficits as at PR09[8], whereas energy networks can recover the established deficit as at 2013 with triennial revaluation to allow for changes in the value of the deficit, but face risk on post-establishment deficits.[9] This difference in the treatment of pension deficit recovery suggests energy networks face less risk relative to UK water networks on this particular factor.

However, CEPA does not undertake a systematic relative risk analysis. Focusing on the difference in treatment of pension deficit recovery does not alone justify CEPA's suggestion that UK energy networks may be less risky than water companies.

We have undertaken comparison of risks across a range of factors as set out in Table 2.2 below).

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6 We draw on the following international comparators: EDP-Energias de Portugal (Portugal), Red Electrica (Spain), TERNA (Italy), ACEA (Italy), Gas Natural SDG (Spain), SNAM (Italy), and Enagas (Spain)

7 CEPA (February 2018), Review of cost of capital ranges for Ofgem's RIIO-2 for onshore networks, p.54.

8 At PR09, Ofwat determined the price control allowance for pension deficit repair costs associated with companies defined benefit pension schemes assuming a 10- to 15-year deficit repair period starting in 2009 or 2010. Ofwat allowed companies to recover about 50 per cent of pension deficit repair costs from customers from PR09, with the rest dealt with by management action or shareholder contributions. Source: Ofwat (October 2013), IN 13/17: Treatment of companies' pension deficit repair costs at the 2014 price review. Link: https://0980a19b0bb02fe4a86d-0df48efcb31bcf2ed0366d316cab9ab8.ssl.cf3.rackcdn.com/wp-content/uploads/2015/11/prs_in1317pr14pension.pdf

9 Ofgem (17 December 2012), RIIO-T1: Final Proposals for National Grid Electricity Transmission and National Grid Gas - Finance Supporting Document, Appendix 5.

Table 2.2
Relative risk assessment shows energy networks face some higher risks relative to other sectors

	Gas Distribution	Electricity Distribution	NGET	NGGT	Water	Heathrow	NATS (air traffic control)
Form / length of control	• Revenue-cap • 8-years	• Revenue-cap • 8-years	• Revenue-cap • 8-years	• Revenue-cap • 8-years	• Revenue-cap • 5-years	• Price-cap • 5-years	• Part revenue part price-cap • 5-years
Setting cost allowances	• Comparative benchmarking of totex (UQ efficiency) • DB pension deficit recovery over 15yrs with 3Y re-valuation • Re-openers for some costs	• Comparative benchmarking of totex (UQ efficiency) • DB pension deficit recovery over 15yrs with 3Y re-valuation Re-openers for some costs	• Expert review of totex • DB pension deficit recovery over 15yrs with 3Y re-valuation Re-openers for some costs	• Expert review of totex • DB pension deficit recovery over 15yrs with 3Y re-valuation • Re-openers for some costs	• Comparative benchmarking of totex (UQ efficiency) • 50% sharing of pension deficit repair costs with customers	• Opex based on benchmarking & capex agreed with airlines • Pass-through of pension deficit costs	• Opex based on benchmarking & capex agreed with airlines • DB pension deficit allowance and 80% pass through of savings / overspend within period
Outturn cost risk & incentives	• TIM • Uncertainty/pass-through of non-controllables • Disapplication of price control	• TIM • Uncertainty/pass-through of non-controllables • Disapplication of price control	• TIM • Uncertainty/pass-through of non-controllables • Disapplication of price control	• TIM • Uncertainty/pass-through of non-controllables • Disapplication of price control	• Totex sharing • Pass-through of non-controllables • IDoK/SAE clause	• Full risk on opex and pass-through of efficient actual capex (s.t. delay penalties)	• 5-year opex roller and pass-through of efficient capex
- Capex/opening RAB	• 6%	• 11%	• 16%	• 9%	• 6-8% (WaSC-WOC)	• 4%	• 10%
- Totex/opening RAB	• 13%	• 15%	• 18%	• 11%	• 13-22% (WaSC-WOC)	• 11%	• 54%
- Ret+Dep./Rev	• 46%	• 57%	• 83%	• 58%	• 51-38% (WaSC-WOC)	• 59%	• 42%
- Totex sharing factor	• 62-64%	• 53-58(70)%	• 48%	• 45%	• 50-57%	• 100% opex, 0% capex	• 5-year opex roller, 0% capex
Financing cost risk	• COD update = 10Y trailing average iBoxx	• COD update = 10-20Y trailing average iBoxx	• COD update = 10Y trailing average iBoxx	• COD update = 10Y trailing average iBoxx	• Fixed at weighted average of industry embedded and new forecast COD	• Fixed at weighted average of HAL embedded and new forecast COD	• Fixed at weighted average of NERL embedded and new forecast COD
Quality of Service/Output incentives	• Performance incentives : +1.3/-0.7% of RORE	• Performance incentives : +2.2/-2.8% of RORE	• Performance incentives : +0.6/-1.4% of RORE	• Performance incentives : +1.7/-1.4% of RORE	• Performance incentives (SIM,ODI): +0.8/-2.1% of RORE	• Service quality: asymmetric -7% penalty.+2% reward of airport charges	• Delays: +/-1% revenue
Stranding/ competition / regulatory risk	• Uncertainty over future gas flows (domestic heat decarbonisation)		• Uncertainty over future role and operation of system from distributed generation	• Uncertainty over future role given uncertainty of CCGT role in energy mix, and decarbonisation of heat	• Competition in NHH retail; future competition for water/ bioresources	• Competition from other London/UK and European hub airports	• No competition in immediate future

Source: Bloomberg, NERA analysis.

At a high level, the regulatory regimes in energy and water are closely aligned, but there are some differences in the respective regimes that would lead to different exposures to systematic risk. UK energy networks may face greater risk from the longer regulatory review period of eight years compared to five years in the water sector, as it can increase in-period volatility in returns. However, such forecasting risk is mitigated (at least in part, if not wholly) by uncertainty mechanisms, reopeners and the mid-period review.[10] UK energy networks may also face greater risk relative to the water sector from the cost of debt indexation mechanism which increases the pro-cyclicality of returns relative to a fixed ex ante allowance. None of these factors are explicitly considered by CEPA in its comparative assessment.

By contrast, UK energy networks bear somewhat lower risk than companies in the aviation sector (HAL and NATS). Whereas energy companies have higher incentives with regard to cost and output, aviation companies are exposed to material within-period volume and competition risks, given their price cap regimes.

In addition to differences in the regulatory framework, our comparative analysis suggests that investors in UK energy networks face higher risk than investors in water networks given the greater capex size (as measured by capex/RAB), and greater exposure to asset stranding risks due to government's decarbonisation plans and uncertainty over the future role of energy networks.

In summary, we consider that CEPA's beta estimates based on historical data, and during the period of the financial crisis, understate the risks faced by investors today. Our empirical analysis provides for a range of around 0.3 to 0.4.

CEPA concludes that the risks between water and energy are broadly comparable. However, the empirical evidences suggests otherwise: National Grid's asset beta is towards the top-end of the range reflecting investors' perceptions of higher risk for energy networks relative to water networks.

2.4. CEPA does not consider how National Grid's US operations affects its beta estimate

CEPA includes National Grid in its group of comparators to estimate the asset beta for RIIO-2, but notes that it is not a pure play comparator because only 36 percent of its operating profit in 2017 was derived from UK regulated network businesses. CEPA makes no attempt to adjust National Grid's asset beta for the differences in risk in its underlying business segments. We have considered how National Grid's non UK regulated businesses affect its asset beta. NG plc retains 39 per cent ownership of Cadent, and along with its other UK energy networks, is the most comparable listed network for estimating Cadent's beta risk.[11]

[10] We note that there may some other benefits of a longer regulatory period including lower regulatory burden and better alignment between investment and the price control period.

[11] See: https://cadentgas.com/about-us/investor-relations/group-structure

In 2016/17, National Grid's UK non-regulated activities accounted for 5 per cent of the group's revenues and about 6 per cent of the group's fixed assets.[12] US regulated operations accounted for 41 per cent of the group's combined regulated asset base.[13] In order to estimate the asset beta of National Grid's UK regulated business, we have decomposed its overall asset beta into a UK asset beta and a US asset beta.

In the US, National Grid's operations are subject to various regulatory regimes, depending on the state in which they operate and the business activity in question. The majority of these businesses are subject to incentive regulation (about 90 per cent of regulated assets), albeit a lower-powered incentive regime than the UK. However, around 8 per cent of assets are subject to rate of return regulation, which exposes the company to less risk in terms of potential over or underperformance. In addition, National Grid Generation, which comprises around 3 per cent of the business' regulated assets, operates under a long-term power supply agreement with the Long Island Power Authority, with very low systematic risk.[14]

2.4.1. US regulatory regimes are lower risk than UK

Although National Grid's US businesses that are regulated under incentive based regimes are subject to revenue caps similar to the UK regulated business, i.e. do not bear material demand or revenue risk, there are some key differences that mean the US incentive based regimes are less risky than RIIO-2:

- Greater objectivity in setting allowed costs: in most cases, cost allowances are set based on outturn costs for a base year and projected forwarded, without explicit efficiency factors that reduce allowances over time. Some are also based on historical costs (especially in Massachusetts). The prudency standard for permissible costs sets a high evidentiary bar for the disallowance of incurred costs. By contrast, RIIO draws on more subjective comparative efficiency analysis and technical review of costs;
- US regimes provide a true-up for pension and other post-employment liabilities, whereas National Grid bears the risk on its post-2012 liabilities in the UK;
- US companies generally have less stringent output and quality of service incentives (they focus mainly on reducing and preventing gas leakage and some efficiency incentives);
- National Grid's US businesses are regulated under shorter regulatory periods (mostly 3-4 years, except gas businesses in Massachusetts which account for only 11 per cent of regulated assets) which reduces the within-period volatility of returns with more frequent updating of revenues in line with costs;[15]

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[12] These activities included UK gas metering activities; the Great Britain-France Interconnector; UK property management; a UK LNG import terminal; US LNG operations; US unregulated transmission pipelines; together with corporate activities. See National Grid Annual Report 2016/17, p.95, 96.

[13] National Grid (18 May 2017), 2016/17 Full Year Results, p.14-17. This calculation only takes into account NG's remaining 39% stake in its former gas distribution business.

[14] See National Grid US Databook for 2016/17, p7,8.

[15] We note that the risks associated with a longer regulatory period can be in part mitigated by uncertainty mechanisms, reopeners and the mid-point review. Moreover there are other benefits associated with a longer price review, including lower regulatory burden and better alignment between investment and the price control period.

- The US regimes incorporate greater use of cost pass-through or true-ups, e.g. for commodity prices, commodity related bad debt, some mandated capex, and environmental remediation costs. By contrast, the true-ups or pass-through provisions for National Grid are more limited, e.g. relating to security, network development, infrastructure enhancement, strategic wider works, and some environmental costs.[16]

Overall, US regulatory regimes are determined with reference to case law which has been tested in the courts. The nature of the proceedings offers greater investor security relative to the more subjective approach, and weaker appeals mechanisms, associated with GB price controls. For example, the rate cases have enshrined principles in relation to the protection of property rights, and notions of prudency standards in relation to permissible costs.[17]

2.4.2. Empirical asset beta evidence for US networks are lower than for NG Group

In order to obtain a measure of the systematic riskiness of National Grid's UK regulated business, we decompose its group asset beta into a UK and US asset beta, based on the equation below.

$$\beta_{National\ Grid} = \frac{Regulated\ assets\ in\ UK}{Total\ regulated\ assets} * \beta_{UK} + \frac{Regulated\ assets\ in\ US}{Total\ regulated\ assets} * \beta_{US}$$

$$\beta_{National\ Grid} = 59\% * \beta_{UK} + 41\% * \beta_{US}$$

In order to estimate the beta associated with National Grid's US regulated businesses (β_{US}), we have identified a preliminary sample of 22 network comparators in the US.[18] We selected these comparators based on networks operating exclusively in the US, and principally engaged in regulated energy network, retail, or generation activities, as well as ensuring that the stocks met standard liquidity thresholds.[19]

Of this initial set of comparators, 3 comparators operate in the same states, and hence similar regulatory regimes, as National Grid. In particular, Consolidated Edison operates in New York (where National Grid USA has about 56 per cent of its regulated assets), and Unitil Corp and Eversource Energy have significant operations in Massachusetts, New Hampshire (and Maine), where about 30 per cent of National Grid USA's regulated assets are located.

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16 Ofgem (2012), RIIO-T1: Final proposals for National Grid Electricity Transmission and National Grid Gas – Finance support document, p89, 90.

17 The regulation of utilities in North America faces a special kind of constraint that most other nations do not exhibit. Particularly in the United States, major regulatory statutes do not become settled methods of government control over private businesses until they are tested in the courts. There are established principles in relation to property rights, and prudency standards. See for example: NERA (2015) Half a century of estimating the cost of capital, Link: http://www.nera.com/content/dam/nera/publications/2015/PUB_Cost_of_Capital_1115.pdf

18 Bloomberg, CEG (2013), Information on equity beta from US companies.

19 We look at bid-ask spreads as a proxy for the liquidity of the listing. We consider stocks with bid-ask spreads above 1 per cent to meet liquidity threshold, based on UK and European regulatory approaches. See for example, NERA (2016) Update of the Equity Beta and Asset Beta for BT, A report for Ofcom. Section A4, pp 58-59. Link: https://www.ofcom.org.uk/__data/assets/pdf_file/0028/97039/annex_31.pdf

Table 2.3 summarises their asset betas over different estimation windows. The average two-year asset beta is 0.23, and all asset betas are below National Grid's group two-year beta of 0.37.

Table 2.3
US comparators operating in same/similar states as National Grid have an average 2Y asset beta of 0.23

	1Y	2Y	5Y	% regulated	States
National Grid Plc	0.54	0.37	0.39	>95%	New York, Massachusetts, New Hampshire, Vermont, Maine, Rhode Island
Consolidated Edison	0.17	0.13	0.21	87%	New York
Eversource Energy	0.22	0.20	0.31	82%	Connecticut, Massachusetts, New Hampshire
Unitil Corp	0.28	0.35	0.34	99%	New Hampshire, Massachusetts, Maine
Average of comparators	**0.22**	**0.23**	**0.29**	**89%**	

Source: Bloomberg, NERA analysis, cut-off: 9 March 2018, daily data, reference index: S&P500.

2.4.3. We derive a higher NG UK asset beta of between 0.43 and 0.47

Using the average asset beta of these three comparators as a proxy of the systematic riskiness of National Grid's operations in the US, and drawing on the equation above, we calculate an implied UK asset beta of 0.47 based on a two-year estimation window, and 0.46 based on a five-year estimation window (see Table 2.4 below). Our estimate is considerably higher than the composite National Grid asset beta of 0.37 (two –year beta), and approximately mid-point of the empirical betas of UK water companies and SSE (see section 2). Our estimates are also higher than CEPA's estimated asset beta range of 0.25 to 0.40 for RIIO-2.

Table 2.4
We estimate implied NG's UK asset beta of 0.46/0.47 based on three most direct comparators operating in same/similar states

	NG overall	US	UK
Share of regulated assets		41%	59%
2Y beta	0.37	0.23	**0.47**
5Y beta	0.39	0.29	**0.46**

Source: Bloomberg, NERA analysis.

To check the sensitivity of our results to the three main comparators, we also present asset betas for the full sample of 22 comparators. We obtain very similar results for the two-year betas, which are in the range of 0.13 to 0.38, with an average of 0.26. This average is

considerably lower than National Grid's two-year asset beta of 0.37. Using the full sample, we obtain an implied asset betas for National Grid's UK operations of 0.45 (2Y) and 0.43 (5Y), only marginally lower than the betas we obtained using the most relevant comparators only.

Table 2.5
Solving for NG UK beta – full set of comparators

	NG overall	US	UK
Share of regulated assets		41%	59%
2Y beta	0.37	0.26	**0.45**
5Y beta	0.39	0.34	**0.43**

Source: Bloomberg, NERA analysis.

We conclude that the asset beta for UK energy networks at RIIO-2 should lie above the overall National Grid asset beta, with an implied value of between 0.43 to 0.47 based on decomposing the National Grid composite beta into UK and US operations.

CEPA does not present any such analysis in evaluating the asset beta for National Grid, and as a result, we consider its approach of simply referencing the National Grid group beta and other GB networks understates the true systematic risk faced by UK energy networks.

3. Critique of UKRN Proposed Approach to Beta Estimation

Three of the UKRN report authors, Mason, Pickford and Wright (MPW) recommend estimating betas at future controls using a methodology which substantially departs from existing UK regulatory precedent. Specifically, they recommend betas should be estimated using:

- Very long-run estimation periods going back to 2000;
- Aggregated or low frequency data (e.g. quarterly returns); and
- Statistical models from the GARCH family for estimating betas.

Based on their recommended approach, they estimate equity betas for listed UK water stocks United Utilities (UU) and Severn Trent (SVT) between 0.3 and 0.5, which MPW consider are substantially lower than equity betas allowed at recent reviews by Ofwat and Ofgem of 0.8 to 0.9.[20]

It is worth noting that the fourth author of the UKRN report, Burns, disagrees with the MPW recommendations regarding beta estimation and highlights that MPW's results are driven by their decision to "*adopt the highly unusual practice of estimating the CAPM on quarterly data, which is the key factor that drives the lower estimates of beta"* while *"MPW's results based on higher frequency data are recognisably similar to existing regulatory estimates over the relevant time frames"*.[21]

In this section, we show that the first two recommendations by MPW regarding the time period and data frequency are not appropriate for estimating betas for UK utilities and that high frequency data (e.g. daily) and recent time periods (e.g. two to five years) should be used. Once these issues are corrected, we find that beta estimates for UU and SVT and indeed other UK and European comparators are consistent with beta estimates at recent reviews, irrespective of the statistical model used (OLS v GARCH).

While we do not contest the usefulness of the GARCH model for estimating betas, we show it produces similar results as the more established OLS technique when the same time period and data frequency is used. Given the substantial increase in complexity associated with the use of GARCH models, we consider that the benefit of GARCH compared to standard OLS appears questionable in the regulatory context.

3.1. Relying on data since 2000 for estimating betas ignores changes in risk and leads to downward biased beta estimates

MPW recommend the use of long time periods for estimating the beta, going back to 2000 for listed UK water stocks, given regulators should be concerned with long-horizon risks.

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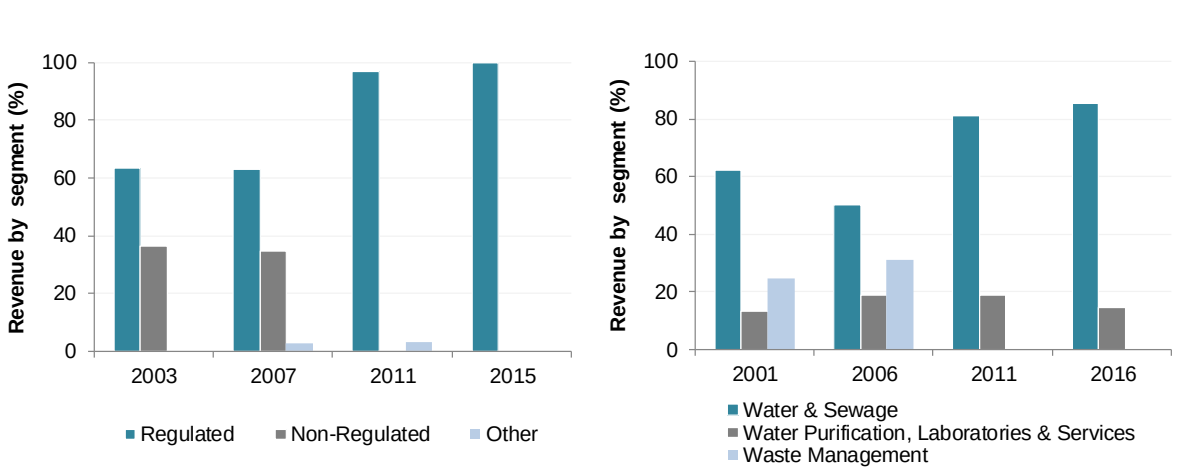
[20] Wright, Burns, Mason, Pickford (2018), Estimating the cost of capital for implementation of price controls by UK Regulators, An update of Mason, Miles and Wright (2003), p.9.

[21] Wright, Burns, Mason, Pickford (2018), Estimating the cost of capital for implementation of price controls by UK Regulators, An update of Mason, Miles and Wright (2003), p. 9.

We consider relying on data going back to 2000 is not appropriate because it fails to take into account changes in UK (and other comparator) companies risk and therefore beta over time.

First, comparator companies' business models have changed over time, implying that historical periods since 2000 are no longer relevant for assessing betas going forward. Figure 3.1 below shows that both UU and SVT businesses in 2000 included a number of activities, e.g. non-regulated activities such as waste management which are no longer part of their current operations. The risks associated with these activities will affect beta estimates going back to 2000, but these are not relevant for the assessment of betas for the upcoming price reviews.

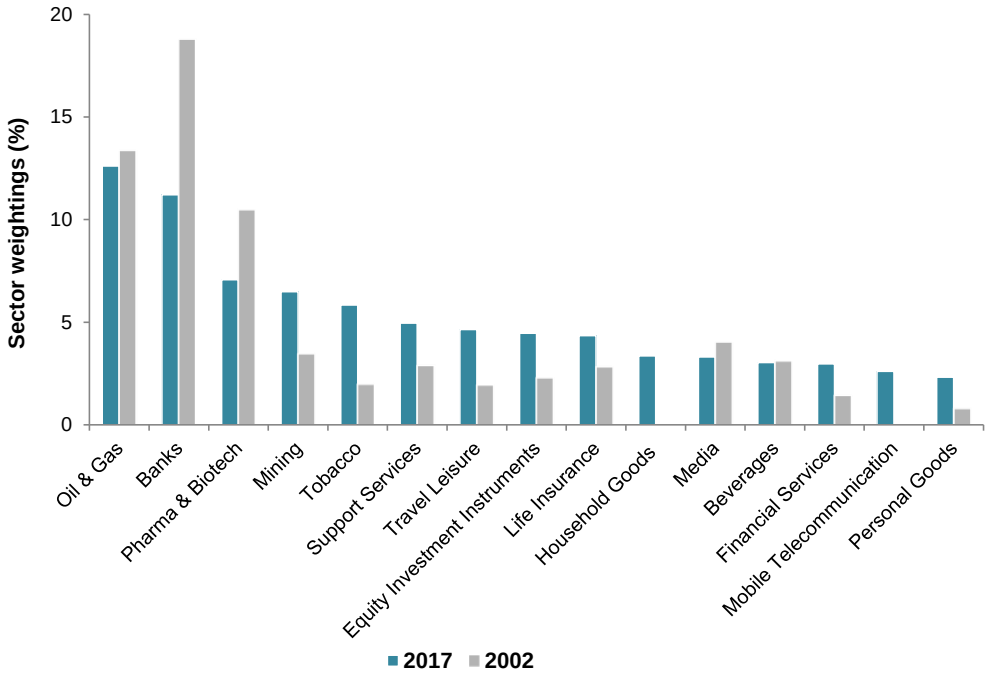
Figure 3.1
Both UU and SVT revenue composition has changed substantively since 2000



Source: NERA analysis of UU and SVT annual reports. Note: Note: United Utilities activities classified as "non-regulated" include investments in Northern Gas Networks and Manila Water, electricity operations and maintenance business in the North West of England, holding in Meter Fit, the Australian business, UK and European non-regulated water interests, contract with Northern Gas Networks, gas and electricity metering installation contract and municipal solid waste related interests. (Annual Report 2011, p.3) as well as Vertex (sold in March 2007), a leading provider of business process outsourcing (BPO) services specialising in the front and back-office management of customer relationships. (Annual Report 2003, cover page 4). Revenue split between different non-regulated activities is not available.

Second, even if comparator companies' business models remained unchanged (which they did not), the composition of the market itself changed substantially since 2000. Figure 3.2 shows a substantial shift in market fundamentals, with the banking sector reducing its importance in the index since 2000 at the expense of other sectors such as mining or consumer-focussed industries. As the sectoral composition of the market index changes, the co-movement of the comparator stock with the market (i.e. relative risk) will change as well, resulting in different beta estimates even if companies' business models remain unchanged.

Figure 3.2
The composition of the FTSE index has changed considerably over time, leading to changes in relative risk and beta even if business models remained unchanged



Source: NERA analysis of Bloomberg data

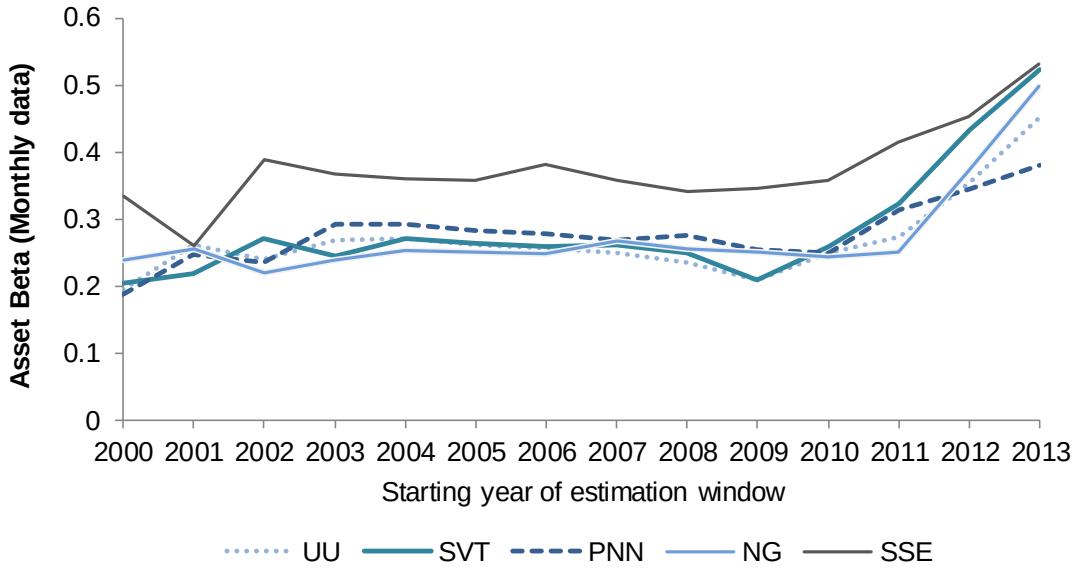
Third, the regulatory framework for UK utilities has evolved substantially over time, with the introduction of high-powered incentives under the RIIO regime for energy as well as water at PR14 and increasing role for competition e.g. through liberalising non-household retail at PR14 and plans to open up other parts of the value chain to competition at future reviews. Political risk has also increased since 2000, e.g. through the introduction of an energy price cap or the recent debate about potential nationalisation. All of the above factors are likely to increase beta risk.

In summary, estimating betas over long horizons going back to 2000 ignores changes in companies' business and financial risk, changes in market conditions as well as changes in the regulatory regime, resulting in beta estimates that fail to reflect regulated companies' risk profile for the upcoming price control periods.

To illustrate the potential bias by relying on long time periods, Figure 3.3 shows estimates of the MPW "Short-Run" asset beta based on monthly returns for the five listed UK utilities (UU, SVT, Pennon, National Grid and SSE) over different time-frames.[22] The betas presented in Figure 3.3 are estimated using the MGARCH model recommended by MPW.

[22] We use monthly instead of quarterly returns recommended by MPW as quarterly returns do not provide sufficient number of observations to estimate betas over shorter time frames.

Figure 3.3
MPW "Short-Run" asset betas show increase in most recent period compared to long-run data



Source: Bloomberg, NERA calculations. Note: Following the terminology of MPW, this figure shows "Short-Run" asset betas for five UK comparators estimated using the MPW recommended MGARCH model. Each figure is calculated based on monthly returns and a time frame where the end date is fixed at 2017Q3 and the start date is the first quarter of the year indicated on the horizontal axis. We use the average net debt to market capitalisation ratio over the given time frame to un-lever the equity betas into asset betas, using the Miller formula.

The values in Figure 3.3 represent betas estimated over a period starting from the year indicated on the x-axis and an end of period in 2017. The leftmost value therefore represents an asset beta estimated over the whole period 2000-2017 (as recommended by MPW) while the rightmost value represents an estimate over the last 5-year period 2013-2017. As shown in Figure 3.3, the asset beta increases substantially as we move to the more recent periods, in particular for estimation periods starting after 2010, which shows a potential structural break in the beta estimates. Potential reasons that could explain this effect would be the impact of the global financial crisis and the subsequent European debt crisis, depressing beta estimates for estimation windows which include this period.

The above demonstrates that he use of long time-series data since the turn of the millennium leads to a downward biased beta estimates compared to more recent data, as it fails to reflect the changes in fundamentals over time (including changes in companies' business and financial risk, changes in market fundamentals as well as regulatory frameworks). To avoid bias beta estimates, we recommend betas are estimated based on recent data to reflect changes in companies' risk over time. This use of more recent time periods, typically of 2 to

5 years, has been the standard practice of UK regulators over many years when estimating betas.[23]

3.2. Low frequency data leads to less precise beta estimates, aggregation rules are arbitrary, and use of low frequency data with GARCH methodology illogical

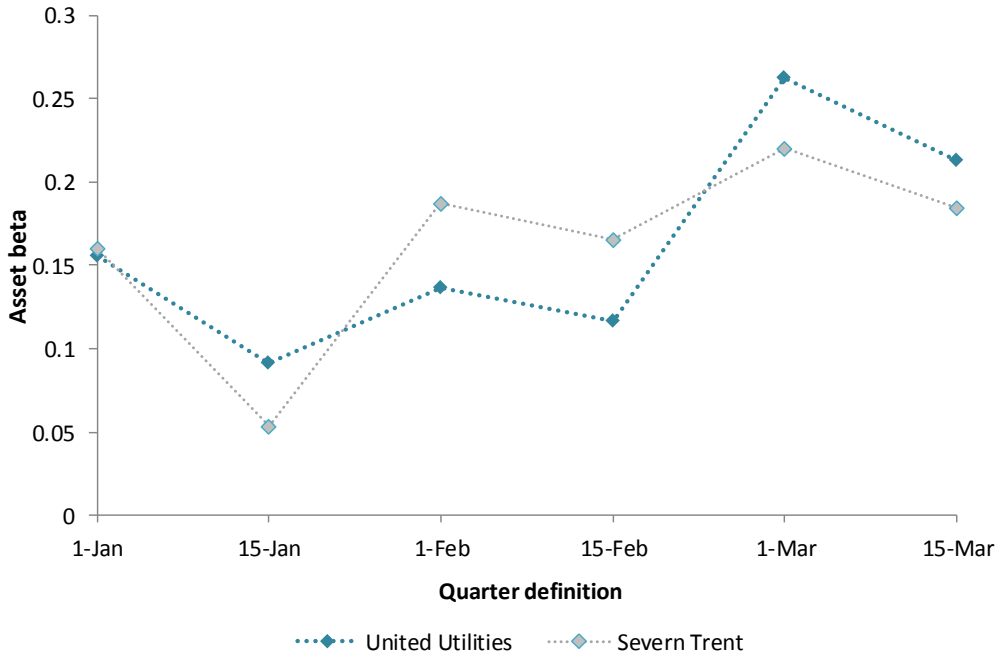
MPW recommend the use of low frequency (e.g. quarterly) data for estimating beta. We consider that estimating betas using low frequency data (in particular quarterly) is not appropriate for a number of reasons.

A lower data frequency results in a smaller number of observations, which in turn requires extending the estimation period to obtain statistically robust results, leading to issues discussed above. Even if all available data is used (in case of MPW over the period 2000-2017), the number of observations for quarterly returns is still considerably smaller compared to common practice, which, in the case of daily data includes thousands of observations over the same period. Aggregating daily returns into lower frequency data therefore results in loss of valuable information included in higher frequency data which in turn results in less precise beta estimates (e.g. as measured by the standard errors).

Moreover, there are a number of ways aggregating daily returns in lower frequency data, e.g. there are 60 different specifications of quarterly returns depending on which day the starting point of the quarter is defined. MPW only present one estimate out of the 60 possible estimates for quarterly betas. Figure 3.4 below shows that MPW's beta estimates based on quarterly returns and an MGARCH model over the period 2000-2017 changes dramatically when the aggregation rule is changed in a trivial manner, demonstrating the volatility of MPW results.

[23] See for example, CMA (2015) Bristol Water plc, para 10.149, p. 323 Link: https://assets.publishing.service.gov.uk/media/56279924ed915d194b000001/Bristol_Water_plc_final_determination.pdf

Figure 3.4
Sensitivity of UU's and SVT's GARCH-based asset beta with regard to quarter definition



Source: Bloomberg, NERA calculations
Note: This figure shows asset betas for UU and SVT when the start date of the first quarter is the one given on the horizontal axis. Figures are not obtained from an MGARCH model, but from CAPM regressions with a univariate GARCH structure of the error term. We use quarterly returns and a time frame of 2000Q1-2017Q3.

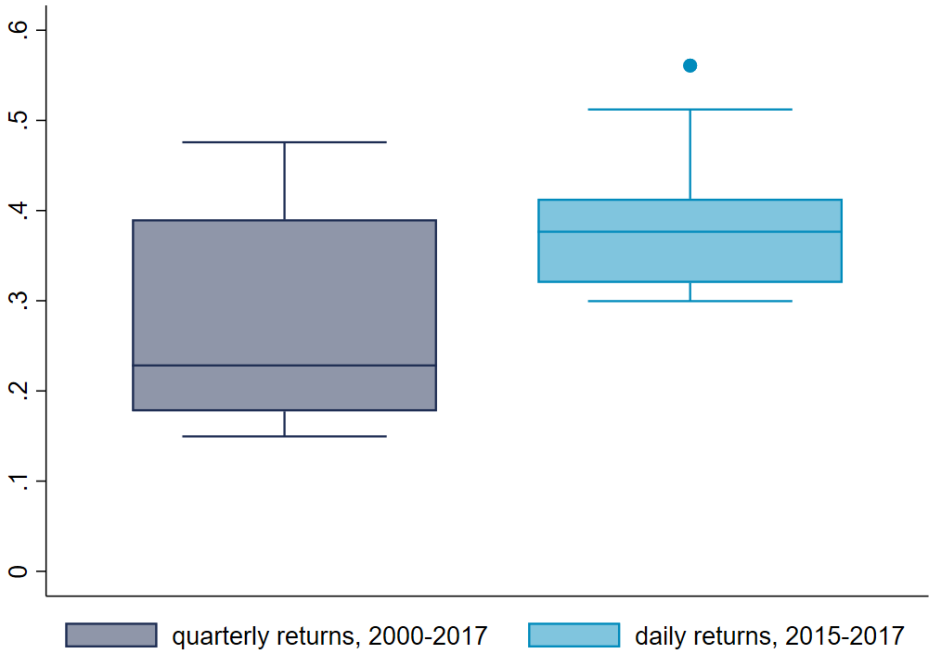
Finally, we note that the use of quarterly data by MPW appears inconsistent with MPWs reasoning for the adoption of the GARCH model in the first place. There is evidence in academic literature that stock returns may not be independently distributed, which is the standard assumption of the OLS model. One way of addressing these issues within the OLS framework is to lower the frequency of the data, but this inevitably leads to fewer observations and less precise beta estimates as discussed above. Models such as GARCH allow the explicit modelling of time-varying properties of stock returns, thus avoiding the issue of losing valuable information by aggregating returns data to lower frequencies. It is therefore puzzling that MPW first propose to use GARCH models to reflect time-varying properties of asset returns (such as time-varying volatility) but at the same time they also recommend removing these very properties from the financial data that GARCH is designed to deal with by aggregating returns to quarterly frequencies.

In summary, we consider that the GARCH model, if applied, should be applied to daily data (assuming no issues with liquidity for the comparator stocks, which do not appear to be the case for UK and other European comparators).

3.3. Correcting MPW estimates using shorter time periods and high frequency data produces asset betas in line with recent determinations using a GARCH model

Figure 3.5 compares beta estimates for UK and European comparators using MPW's preferred approach (quarterly frequency and 2000-2017 period) and our preferred approach of relying on daily data and more recent estimates (last 2 years). We use a sample of 11 comparators, including, National Grid (UK), SSE (UK), United Utilities (UK), Severn Trent (UK), Pennon (UK), Red Electrica (Spain), TERNA (Italy), ACEA (Italy), Gas Natural SDG (Spain), SNAM (Italy), and Enagas (Spain), as we consider MPW's focus on two water stocks is too restrictive and a wider range of comparators should be considered for beta estimation.

Figure 3.5
GARCH-based short-run asset beta estimates for recent time frames and daily data support betas in line with recent UK precedent



Source: Bloomberg, NERA calculations
Note: This figure shows the distribution of MPW "short-run" asset betas as obtained from the MGARCH model for 11 UK and EU comparator firms in the form of box plots. The left panel shows figures based on the specification suggested by Wright et al., i.e. quarterly returns and a time frame of 2000Q1-2017Q3. The right panel shows figures based on daily returns and a time frame spanning the two years from 1 October 2015 through 25 September 2017.

Figure 3.5 shows a range of estimates for the 11 comparators using the MPW preferred approach (left-hand side) versus our preferred approach (right-hand side). In each panel there is a central rectangular shape with a horizontal bar. The horizontal bar represents the median, whereas the lower and upper edges represent the 25- and 75-percentile, respectively. This implies that the central 50 per cent of beta estimates are contained in the rectangular shape. The highest and lowest "cross-bars" represent the range of beta estimates that are not

considered as outliers. Outliers are defined as those estimates which are higher /lower than the 75th / 25th percentile +/- 1.5 times the inter-quartile range and are indicated as dots.

Figure 3.5 reveals a number of key observations regarding MPW's results:

- The lower beta estimates MPW claim to find are primarily driven by their choice of time frame and the aggregation of returns, not by the introduction of a new MGARCH model, which produces much higher estimates when estimated using more recent data (2 years) and daily frequency.
- When applied to the wider set of 11 comparators, the MPW recommended approach of using long-time periods and low frequency data yields a substantially wider range of betas (as measured by the inter-quartile range, or the width of the "box" in each panel) compared to the approach of relying on recent data and daily frequency. This is surprising, given the comparator group includes broadly similar companies, and casts further doubt on the reliability of MPW results.

As we explain above, we do not consider the use of long time frames since 2000 and low frequency data (e.g. quarterly) is appropriate for estimating betas for UK regulated utilities at future reviews. Figure 3.5 shows that asset betas estimated using the MGARCH model based on more recent time periods and daily data frequency, in line with UK precedent, are consistent with asset betas determined at recent reviews.[24]

We conclude that we find no evidence for lower asset betas for the upcoming price control reviews.

3.4. GARCH produces similar results as OLS when same time frames and data frequency used

Table 3.1 below shows that once consistent time periods and data frequencies are used, the results from standard OLS estimation and the MGARCH model proposed by MPW become very similar.

[24] For example, at RIIO-1, Ofgem determined asset betas in the range of 0.32 to 0.43. See for example, NERA (2012) Cost of capital estimation for RIIO-ED1, a report for WPD. Link: https://www.westernpower.co.uk/docs/About-us/Stakeholder-information/Our-future-business-plan/Supporting-Financing-plan/NERA-Cost-of-Capital-Estimation.aspx

Table 3.1
MGARCH and OLS models produce similar asset betas once consistent time periods and data frequencies are considered

	Quarterly returns		Daily returns	
	18 years		5 years	
	MGARCH	OLS	MGARCH	OLS
National Grid	0.25	0.24	0.38	0.37
SSE	0.21	0.16	0.54	0.56
United Utilities	0.15	0.15	0.34	0.32
Severn Trent	0.18	0.15	0.35	0.35
Pennon	0.15	0.17	0.38	0.38
Snam (GT)	0.21	0.17	0.39	0.41
Terna (ET)	0.23	0.22	0.39	0.40
Acea (ED)	0.48	0.42	0.31	0.30
Enagas (GT)	0.39	0.36	0.41	0.38
Red Electrica (ET)	0.28	0.39	0.40	0.39
Gas Natural (GD)	0.42	0.49	0.50	0.48
Range	**0.15-0.48**	**0.15-0.49**	**0.31-0.54**	**0.30-0.56**
Average	**0.27**	**0.26**	**0.40**	**0.40**

Source: NERA calculations based on Bloomberg data

This confirms the above conclusion that the lower beta estimates MPW claim to find are primarily driven by their choice of time frame and the aggregation of returns, not by the introduction of a new MGARCH model. This is consistent with the view presented by Burns.[25]

While we do not object to the use of GARCH model for the purpose estimating betas, we note that GARCH-type models are complex and difficult to implement and reproduce by stakeholders, which may introduce arbitrariness in the regulatory decision making process and increase perceptions of regulatory risk. Given we find that MGARCH and OLS models produce consistent results, we consider that the substantial increase in complexity associated

[25] Wright, Burns, Mason, Pickford (2018), Estimating the cost of capital for implementation of price controls by UK Regulators, An update of Mason, Miles and Wright (2003), p. 9.

with the use of GARCH models as opposed to standard OLS appears questionable in the regulatory context.

4. Use of Actual or Notional Equity Beta Estimates

In this section, we consider the relative merits of de-gearing and re-gearing estimated equity betas to reflect the regulator's notional gearing assumption, or alternatively using the actual equity beta without adjustment.

The UKRN report provides two views on how to estimate the beta for a notionally geared efficient network. The first approach, proposed by the academics Mason, Pickford and Wright (MPW), argues that the use of a notional gearing to re-lever the asset beta is incorrect and that the most reliable equity beta is the raw estimation. The second approach, noted by Burns and in line with regulatory practice, involves de-levering the observed equity beta at the actual company gearing and then re-levering the asset beta to the notional gearing, determined by the regulator.

Overall, we do not consider the MPW approach has any merit: it implies that cost of equity allowance would be based on listed companies' actual capital structure decisions, and would undermine incentives to optimise capital structure and minimise financing costs.

4.1. The Miller formula is commonplace in regulation

The systematic risk of a company is measured by the asset beta of the firm. Unlike the equity beta, the asset beta is not affected by the firm's particular capital structure decision. The asset beta is estimated by de-levering the equity beta for the listed companies using each company's gearing. In setting the allowed cost of equity, the asset beta is then typically levered to derive an equity beta using the notionally efficient gearing assumption determined by the regulator, and in that way the allowed rate of return is independent of listed companies' capital structure choices.

In presenting beta estimates in our earlier chapters, we used the so-called Miller formula to de-lever and re-lever which is the standard approach in GB regulation, e.g. used by CMA:[26,27]

- $\beta_e = \beta_a * (1 + D/E)$

In its report for Ofgem on the cost of equity at RIIO-2, CEPA's approach also uses the same approach, that is, CEPA first un-levers the raw equity raw beta at the company actual gearing and then re-levers the estimated asset beta at the notional gearing.[28]

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[26] CMA (2015), Bristol Water plc - A reference under section 12(3)(a) of the Water Industry Act 1991, p333. CMA (2014), Northern Ireland Electricity Limited price determination - A reference under Article 15 of the Electricity (Northern Ireland) Order 1992, p 13-40.

[27] The Miller formula assumes that the capital structure of the firm is constant, or in other words the firm pursues a target capital structure and it rebalances its debt and equity constantly towards its target. By contrast, the Modigliani-Miller formula assumes that the debt *level* of the firm is constant, whilst the capital structure can change. See: Brealey and Myers (2011), Principles of Corporate Finance, 10th edition, p484-486.

[28] $\frac{E}{D+E}\beta_e = \frac{V_u}{V_u+tD}\beta_A$ or $\beta_A = (1-g) * \beta_E$.

A variant to Miller is the Modigliani-Miller formula. In the UKRN report, Burns recommends un-levering asset betas based on actual gearing and re-gearing equity betas for notional gearing assumptions based on the Modigliani-Miller formula:[29,30]

- $\beta_e = \beta_a * (1 + \{1\text{-Tax Rate}\}*D/E)$

Setting aside technical issues around the use of the Miller or Miller-Modigliani formulae, the approach to de-levering listed equity betas using actual gearing and re-leveraging based on the notionally efficient structure ensures that the cost of equity is independent of the (listed) companies' financing decisions and provides incentives to seek the optimal capital structure and minimise financing costs.

4.2. Mason, Pickford and Wright (MPW) approach

MPW note that in the case of STV and UU, since both companies had average measured gearing lower than the notional 65 per cent, the notional re-geared equity betas are above their actual equity betas.[31] MPW argue that in the case of these two companies this calculation is "purely notional":

> "*the equity beta for these companies can be, and has been, directly estimated in the data, and it is this value, not the notional value […] that determines their marginal cost of equity in the CAPM framework.*"[32]

The authors go on to state that:

> "*If, for example, United Utilities needs to raise equity to finance an increase in its Regulated Capital Value, it is the equity beta of its quoted shares that will determine the expected return on this new equity, and hence of the new equity capital. Thus, MPW argue that "re-gearing" does not constitute a valid argument for assuming values of equity beta outside the range of econometric estimates."*[33]

Furthermore, MPW argues that if re-gearing assumed asset betas using notional leverage levels is inappropriate for listed companies, it is "*hard to argue*" that it is suitable for un-listed companies. [34]

Finally, MPW note that an advantage of the "pure" CAPM-WACC (where the allowed return is based on unlevered betas) is that only the asset beta matters, and so it is entirely unaffected by considerations of "re-gearing". However, to the extent that regulators rely on the standard CAPM(E)-WACC that only applies CAPM to the cost of equity (as is the standard approach),

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29 $\frac{D}{D+E}\beta_D + \frac{E}{D+E}\beta_e = \frac{V_u}{V_u+tD}\beta_A + \frac{tD}{V_u+tD}\beta_{tD}$

30 $\beta_A = \frac{\beta_E}{1+(1-t)*\frac{D}{E}}$

31 UKRN (2018) op.cit., p. 56

32 UKRN (2018) op.cit., p. 56

33 UKRN (2018) op.cit., p. 57

34 UKRN (2018) op.cit., p. 57

MPW simply conclude that regulators should apply caution in re-gearing techniques they employ.

4.3. Our views on MPW's Approach

We disagree with MPW's suggestion that the actual equity beta, as opposed to the re-geared equity at the notional level, should be considered in setting the allowed cost of equity.

The overall purpose of de-gearing the observed equity beta to identify the asset beta, and then re-gearing to notional, is to remove the actual company gearing decision from the comparator beta estimates, and ensure that the regulator determines an equity beta based on a notional level, independent of listed companies' capital structure decisions, and consistent with the weighting of debt and equity in the (notionally) weighted average allowed rate of return.

By contrast, MPW's proposed use of the estimated equity betas cannot be combined with the notional gearing level to set the overall weighted average cost of capital. MPW correctly state that SVT and UU's actual gearing is below notional which implies a lower cost of equity allowance under its proposed approach. However, consider the case where the listed company has higher leverage than the notional gearing, e.g. greater than 65 per cent. In this case, the estimated equity beta may be very high, and certainly greater than 1. The corresponding cost of equity included in the *notionally* weighted average cost of capital would then overstate equity risk at least relative to most recent network decisions where the equity beta has been set at less than 1, and overstate the required rate of return.

Indeed, the practical effect of MPW's proposals is that the cost of equity becomes dependent on the listed companies capital structure decision, and cannot be combined with notional weightings of debt and equity in determining the overall allowed return.

Where the actual capital structure informs the cost of equity, listed companies many have an incentive to gear-up to increase equity beta risk. For companies that are not listed, their cost of capital would be dependent on the capital structure decisions of the listed companies – where the listed company may be outside the relevant sector or country. The use of companies' actual capital structure would be contrary to a notional approach adopted by GB regulators (at least where the sector comprises more than a single company), and the incentive to game will undermine incentives for companies to optimise capital structure and minimise financing costs, as per the current arrangements.

In conclusion, we agree with MPW that the estimated beta reflects the marginal cost of equity for the listed companies: but the use of the listed companies' cost of equity cannot be combined with a weighted average cost of capital with notional weights, and undermines incentives to minimise financing costs.

5. Conclusions

In this report, we have considered evidence on beta risk for Cadent at RIIO-2.

Our empirical evidence for UK listed network companies – NG plc, United Utilities, Severn Trent, and Pennon – show that the majority of beta estimates lie in the range of 0.3 to 0.4, with values for NG plc, the most relevant comparator for Cadent, towards the top-end of this range, e.g. NG plc's two-year asset beta is 0.37.

However, NG plc's composite beta reflects the combined systematic riskiness of NG plc's UK and US operations. UK and US operations have a similar share of NG plc's overall regulated asset base, but US regulatory regimes impose lower risks as a result of, among others, objective methods for setting cost allowances, and greater investor security offered by court based proceedings. Using a sample of US-only comparators as a proxy for the systematic riskiness of NG plc's US operations, we have solved for the implied UK beta. We obtain a range of 0.43 to 0.47 for NG plc's implied UK beta (2Y), which is considerably higher than the two-year asset beta of the overall company (0.37).

We show that MPW's recommendations on the use of GARCH do not provide different results from the more commonplace OLS estimation techniques, where regressions are based on high frequency and recent time periods, as they must be to ensure precise and relevant results. We also show that MPW's recommendation on the use of equity based unadjusted for notional gearing would undermine incentives for companies to optimise the balance of debt and equity, and minimise financing costs.

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