Draft Determination Supporting Document NGET - Finance Annex FQ5 & FQ6 Technical Report - Beta for RIIO T2-GD2

As a part of the NGET Draft Determination Response

nationalgrid

ESTIMATING BETA FOR RIIO-2

A report prepared for National Grid

4 September 2020

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EXECUTIVE SUMMARY

Frontier Economics has been commissioned by National Grid to undertake a thorough review of Ofgem's proposals in respect of asset beta as set out in its recently published Draft Determination. In doing so, we were asked to review and comment on:

- the relevant parts of Ofgem's Draft Determination finance annex[1];
- a related technical paper on the estimation of beta prepared on behalf of Ofgem by CEPA[2];
- a further technical paper on GARCH estimation of betas prepared by Professor Robertson on behalf of Ofgem[3].

We were also asked to undertake any additional analysis that we considered may be helpful in informing the appropriate range for beta for a GB energy network.

Ofgem's proposed decision

Ofgem has proposed to adopt a range of 0.34 to 0.39 for asset beta. It then proposes to take the mid-point of this range as its preferred point estimate, i.e. 0.365. All of these asset betas are estimated based on an underlying debt beta of 0.125.

Ofgem's proposed beta range – and particularly its point estimate – is low compared to any relevant precedent. Since an asset beta this low will feed directly into a low headline rate of return, it is of critical importance to the validity of the price control. Setting the headline rate of allowed return too low could have profound consequences for incentives to invest. It may cause Ofgem to fail to satisfy one of its primary duties, i.e. with respect to financeability. And it may as a direct result cause direct and material harm to consumers.

Ofgem sets out the reasoning that underpins its decision in paragraphs 3.56 to 3.64 of its Draft Determination finance annex. While Ofgem's document is ambiguous around exactly how it has arrived at its proposed beta range, it seems clear that Ofgem has placed most weight on GB water company betas, as it considers the risk profile of GB energy networks to be the same as that of GB water networks. It seems the only evidential support for this position is chapter of a beta study prepared by CEPA, published alongside the DD..[4] In contrast it has placed no weight at all on SSE (and possibly no weight on NG either) and used CEPA's narrow sample of European peers as a cross check. Ofgem has also chosen to place most weight on very long runs of data (5 and 10 year estimation windows with 5 and 10 year averaging periods, so looking back up to 20 years). Finally, it

1 https://www.ofgem.gov.uk/system/files/docs/2020/07/draft_determinations_-_finance.pdf. Ofgem's discussion of beta begins at paragraph 3.24.

2 RIIO-2: Beta estimation issues, CEPA, 9 July 2020.

3 Re-estimating beta, Prof Donald Robertson, 29 June 2020.

4 We note that CEPA has stated explicitly that its study did not provide a beta range for RIIO2. On page 4 of the report, CEPA states: "We have not been asked to produce an overall asset beta range and so we do not provide one.".

would appear that Ofgem may have made a downward revision of some kind owing to its GARCH findings.

In our view Ofgem's proposed decision, and the apparent basis for it, gives rise to a series of critical questions.

- Is there any actual empirical evidence to support the hypothesis that GB energy network risk may be the same as GB water network risk?
- Is it reasonable to assert that decomposition analysis is so unreliable that no weight can be placed on it at all?
- Is the CEPA sample of European peers sufficiently broad, balanced and reasonable to act as a sound cross check of Ofgem's analysis of GB company betas?
- Is it reasonable to place most weight on very long runs of data (10-20 years or more, given the intended use of long estimation windows averaged over long periods) at the current time?
- Is it correct to make some downward adjustment to betas because GARCH evidence suggests that OLS betas may be too high?
- Generally, does the balance of available evidence support Ofgem's proposed range for asset beta?
- Is it reasonable for Ofgem to assume a debt beta of 0.125?

We address all of these questions, apart from the last one[5], in this report.

The challenges of estimating beta

Beta estimation is inevitably subject to uncertainty

Estimating the systemic risk exposure of a company through betas is not an exact science. Beta estimates are inherently uncertain in a statistical sense, typically having large standard errors. Moreover, we often observe that beta estimates for any given company may change markedly:

- as one's estimation method changes, for example if one looks at betas estimate over a 2-year window vs a 5-year window; and
- over time even if we continue to apply exactly the same estimation method.

It is common to see beta estimates for companies that may, on the face of it, appear broadly similar take materially different levels. And we may observe periods of time where companies may have the same or similar betas, but these will be followed by other periods of time where they may diverge markedly.

We can sometimes attempt to infer what may be driving some of these changes.

- Regulatory changes?
- A change in the mix of activities undertaken by the business?

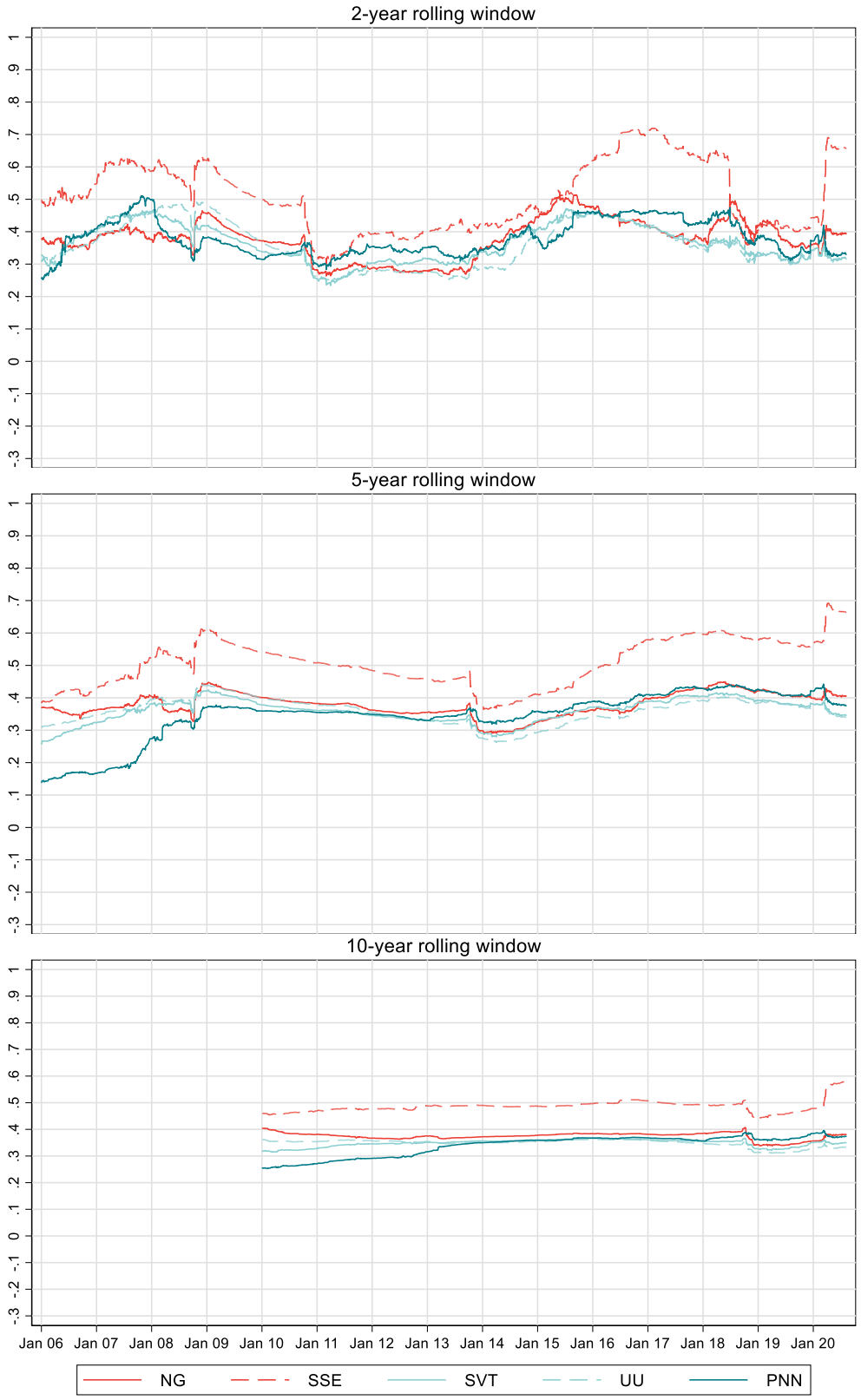
[5] We understand that National Grid is receiving separate advice on the topic of debt beta and as such it has been agreed that debt beta will sit outside our scope of work.

- A technological change?
- Changes in legislation?

But to a degree all such considerations can only ever be speculation, even if we attempt to make it informed speculation. Betas can change markedly owing to a single day of anomalous trading, noting that particularly pivotal events may remain within a company's beta measure for a long time given that it is standard practice to estimate betas over long(ish) windows. Of course, it may be none of these things, and instead betas may evolve owing to changes in the wider market (as a reminder, betas are all relative, as they are all measured relative to a given market index).

We illustrate this intrinsic "noise" in beta estimation in the figure below, which shows betas for the five listed UK utilities that we study in depth in this report (National Grid, NG, Pennon, PNN, SSE, Severn Trent, SVT, United Utilities, UU) over three different estimation windows over almost two decades. Certain incontrovertible "facts" seem to emerge from the figure, e.g. SSE is clearly the company with the highest beta. But it is clearly hard to identify definitively what "the beta of SSE" is, given the volatility in the evidence base.

Figure 1 Asset beta estimates over time for different estimation windows



Source: Frontier Economics based on Bloomberg

It is because of this intrinsic uncertainty that we consider it important to include as many relevant comparators as possible in order to come to a balanced view on the plausible range on the beta. Ofgem and its advisor CEPA both seem to take decisions to exclude comparators from the sample and/or reject methodologies (even though they recognise them as sound in principle) purely because they consider the estimates to be "volatile", "not in line with expectation" or otherwise unexplainable.

Time period matters

From a statistical perspective, it may be tempting to use as much data as possible to estimate betas, as this reduces statistical uncertainty. However, this carries a risk that, by using a longer time period, we then produce estimates that are not representative of the **current** (and forward looking) systemic risk exposure of the firm, but are an average of the risks that were faced over some **past period**. One would therefore need to be confident that nothing material has changed over time in order to believe that beta estimates over the longest estimation window are unambiguously "the best". There is no consensus amongst practitioners over which estimation window is preferred.

It is worth noting that longer estimation windows (10-years or more) will lead one to include data from the Global Financial Crisis (GFC) period of 2008-2010, and data from the period immediately following which were punctuated with several waves of Sovereign Debt Crises (SDC). Markets were highly volatile during these periods, and this has the potential to distort beta estimates. We note that Ofwat relied primarily on 5-year betas in setting allowed returns for the water and therefore did not rely on evidence from the GFC/SDC period, which we consider appropriate at this time.

Underlying risk is likely to have increased over time

Regulatory risk

The RIIO-1 price control contained (for some sectors) significant changes in regulatory framework vs the arrangements that prevailed in previous periods. In the main these changes were an increase in the totex incentive rate, including a rebalancing of incentive rates to place much higher incentives on capex, an expansion of wider incentive packages and a far more detailed description of the outputs that needed to be delivered. Moreover, it is very clear from reading the RIIO-2 documentation as a whole – and from the emerging reaction to those proposals – that RIIO-2 is a marked departure from previous regulatory arrangements. Some of the important changes that Ofgem proposes to make include:

- Defining in much more detail and with more precision than ever exactly what a company must deliver for its allowances, thereby removing a significant proportion of the networks' flexibility in delivery. Adding greater constraints over what must be delivered, and exactly when and how, will increase risk.

- Making far greater use of Uncertainty Mechanisms (UMs) and prescriptive Price Control Deliverables (PCDs) coupled with extensive and open-ended ex post review. This is likely to greatly increase regulatory risk.
- Also, due to the use of these instruments, there will be a material delay in the point at which revenue can be recognised. In fact, certain activity is currently intended to trigger revenue only after ex post review as part of the close out process. This will markedly reduce funding certainty and greatly slow cash flow, together acting as a drag on the financial capacity of networks to deliver needed investment without delay.
- Introducing an entirely novel and flawed adjustment to the headline allowed rate of return (i.e. the outperformance wedge), thereby weakening regulatory credibility and predictability.
- At the same time introducing a marked toughening in the general approach to benchmarking, with a much greater disallowance of volumes, and more extensive cost/unit cost challenges than ever before – thereby making the imposition of an out performance wedge a clear double count.
- Awarding huge penalties across all of the transmission sector through the Business Plan Incentive.
- In respect of NGET, introducing a retrospective reopening of RIIO-T1 to clawback past allowances.

While most of these changes will, we consider, markedly increase the kinds of risks that investors care about, at the same time Ofgem is minded to:

- Generally lower the incentives; and
- Introduce indexation in a range of new areas, such as RPEs.

These last two points may moderate investor risk, but any such reduction in risk will be modest compared to the increase in risk arising from the longer list of changes set out above. Taken in the round, we consider it reasonable to say that RIIO-2 may see a reduction in exposure to certain performance risks (as a result of the lower totex sharing factor), but lead to a very large increase in regulatory/political risk.

Increased risk from Net Zero

At the same time we note that the business risks around Net Zero are likely to have become better understood over recent years, firstly as the legislative support for Net Zero is now set, and also as more research has emerged about the scale of the decarbonisation challenge and the resultant challenges that the energy sector including the networks will face. This will no doubt create opportunities for the networks, but will bring with it material risks.

In respect of gas, existing gas networks are now expected to become stranded to at least some (possibly material) extent. We are aware that some investors will at present not consider investment in conventional gas infrastructure owing to this risk. We also note that stranding risks are highly likely to be systematic, not idiosyncratic, as regulator attitudes and their ability to support investors will be heavily dependent on the wider strength of the economy. When the economy is

weak, unemployment is high and real wage growth low, steps to protect the interests of investors are likely to be highly unpopular. Similar measures will be far more likely to appear generally palatable at times when the economy is performing well.

In respect of electricity, there is no similar prospect of a vertiginous fall in demand, but there is still scope for stranding there too, as many investments may be made in the face of very material uncertainty. Where assets are built that then prove not to be needed, this may prompt future questions as to why they were built and who should pay for them. Ofgem apparently considers that it is protecting investors from these risks through its PCDs and UMs, but we are far from persuaded that this is the case given their design, for the reasons set out just above.

Betas estimated over very long runs of data may be too low

We consider therefore that there are three primary reasons to be cautious in using 10 year betas:

- They may be artificially lowered by the effects of the GFC/SDC.
- They will fail to capture the increase in risk arising from certain design choices Ofgem is minded to take for RIIO-2.
- They may fail to capture well the latest view of risks around Net Zero.

Given these changes, estimates of betas over a 10-year window may not be as appropriate as those over shorter windows. We present all the evidence available to us in our report, including 2-year, 5-year and 10-year estimation windows, but recommend to keep the above in mind in assessing the relative weight placed on the evidence.

Uncertainty over COVID period data

The effect of the COVID19 pandemic on the global stock market has been significant. The markets relevant for our beta estimation exercise, i.e. the US, UK and Continental European markets, were affected to different degrees and have to date recovered to different extents.

In addition, utilities are affected by the COVID19 crisis in a different manner compared to previous crises. Where utilities tended to be treated as the safe haven for investors to flee to during previous crises, the pandemic and the resulting shut-down of the general economy has made utilities less of a safe haven, with many investors apparently choosing a new alternative – tech stocks. In fact, it seems that utilities are now treated more like the cyclicals, and there has been a general increase in beta estimates for utility stocks. The precise drivers of this change are of course unknown, but they may include a perception that utilities may be at greater risk of bad debt in the present climate should the economy slow and there be pronounced job losses. Or it may reflect a view that utilities will now get a "rougher ride" at regulatory determinations, as any perception of regulatory largesse may be far less palatable at a time of widespread economic dislocation.

A recent Frontier Economics publication shows the extent to which the role for tech companies and utilities have reversed.[6] With short estimation windows, this is effect is dramatic, but even when taking a longer estimation window, say 10 years, the effect is still significant. We have found that this effect appears most pronounced in the US market, where the majority of tech companies are listed, and we observe dramatic increases in beta estimates for US energy firms. This has an important bearing on our decomposition results (see Section 5), as we rely on a robust estimate for the US activities to decompose our NG beta. We therefore caution the direct use of the latest result in this particular area, and defer our attention more to the pre-COVID19 period.

However, we do not propose to discard latest results from our analysis entirely, despite the potentially large impact from COVID. There is a huge amount of uncertainty regarding whether or not the effect is temporary or a structural break. While this will become easier to discern in the intervening years to come, we do not propose to simply ignore the latest data where there is no strong evidence that the effect is distorted or short-lived. We present both pre-COVID and up-to-date results in this report.

The particular challenges arising from limited GB data

Given the challenges of estimating beta, we would ideally draw estimates from many highly relevant companies to inform an "in the round" judgement over the appropriate level of beta pure-play GB energy networks, in turn informing the relevant asset beta for RIIO-2. However, such companies do not exist in GB. The majority of GB energy networks are not listed at all, but are privately held. The only GB energy networks that are listed are part of corporate entities that also undertake additional and material business activities in other countries and/or in unregulated markets.

To estimate a beta for GB energy networks one must therefore seek other information, while noting at each stage that none of this information is ideal and that if we rely on such evidence that reliance must be qualified. A range of potential sources of information may be relevant:

- Energy networks in other countries can be used as a potential benchmark, subject to accounting for the different country features as well as the different regulatory regimes;
- Companies from other sectors in GB can also be informative, however different sectors bring different inherent risks which may vary from energy networks, and they may also be subject to a different regulatory regime despite being in the same country; and
- Data for companies that own GB energy networks can be analysed to see what can be inferred about the pure play GB energy networks component of their business, given a wider set of assumptions.

In terms of the total universe of empirical work that could inform estimation, the list above would appear to include more or less everything that could be done, and we note that this list is not particularly extensive. One would need a compelling reason

[6] Frontier Economics (2020) Have utilities caught the risk bug? Stock volatility and COVID-19

to decide not to pursue any of these analyses, given the paucity of information that is available.

Ofgem has failed to take a rounded view on appropriate beta values for RIIO-2

In the absence of the ideal body of evidence, it is our view that the entire body of that is available needs to be examined sensibly and objectively. We do not consider it wise to focus attention to a small number of water companies, or to consider only one approach to estimation, or to reject out of hand approaches that may help us test the robustness of decisions that could be taken. One should allow all the available data to speak, even if it is necessary to interpret the available evidence carefully in the light of its merits.

We consider that Ofgem has failed to do so in its Draft Determination, as it has rejected key and highly informative evidence for no good reason. As a result, in so far as it is possible to tell given the lack of clarity over what Ofgem has depended on in making its decision, this has led Ofgem to make an assessment of beta that is biased downwards.

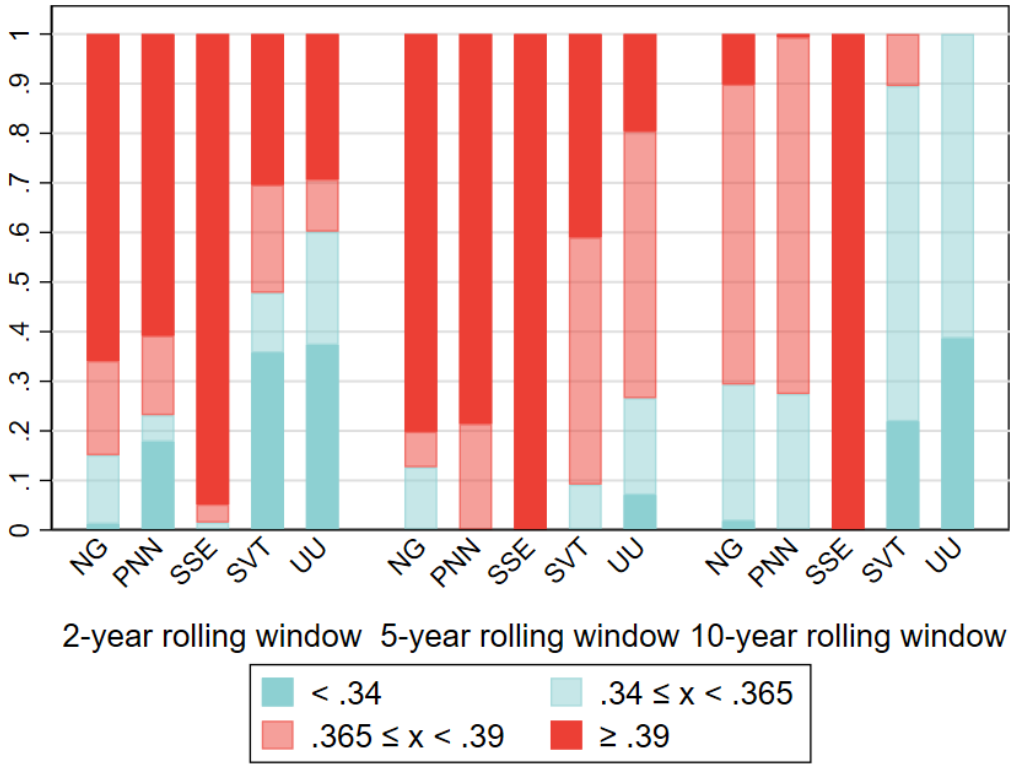
Evidence from the five listed GB utility firms

Rather than focussing on a wide set of evidence, Ofgem has said that it intends to place particular weight on two water companies, UU and SVT.

- We do not argue that the water companies are irrelevant. However there are good reasons to believe that the systemic risk that water companies are exposed to is lower than that for energy networks and hence deriving a beta estimate for energy networks largely from two water companies will lead to a range and point estimate that is set too low.
  - In particular Energy companies including the networks are facing considerable uncertainty arising from the challenges of delivering Net Zero. There is no comparable risk faced by the water companies.
  - CEPA acknowledges this in their report for Ofgem, but Ofgem pays no attention to this part of CEPA's assessment.
- None of the available empirical evidence from the GB sample of five supports a view that the risks of the two sectors are highly similar. In fact, it is clear that NG's group beta is the most relevant evidence.
  - It is more directly relevant than the three water companies.
  - Even though it will reflect NG's US activities, all of its activities reside in the energy network sector, making it a highly relevant peer.
  - We find that over time National Grid's group beta tends to sit systematically above the betas of SVT and UU for all estimation windows.
  - Furthermore, our analysis shows that while there are periods of time where NG's group beta supports Ofgem's range, there is a substantial period of time where its beta sits above, sometimes far above, the upper end of Ofgem's range.

- Ofgem's apparent focus on just UU and SVT is also at odds with GB regulatory precedent: we understand that previously Ofgem considered a group of 5 UK companies including National Grid, SEE, PNN, UU and SVT. We also note that the latest CMA determination on an energy company in the UK pertaining to the asset beta estimation was made on Northern Irish Electricity in 2014 in which it also considered the above five comparators.

Figure 2 Percentage of time that estimated asset betas are within Ofgem's range (2016 to date)



Source: *Frontier Economics based on Bloomberg*

Note: *Analysis carried out from 2016 onwards for available data points. We note that the 5Y and 10Y estimation windows includes data from pre-2016 (e.g. the 10-year beta reported against date 01/01/2019 is estimated by regressing stock returns over market returns over the previous 10 years, so from 2009 onwards). Hence this estimate may be distorted by data from the GFC/SDC period.*

Evidence from beta decomposition

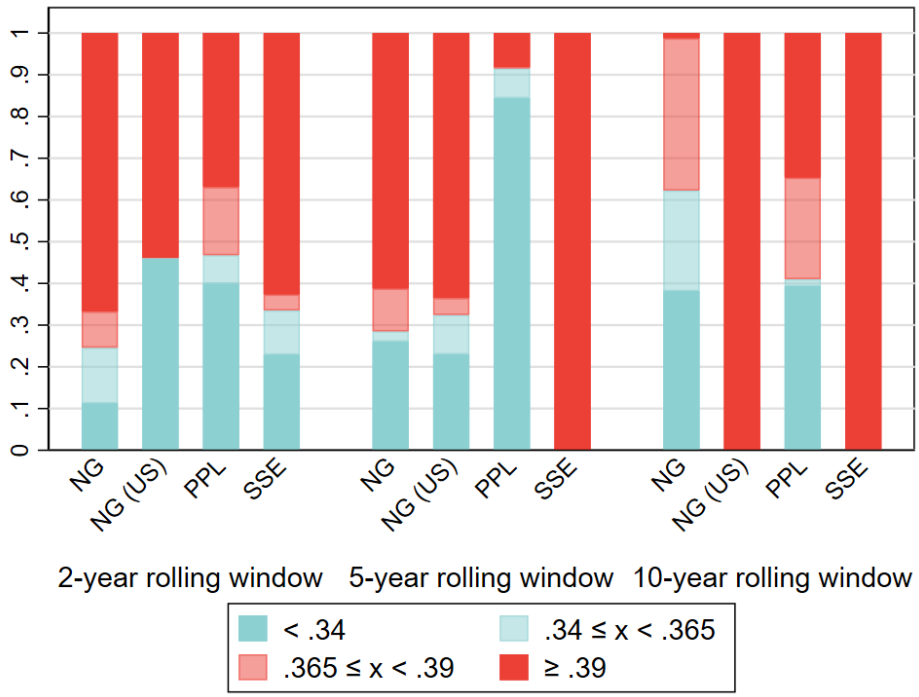
Rather than consider evidence from beta decomposition as a reasonable complement to the evidence set, Ofgem has dismissed it entirely.

- Ofgem justifies this decision by saying that the results are "too noisy" over time.
- However, noise and volatility across time and across companies is found in **all** beta estimates (as we find here in this report, and as CEPA found in its report) and we see no good reason to exclude the decomposition results on this basis alone.
- Our decomposition analysis for NG supports and reinforces our findings from the UK sample.

- Generally, our analysis indicates that Ofgem is likely to have set its upper bound of its beta range too low.
- This finding emerges very strongly indeed when we focus on shorter estimations windows, placing less emphasis on 10-year betas and focusing attention on the most recent 5/6 years of market evidence.
- We note with interest the effect of the COVID-19 period on our decomposition analysis. However more data are needed to understand if this is a temporary artefact of market turbulence, or something longer lived.

- Our findings derived from NG's US listing (NGG, the US American Depository Receipt/Share listed on the NYSE) are highly supportive of our findings from NG's UK listing.
- As are our results for SSE.
- We consider that our findings from these three decomposition exercises broadly "triangulate" and taken together lead to important insights on GB energy network risk, that it would be wrong to ignore.
- Moreover, we note that CEPA's decomposition and recomposition analyses provide results that are highly consistent with our findings.
  - In respect of its decomposition analysis, CEPA finds that:
    - Over the past 6 years, the underlying GB pure play energy network beta derived from NG's beta has been above NG's group beta, suggesting that NG's group beta should be a **lower bound** for setting GB energy network beta;
    - Over the period since 2014, the underlying GB pure play energy network beta derived from SSE's beta has been in the range 0.4 to 0.5 for most of the period, supporting a view that the upper end of Ofgem's range has been set too low; and
  - In respect of its recomposition analysis:
    - When CEPA uses GB water betas as a proxy for NG's underlying GB network beta to reconstruct NG's group beta, the result is systematically below NG group's actual beta over time.
    - It finds the same when CEPA's EU peer group average beta is used instead of GB water companies.
  - These findings are important and more attention should have been paid to them, yet Ofgem does not comment on them at all.
- The volatility in findings for PPL are noted, but we consider that these arise as a result of the numerous changes in PPL's business footprint over time, as it has acquired and disposed of many different types of asset. We also note, as we have stressed throughout, that volatility in beta estimates across companies is commonly observed. The fact that the analysis of PPL does not line up perfectly with other decomposition exercises does not provide a valid reason to reject the entire approach.

Figure 3 Percentage of time that estimated GB pure play asset betas fall within Ofgem's range by utility – from 2016



Source: *Frontier Economics based on Bloomberg*

Note: *Analysis carried out from 2016 onwards for available data points. We note that the 5Y and 10Y estimation windows includes data from pre-2016 (e.g. the 10-year beta reported against date 01/01/2019 is estimated by regressing stock returns over market returns over the previous 10 years, so from 2009 onwards). Hence this estimate may be distorted by data from the GFC/SDC period*

Evidence from analysis of European peers

Rather than relying on a wide European sample, Ofgem relies on a CEPA study that includes a handpicked set of low risk peers, arrived at through the flawed application of generally sound criteria.

- CEPA completely disregards significant differences in regime risk between the European regulatory frameworks covered by the sample. Their preferred, limited sample of six companies is exclusively focused on low-risk frameworks which are not comparable in the degree of return uncertainty that equity investors would expect from the RIIO-2 framework.
- CEPA argues that (subjectively identified) volatile betas over time represent estimates that should be considered less robust. But as already noted, betas are intrinsically volatile for *all* companies – including the GB utilities.
- CEPA's assessment of the change in beta for companies, when these are calculated using an international index rather than a domestic index, by construction leads to large differences for Transelectrica's beta. Owing to this finding, beta estimates for Transelectrica are considered to be insufficiently robust to be relied on. However, CEPA does not acknowledge that estimations against an international index are consistently characterised by inferior statistical robustness, putting in question the results for international betas

compared to those betas estimated against the local index, or any of the other underlying reasons for this finding.

- Finally, CEPA uses a too restrictive assessment of the regulated share of value, removing every company with a certain degree of footprint in a competitive segment, even though the evidence on the scale of this footprint, and therefore its impact on betas, does not clearly support this.

The net effect of these flawed choices is to retain within the sample only companies with comparatively low betas and to eject any company with a higher beta. In the light of this, it is not surprising that the beta CEPA derives from its selected peers is so low.

Figure 4 below presents individual beta estimates for the European peer group for the two- and five-year estimation windows and two- and five-year averaging windows as well as average betas for CEPA's preferred sample and an alternative sample of nine networks, which we consider should, *at least*, be considered when assessing asset betas across Europe.

- On average, our minimum sample of nine network operators excluding Fluxys, Hera and A2A yields an average asset beta range of 0.42 to 0.45 compared to an average range of 0.34 to 0.38 if only the CEPA sample was used.
- This is despite retaining all low risk companies within the sample.

Figure 4 Asset beta estimates for the European peer sample (Frontier sample in bold)

Operator	2Y-2Y average	2Y-5Y average	5Y-2Y average	5Y-5Y average
Elia (also in CEPA sample)	**0.27**	**0.26**	**0.27**	**0.25**
Red Electrica (also in CEPA sample)	**0.36**	**0.38**	**0.39**	**0.39**
Terna (also in CEPA sample)	**0.45**	**0.42**	**0.41**	**0.38**
REN (also in CEPA sample)	**0.29**	**0.30**	**0.30**	**0.27**
Enagas (also in CEPA sample)	**0.40**	**0.38**	**0.38**	**0.37**
Snam (also in CEPA sample)	**0.48**	**0.44**	**0.43**	**0.40**
Enel	**0.50**	**0.50**	**0.51**	**0.49**
Endesa	**0.52**	**0.50**	**0.49**	**0.53**
HERA	*0.46*	*0.36*	*0.34*	*0.31*
A2A	*0.50*	*0.47*	*0.47*	*0.44*
Fluxys	*0.14*	*0.11*	*0.11*	*0.10*
Transelectrica	**0.80**	**0.82**	**0.81**	**0.72**
CEPA sample average	**0.38**	**0.36**	**0.36**	**0.34**
Frontier sample average	**0.45**	**0.45**	**0.44**	**0.42**

Source: Bloomberg data, Frontier Economics analysis

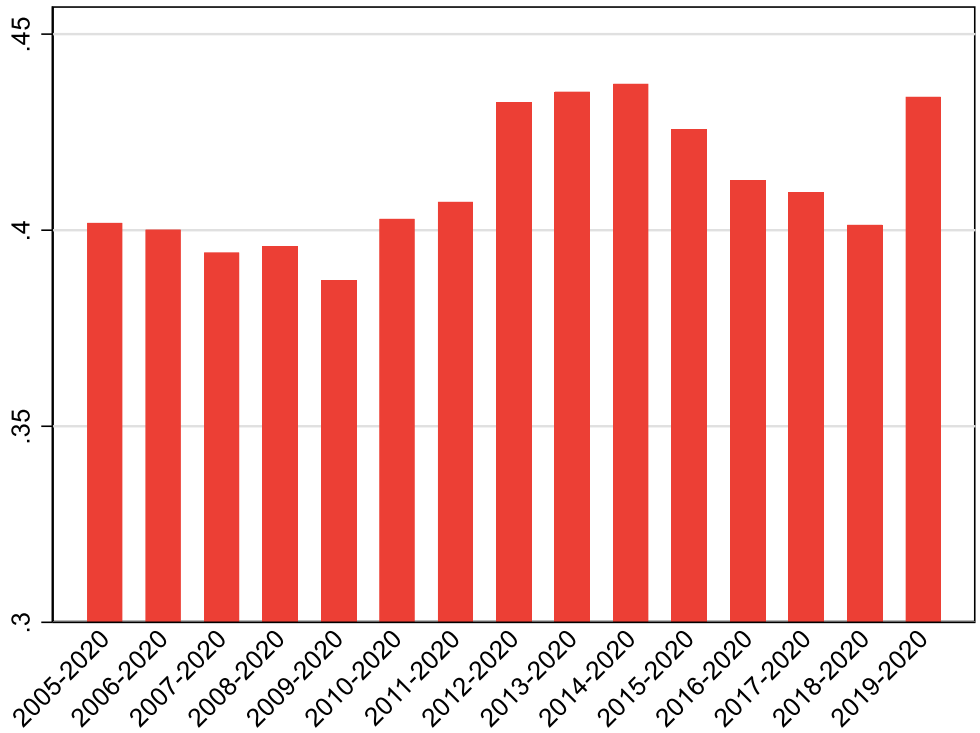
Note: Frontier sample includes all firms except HERA, A2A and Fluxys.

Choice of estimation window

Of all the estimation windows one might select, 10 year yields the lowest of all betas at this time. Yet Ofgem, through its choice of 5- and 10-year estimation windows averaged over 5 and 10 years effectively tells us that this is the measure it prefers. In fact by taking a long averaging window (5 years or 10 years) to

combine with long estimation windows, Ofgem is in effect placing very little weight on 5 years betas at all, and generally reduced weight on recent evidence. By choosing to rely on the period that delivers the lowest possible beta estimates, Ofgem creates a risk of downward bias, as a significant weight will then be placed on older evidence that is affected by the GFC/SDC and which may cover a period where energy networks were regarded as generally less risky.

Figure 5 Effect of the estimation window on estimated beta levels for the average of the UK 5



Source: Bloomberg data, Frontier analysis.

Note: Horizontal axis indicates the years of data included in the regression

GARCH vs OLS

Ofgem claims that OLS estimates may be systematically biased upwards, according to its GARCH analysis. Yet we find that Ofgem's claim is supported by just one GARCH specification out of the very many that might equally well be chosen instead. We have examined a much wider range of possible GARCH estimation models, and find GARCH results both above and below standard OLS estimates, not evidence to suggest that OLS estimates are systematically too high.

Debt beta

We have not completed any material work in respect of debt beta for this report. Throughout, we have used a debt beta of 0.125 so that our analysis is as comparable as possible to that presented by Ofgem and CEPA in the DD. For the avoidance of doubt, this should not be taken as an indication that we agree with Ofgem's assumption in respect of debt beta.

We are aware that National Grid is receiving separate advice on debt beta and will be making its own submissions on this topic. Nevertheless, it seems to us that Ofgem's estimate of debt beta is likely set too low, and the effect on the allowed cost of equity of this is material. This seems to us to be another area in which Ofgem is adopting a selective approach to the evidence it will rely on leading it to arrive at a range for allowed returns that is too low.

Figure 6 Impact of the debt beta assumption on the cost of equity

	Ofgem's debt beta	Oxera debt beta
NG asset beta (5-year)	0.405	0.372
Gearing	60%	60%
Debt beta	0.125	0.050
Re-geared equity beta	0.825	0.855
RFR	-1.5%	-1.5%
ERP	8%	8%
Cost of equity	5.10%	5.34%

Source: Frontier economics

Market value of debt

Ofgem has presented its beta estimation both with book value and market value of debt for the purpose of calculating gearing levels.

While we consider it is in principle appropriate to use the market value of debt to calculate gearing levels for the purpose of de-gearing beta comparators, we note that there are practical challenges involved with the underlying data on market value of debt. In particular, almost all of the beta comparators in the sample hold debt that is not traded on the market and it would therefore be challenging to obtain up-to-date market values. This challenge is recognised in CEPA's study "Use of market evidence annex".

In the Draft Determination, it is not clear whether Ofgem has based its final range on the asset betas derived from the market value or the book value of debt. Furthermore, it is also not clear exactly how Ofgem has calculated the market value of debt for each comparator in the beta sample, although Ofgem refers to the methodology adopted in the Sector Specific Methodology Decision (SSMD).

Ofgem's proposed range seems to come from CEPA's estimate for the GB water asset beta. However, it is not clear from the CEPA report whether the range proposed for this, 0.34-0.39, is estimated using market value of debt or book value of debt.

We note that we have used the book value of debt in all of our estimates in this study, in line with common practice. We have not sought to ascertain the market value of debt either for the GB peers or for the US and European peers. Doing so would introduce considerable uncertainty that is not necessarily required for the scope of this study. We caution that if Ofgem is to rely on the market value of debt, it should not simply use a proxy such as the method employed in SSMD, but should seek to estimate this for each peer in a sufficiently transparent manner. If it chooses to go down this route, then the approach it intends to adopt should be

published as soon as possible to allow detailed analysis by stakeholders in advance of the Final Determination.

The overall effect of Ofgem's partial choices

At each stage Ofgem has taken unjustified choices as to what evidence it will and won't consider. Across a wide range of topics, the effect of each of these choices is clear. Whether by design or by coincidence, we consider that all of the evidence that Ofgem has disregarded consistently indicates that the upper end of Ofgem's range has been set too low. As a direct consequence of this, Ofgem's selected point estimate for beta will also have been set too low.

While our review has found that a subset of the available evidence supports the lower end of Ofgem's range, much of that evidence comes from peers that it is reasonable to assume have a lower risk profile than GB energy networks.

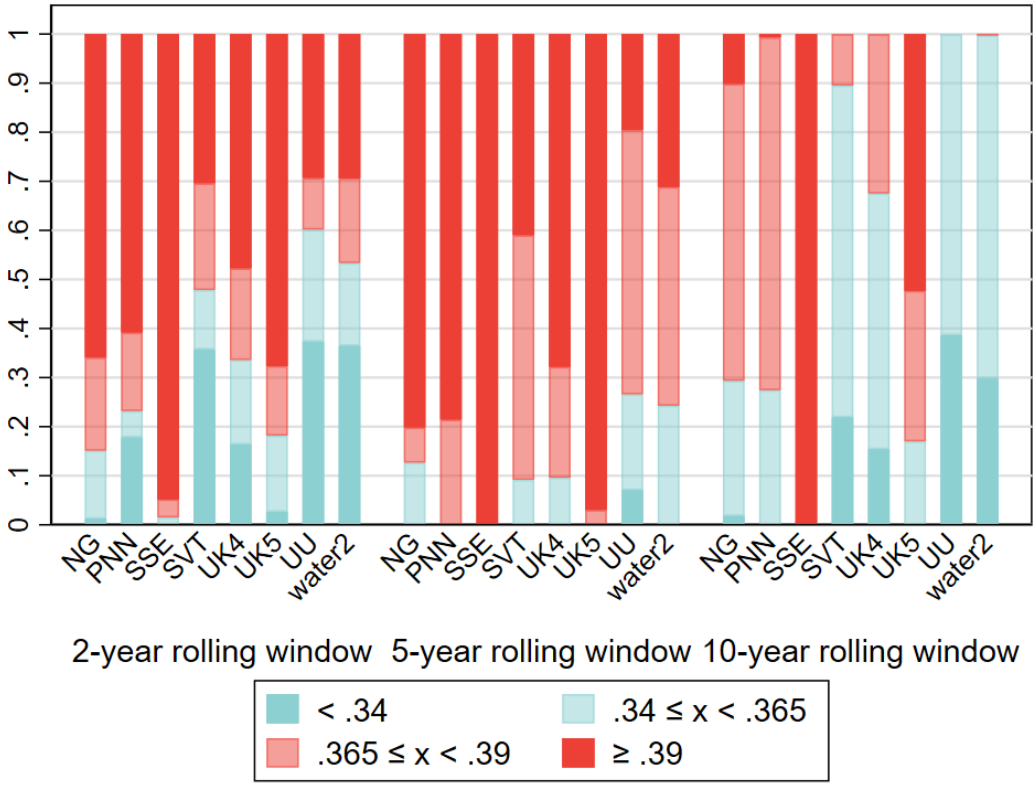
In addition to this narrow subset of evidence, we have found a raft of further evidence, which has been entirely ignored by Ofgem, that strongly indicates that the upper end of Ofgem's beta range is far too low. NG's own beta – in particular over the last 5-6 years – is wholly inconsistent with the top of Ofgem's range, commonly sitting far above 0.39. The decomposition analysis also contains a wealth of evidence to suggest that the underlying GB energy network beta is likely to sit above Ofgem's upper bound. And a broader set of European evidence – while lending some support to the location of Ofgem's lower bound – strongly suggests that the upper bound has been set too low.

This substantial body of evidence cannot be ignored, in particular as Ofgem apparently intends to select a central value from its range. All of the evidence that the upper bound may be set too low supports an even stronger case that Ofgem's proposed point estimate has been set far too low.

A balanced way forward

In order to avoid setting an asset beta that is too low Ofgem needs to reconsider all of the evidence available. In our view, a pragmatic way forward would be set a range based on the simple average of the UK 5. This would strike an appropriate balance between the risks of going too high and too low, with SSE included to broadly offset the effect of including three water companies. The movement of this average seems much more consistent with the movements of NG's own group beta and our decomposition analysis (as illustrated in the figure below), and is also corroborated by a reasonably broad European sample. This approach would also allow Ofgem to make use of all of the UK evidence, and avoid heavy reliance on just two water companies.

Figure 7 Percentage of time that estimated asset betas fall within Ofgem's range - from 2016



Source: *Frontier Economics*

Note: *Analysis carried out from 2016 onwards for available data points. We note that the 5Y and 10Y estimation windows includes data from pre-2016 (e.g. the 10-year beta reported against date 01/01/2019 is estimated by regressing stock returns over market returns over the previous 10 years, so from 2009 onwards). Hence this estimate may be distorted by data from the GFC/SDC period*

Lastly, as we have noted above, use of 10-year betas at this time may be inappropriate. If Ofgem were to follow Ofwat and rely more on a 5-year window, then our analysis suggests that its range is set too low even for the water companies.

1 INTRODUCTION

Frontier Economics has been commissioned by National Grid to undertake a thorough review of Ofgem's proposals in respect of asset beta as set out in its recently published Draft Determination. In doing so, we were asked to review and comment on:

- the relevant parts of Ofgem's Draft Determination finance annex[7];
- an related technical paper on the estimation of beta prepared on behalf of Ofgem by CEPA[8];
- a further technical paper on GARCH estimation of betas prepared by Professor Robertson on behalf of Ofgem[9].

We were also asked to undertake any additional analysis that we considered may be helpful in informing the appropriate range for beta for a GB energy network.

This report provides a summary of our own work and our views on the analysis and views of Ofgem and its consultants.

1.1 Ofgem's proposed decision

Ofgem has proposed to adopt a range of 0.34 to 0.39 for asset beta. It then proposes to take the mid-point of this range as its preferred point estimate, i.e.. 0.365. All of these asset betas are estimated based on an underlying debt beta of 0.125.

It is far from clear exactly what evidence Ofgem has relied on to make its assessment that this range and point estimate are appropriate. Based on what Ofgem has written in support of its proposed decision however, in particular in paragraphs 3.56 to 3.64, we infer the following.

- Ofgem notes that '*Market evidence for NG, PNN, SVT and UU, as presented in Table 14 suggests asset betas are in the range 0.32 to 0.43, given 5-year and 10-year estimation windows.*'. It is not clear how this range has been translated into a reduced range of 0.34 to 0.39, but we note that if this is Ofgem's starting point then the truncation it adopts is markedly biased to the downside.
  - It may be that Ofgem's GARCH findings may play some role in this lowering of the range, as Table 15 (where Ofgem presents a comparison of its OLS and GARCH findings) is referenced in this paragraph.
- Ofgem appears to consider longer run evidence the most relevant, in particular betas '*with estimation windows and averages of 5 and 10 years*'.
- Ofgem has placed no weight at all on evidence that might be drawn from SSE's beta.

[7] https://www.ofgem.gov.uk/system/files/docs/2020/07/draft_determinations_-_finance.pdf. Ofgem's discussion of beta begins at paragraph 3.24.

[8] RIIO-2: Beta estimation issues, CEPA, 9 July 2020.

[9] Re-estimating beta, Prof Donald Robertson, 29 June 2020.

- Ofgem considers that the risk profile of GB energy networks is essentially the same as GB water networks.
  - It would appear that this hypothesis is arrived at solely based on CEPA's advice to Ofgem, in particular Section 2 of CEPA's report, not by reference to any empirical analysis.
  - This would appear to imply that Ofgem has placed most weight on evidence from the GB water companies, but it is not explicit about this.
- Ofgem has not placed any weight at all on decomposition analysis, as it considers it unreliable.
- Ofgem appears to have placed some weight on the betas one can estimate for European energy networks. But only the sample of firms recommended by CEPA, no others.
  - CEPA's sample is the result of applying a set of criteria that it developed to a long list of 12 potential peers.
- Ofgem seems to place some weight on its view that the risks faced by GB energy networks are now lower than in the past, e.g. at RIIO-1, primarily as it has proposed to reduce totex sharing factors in its RIIO-2 Draft Determination.

1.2 Relevant questions posed

Ofgem's proposed beta range – and particularly its point estimate – is low compared to any relevant precedent. Since an asset beta this low will feed directly through into a low headline rate of return, it is of critical importance to the validity of the price control. Setting the headline rate of allowed return too low could have profound consequences for incentives to invest. It may cause Ofgem to fail to satisfy one of its primary duties, i.e. with respect to financeability. And it may as a direct result cause direct and material harm to consumers.

We consider that Ofgem's Draft Determination raises a series of critical questions.

- Is there any actual empirical evidence to support the hypothesis that GB energy network risk may be the same as GB water network risk?
- Is it reasonable to assert that decomposition analysis is so unreliable that no weight can be placed on it at all?
- Is the CEPA sample of European peers appropriately broad, balanced and reasonable to act as a sound cross of Ofgem's analysis of GB company betas?
- Is it reasonable to place most weight on very long runs of data (at least 10 years or more)?
- Is it correct to make some downward adjustment to betas because GARCH evidence suggests that OLS betas may be too high?
- Generally, does the balance of available evidence support Ofgem's proposed range for asset beta?
- Is it reasonable for Ofgem to assume a debt beta of 0.125?

We address all of these questions, apart from the last one, in this report.

1.3 Methodological note

Throughout this report, aside from in one or two clearly signposted sections, we have used a debt beta of 0.125. We have made this assumption in order to ensure that all of our estimates are consistent with those presented by Ofgem and CEPA. However, for the avoidance of doubt, this should not be interpreted as implying that we agree that the debt beta should be set at this level. We understand that National Grid is receiving separate advice on this topic and will be making further submissions in this regard.

Finally, in the interests of clarity, we note that all of our beta estimations are based on data up to and including 6th August 2020 unless specified otherwise.

1.4 Report structure

The remainder of this report is structured as follows:

- In Section 2 we set out our analysis of the five listed UK utilities.
- In Section 3 we present updated and expanded beta decomposition results, for NG (using both its UK and US listing), SSE and PPL.
- In Section 4 we examine potential European peers, starting with CEPA's long list of potential peers and considering the application of CEPA's proposed selection criteria.
- In Section 5 we cover a range of technical estimation topics.

An annex provides further technical details around beta decomposition.

2 ANALYSIS OF THE FIVE LISTED GB COMPANIES

There only exist five listed GB companies that own and operate utility infrastructure networks (sometimes alongside other activities). Careful analysis of these companies can provide evidence to support inferences about what the beta might be for a pure play energy network in GB. However, this represents a limited and imperfect set of potential peer companies.

The listed GB infrastructure companies are:

- National Grid (NG, energy networks in GB and the US plus a relatively small unregulated energy business);
- United Utilities (UU, water networks in GB);
- Severn Trent (SVT, water networks in GB);
- Pennon (PNN, water network in GB and until recently a water services business, although the sale of Viridor to KKR was concluded in 2020)
- SSE (energy networks in GB and unregulated energy activities in GB, noting again the recent sale of SSE's retail activities to Ovo)

We describe this set as limited as it is comprised of only five firms. Given the intrinsic volatility of beta estimates, we consider this a small sample to inform beta estimation. Moreover we note that:

- The only two pure play utility networks are the two water companies, SVT and UU.
  - Neither of these companies operate energy networks. While both operate infrastructure networks, they have to at least some degree different inputs, cost structures and underlying demand drivers. They are not regulated by Ofgem, but by Ofwat, and are hence subject to different regulation, that follows a different cycle, and more generally subject to a somewhat different legislative framework.
- The beta of the third water company, PNN, may also be more complex to interpret, given that a reasonable proportion of its business sits in the water services sector and hence outside the regulated network sector.
- There are no pure play listed GB energy networks.
  - Interpretation of NG's corporate beta is complicated by its ownership of US regulated energy networks.
  - Interpretation of SSE's corporate beta is complicated by its ownership of energy assets that are unregulated and operate in competitive markets.

Our prior assumption is that NG's own beta is likely to be particularly informative as to the underlying risk of energy networks (we note that, aside from its small unregulated business, all of NG's business activity sits in energy networks, albeit in two different countries) and of GB energy networks in particular. But whether we should consider this likely to be a central estimate of GB energy network risk will depend on what it is reasonable to assume about the riskiness of US regulated networks. If US networks are generally found to have lower betas than NG's

corporate beta, then, this might lead us to consider that NG's own beta may provide an estimate of pure play energy network risk that is likely to be low, all other things equal.

We might also compare NG's corporate beta with that of the GB water companies to consider whether this supports a hypothesis that energy and water network risk is approximately the same, an argument that Ofgem now appears to strongly support. Or, whether it may suggest that risk in one sector is potentially higher.

Interpretation of SSE's corporate beta, unadjusted, is also challenging, as it is likely to be dragged up by SSE's competitive market activity.

Based on these preliminary thoughts, coupled with the desire to make the most of the limited evidence that exists in respect of GB peers, we have conducted a range of different analyses. In this section we present:

- The relative levels of estimated betas for GB water networks and NG
- An assessment of the relative risk exposure of energy vs water networks in GB

In the following section we complement this analysis with the results from a beta decomposition analysis conducted on NG, SSE and PPL.

2.1 Beta estimates for the UK 5 over time

We begin by showing beta estimates for all of the UK 5, and various averages of those betas over time and for different estimation windows (2 years, 5 years and 10 years). These can be seen in Figure 8 below. In each case we overlay Ofgem's proposed beta range, in order to appraise whether, based on an initial overview, actual beta estimates generally support the bottom and top of Ofgem's range.

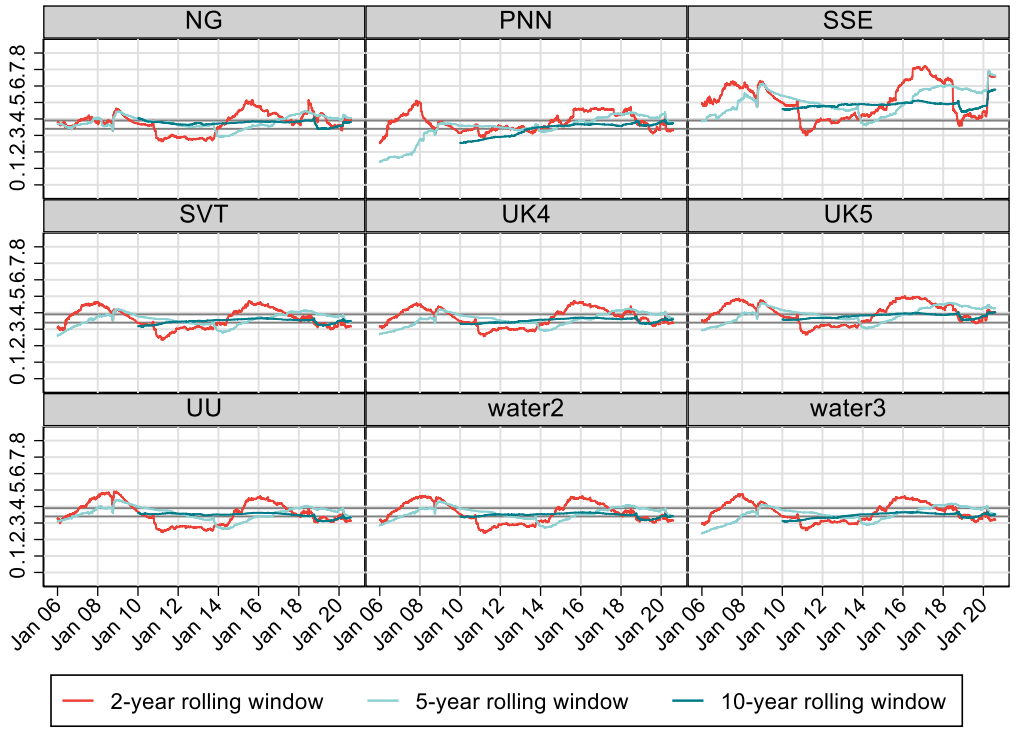
It is hard to draw definitive conclusions from these figures, but some themes emerge:

- All betas for all companies look low over a period running from approximately 2011 to 2015, when compared to the levels seen for the same stock in other periods. As we discuss in Section 5, this is likely to result from the hangover effects of the Global Financial Crisis (GFC) and Sovereign Debt Crisis (SDC) that caused significant market volatility captured by beta estimates over that window. This should be kept in mind when interpreting evidence from that period.
- The Ofgem range seems to be a poor fit for NG's beta which, other than in the 2011 to 2015 window, is often well above the upper end of Ofgem's range. While the lower beta estimates for NG offer support for the location of the lower end of Ofgem's range, the higher beta estimates suggest that the upper end of Ofgem's range may have been set too low. It is noted that the interpretation of NG group's asset beta is complicated by their ownership of not only a GB network but also a US network, a topic we address in Section 3. However, despite this, we note again that NG's entire business footprint is in energy networks (aside from a small unregulated business), which in our view makes the NG group beta highly relevant nevertheless.

- On the contrary, the range seems to capture reasonably well the movements of the water companies, particularly the pure play water companies UU and SVT.
- Beta estimates for SSE are more volatile and generally higher than the other four companies in the sample, in particular far above the betas of the water companies.
- We obviously observe an appreciable effect from COVID19 on SSE, where there is a marked jump early in 2020.
  - This may of course simply be a coincidence, but it is certainly entirely plausible to regard this as a direct consequence of COVID19.
  - There is a much small increase in NG's beta at around the same time.
  - There is no discernible effect from COVID19 on the water companies.

The data generally suggests that NG's beta is more in line with the average of all 5 GB companies.

Figure 8 Beta estimates for the GB utility companies



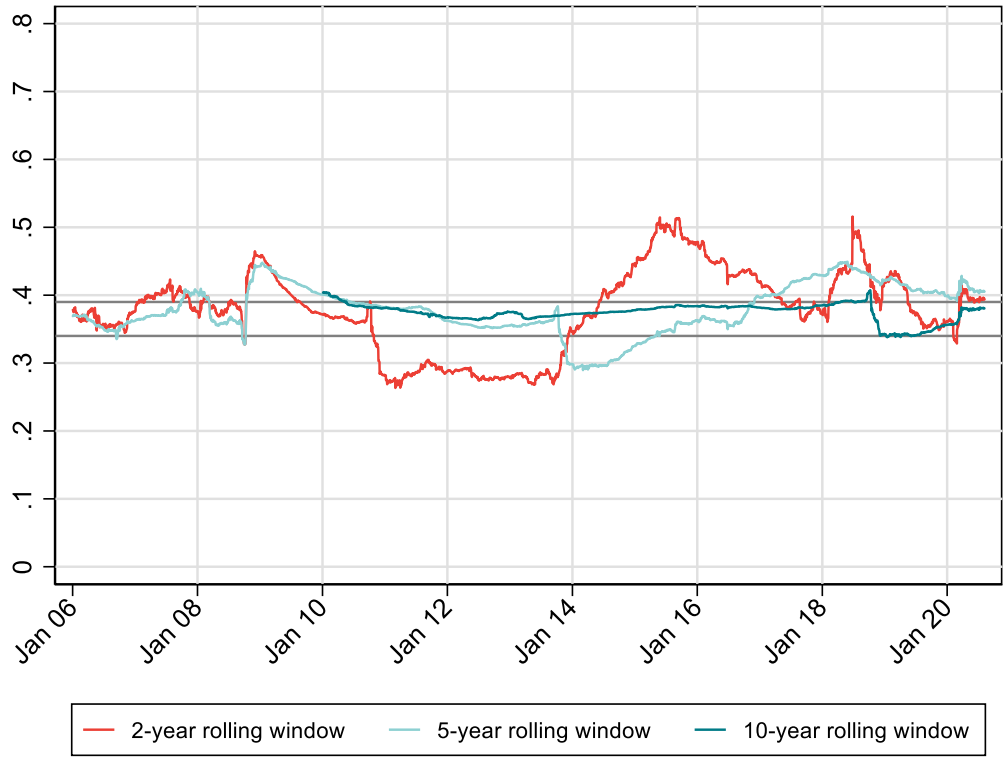
Source: *Frontier Economics based on Bloomberg*

Note: *water2: average of UU, SVT ; water3: average of UU, SVT, PNN ; UK4: average of UU, SVT, PNN, SSE ; UK5: average of UU, SVT, PNN, SSE, NG.*

It is also helpful to zoom in on the betas for NG, since we consider NG to be the most informative stock in the UK sample. In Figure 9 it is now clearer to see that estimates of NG's beta over time do, to some extent, lend some support to the location of the lower end of Ofgem's range. However, they appear highly inconsistent with the top end of the range, which is too low to accommodate evidence from the last few years. Evidence from 10-year betas shows more support for Ofgem's range – noting again the risk that 10-year betas may presently

be distorted – but even here NG's beta has far more commonly been towards the top of the Ofgem range, rather than the bottom, which would suggest that a best estimate for beta is more likely to be above the centre of Ofgem's range.

Figure 9 Estimates of NG's group beta against Ofgem's proposed range (0.34 – 0.39)



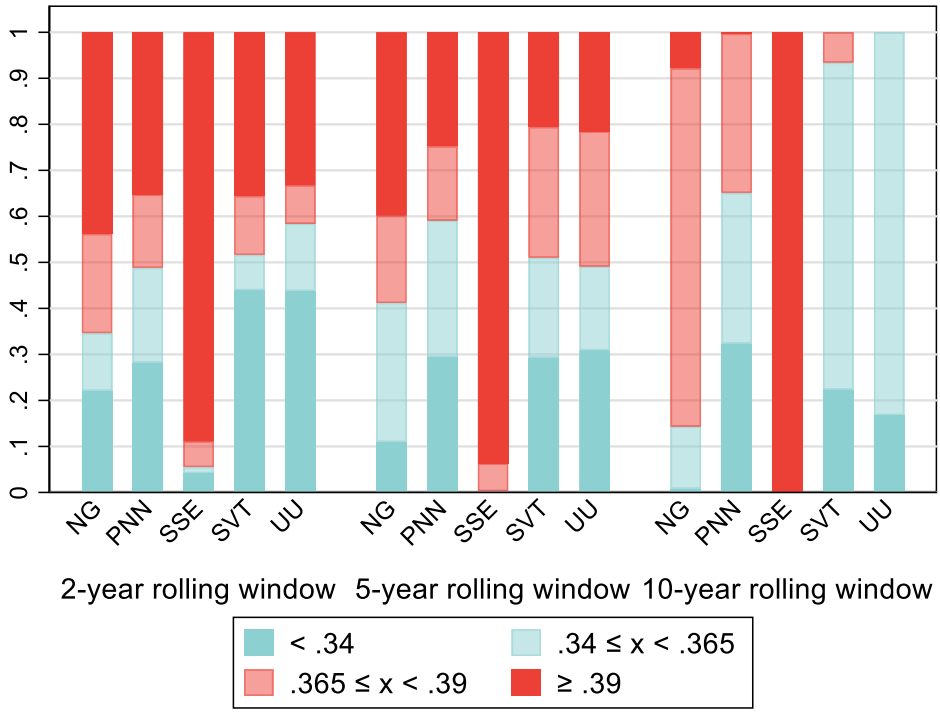
Source: Frontier Economics based on Bloomberg

To aid drawing conclusions from these charts, in respect of whether the evidence generally supports Ofgem's proposed beta range and point estimate, we present below a summary of the proportion of time that beta estimates are located above/below Ofgem's critical levels (given that we estimate betas on a daily basis, we can calculate the proportion of estimates within the range in a certain time period – from 2006 to date in the figure below).

This figure generally supports the themes noted above.

- NG's beta on any estimation window is more often than not above the midpoint of Ofgem's range, and with a relatively high frequency above the top end of the range. Again, this would point to the top of Ofgem's range being too low to adequately cover the evidence from the only (almost) pure play energy network in the sample.
- On the contrary, Ofgem's proposed range, both top and bottom, seem to cover well the evidence from the water companies, although it is noted that 10-year betas are generally lower. 10-year betas will of course cover an estimation period that may be confounded by the GFC and SDC.

Figure 10 Percentage of time that estimated asset betas are within Ofgem's range (2006 to date)

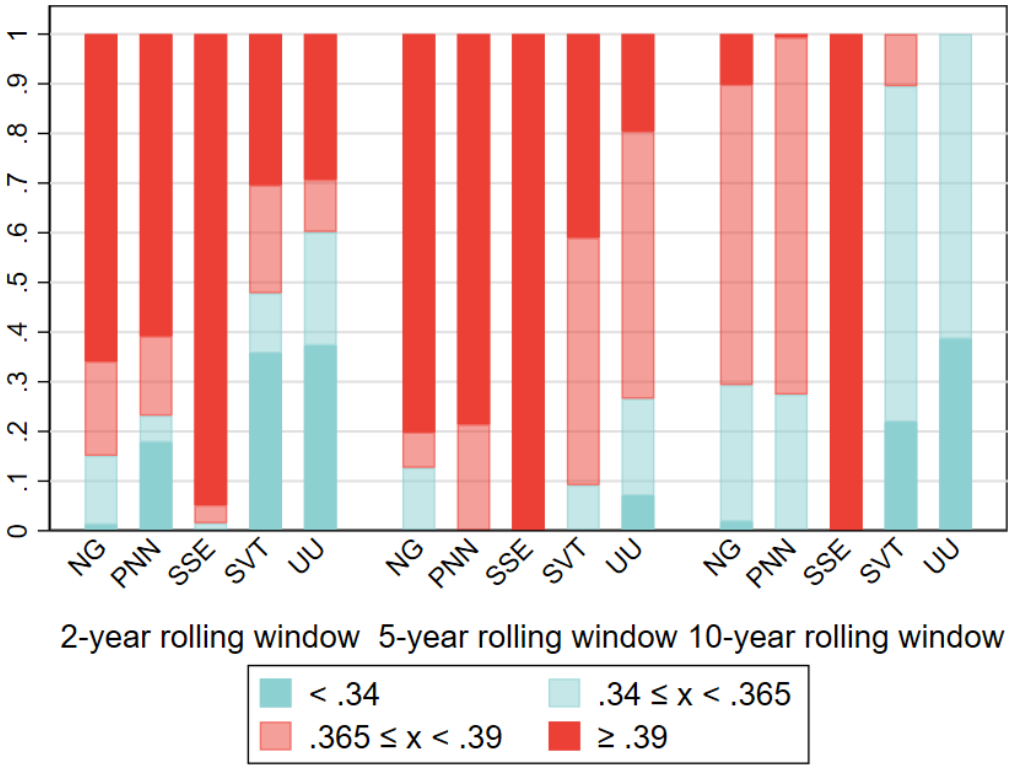


Source: *Frontier Economics based on Bloomberg*

Note: *Analysis carried out from 2006 onwards for available data points*

As we have noted, there is a potential concern that the 2011 to 2015 period may be distorted. There may also be a question as to whether the underlying risk profile of the energy networks may be different now compared to the past, in particular given the role that they will play in delivering Net Zero. Therefore we present below the same analysis as in Figure 10 for only the most recent period, running from the start of 2016. We note that this does not mean that data before 2016 is excluded entirely from the estimations, as all estimations (over each of the three estimation windows relied on here) for 2016 will include some at least some data from 2015 and earlier. In particular we note that the 10-year and 5-year regressions over this window will include past data from the period that we consider distorted by the GFC/SDC period. This shows that more recent evidence supports even more strongly the view that the top end of Ofgem's range has been set too low, and that the mid-point will prove an inadequate estimate of underlying energy network risk.

Figure 11 Percentage of time that estimated asset betas are within Ofgem's range (2016 to date)



Source: Frontier Economics based on Bloomberg

Note: Analysis carried out from 2016 onwards for available data points.

Taken together, we consider that the evidence presented in this subsection is inconsistent with Ofgem's range. This evidence suggests that the upper end of the range is set too low, and as hence the mid-point will be too low too.

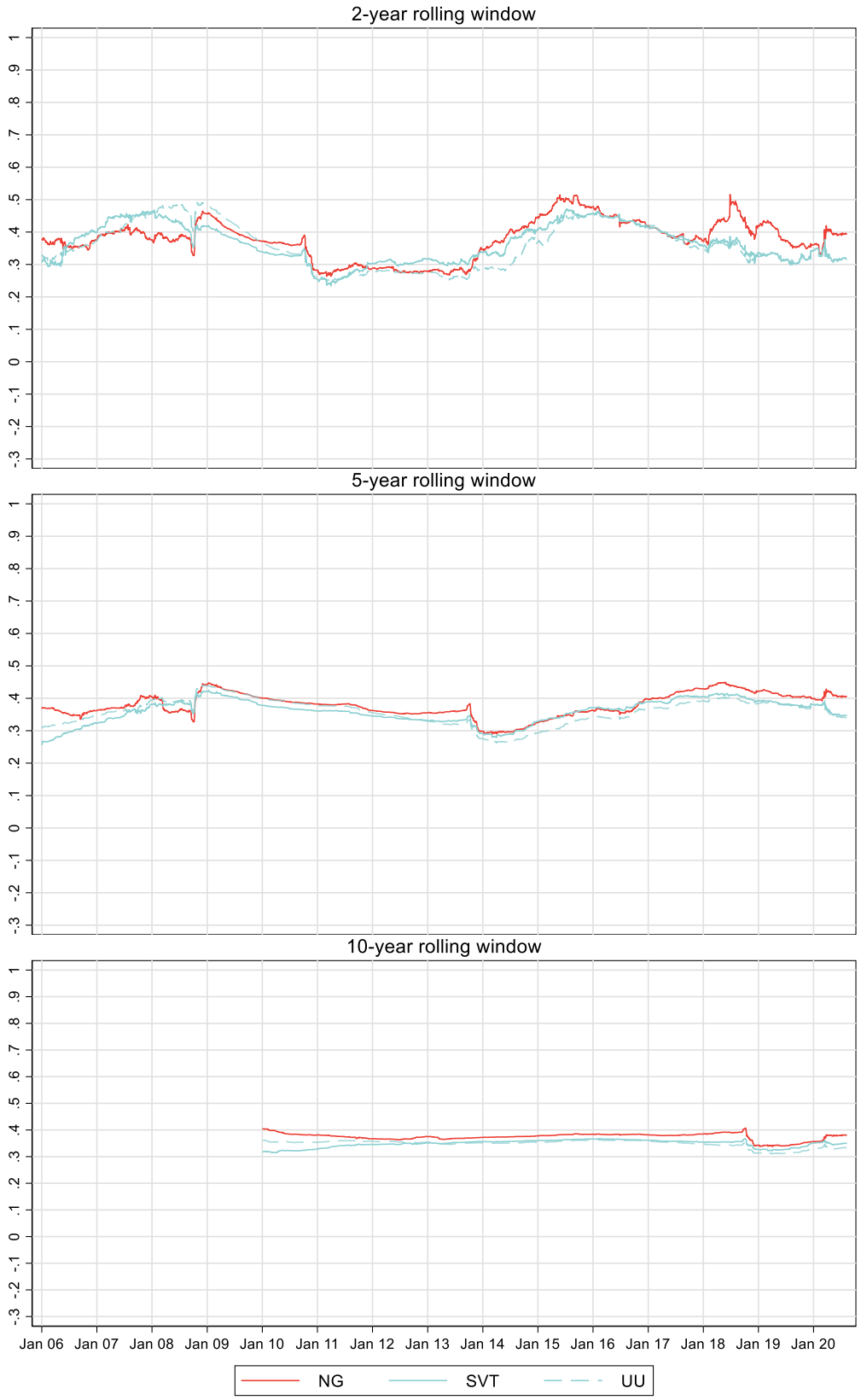
2.2 NG compared to the water companies

It is unclear exactly what Ofgem has used to inform its beta range. However, it is clear that it has decided to place more emphasis than before on evidence from the water sector[10]. As is already clear from the preceding section, our empirical findings do not support a view that risks in the GB energy network and water network sectors are similar, based on the estimated betas of NG, SVT and UU (and also PNN).

Even absent any adjustment, NG's group beta has generally been higher than SVT and UU betas throughout much of the last 10 years. We show first, for comparison, a series of line charts that compare rolling beta estimates for NG, UU and SVT.

[10] See for example paragraph 3.49 of the Finance Annex.

Figure 12 Estimates of NG's group beta vs beta of water companies



Source: Frontier Economics based on Bloomberg

Again it is helpful to provide an alternative summary presentation of the information in these charts, which we do below in Figure 13 below. We see that NG's beta estimate over 2-year, 5-year and 10-year windows are above those of SVT's beta respectively c. 65% of the time, c. 82% of the time and c. 100% of the time. The same pattern is observed between UU and NG: NG's estimated beta in the 2-year, 5-year and 10-year windows is above UU's estimated beta respectively c. 75% of the time, c. 92% of the time and 100% of the time.

While the complication of NG's ownership of a US network is again noted, this evidence is clearly at odds with a presumption that the risk profile of energy networks and water networks in GB is highly comparable. If this were the case, then we might expect to see NG's beta below that of the two water companies roughly as often as it is above. But this is not what we see, over time, across any estimation window.

Figure 13 Percentage of time that NG's estimated asset beta is above UU and SVT's beta

Source: Frontier Economics

Note: Analysis carried out from 2006 onwards for available data points

It would seem that our findings are consistent with those reported by Ofgem. For example, in Table 14 of its Finance Annex, we observe that the beta of NG group is found to be strictly greater than those of SVT and UU across all 22 rows of the table (covering estimates over 2, 5 and 10-year windows, over four different averaging periods and with or without an MVD adjustment). If we also consider PNN, then we observe in the same table, that NG's corporate beta is higher than the simple average beta of PNN, SVT and UU across 21 rows of the table, and in the other row it is equal.

We are surprised that Ofgem has not commented on this empirical information on the relative risk across energy and water networks, preferring it appears to rely primarily on CEPA's more subjective assessment of relative risk. We comment on this further below.

Comment on CEPA's appraisal of relative risk of energy vs water

CEPA conducted a lengthy, qualitative analysis of relative exposure to systematic risk between water companies and energy networks, with page after page of discussion of different aspects of the energy and water sectors and how this may, or may not, affect systematic risk.

Aspects of CEPA's lengthy discussion appear reasonable, other parts less reasonable, or at the very least topics over which one could engage in lengthy debate. This is particularly true in respect of carefully caveated conclusions.

What is clear is that CEPA's qualitative analysis can only be regarded as a qualitative opinion. Moreover, given its nature, it cannot be regarded as an analysis that is capable of uncovering the objective truth of the matter, i.e. no analysis of this kind can hope to reach an unambiguous conclusion on whether risk in GB energy networks is the same as that in GB water networks.

CEPA itself recognises the uncertainty in a number of key elements of its analysis. And it seems clear to us that CEPA's analysis falls short of proving this equivalent risk argument, and indeed that CEPA stops short of concluding this itself.

For example, whilst CEPA concludes that "*energy and water networks […] exhibit many similarities*", they also note that they "*will face different sources of dynamic uncertainty*" and that "*the scope for change may be greater in energy networks*". While CEPA then starts to sketch an argument to suggest that current regulatory arrangements may deal with underlying differences ("*under the current regulatory arrangements greater uncertainty does not necessarily translate into greater systematic risk exposure*") CEPA itself then goes on to conclude that "*there are aspects of this risk exposure that are difficult to conclude on decisively and they cannot be considered perfect substitutes*".

While CEPA notes the effect that Net Zero is likely to have on energy networks, we consider that the potential effect of this on risk has been downplayed.

Future gas demand is highly uncertain, given the uncertainty over how the UK will fuel space and water heating in future. There are future scenarios where the existing networks continue to meet this need, delivering alternative low/no carbon sources of gas. But there are also future states of the work where demand falls markedly. This asymmetric demand risk is not present in water and is highly likely to give rise to systematic risks since macro-economic conditions will influence how these costs will be treated and how much of the risk will be borne by the operator.

Electricity networks are also facing unprecedent challenges with large investment programs needed to adapt to the penetration of renewables and an electrification of sectors, with new forms of investments inherently more risky to network operators. Since many investments are and will be made in the presence of uncertainty, similar risks over future regulatory treatment arise there too.

The water sector may need to adapt to future resource availability and usage patterns, but there is no evidence for a structural change in the industry, that the demand for water would drastically change in the future or that large investment programs are needed in the short term.

We agree with CEPA that while the regulatory regime may mitigate partially some systematic risks, such a different context is unlikely to leave the same risk faced by both energy and water networks. As CEPA itself noted "*the regulatory regime currently mitigates systematic risks – but if economy-wide transitions necessitate changes to the regime that might not continue to hold to the same extent*". The structural changes that the energy networks will face in the near future are widely recognised by other European regulators and support the conclusion that energy networks' systematic risk exposure is higher than that of water companies. In the light of the points raised by CEPA in discussion, and the carefully caveated nature of its conclusion, we do not believe that Ofgem's assertion that SVT and UU are in some senses the most important peers is correct. Both the qualitative and quantitative analysis point towards a different conclusion, i.e. that material differences exist between GB energy and water betas.

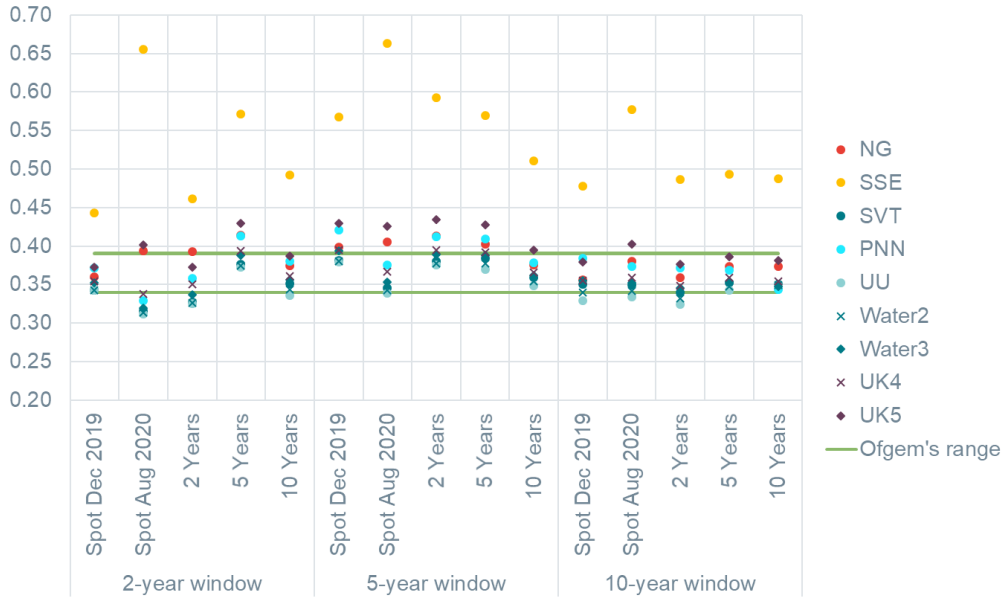
The differential effect of COVID19 on energy and water

As a final observation, it is helpful to recall the markedly different responses of betas of energy and water sector firms in GB to COVID19. Both the GB energy firms saw contemporaneous increases in beta in early March. The betas of water companies have, if anything decreased over that time frame. This markedly different response again fails to lend any support to the hypothesis that water and energy network risk is fundamentally the same.

2.3 Summary results for the UK 5

In this section we have explored the limited set of evidence available for listed utility stocks in the UK, NG, SSE, UU, SVT and PNN. We summarise that evidence in the following two figures. Figure 14 shows the location of beta estimates and average beta estimates over various estimation windows and averaging periods (following the approach adopted by Ofgem in its Draft Determination – see Table 14 in particular).

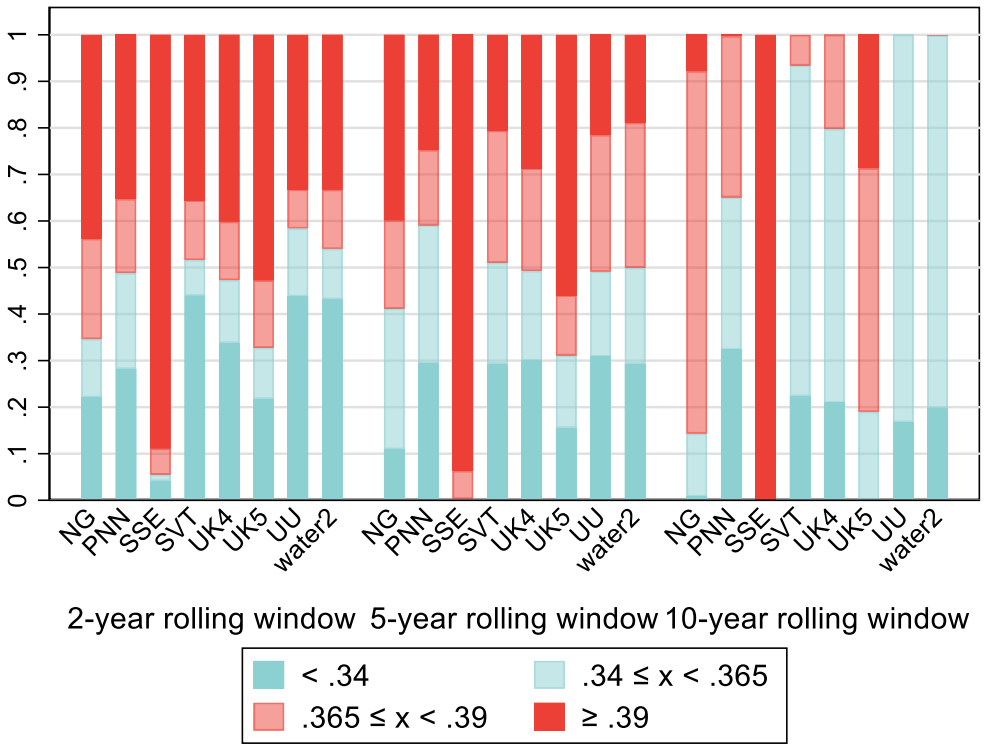
Figure 14 Summary results from GB betas



Source: Frontier Economics based on Bloomberg

We also reproduce and expand our analysis of the proportion of estimates that sit above/below Ofgem's range and point estimate, now including various average measures (Figure 15).

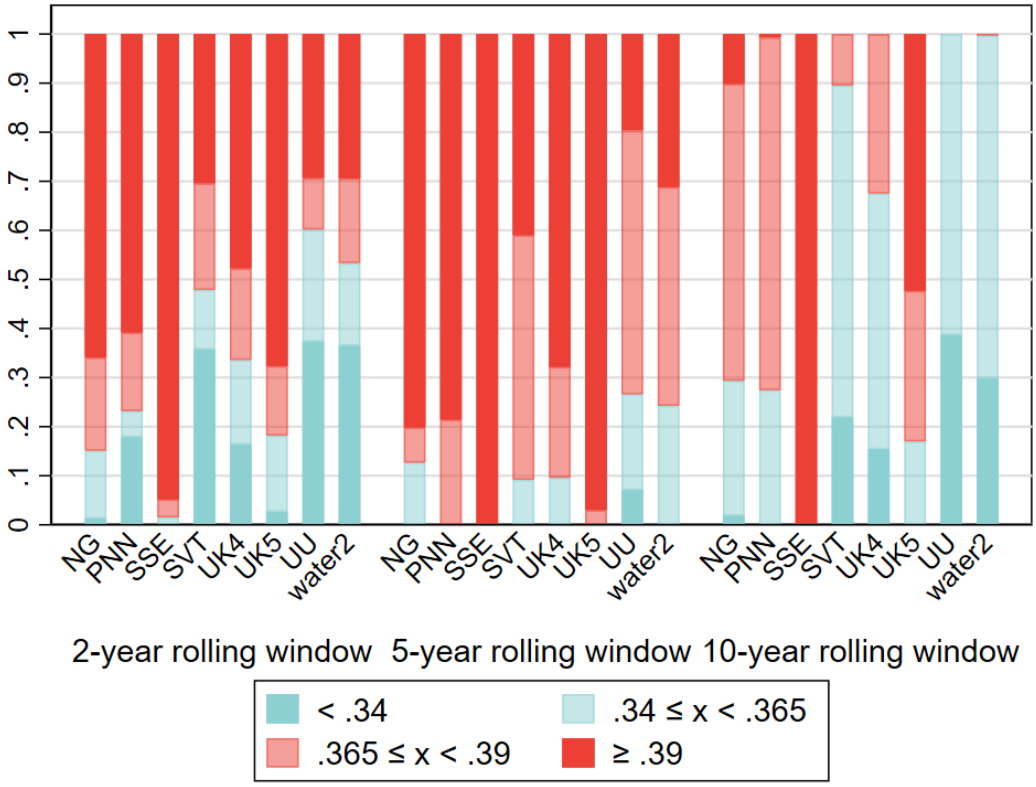
Figure 15 Percentage of time that estimated asset betas fall within Ofgem's range - from 2006



Source: Frontier Economics

Note: Analysis carried out from 2006 onwards for available data points

Figure 16 Percentage of time that estimated asset betas fall within Ofgem's range - from 2016



Source: *Frontier Economics*

Note: *Analysis carried out from 2016 onwards for available data points. We note that the 5Y and 10Y estimation windows includes data from pre-2016 (e.g. the 10-year beta reported against date 01/01/2019 is estimated by regressing stock returns over market returns over the previous 10 years, so from 2009 onwards). Hence this estimate may be distorted by data from the GFC/SDC period*

We consider that this evidence shows that:

- there is no empirical support in the limited dataset available for the proposition that energy and water network risk are highly similar. On the contrary, estimates of NG's beta are systematically higher than those of the water companies, in particular UU and SVT. This is the case over any estimation window;
- Ofgem's proposed beta range fits with the beta estimations of the listed water companies rather well, in respect of the location of both the bottom and top of the range; but
- this range fits very poorly with beta estimates for NG.
  - there is some support, over certain limited periods of time and for some estimation windows, for the location of the lower end of Ofgem's range; but
  - the location of the upper end of the range is far too low.
- As a result, based on evidence from NG and the GB water companies, the midpoint of the range seems likely to materially underestimate the relevant beta.

- While the match is not perfect, we consider that the average of the UK 5 appears generally to be a better match to NG's own beta across many of these estimations. This is supported by the evidence in Figure 15: the distribution of NG's beta estimates around Ofgem's range is much more similar to that of the UK 5 average than the average of SVT and UU (water2 in the graph) across all estimation windows.
  - We note that reliance on the average of the UK 5 is much more consistent with what we understand past regulatory practice to have been.
  - This average may have the effect of arriving at a broadly sensible outcome, with SSE's "too high" beta counterweighted by three water network betas that are likely to be "a bit too low".

3 DIRECT DECOMPOSITION

In Section 2 we have focused on the headline betas of the 5 UK listed firms, with a particular emphasis on NG's group beta. One issue with this is that NG's group beta will not reflect solely the risks of GB energy networks as it has a sizeable business in the US, alongside a modest unregulated set of activities. To illustrate the make-up of NG group's business footprint, we show in the Figure below the split of NG's business across its various activities, based on operating income.

Figure 17 NG's average activity weights over FY2016-FY2020

Activities	Proportion of total operating income
UK regulated	48%
US regulated	42%
Unregulated	10%

Source: Frontier Economics based on Bloomberg

Note: Analysis carried out using operational income as weights for different activities

Given this mix of activities, the question then arises as to whether we can undertake further analysis to help us qualify the interpretation that we might place on NG's group beta. For example, if the beta for the US regulated energy network activity is seen to be "low" (in particular lower than the NG headline beta), then this would imply that the underlying GB pure play energy network beta nested within NG's corporate beta must be "high" (in particular higher than NG's headline beta).

Similarly, it may be possible to make more of SSE's group beta, if we were able to find a way to control for its non-regulated activities.

In this section, following on from our previous work for NG and SSE, we undertake a decomposition exercise to estimate the underlying beta of a pure play GB energy network. We present updated analysis for NG, including a new analysis where we look at what can be inferred from NG's US ADR listing. We also present a decomposition of SSE and (following CEPA) PPL. Where appropriate, we also comment on CEPA's empirical findings. We begin however by addressing the criticisms to our approach that Ofgem and CEPA raised as part of the DD.

Technical details of our estimation methodology can be found in an annex.

3.1 Addressing the Ofgem/CEPA criticisms of beta decomposition

Ofgem has rejected the evidence from the direct decomposition analysis we presented in our beta decomposition report, as it considers it entirely unreliable. In making this decision, Ofgem followed CEPA's advice on our analysis.

CEPA considers it difficult to draw conclusions from the direct decomposition analysis for three main reasons:

- it is based on several assumptions;
- the results are volatile over time;

- the results show differences in the level of UK regulated betas between companies, e.g. between NG and SSE. In particular, CEPA picks out periods in which the implied UK regulated betas exhibit "challenging" patterns, and uses these periods as evidence to reject the direct decomposition results as a whole.

We address each of CEPA's points in turn.

No basis to reject direct decomposition based on additional assumptions

To perform a direct decomposition analysis, we need to make two assumptions.

- We need to select the activity weights, i.e. how to split the company's activities into UK regulated, US regulated, and other activities.
- We need to decide how to measure the beta of US regulated activities, and other activities, so these can be stripped out.

The need for such assumptions to be made to support decomposition is noted. However, we do not consider that the need to make additional assumptions is sufficient reason to reject the use of decomposition analysis entirely.

Almost all analysis will require the researcher to make at least some assumptions, so this does not in and of itself render such evidence invalid. This is particularly the case where the merits of assumptions can be considered carefully, developed and tested. For example, in our original decomposition work, we put forward a proposed US peer group, to allow us to estimate US regulated energy network betas. CEPA, in reviewing our work, approached the question in a slightly different way, and proposed a (very) slightly different peer group. Based on our analysis, the use of this different peer group leads to minimal difference in decomposition results. So in the end, we have two independent approaches that we can triangulate and test, that lead to similar results. This hardly provides a basis to assert that this decomposition analysis is entirely unreliable, and can never be made sufficiently reliable.

Moreover, sensitivity analyses can be carried out to assess whether the evidence from the direct decomposition analysis is sensitive to those assumptions or not. If the latter is true, the analysis cannot be rejected solely on the basis of the assumptions required (as they do not affect the conclusions).

We note that in its DD Ofgem takes into consideration the evidence from CEPA's Market Asset Ratio (MAR) analysis, in particular for the two energy companies NG and SSE. In order to make such an analysis, CEPA will not just have needed to identify an approximate split in underlying business activities, but it will have needed to place an explicit valuation on those other, non GB energy network business units. Many more judgements will have been needed to support such a valuation, compared to a beta decomposition exercise. We therefore find the standard applied to evidence by Ofgem inconsistent, in respect of its rejection of beta decomposition analysis. Assumptions of the kind made in the decomposition analysis – indeed even more ambitious assumptions – are clearly fine elsewhere.

Overall, there are no reasons to reject the direct decomposition analysis on the basis of the assumptions required.

No basis to reject direct decomposition based on volatility, differences in levels and/or differences between companies

We acknowledge that our decomposed betas show some volatility, and that CEPA found the same in their analysis. There are also differences in the levels of the decomposed betas between e.g. NG and SSE and other companies.

However, this is not a peculiarity of the direct decomposition method. Such volatility and differences in levels can be observed in **all** the betas that both Frontier and Ofgem/CEPA have considered.[11] This is a commonly found feature of all forms of beta estimation.

We therefore do not see the rejection of the direct decomposition analysis on the basis of volatility or differences in levels between companies as valid, not least as it has the effect of excluding evidence from the two UK listed groups that own sizeable interests in energy networks.

Our view remains that direct decomposition analysis can be considered as informative and should properly form a part of the evidence base that Ofgem relies on:

- Unlike evidence from GB water and/or European peers, direct decomposition produces an estimate of the beta of exactly the correct type of entity (i.e. the beta of a UK regulated energy utility), making it highly relevant.
- We do not disregard the estimation challenges of direct decomposition analysis, however a clear minded walk through evidence can readily allow one to draw informative conclusions.
- The evidence is informative as it indicates that while there may be support for the lower end of Ofgem's range, much of the evidence that emerges from this decomposition indicates that the upper end of Ofgem's range has been set too low.

The results of the analyses carried out are presented below.

3.2 Decomposition of National Grid's beta

As noted above, NG's business footprint includes:

- GB regulated energy networks;
- US regulated energy networks; and
- A small proportion of unregulated businesses.

We complete our beta decomposition as follows.

- First, we directly estimate NG's group beta.
- We understand from our appraisal of CEPA's report that there is no dispute that, as matter of principle, the beta that one estimates for NG corporately can be understood to be a weighted average of the underlying betas for each of NG's business units.
- Second, we can estimate betas for all but one of the underlying business activities of NG, and use this simple relationship to impute the beta for any

[11] See for example Figures 4.6 and 4.8 in CEPA's report .

single activity where direct peers for that particular activity are not readily available:

- The beta of NG's US regulated network activities can be estimated using a sample of US firms whose principal or sole activity is the operation of energy networks in the US. We note that CEPA has formed its view of the preferred US regulated energy network sample, which is highly similar but not exactly the same as the sample we used in our original report on beta decomposition. To narrow down areas of debate, we have adopted the CEPA sample, which we consider broadly reasonable.
- The beta of NG's unregulated activities can similarly be estimated using the beta of a company (or sample of companies) whose principal or sole activity is the supply/generation of energy. We use Centrica for this purpose, and again our assessment is that CEPA did not find this controversial.
- The simple weighted average relationship between NG's group beta and the beta of its underlying activities can be used to impute the beta for NG's UK regulated activities, for which a beta cannot be observed directly.
- For the purposes of this report, we rely on operating income to provide the weights, and consider this consistent with standard finance/valuation practice, and not inconsistent with CEPA. We acknowledge that there are other ways of calculating business weights, such as by using data on revenue and value of assets.

We note that since NG's unregulated activities are modest, the decomposition of NG's group beta will be mostly driven by the UK and US regulated energy networks.

Further technical details of how we have completed our estimations can be found in an annex.

Findings

Whereas our earlier work presented only a snapshot of results, and then only for two estimation windows (5 years and 10 years), in this present exercise we have calculated our decomposition results on a rolling average basis (as did CEPA) for 2-year, 5-year and 10-year estimation windows.

Our findings are illustrated below.

As we found in our results in Section 2, for the UK 5, there is volatility over time and over different estimation windows.

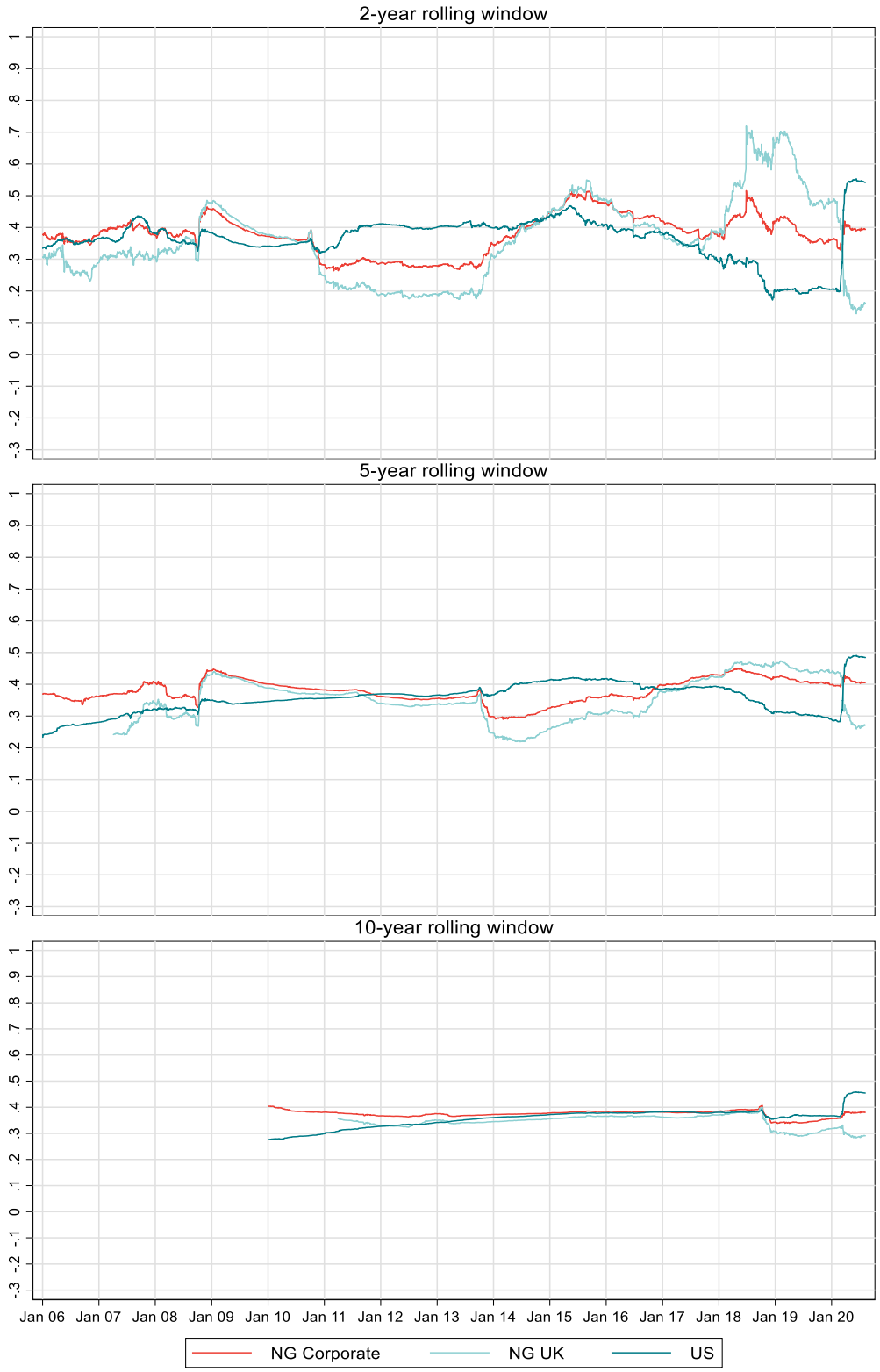
- We see periods where the implied pure play GB energy network beta is above NG's group beta, but also periods when it is below.
  - In the main, recent data (since 2016) suggest that US regulated energy networks have lower betas than NG group. This would imply that NG's group beta should be interpreted as a lower bound for the underlying pure play GB energy network beta.
  - Going back further suggests a more mixed pattern.
  - We also observe a marked spike up in US regulated energy network betas since the beginning of this year. The jump is large and observed to an

appreciably similar extent across all of the stocks in the US sample. It seems highly likely that this is a COVID19 effect, as we discuss in Section 5.2.

  - The effect of this spike is to cause all spot measures derived from our decomposition analysis to become very low. It is for the moment uncertain whether this is a real effect, or an artefact of market volatility.

- Betas using a 10-year window are the lowest, a possible consequence of the GFC/SDC period that is covered in such measures.
- In a similar vein, in the 2011 to 2014/15 period the low betas we saw for NG and other UK stocks in that window lead to a particularly low appraisal of underlying GB pure play energy network betas. This may be because the Sovereign Debt Crisis was a broadly European concern which had far less effect on the US.

Figure 18 Estimates of NG GB pure play energy network asset beta



Source: Frontier Economics based on Bloomberg

Note: Analysis carried out using operational income as weights for different activities

What then does this evidence tell us? In an attempt to summarise, we have prepared a summary exhibit structured in a broadly similar way to Ofgem's Finance Annex Table 14. See Figure 19 below.

Figure 19 NG GB pure play energy network asset beta

Estimation window	Averaging period	NG's GB pure play asset beta
2 years	Spot (27/12/2019)	0.48
2 years	Spot (06/08/2020)	0.16
2 years	2 years	0.49
2 years	5 years	0.45
2 years	10 years	0.37
5 years	Spot (27/12/2019)	0.44
5 years	Spot (06/08/2020)	0.27
5 years	2 years	0.42
5 years	5 years	0.39
5 years	10 years	0.35
10 years	Spot (27/12/2019)	0.32
10 years	Spot (06/08/2020)	0.29
10 years	2 years	0.31
10 years	5 years	0.34
10 years	10 years	0.34

Source: Frontier Economics based on Bloomberg

Note: Analysis carried out using operational income as weights for different activities. Cells highlighted in red sit above Ofgem's proposed point estimate.

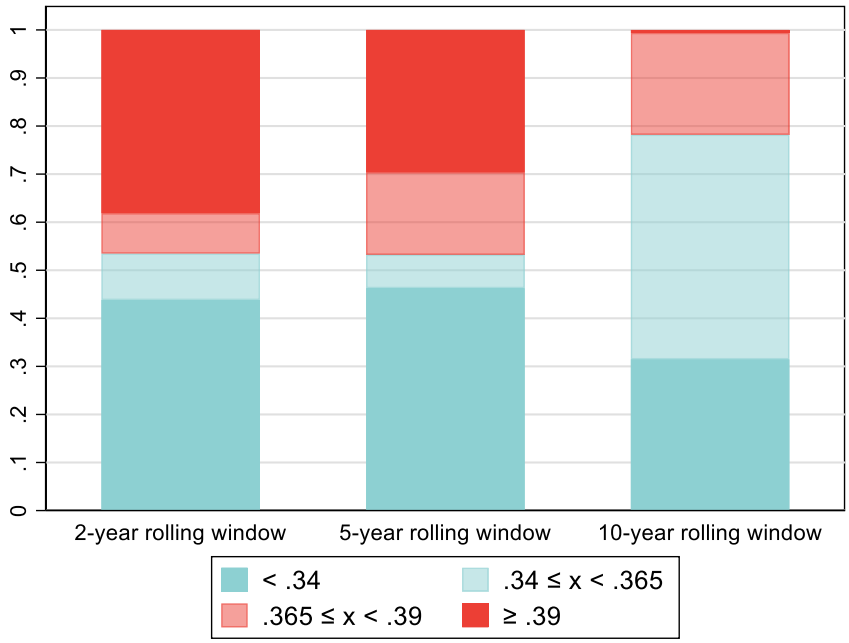
The results in this table strongly emphasise the spread in results that emerge from different estimation windows and averaging periods.

First and foremost, there is a marked difference between "spot" measures of betas across all estimation windows depending on whether we consider pre-COVID19 evidence or post-COVID19 evidence. The pre-COVID19 results mirror those found in our earlier work – those post-COVID19 yield a much lower estimate of pure play GB energy network betas.

The table also highlights a similar difference in evidence from, roughly speaking, the last 5 years (even including the post CV period) compared to the evidence from longer ago. The further back one goes, the more evidence one finds to support generally lower beta estimate for GB energy networks. More recent evidence provides a markedly different picture, with generally much higher implied GB energy network betas.

These observations are further illustrated by the two figures below, showing the proportion of time over a certain period that the estimates of the GB pure energy network beta derived from NG's group beta fall within Ofgem's range. We see that over the whole time horizon (2006 onwards), NG's GB pure play beta is often in line or below Ofgem's range. However, over more recent years (2016 onwards), this is not the case. Now the evidence strongly points towards the upper end of Ofgem's range being too low.

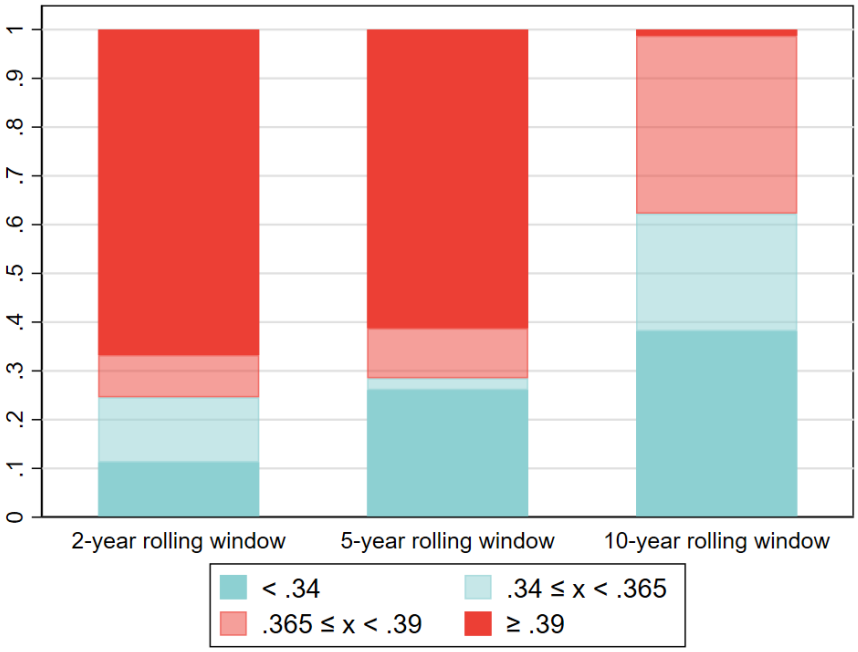
Figure 20 Percentage of time that NG's estimated GB pure play asset beta falls within Ofgem's range – from 2006



Source: *Frontier Economics based on Bloomberg*

Note: *Analysis carried out from 2006 onwards for available data points*

Figure 21 Percentage of time that NG's estimated GB pure play asset beta falls within Ofgem's range – from 2016



Source: *Frontier Economics based on Bloomberg*

Note: *Analysis carried out from 2016 onwards for available data points. We note that the 5Y and 10Y estimation windows includes data from pre-2016 (e.g. the 10-year beta reported against date 01/01/2019 is estimated by regressing stock returns over market returns over the previous 10 years, so from 2009 onwards). Hence this estimate may be distorted by data from the GFC/SDC period*

How one would interpret the evidence will depend on the time period that we think is more relevant. In this regard, following the thinking we set out in Section 5.1, we note that is on balance more reasonable to focus more on more recent data, and less on older evidence, not least as older evidence is likely to be confounded by the GFC/SDC. While older evidence lends support to the location of Ofgem's bounds for beta, more recent evidence certainly does not.

3.3 An alternative decomposition of NG's beta using its US listing

Another way of arriving at an estimate of a GB pure play energy network is to take NG's US listing (NGG), derive a beta vs the S&P 500 index, and then net off NG's US regulation business. This results in another measure of the underlying risk of NG's GB pure play energy network business, that can be used as a cross check.

We note that the result from this cross check is different from the main result using the NG US listing. There may be different reasons causing this difference, but one of the main reasons is the fact that the starting point measurement of the corporate beta is based on the US market rather than the UK market. In other words, in the UK listing analysis, the assumption is that investors are diversifying the group share against the FTSE all share index, whilst in the UK listing analysis investors are diversifying against the S&P 500. To the extent the two market indices are not perfectly correlated, the starting point of the group betas from these two exercises are different. The resulting decomposed GB energy network beta would in turn be different.

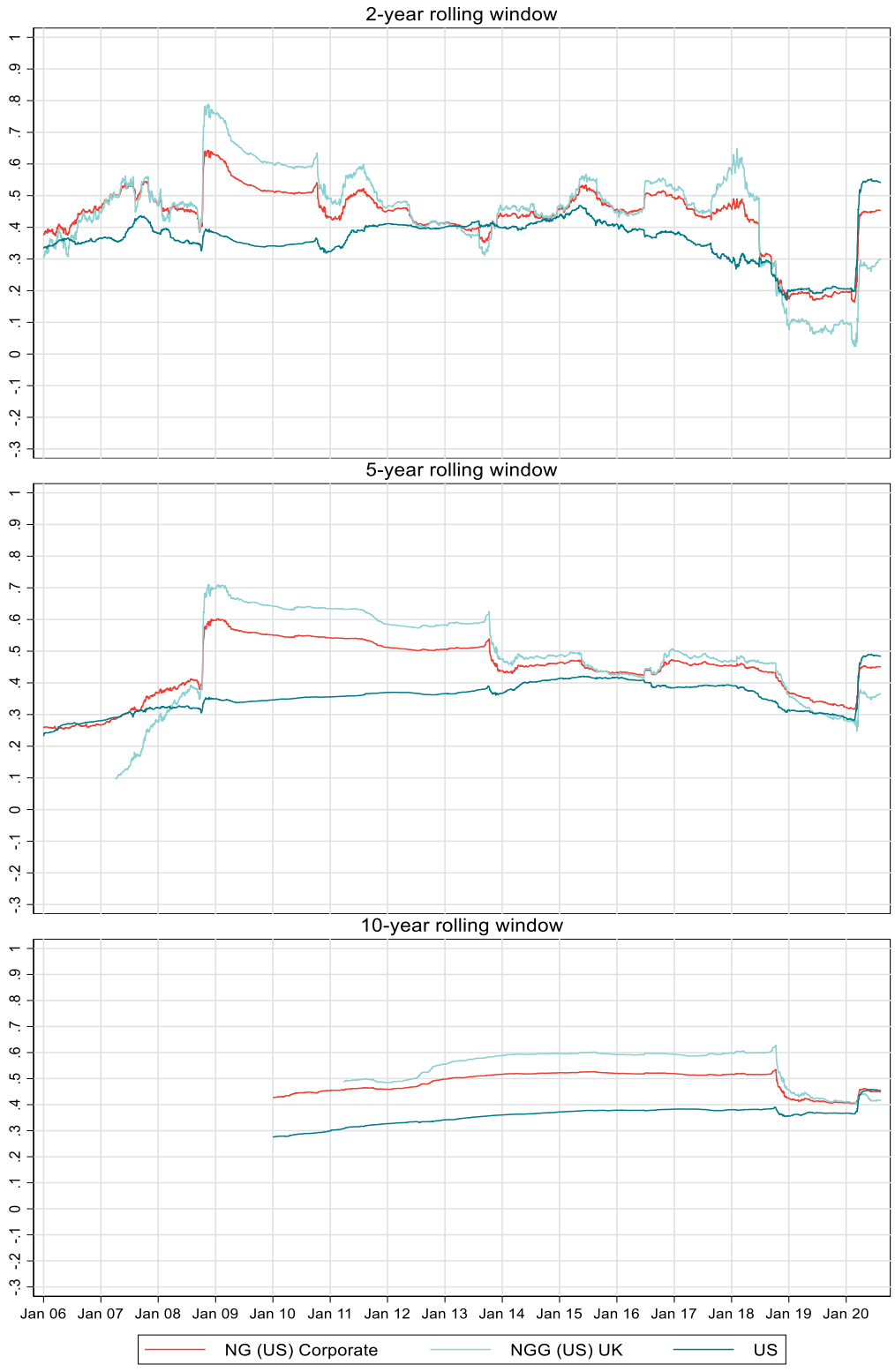
Findings

The figure below presents NGG's estimated pure play GB energy network beta using the US listed stocks for the NG group. As with previous estimations, shorter windows give more volatile results. However we see that apart from the last two years in shorter estimation windows:

- The implied GB pure play energy network beta is above NGG's group beta, implying that NGG group beta represents a lower bound for NGG's GB pure play beta.
- NG's estimated GB pure play energy network beta is consistently above Ofgem's proposed range.

This evidence corroborates and strengthens our findings from NG's UK listing.

Figure 22 Estimates of a GB pure play energy network beta using NG's US listing

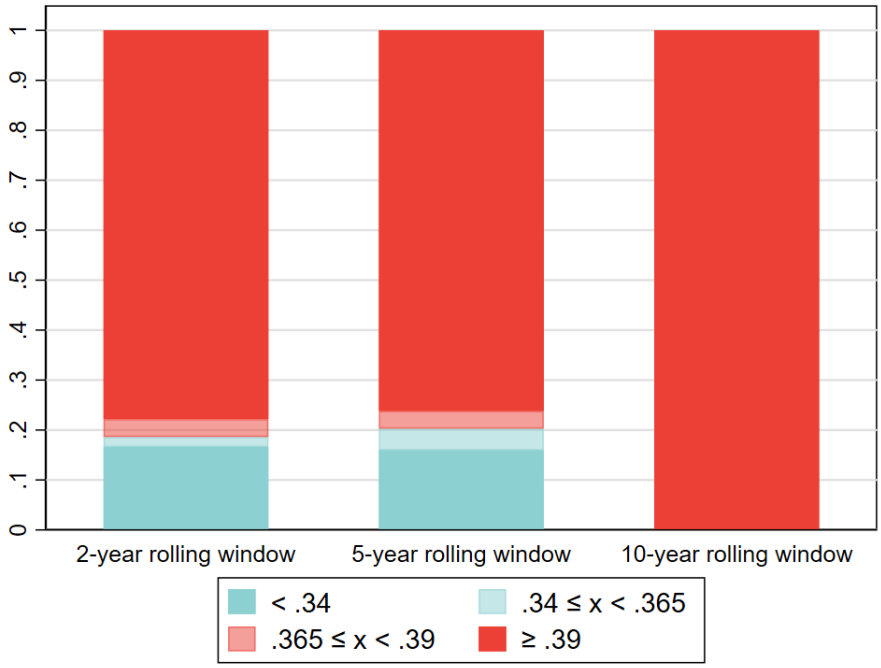


Source: *Frontier Economics based on Bloomberg*

Note: *Analysis carried out using operational income as weights for different activities*

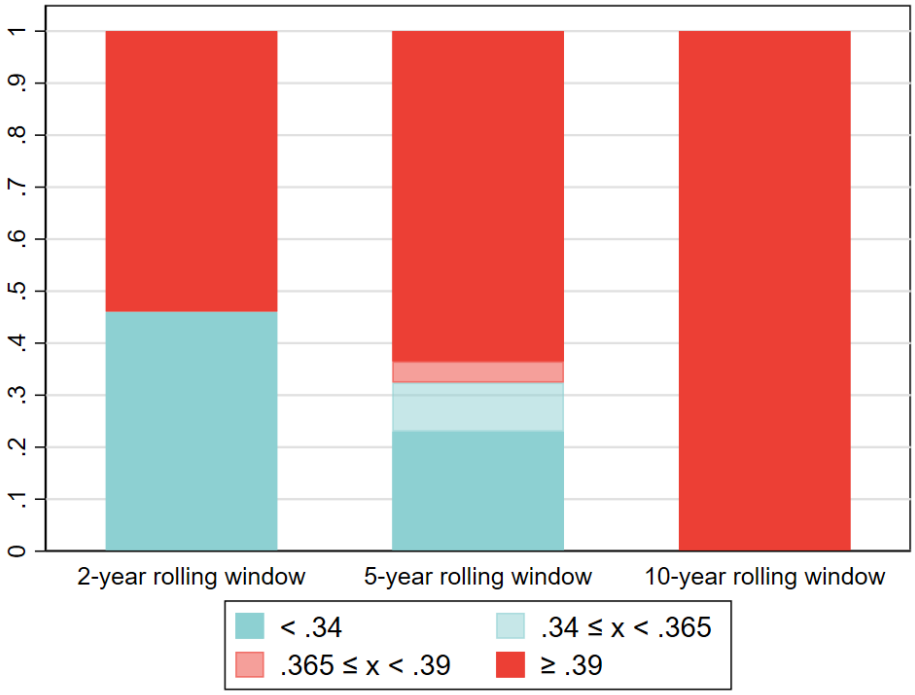
As in other sections, it is also helpful to provide a summary figure of whether these findings support Ofgem's chosen range, or otherwise. Below we show two further figures that address this question, one running over the whole period of analysis from 2006, and a second that looks only at more recent evidence from 2016.

Figure 23 Percentage of time that NG US's estimated GB pure play asset beta falls within Ofgem's range – from 2006



Source: *Frontier Economics based on Bloomberg*
Note: *Analysis carried out from 2006 onwards for available data points*

Figure 24 Percentage of time that NG US's estimated GB pure play asset beta falls within Ofgem's range – from 2016



Source: *Frontier Economics based on Bloomberg*

Note: *Analysis carried out from 2016 onwards for available data points. We note that the 5Y and 10Y estimation windows includes data from pre-2016 (e.g. the 10-year beta reported against date 01/01/2019 is estimated by regressing stock returns over market returns over the previous 10 years, so from 2009 onwards). Hence this estimate may be distorted by data from the GFC/SDC period*

These two figures require little additional commentary. It is clear that the great majority of estimations over time and for all estimation windows suggest that the upper end of Ofgem's beta range has been set too low.

3.4 Decomposition of SSE's beta

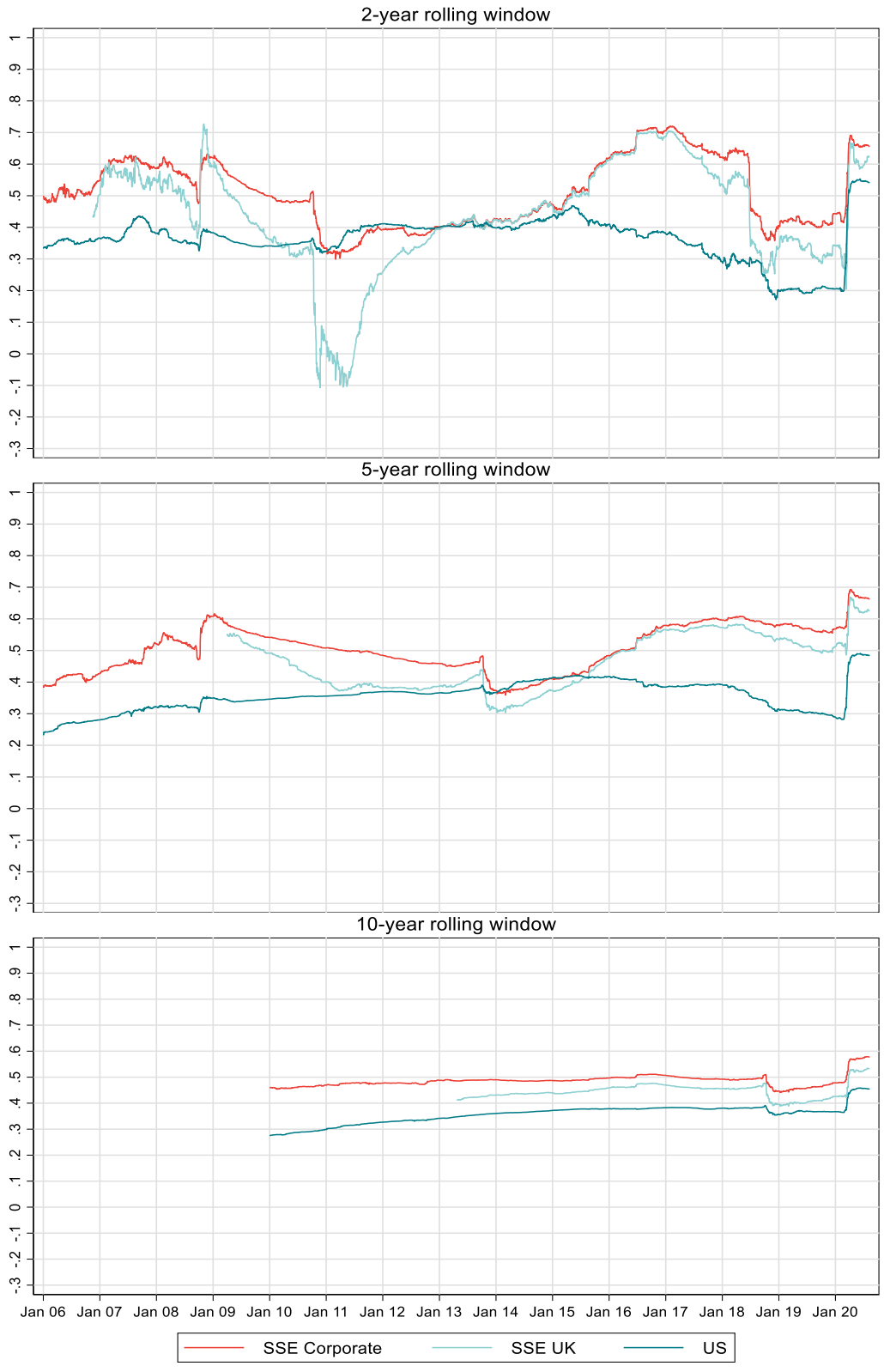
A similar approach can be adopted to decompose SSE's corporate beta, so as to produce a further estimate of the underlying GB pure play energy network beta.

- We first directly estimate SSE's group beta.
- We then use the fact that this beta is a weighted average of:
  - The underlying beta for SSE's GB regulated energy network; and
  - SSE's underlying beta for the unregulated business.
- By estimating the beta for SSE's underlying unregulated business (using Centrica) we can then impute the implied GB regulated energy network beta.

Findings

Our decomposition of SSE results show that the estimated GB pure play energy networks beta is generally higher than those found when this exercise was conducted on NG. Both the figure and table below support an energy network asset beta well above Ofgem's proposed upper bound.

Figure 25 Estimates of the GB pure play energy network asset beta imputed from SSE's group beta



Source: *Frontier Economics*

Note: *Analysis carried out using operational income as weights for different activities*

Figure 26 SSE's estimated GB pure play energy network asset beta

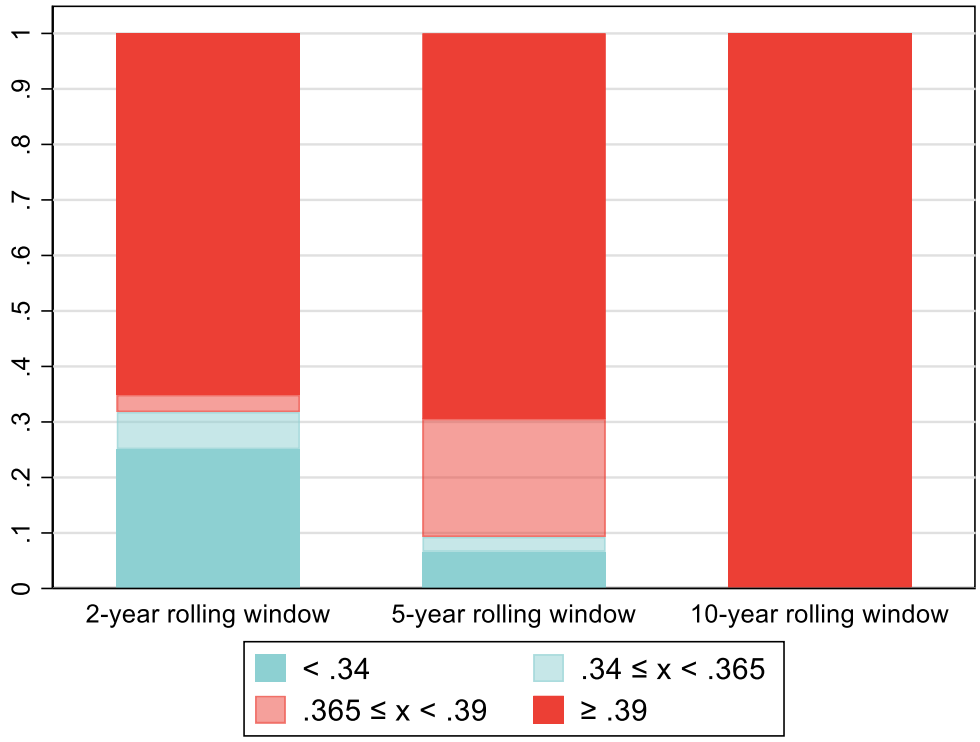
Estimation window	Averaging period	SSE's estimated GB pure play asset beta
2 years	Spot (27/12/2019)	0.34
2 years	Spot (06/08/2020)	0.62
2 years	2 years	0.38
2 years	5 years	0.52
2 years	10 years	0.42
5 years	Spot (27/12/2019)	0.51
5 years	Spot (06/08/2020)	0.63
5 years	2 years	0.54
5 years	5 years	0.54
5 years	10 years	0.46
10 years	Spot (27/12/2019)	0.43
10 years	Spot (06/08/2020)	0.53
10 years	2 years	0.44
10 years	5 years	0.45
10 years	10 years	0.45

Source: Frontier Economics based on Bloomberg

Note: Analysis carried out using operational income as weights for different activities. Cells highlighted in red sit above Ofgem's proposed point estimate.

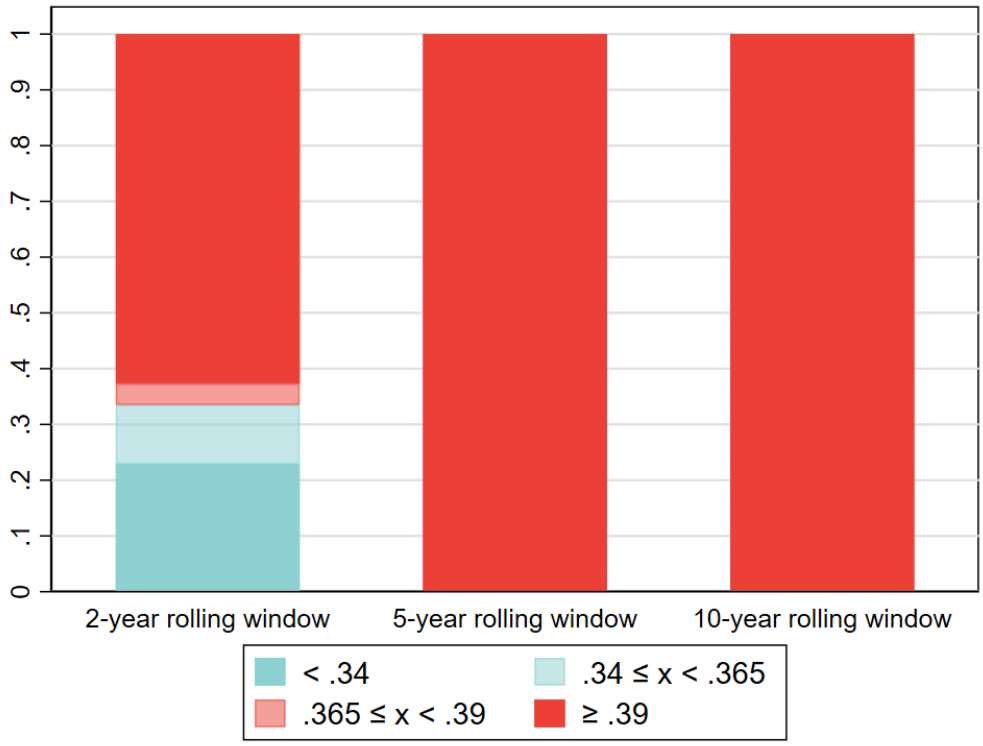
These conclusions are supported by the figure below, which shows that across all estimation windows, SSE's estimated BG pure play asset beta is consistently above Ofgem's proposed range.

Figure 27 Percentage of time that SSE's estimated GB pure play asset beta falls within Ofgem's range (from 2006)



Source: Frontier Economics based on Bloomberg
Note: Analysis carried out from 2006 onwards for available data points

Figure 28 Percentage of time that SSE's estimated GB pure play asset beta falls within Ofgem's range (from 2016)



Source: *Frontier Economics based on Bloomberg*

Note: Analysis carried out from 2016 onwards for available data points. *We note that the 5Y and 10Y estimation windows includes data from pre-2016 (e.g. the 10-year beta reported against date 01/01/2019 is estimated by regressing stock returns over market returns over the previous 10 years, so from 2009 onwards). Hence this estimate may be distorted by data from the GFC/SDC period*

The decomposition of SSE's beta therefore provides further evidence that the top end of Ofgem's beta has been set to low.

3.5 Decomposition of PPL's beta

In its report on behalf of Ofgem, CEPA suggested that a similar decomposition exercise could be carried out on another stock, i.e. PPL. PPL is a US-listed company with activities in US and GB regulated energy networks (WPD, an electricity DNO). As for NGG , PPL's group beta listed on the US market can be decomposed into individual betas for its US and GB regulated activities.

However, this exercise is potentially exposed to considerable uncertainty due to the fact that the stock is not listed in a UK stock market. The beta of PPL against S&P 500 can serve as a cross check in the same way as the NG US listing decomposition carried out above. The absolute level of the beta estimate for PPL is of less relevance for estimating a GB energy network beta as the starting point of the group beta is against the US market.

Moreover, it is worth nothing that the underlying business is more complex in the case of PPL, as it has engaged in a number of transactions over time that have markedly changed the footprint of its activities. Whereas NG (and SSE, to the

extent one excludes the recent sale of Ovo) have much more stable business footprints.

- PPL owns WPD, which owns four electricity DNO licences operating in GB. Two of those licences have been held since the 2000s. But two more (East and West Midlands) were only added in 2011.
- In the US, PPL currently owns and operates assets in Pennsylvania, Kentucky, Virginia and Tennessee. It also owns Safari Energy, a provider of solar power solutions for commercial customers.
  - Its operations in Kentucky were only acquired in 2010, with the purchase of LG&E and KU from what was then E.On US.
  - In 2014 PPL Montana (a subsidiary of PPL) disposed of a sizeable portfolio of hydroelectric facilities to NorthWestern Energy.
  - Until 2015 PPL owned a large portfolio of generating assets. These were disposed of at that time in a process that commenced in 2014 and created Talen energy.
  - In 2016 PPL disposed of PPL Solutions, a provider of billing, business process outsourcing, call centre and IT services, to Hansen Technologies Ltd.
- We note that PPL has just announced a process to dispose of its UK holdings.

Taken in the round, it is safe to say that PPL has had a rapidly evolving business footprint with marked changes in the underlying split between UK, US and regulated/non regulated parts of its business. This can be seen by looking directly at estimated business weights. The table below shows PPL's business weights over time, calculated using operating income. This measure indicates that, in the past 5 years, UK and US regulated activities have become a larger part of PPL's business.

Figure 29 PPL's business weights based on operating income

	UK reg	US reg	Unreg
2004	33%	20%	46%
2005	35%	30%	35%
2006	36%	31%	33%
2007	38%	15%	47%
2008	27%	20%	53%
2009	40%	35%	25%
2010	22%	21%	57%
2011	24%	29%	46%
2012	46%	26%	28%
2013	63%	50%	-12%
2014	54%	39%	7%
2015	83%	66%	-48%
2016	55%	46%	-1%
2017	43%	58%	0%
2018	54%	47%	-1%
2019	50%	51%	-1%

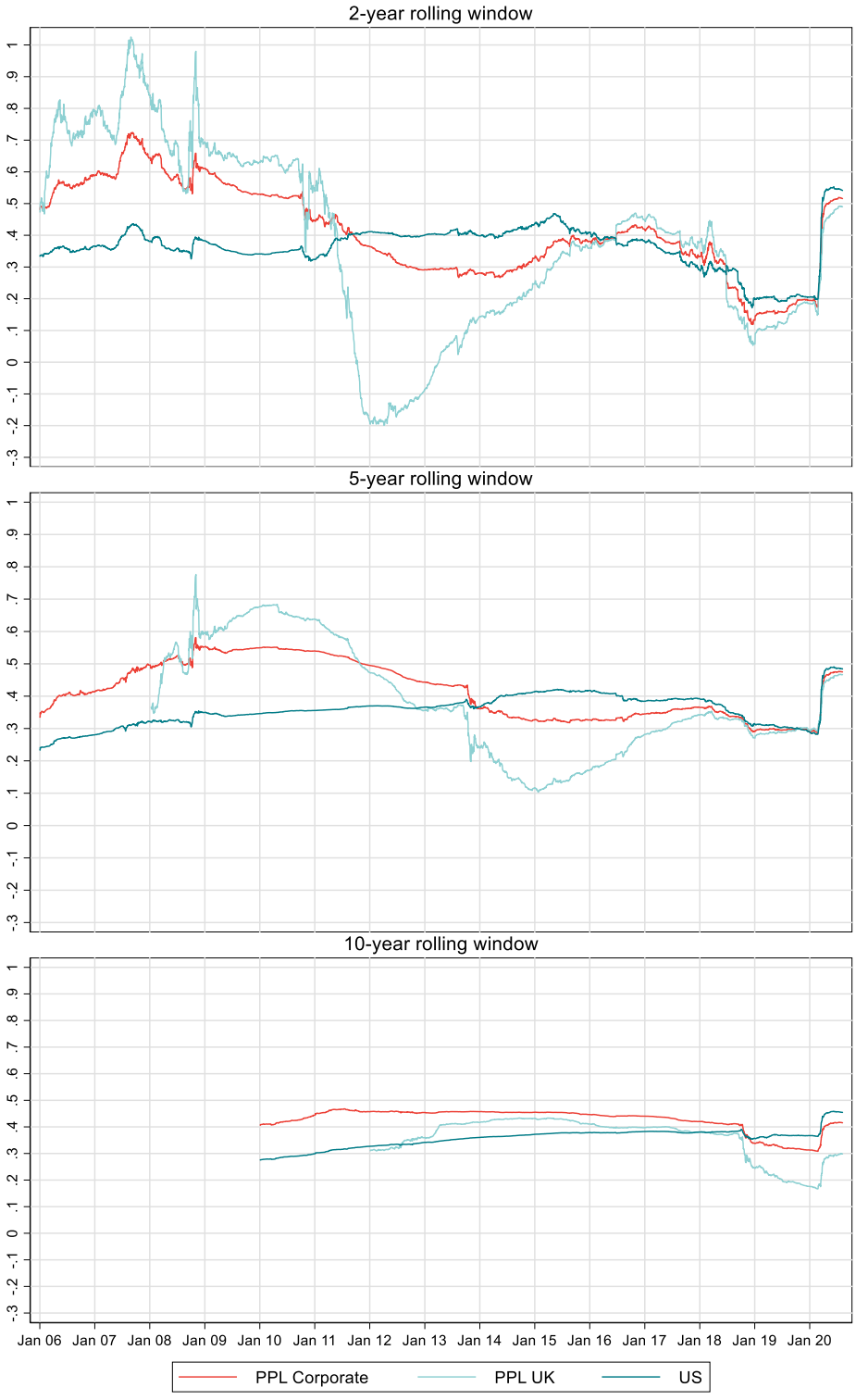
Source: Frontier Economics based on Bloomberg data

Despite this, the figure below shows our decomposition of PPL's beta. Our analysis of PPL produces relatively volatile results. Given PPL's activity in M&A, this is perhaps not surprising.

- The 2-year estimations suggest that PPL's UK regulated beta would have alternated in time between being higher and lower than PPL's group beta. Recently, it has been slightly below.
- The 5-year estimations show that between 2008 and 2012 and since 2017, PPL's UK regulated beta would have sat above PPL's group beta. The opposite is true between 2012 and 2017.
- The 10-year estimates suggest that PPL's UK regulated beta would always be below PPL's group beta.

On balance, we consider the PPL decomposition offers only the value of a cross check for our decomposition result. It is less relevant than our other UK listed companies such as NG and SSE, because the starting point of the group beta is estimated against the US equity market, which is not the underlying assumption in our cost of equity estimation (which is based on the UK market). Coupled with the complex nature of the underlying businesses of PPL, we present these findings only for completeness. We do not agree with CEPA's interpretation that PPL presents a challenge to the underlying robustness of our direct decomposition methodology.

Figure 30 Estimates of PPL GB pure play energy network asset beta



Source: Frontier Economics based on Bloomberg data

Note: Analysis carried out using operational income as weights for different activities

3.6 Discussion of CEPA's analysis

CEPA has conducted its own decomposition analysis for NG and SSE using the same method as we describe above. Whilst CEPA concludes that the volatility of the results and the assumptions that need to be made do not allow the analysis to be useful, we note that the results they obtain are similar to ours.

CEPA has also carried out a recomposition analysis by estimating NG's group beta using a weighted average of estimated beta from a US sample and estimated beta from a representative sample of NG's pure play activities (water companies or European energy networks). Again, we find that CEPA's results are supportive of our conclusion that NG's beta usually sits above that of GB water, as explained below.

Decomposition analysis

CEPA's decomposition results from NG and SSE are presented below. They show similar conclusions to our analysis:

- Over the past 6 years, the underlying GB pure play energy network beta derived from NG's beta has been above NG's group beta, suggesting that NG's group beta should be a **lower bound** for setting the GB energy network beta.
- Over the period since 2014, the underlying GB pure play energy network beta derived from SSE's beta has been in the range 0.4 to 0.5 for most of the period, supporting a view that the upper end of Ofgem's range has been set too low.

Figure 31 CEPA's decomposition results

Source: Frontier Economics based on CEPA

Recomposition analysis

To test the validity of its conclusions, CEPA reconstructs NG's group beta using its decomposition approach, by:

- Estimating the implied beta of NG's US activities via a sample of US comparators

- Estimating the implied beta of NG's GB regulated utilities via the UK water sample (UU / SVT / PNN) or a European sample (see section 4 for CEPA's selection of European peers)
- Using adjusted operating income to weight these together in order to produce an alternative, bottom-up, estimate of NG's headline beta.

CEPA argues that if the reconstructed beta estimates are close to NG's actual group beta, then water companies (or the sample of European companies) are a good proxy for NG's GB regulated beta. CEPA concludes that this is indeed the case over the long term as the two estimates are indeed close together.

However, the evidence presented by CEPA does not support this conclusions. The figures below show that CEPA's constructed NG beta is systematically below the actual beta in both analyses, implying that the UK water and European samples used by CEPA only represent lower bounds for NG's pure play beta.

Figure 32 NG beta reconstructed using the UK water sample

Source: CEPA, RIIO-2: Beta estimation issues, 9 July 2020

Figure 33 NG beta reconstructed using the European sample

Source: CEPA, RIIO-2: Beta estimation issues, 9 July 2020

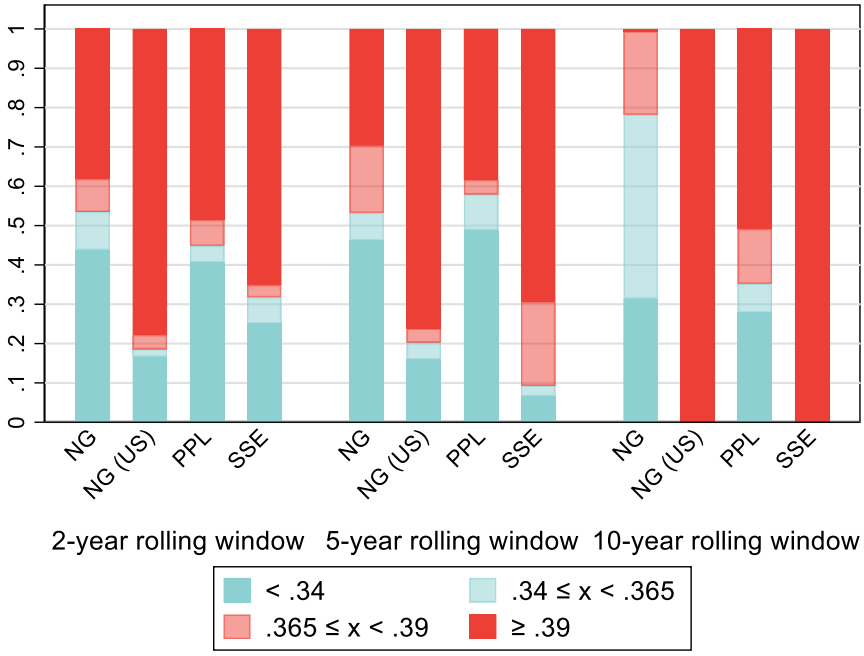
3.7 Summary findings from our decomposition analysis

In this section we pull together all of the evidence from our decomposition work, and our review of CEPA's decomposition work.

- The conclusions one draws from our decomposition of NG's group beta depend to a large extent on the estimation window and time horizon.
  - The evidence from long estimation windows and/or averaging periods tends to support the location of Ofgem's upper and lower bounds.
  - But in contrast more recent evidence strongly supports the view that the upper bound has been set far too low.
  - To prefer the theory that Ofgem's current proposed range is appropriate, one would need to set out a compelling case for why the most recent five years (or so) of evidence should be largely discounted, in favour of much older evidence.
  - The picture is further clouded by a strong COVID19 effect which is evident in the US sample.
- In contrast to the NG decomposition, our decompositions for both SSE and NGG strongly indicate that Ofgem's upper bound have been set too low.
  - This is the case regardless of the estimation window or time horizon one considers to be most informative.
- It is difficult to draw clear conclusions from the PPL decomposition, which we consider self-evidently the least informative owing to the volatility of PPL's underlying business footprint.
- Taken in the round, we consider that the decomposition analysis reinforces our findings from analysis of the UK 5.
  - There is some evidence to support the location of Ofgem's lower bound.
  - But there is considerably more weight of evidence to suggest that the upper bound has been set too low.

The balance of evidence over different time periods and estimation windows is summarised in the figures below, showing the proportion of our beta estimations that fall above/below Ofgem's proposed range, first for the full run of data from 2006 (Figure 34) and then from beginning of 2016 Figure 35). The red segment of the bars, indicating evidence that lies above Ofgem's upper bound, is most prevalent across all these figures and bars, particularly the second figure containing more recent evidence.

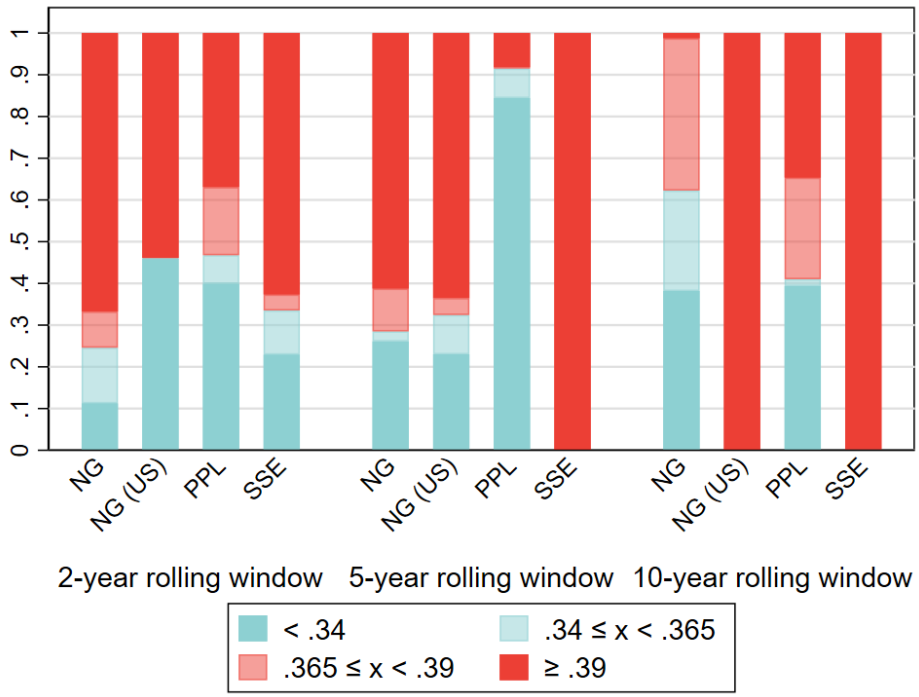
Figure 34 Percentage of time that estimated GB pure play asset betas fall within Ofgem's range by utility – from 2006



Source: *Frontier Economics based on Bloomberg*

Note: *Analysis carried out from 2006 onwards for available data points*

Figure 35 Percentage of time that estimated GB pure play asset betas fall within Ofgem's range by utility – from 2016



Source: *Frontier Economics based on Bloomberg*

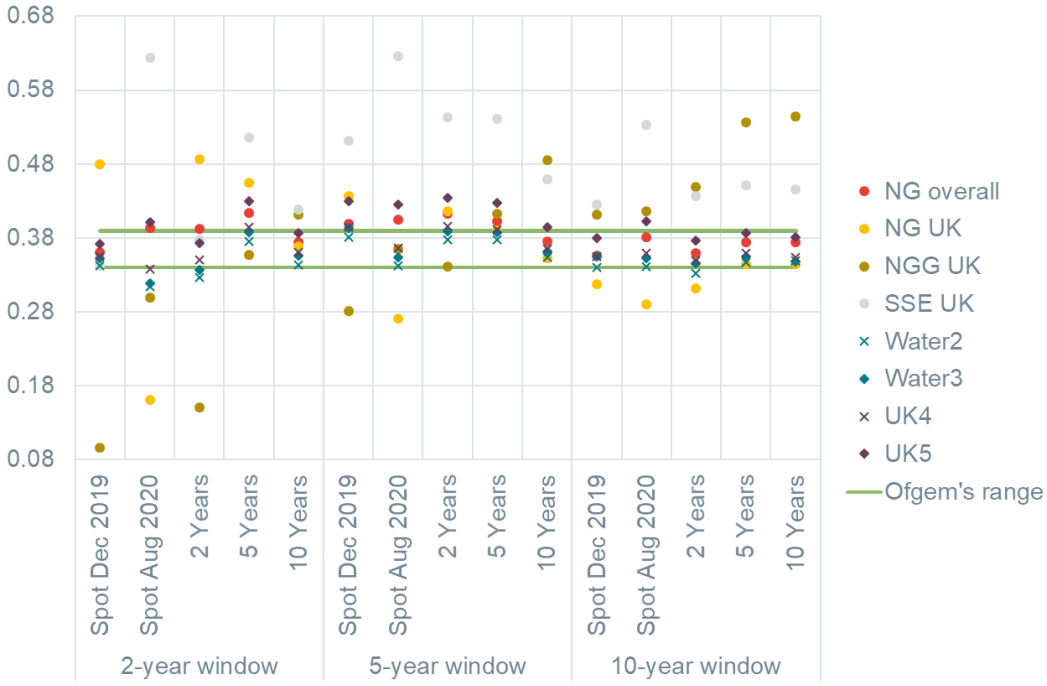
Note: *Analysis carried out from 2016 onwards for available data points. We note that the 5Y and 10Y estimation windows includes data from pre-2016 (e.g. the 10-year beta reported against date 01/01/2019 is estimated by regressing stock returns over market returns over the previous 10 years, so from 2009 onwards). Hence this estimate may be distorted by data from the GFC/SDC period*

We consider that our analysis broadly matches CEPA's findings, although we note that CEPA reported its findings rather differently. As we noted above:

- CEPA's decomposition work supports a view that:
  - NG's group beta is likely to be an underestimate of the underlying GB pure play energy network beta over the recent 5 years or so.
  - All of the evidence from decomposing SSE's beta supports a much higher upper bound for beta than Ofgem has presumed.
- All of CEPA's recomposition work indicates that neither the water companies nor CEPA's EU peers can, when combined with other evidence, explain NG's or SSE's group betas – in all cases, the result is systemically too low.
  - The logical conclusion is that neither the water sector nor the CEPA EU group contains firms that are as systematically risky as GB energy networks.

Our final exhibit summarises all of this evidence alongside some of the evidence we presented in the preceding section. As ever when estimating beta, there is considerable noise. But our assessment is that there is too much evidence that sits above Ofgem's upper bound – in particular the great majority of recent evidence – and that this must not be ignored.

Figure 36 Summary of results from decomposition analysis



Source: *Frontier Economics based on Bloomberg*

Note: *Analysis carried out from 2006 onwards for available data points*

4 ASSESSMENT OF EUROPEAN PEERS

Given the limited number of listed pure play utility network operators in Great Britain, asset betas for European energy network operators can provide useful additional evidence to assess the appropriate beta for RIIO T2/GD2. In this section we build on the work undertaken by CEPA for Ofgem on the betas of European energy companies.

4.1 Variation in beta across the European peer group

Any cross-country comparison will need to be carried out with care (as rightly noted by Ofgem[12]) and the results from such an exercise need to be interpreted with caution – on first sight, comparing network operators across Europe (including GB) may seem straightforward, but there are numerous factors that can lead to significant differences in the respective risk profiles and, by extension, investors' perception of each company's exposure to systemic risk.

These factors can lead to material differences in betas across companies that look ostensibly similar:

- The degree of protection provided by the regulatory framework, e.g. the treatment of differences in forecasted and actual costs, with a larger share of these differences being supported by operators leading to higher uncertainty;
- The scope and strength of incentives on quality measures/outputs, with larger shares of exposed regulated revenue leading to increased perceived risk;
- The transparency and maturity of regulatory frameworks, with more significant changes leading to increased uncertainty over the characteristics of the future regime;
- The share of unregulated activity in the business, with footprints in competitive markets typically being associated with higher risk; and
- The share of activity in a particular country, exposing an operator to systemic risk factors specifically related to the country in question.

We note that all of the estimation challenges we discuss for the GB firms above equally arise for operators from other European countries. In particular, there are very few energy network pure players, with most firms also engaging in a range of non-network-related and/or non-regulated activities.

Beta estimates for European peers will also be affected by a range of technical matters, which need to be carefully assessed before drawing any inferences for the appropriate asset beta for the RIIO-2 period. These various factors yield significant differences in betas for individual companies – some pointing to lower betas and some pointing to higher betas.

Even before considering a possible refinement of the sample, the number of available comparators for the European peer group is already small with a

[12] "Similarly, if GB energy networks are exposed to higher levels of systematic risk than GB water networks, as argued by network companies, then reliable analysis of European comparators should help reveal this.", Ofgem, RIIO-2 Draft Determinations – Finance Annex, 3.59

maximum of 12 firms being considered by CEPA as a starting point. While a further reduction of the sample could, in principle, be justified where a beta estimate isn't considered to be robust enough, it is equally easy to bias results by excluding companies arbitrarily as the sensitivity of the sample to individual firms will only increase.

4.2 A criteria based approach

Careful consideration of the estimated betas is therefore required to ensure a balanced assessment of the full body of appropriate evidence. We agree with Ofgem and CEPA, that a criteria-based approach can, in principle, help to guide such an assessment. We also generally agree with the set of criteria that CEPA proposes.

However we find that **CEPA's application and interpretation of the selection criteria is characterised by a number of fundamental shortcomings that lead to a downwards-biased assessment of the European peer group evidence** and a consistent rejection of evidence pointing to higher betas:

- **CEPA's assessment of regime similarity fails to appropriately reflect important risk differences between regulatory frameworks in Europe**, even where their general characteristics seem to broadly align. Our direct analysis of regulators' decisions demonstrates that CEPA's proposed sample exclusively covers network companies from "low-risk" regimes, failing to equally include "higher-risk" frameworks that more closely align with the RIIO-2 regime.
- Equally, **when assessing technical criteria, CEPA's approach is overly restrictive and leads to a rejection of comparators without appropriate justification**. Similarly, we consider that CEPA erroneously rejects firms from its sample based on there being insufficient data, while, in fact, required data is available to extend the assessment to these firms.

In the following section, we discuss how a balanced assessment of the proposed criteria allows to consider all of the available evidence, demonstrating in particular that there is no credible justification to reject high-beta peers out of hand as practiced by Ofgem and CEPA.

4.3 The initial peer group of 12

We use the same initial sample of twelve European utility companies proposed by CEPA and considered in their report. We understand that this sample is in turn mainly based on comparators used in previous expert reports by Frontier Economics[13] and Oxera[14] and supplemented with three additional firms by CEPA. This list of potential peers is as follows:

- Elia – Electricity transmission in Belgium and Germany
- Fluxys – Gas transmission in Belgium
- Red Eléctrica de España – Electricity transmission in Spain

[13] Frontier Economics (2020) Beta decomposition. A report for National Grid and SSE

[14] Oxera (2019) Cost of equity for RIIO-2 – Q4 2019 update.

- Enagás – Gas transmission in Spain
- Endesa – Electricity distribution and generation in Spain
- Redes Energéticas Nacionais (REN) – Electricity and gas transmission in Portugal
- Terna Group – Electricity transmission in Italy
- Snam – Gas transmission in Italy
- Enel Group – Electricity distribution and generation in Italy
- Holding Energia Risorse Ambiente (HERA) – Electricity and gas distribution, waste and water management in Italy
- A2A – Electricity and gas distribution and generation, waste and water management in Italy
- Transelectrica – Electricity transmission in Romania

All of these firms are generally also retained within the peer group samples (amongst, at times, other non-European firms) used by energy regulatory offices across Europe.

4.4 Accounting for differences in regime risk

The regulatory regime can significantly influence the exposure of a network operator to systemic risk, hence influencing its asset beta. During our analysis, we identified a fundamental misunderstanding of the relevant dimensions of regulatory risk in CEPA's assessment of regime similarity for the European comparators:

- CEPA themselves note in their report that they "have not conducted a detailed relative risk assessment" limiting their assessment to what they consider to be the "key features" of each regime.[15] In our view this provides insufficient evidence to take a view on how investor's risk perception and minimum return requirements may vary across the sample as it misses a range of potentially important dimensions.
- CEPA identifies as "key" many dimensions in which there is very little variation across Europe, namely the existence of a RAB model, the type of cap or the duration of the price control period.
  - While we agree that some of these aspects can have strong impacts on the perceived regulatory risk and return uncertainty, such as notably the frequency of price reviews, we equally observe that these are now largely aligned across the European countries in question.
  - More generally, we note that almost all regulatory offices now adopt the same foundational features that CEPA covers in their analysis. As such, while important variation may exist in principle, it is unlikely that these dimensions would drive differences in the regulatory risk perceived by equity investors.[16]

[15] Page 42, "RIIO-2: Beta estimation issues", CEPA

[16] Indeed, CEPA themselves state: "[…] we view the resulting differences [*in their "key features"*] as being unlikely to completely obscure the relevance of the comparison".

In contrast, we have carried out a detailed assessment of regulatory decisions for each of the relevant sectors and have particularly focused on:

1. The stability and maturity of the regulatory framework;
2. The strength of incentives on operating expenditure and capital expenditure; and
3. The treatment of losses as well as the scope and strength of incentives related to quality.

On this basis, we identify potentially significant differences in regulatory risk between different countries and network types which are completely omitted by the analysis that CEPA conducted. As discussed above, the set of drivers that gives rise to some differences in estimated beta values can never be perfectly known, however, we would expect to observe a wide beta range in line with the risk characteristics of the regulatory frameworks that we have identified.

The following table provides an overview of our detailed assessment of the regulatory frameworks.

Figure 37 Key characteristics of regime risk of European regulatory frameworks

Country - Network	Regime maturity	Opex - Incentives	Capex - Incentives	Losses	Quality incentives
GER – ET	Mature	100% pass through on non-controllable (volatile) costs Controllable costs are 100% incentivised Efficiency factors are based on operator benchmarking		Treated as pass-through	None
BEL – ET	Mature	100% pass-through on non-controllable Opex 20% sharing factor on "less-controllable" Opex (capped to -2M€/+6M€) 100% sharing factor on controllable Opex	100% pass through, as long as deemed reasonable by the regulator	Treated as pass-through	Financial bonus on certain quality indicators (e.g. quality of supply and market integration)
BEL – GT					Introduction of financial bonus if TSO satisfies a number of quality objectives (emissions, energy efficiency, data availability, etc.)
ESP – ET	The regime has recently been subject to considerable change, as CNMC has retaken decision power from the Ministry	100% sharing factor on Opex Non-linearly increasing additional Opex allowance for operating fully depreciated assets	50% sharing factor within a +/-25% of reference band 100% pass-through otherwise	None	Financial incentives capped at -3.5% / +2.5% of regulated revenues for quality of supply
ESP – GT			50% sharing factor		None
ESP – ED			100% pass-through within a -10% / +5% reference band 50% sharing factor otherwise	Losses incentive with respect to a reference target – included in quality financial cap	Financial incentives capped at +/- 3% of regulated revenues Includes quality of supply, losses, fraud, etc.
PT – ET and GT	Mature	100% sharing factor on controllable Opex Variable Opex determined on the basis of a price-cap and various cost-drivers (volume, number of consumers, ...), trued up in n+2	100% pass-through, as long as deemed reasonable by the regulator	None	None
ITA – ET, GT	Currently in a transition period to an output-based regime	Asymmetric incentives on Opex: ▪ 100% sharing factor if above reference trajectory ▪ 50% sharing factor if below reference trajectory	100% pass-through, as long as deemed reasonable by the regulator 20% sharing factor expected to be introduced going forward (ET only)	None	Financial incentives capped at -0.5% / +1.5% of regulated revenues Quality of service
ITA – ED, GD	Currently in a transition period to an output-based regime Tariffs determined by the regulator	Asymmetric incentives on Opex: ▪ 100% sharing factor if above reference trajectory ▪ 50% sharing factor if below reference trajectory	100% pass-through, as long as deemed reasonable by the regulator	Losses incentive included in scope of quality incentives	Financial incentives Quality of service and customer satisfaction and losses
ROM – ET	Transition period following public intervention in the energy market in 2018-2019 Second regulatory period started recently	100% pass-through on non-controllable Opex 50% sharing factor on controllable Opex	100% pass-through, as long as deemed reasonable by the regulator	Operator carries some downside-risk if losses differ too much from reference values	None
GB – ET, GT	Considerable change through a number of regulatory changes expected for RIIO-2	The level of pass through is low, limited to costs that are outside company control - e.g. business rates RoRE variation of up to 2.6%/2.9% (ET, GT) – This translates into regulated revenue at risk (excluding variation for Totex incentives) of +0.8% / -4.7% (ET) and +1.6% / -2.3% (GT), applying to a large scope on quality, spanning six main output categories			

Source: Frontier Economics

Figure 38 below summarises our risk assessment for each regime and dimension. We have used a colour-code to highlight risk exposure, with "green" being assigned to the lowest risk regimes, gradually increasing to "red", which is used for the highest risk environments. We find that:

- **The RIIO framework is one of the riskiest regimes in Europe.** In particular, our analysis suggests that the scope and strength of the financial incentives to which operators are exposed is unparalleled in other European regimes and creates significant uncertainty on future returns compared to what investors would expect for the continental peer group. We also note the highly asymmetric nature of financial incentives provided by the regime, in particular for the electricity transmission business, as outlined by Ofgem in its RIIO-2 Draft Determination. By Ofgem's own analysis, compared to the baseline return on equity, the network operator faces a possible upside of only 0.2% (absent the totex incentive), but a possible downside of 1.3%. This translates into a range of regulated revenue at risk of 0.8% upside and -4.7% downside – this is significantly above and more asymmetric than what is applied by other regulatory offices.[17]

  In addition, the important changes that Ofgem proposes for RIIO-2 creates additional risk due to an increased focus on ex-post assessments and clawbacks. The challenging nature of the regime for network operators, in particular going forward, has also been recognized by several credit rating agencies, for instance

  - **Moody's** states "*… the inclusion of an 'assumed outperformance wedge' in the cost of capital calculation represents the largest shift from precedents. Ofgem has made an ex-ante assumption of outperformance of the RIIO-2 price control, based on historical performance in both RIIO-1 and the wider UK regulatory regimes, and reduced the allowed cost of equity. […] The change represents a departure from established regulatory practice, adherence to which has supported widespread confidence in the stability and predictability of the regime. As such, it is credit negative.*"

    "*[…] Where, however, regulatory developments lead to a scenario in which network companies can no longer recover their efficient costs in a timely manner or earn a fair return in prevailing market circumstances, their credit risk will increase. Consequently, further measures to promote legitimacy at the expense of the networks may cause us to review our assessment of business risk. Assuming no outperformance and in the absence of measures to protect credit quality, the regulator's wedge will lead to even weaker adjusted interest coverage ratios.*"[18]

  - **Fitch** also notes "*Ofgem's draft determinations (DDs) for the RIIO-2 price control period of 2021-2026 propose allowed real equity returns that are around 40% below the current level. Additionally, the scope for*

[17] We note that comparability of return uncertainty should in principal be based on upside and downside potential on the rate of regulated return directly. However, given data limitations on the equity-financed shares of RAB for most of the countries in the sample, we consider that a comparison of regulated revenue-at-risk provides a sufficiently good proxy to assess return uncertainty across the peer group.

[18] „RIIO-2 proposals support sector's business risk profile, but legitimacy in greater focus", Moody's sector comment, 3 August 2020

outperformance could be halved in terms of returns on regulated equity (RoRE). This will significantly reduce companies' cash flow. Fitch Ratings expects significant pressure on financial profiles, including gearing and post-maintenance, post-tax interest coverage ratios (PMICRs). Fitch expects that most companies will need to adjust their dividend policies in order to maintain gearing commensurate with their current ratings. […]

We believe Ofgem's proposal will put pressure on the credit profiles of all Fitch-rated UK energy networks. Wales & West Utilities Limited (BBB/Negative) and National Grid Plc (NG; BBB/Stable) are currently the most exposed to potential negative rating actions if the proposal is implemented in the final determinations (FDs) in December 2020 or if the companies fail to implement enough mitigating measures to maintain credit metrics in line with our sensitivities."[19]

The Belgian framework can in no way be qualified as "closest comparable" to the GB regime. In their report, CEPA argue that "comparability appears strongest, at a high level, for Elia and Fluxys". Our analysis shows that the opposite is in fact true. Amongst the different regulatory frameworks we investigated, the Belgian regime can be considered as having the lowest risk. For example, both transmission system operators are not subject to any downside risk on quality of supply with the framework exclusively providing financial bonuses if operators exceed pre-defined thresholds. This contrasts with most of the other regimes, and particularly the GB framework, where quality incentives can lead to both bonuses *and* penalties and cover a large scope of outputs, producing a significantly larger degree of uncertainty/scope for variation in future returns for equity investors compared to the Belgian regime.

- **CEPA's preferred sample only includes evidence on the lower range of betas.** Our analysis shows that CEPA's preferred sample (highlighted in yellow below) exclusively includes the lowest risk regimes and seems to have excluded *all* higher risk regimes – electricity and gas distribution in Spain and Italy and electricity transmission in Romania.

[19] https://www.fitchratings.com/research/corporate-finance/what-investors-want-to-know-riio-2-draft-determinations-for-electricity-gas-16-07-2020 ; 16 July 2020

Figure 38 Summary of the regime risk assessment – CEPA sample highlighted in yellow

Country-Network	Regime maturity	Opex - Incentives	Capex - Incentives	Losses	Quality incentives
GER - ET					
BEL - ET					
BEL - GT					
ESP - ET					
ESP - GT					
ESP - ED					
PT - ET and GT					
ITA - ET, GT					
ITA - ED, GD					
ROM - ET					
GB - ET, GT					

Source: Frontier Economics

Note: CEPA proposed sample highlighted in yellow

This evidence is consistent with the betas we estimate for each of the European comparators as shown by Figure 39 below. Network firms which are, according to our appraisal, subject to a higher risk regime tend to have higher betas and firms subject to a lower risk framework have lower beta estimates.

Our general preference is not to exclude entirely a firm from consideration owing to our assessment of regime risk in order to retain a large sample. However, **our analysis clearly shows that CEPA's preferred sample *cannot* yield an appropriate beta for the GB energy networks** on the basis of the risk differences we have identified. When assessing evidence from the CEPA sample, it should be understood that the set of companies included are likely to have lower risk exposure than GB energy networks. The beta range resulting from CEPA's sample range is therefore likely to exclusively inform only the lower bound for the appropriate beta for the RIIO-2 period.

This is further reinforced by an analysis of average betas with the CEPA sample *consistently* leading to lower betas when compared to the sample average for the full set of European peers (even when including clear outliers like Fluxys).

- In fact, given the results of our risk assessment above, it is not obvious that Elia, Fluxys and REN should be considered close comparators for the GB regime given the de-risked nature of their respective regulatory frameworks compared to the rest of the sample.
- While we do consider that comparators should not be removed unless there are clear technical concerns on the robustness of the estimates (cf. for Fluxys below), we note that the average beta for a sample of operators with regulatory regimes that can be seen as closer to the GB framework would yield an even higher average beta of between 0.45 and 0.49, i.e. between 8 and 15 points above the beta resulting from the CEPA sample.

Figure 39 Beta estimates based on a 5-year estimation window

Comparator	Country-Network	Spot	2Y-average	5Y-average
Elia	BEL - ET	0.31	0.27	0.25
Fluxys	BEL - GT	0.15	0.11	0.10
Red Electrica	ESP - ET	0.35	0.39	0.39
Enagas	ESP - GT	0.39	0.38	0.37
Endesa	ESP - GD	0.54	0.49	0.53
REN	PT - ET, GT	0.30	0.30	0.27
Terna	ITA - ET	0.43	0.41	0.38
SNAM	ITA - GT	0.46	0.43	0.40
ENEL	ITA - ED	0.51	0.51	0.49
Hera	ITA - ED,GD	0.41	0.34	0.31
A2A	ITA - ED,GD	0.50	0.47	0.44
Transelectrica	ROM - ET	0.81	0.81	0.72
CEPA sample average	-	**0.37**	**0.36**	**0.34**
Full sample average	-	**0.43**	**0.41**	**0.39**

Source: Bloomberg data, Frontier Economics analysis
Note: Debt beta of 0.125; CEPA proposed sample highlighted in yellow

4.5 Liquidity considerations

A stock needs to be characterised by a certain degree of liquidity to avoid biased beta estimates. In line with regulatory best practice, the bid-ask spread may be considered an appropriate proxy to measure liquidity. We share CEPA's view that a spread of 1% is a reasonable threshold to identify companies with insufficient liquidity. We also note that a number of regulatory offices around Europe apply a 1% threshold.

However, in their analysis **CEPA erroneously removes comparators from the European peer sample without justification**:

- **Transelectrica's stock is sufficiently liquid.** CEPA argues that it was not possible to assess liquidity for Transelectrica as data was not sufficiently available. This leads CEPA to remove Transelectrica from their preferred sample. However, based on data from Bloomberg, we find that daily bid-ask spread data is indeed available from 2012 onwards for the Romanian TSO. We consider that this time period is sufficiently large to robustly assess liquidity for the company.

  Using annual averages for clarity, the chart below shows that Transelectrica's bid-ask spread has consistently sat well below the 1% liquidity threshold. Even though it displays a larger spread than most of the other European utilities (whose spreads oscillate around 0.1%-0.2%), Transelectrica cannot and should not be excluded on the grounds of insufficient liquidity.

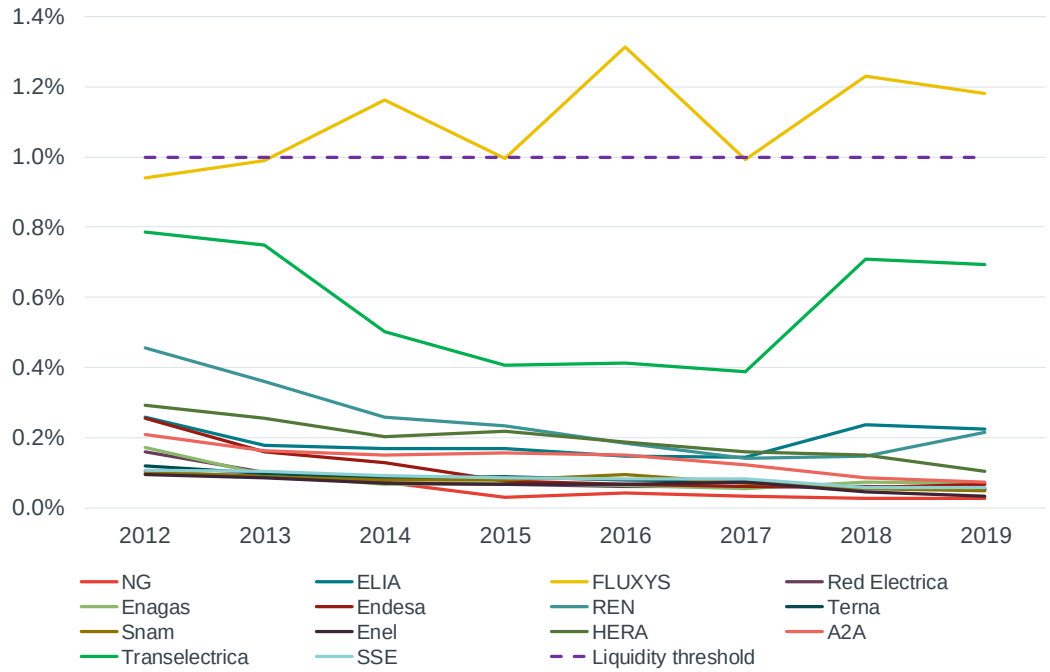
- **However, Fluxys' beta will be unreliable as there is insufficient liquidity.** Our analysis of bid-ask spread data confirms that Fluxys' bid-ask spread has generally been significantly larger than the 1% liquidity cut-off.

  Even though CEPA finds a similar result, they state that "the resulting data [*for Fluxys' beta*] is not obviously lacking in robustness". It is unclear what justifies this statement:

  - Fluxys has by far the lowest beta of the 12 European comparators. We agree that the simple fact that it is an outlier compared to other beta values does not in itself justify its exclusion, but the evidence of limited trading liquidity strengthens the case for questioning its robustness.
  - An analysis of additional liquidity measures used by other regulatory offices, such as the share of free-float, confirms concerns with Fluxys' trading liquidity with only 10% of the firm's stocks being available on the open capital market. We show the average share of free-float over the last five years in Figure 40 below.
  - Finally, the inappropriateness of Fluxys for estimating regulated asset betas has also repeatedly been recognized by regulatory offices across Europe. For instance, the Bundesnetzagentur (BNetzA) in Germany explicitly mentions liquidity as a valid reason for exclusion[20] and the consultants advising the Commission de régulation de l'énergie (CRE) in France on the upcoming electricity and gas transmission and distribution price controls have both excluded the firm from their beta sample.

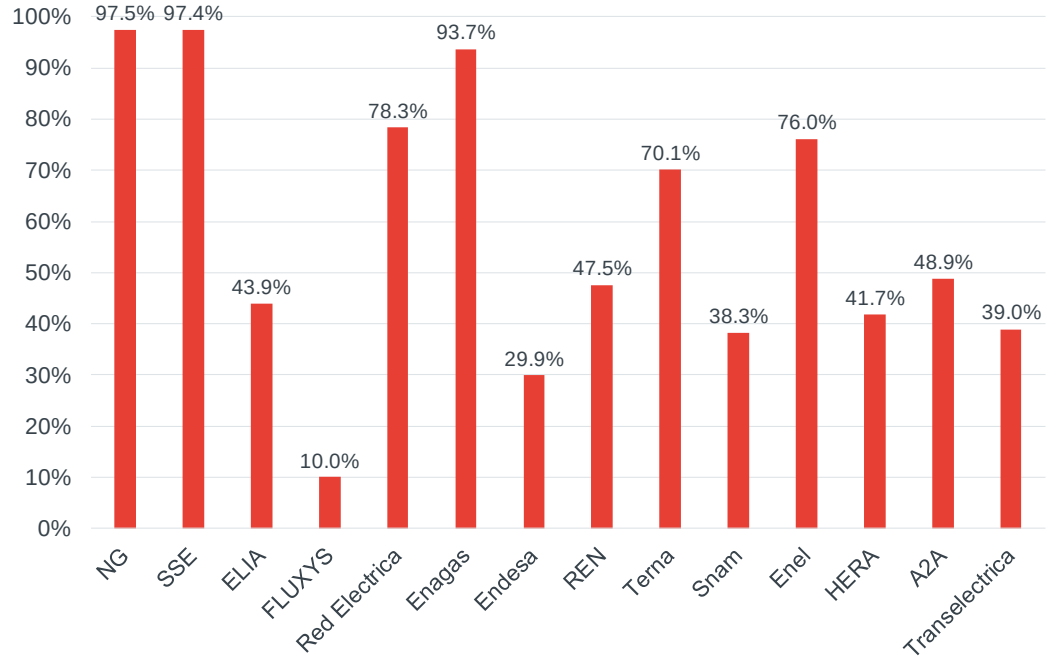
[20] "Die Herausnahme von Fluxys ist sachgerecht, da das Unternehmen in allen betrachteten Zeiträumen keine ausreichende Handelsliquidität aufweist. Die relative Geld-Brief-Spanne liegt sowohl für den einjährigen Betrachtungszeitraum als auch für die Zeiträume von 3 bzw. 5 Jahren über der Schwelle von 1%. Da die Analyse mittels CAPM neben der ausreichenden Datenverfügbarkeit eine ausreichende Liquidität der betrachteten Unternehmen voraussetzt und Fluxys diese Eingangsvoraussetzung nicht erfüllt, wurde das Unternehmen nicht in die engere Stichprobe möglicher Vergleichsunternehmen einbezogen.", BK4-16-161

Figure 40 Bid-Ask spread (%), 12 European companies sample, 2012-19



Source: Bloomberg data, Frontier Economics analysis

Figure 41 Free float (%), 12 European companies sample (2015-2019)



Source: Bloomberg data, Frontier Economics analysis

4.6 Regulated share of activity

Estimating betas for a European peer group is meant to overcome the limitations arising from the absence of a pure play network in GB. However, many European

network companies are not pure play entities either and often have a trading arm or other unregulated activities.

Assessing the regulated share of value may therefore constitute a valid analysis to limit the sample to those entities for which we expect the beta to primarily represent the systemic risk exposure of the regulated business.

- This assessment should be aligned with an equity investor's approach to valuing the business. This is done by analysing future cash-flows for which past profits are typically used as a reasonable proxy.
- As a result, operating income is the most appropriate measure of where values arises in a business.

We note that CEPA also seems to favour operating income, but nevertheless bases its assessment on a multi-dimension approach also considering the share of revenues and assets to justify the exclusion of comparators, even though they previously state possible shortcomings related to these measures. In our view this serves to unnecessarily narrow the sample.

We use financial analysis data provided by Bloomberg and cross-checked with the financial reports of the relevant companies to determine the regulated shares of value for the European peer group. The results of this analysis are presented in Figure 42 below as average shares for the last five years. In line with CEPA, we are using a 50% threshold to assess whether a network firm satisfies this criterion.

Figure 42 Regulated shares as based on revenues, operating income and assets for the European peer sample (2015-2019)

Comparator	% of operating income	% of revenues	% of assets	CEPA assessment	Frontier assessment
Elia	100%	99%	93%		
Red Electrica	100%	99%	100%		
Terna	96%	90%	N/A		
REN	100%	39%	69%		
Enagas	93%	91%	48%		
Snam	100%	96%	70%		
Enel	54%	22%	N/A		
Endesa	72%	14%	46%		
HERA	48%	77%	N/A		
A2A	44%	14%	34%		
Fluxys	88%	97%	94%		
Transelectrica	100%	100%	100%		

Source: Bloomberg, Operators' financial reports, Frontier Economics analysis

We find that only two of the twelve firms do not satisfy a minimum share of value of 50% for their regulated business on the basis of operating income[21], while CEPA argues that at least four, if not more, companies should be excluded from the sample.

[21] In fact, the closeness of the operating income share to the 50% threshold and the high share of regulated revenues for HERA, could also justify retaining the firm in the sample.

- CEPA has further erroneously qualified Transelectrica as having a minority stake of their activity in regulated activities. In fact, since 2000 Transelectrica has been a pure-play transmission system operator focusing exclusively on this regulated business.[22]
- Finally, CEPA specifies that the "Sum of the Parts" valuation of assets is used to aggregate the three measures it considered in a final "traffic light" rule assessment. The valuation method remains however unexplained and is sourced from a report by Barclays[23], which is not publicly available and cannot be verified.

As a result, we consider that CEPA's approach leads to the exclusion of all firms that have some kind of footprint in a competitive market. This approach is inevitably too restrictive – in particular given that the evidence of the scale of this footprint is mixed – does not lead to a balanced sample of European peers and limits the sample to a set of firms that only yield evidence for the lower range of possible beta estimates.

4.7 Beta volatility as a selection criterion

As a final criterion, **CEPA uses a range of highly subjective, and theoretically incorrect, tests to allegedly assess the robustness of beta estimates**, notably arguing for the exclusion of Transelectrica on this basis. In particular,

- **There is no objective measure to qualify betas as being "too volatile"** and any attempt to identify betas on this basis will inevitably be subjective. In fact, the absence of an accepted volatility measure is explained by *all* betas being inherently volatile. Below, we show that there is nothing unusual about the variation in Transelectrica's beta over time when compared to other operators – and this includes the GB utilities.
- **Beta estimates on the basis of international indices are of inferior statistical quality to using local indices** and are therefore not well-placed to provide robust European peer group evidence. In addition, CEPA's analysis of the sensitivity of estimates to the choice of index suffers from confirmation bias as its design will always yield larger differences for Transelectrica due to Romania being the *only* country of the peer group that is not included in the Eurostoxx TMI index that CEPA uses for its estimations.
- **The existence of negative gearing does not justify the exclusion of comparators.** Managerial prudence can lead companies to retain cash or cash equivalents that are exceeding the amount of debt that a company takes on, which can lead to negative gearing and investors will reflect this in the valuation of the business. While negative gearing can lead to asset betas that may, at first sight, look like outliers, it does not in itself invalidate the robustness of the estimated beta for the company in question.

We discuss each of these points in detail below.

[22] https://www.transelectrica.ro/en/web/tel/istoric-2000

[23] Barclays (2020) European Utilities – Covid-19: double upgrade Centrica, Engie to OW. 14 April 2020.

Volatility of beta estimates

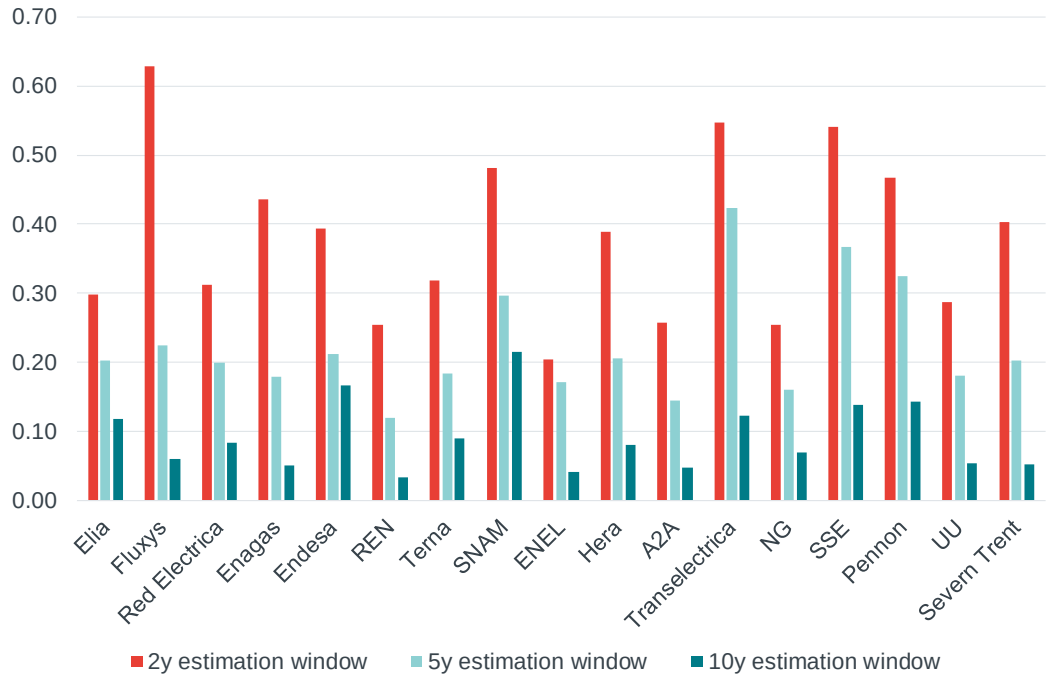
CEPA uses measures of volatility to argue for or against the robustness of beta estimates, notably assessing the difference of min- and max-values over time

However, as discussed at length earlier in this report betas are inherently volatile and can exhibit significant variations over time. **Given this intrinsic feature of all beta estimates, this provides no basis to reject a company**.

The chart below shows that there is nothing unusual about the differences in beta estimates we observed for Transelectrica compared to those estimated for other utility companies – even for the most volatile, two-year estimation window.

- In fact, even though Transelectrica shows the highest beta variation in our five-year estimation window, this is not the case for either the two-year or the ten-year windows.
- We also note that the water companies, considered to be the most robust comparators by Ofgem and CEPA, also exhibit higher variations than the average observed across the GB and European sample.

Figure 43 Measured distance of minimum and maximum betas over the last twenty years

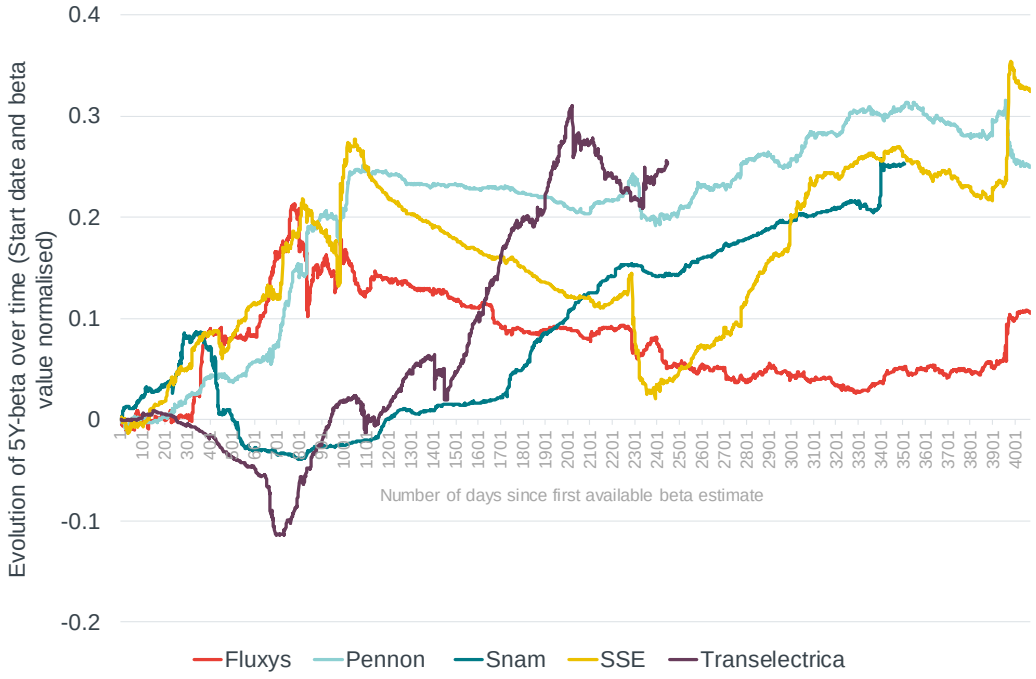


Source: Bloomberg data, Frontier Economics analysis

Among the top-five most volatile firms, we observe no discernible difference that would justify an exclusion of Transelectrica while retaining other comparator companies. Figure 44 below shows the evolution of the 5-year beta (the one where Transelectrica is the most volatile) over time – for better comparability, we have normalised the start date of available data as well as the starting value for the asset beta.

The chart clearly shows that Transelectrica's beta variation is in line with the other companies, both in terms of the "speed" of evolution as well as the overall magnitude of the change.

Figure 44 Evolution of 5Y-betas over time for five most volatile firms (Start date and beta value normalised)



Source: *Bloomberg data, Frontier Economics analysis*

Note: *Horizontal axis shows days of available data. Lines for Transelectrica and Snam are shorter due to limited market data availability for these companies.*

The chart shows that even with the 5-year beta where Transelectrica is the most volatile in the sample, its beta variation is well in line with the other companies, both in terms of the "speed" of evolution as well as the overall magnitude of the change.

Sensitivity to the choice of index

CEPA argues that a robust beta should be less sensitive to the choice of the reference index that is used for the estimation. We disagree with this in principle. Any stock return can be regressed against any index return, and it would be implausible for the regression results to be insensitive to the choice of the index. The CAPM framework requires the stock to be assessed against a well-diversified portfolio, often proxied by the wider market index to which the stock belongs. If a stock return is regressed against the return of an irrelevant index, one would expect a more random result (e.g. imagine regressing a UK stock against the Chinese blue chip index) with potentially a downward biased beta and high standard errors. Indeed, this is similar in effect to what CEPA's assessment of Transelectrica does.

In particular, CEPA assesses index sensitivity by comparing beta estimates obtained with a local index and an international index, for which it uses the Eurostoxx TMI index. This index includes 631 companies from 11 Eurozone countries, but does not however cover Romania.

- Indeed, Romania is not part of the Eurozone as its local currency remains the Leu. As a result, neither Romanian stocks in general nor Transelectrica more specifically are covered by the index. This goes against one of the core assumptions of the CAPM framework, which assumes that an investor is perfectly diversified across the market portfolio. If a stock (Transelectrica in this case) is not covered by the index that is used, diversification cannot be perfect.
  - This in turn means that the Eurostoxx index cannot be an appropriate index to estimate a beta for a Romanian company and will always lead to low correlation between the respective returns, i.e. leading to important differences in beta compared to an estimation using the local index.
  - This observation is amplified by a recent financial crisis in Romania in 2018 and 2019 that significantly affected both the overall stock market as well as its individual constituents. We would expect this to be reflected in the beta estimated against the local index, but not in the beta estimated using the global index.[24] As a result, it is likely that in these periods, beta values for Transelectrica will differ even more significantly.
- We also note that all other comparators are either directly included in the index (e.g. Enel, Terna, Endesa or Elia), or have their local country risk reflected in the index. As a result, we would expect there to be a more limited difference in estimated beta values when using the local or international index for these companies.

As a result, **CEPA's assessment will, *by design*, always lead to a stronger difference in estimated betas for Transelectrica compared to the other firms in the sample**.

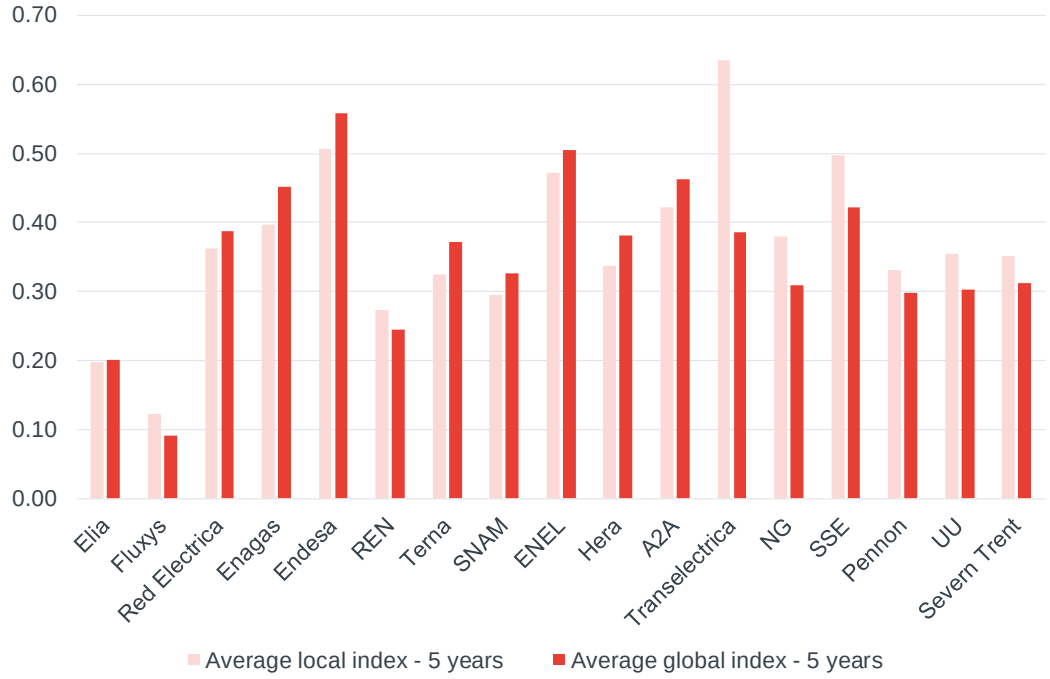
If an international index were to be used, we would ideally rely on a global index which includes the Romanian stock market. However, as the Romanian market is not part of the developed markets, it is not clear which global index would include Transelectrica. Nevertheless, we have considered the MSCI World index (which also does not include the Romanian market), as a more appropriate global index to use. It is reasonable to expect that a Romanian investor looking to invest beyond its local market might equally likely look to diversify globally, i.e. rather than purely focus on the Eurozone, given that risk considerations for diversification such as currency risk against the Leu would equally apply across investments in global financial markets.[25]

An assessment of betas estimated against the MSCI World shows that it leads to differences in beta values across the whole of the European peer sample with betas sometimes being higher and sometimes being lower than if they were estimated against the local reference. The relatively larger difference we observe for Transelectrica is not surprising as the Romanian stock market is likely underrepresented or not covered at all by the global index, therefore omitting specific country or currency risk factors.

[24] https://business-review.eu/money/bucharest-stock-market-crashes-as-investors-worry-about-new-taxes-in-2019-193803

[25] I.e. an investor is exposed to currency risk on the FX rate EUR:RON when investing in the Eurozone and may seek to diversify this risk with investments in other currencies, e.g. the USD or JPY.

Figure 45 Average beta estimates against local and global reference indices – 5Y betas

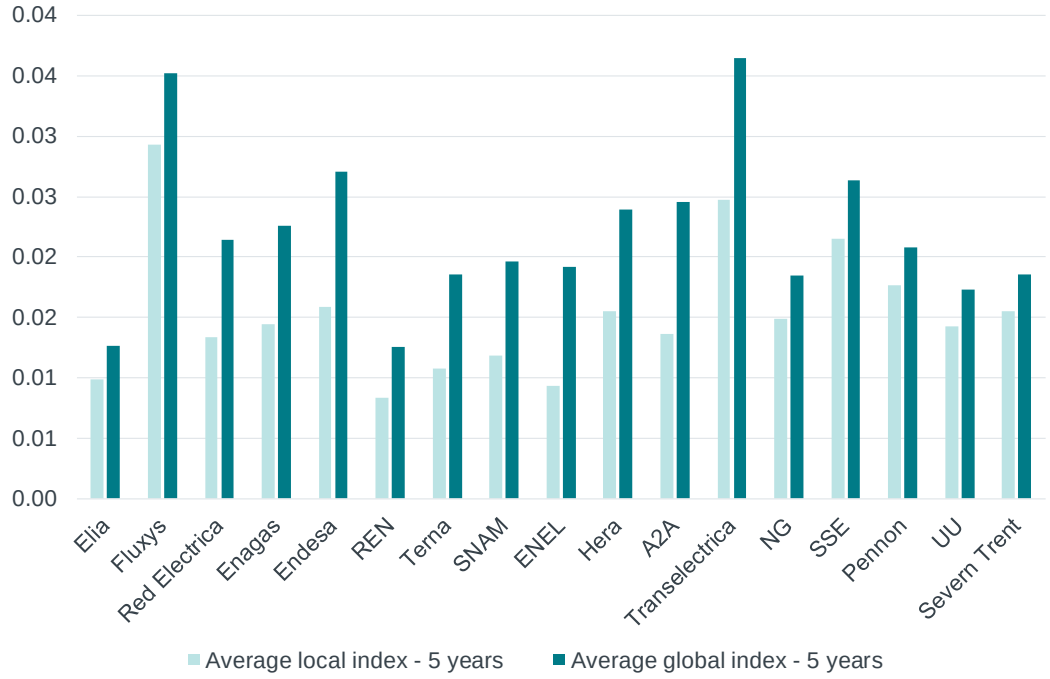


Source: Bloomberg data, Frontier Economics analysis

As we explain in more detail in section 5.4 below, we generally consider the local index to be the most appropriate reference for beta estimation. Investors still tend to diversify their portfolios locally and would therefore use local stock market performance as the relevant benchmark.

The preference for local indices is also re-enforced by the statistical properties observed when comparing the performance of our estimates against the global index. As shown in Figure 46 below, the average standard errors for estimates against the international benchmark are unequivocally larger than the average standard errors for estimates using the local index. This suggests that the former beta estimates are less certain and should therefore be considered less robust than the latter.

Figure 46 Average standard errors for beta estimates against local and global reference indices – 5Y betas



Source: Bloomberg data, Frontier Economics analysis

We note particularly the higher standard errors of the estimation on Transelectrica when regressed against the global index.

In conclusion, for all the reasons above, we do not consider CEPA's criticism of our beta estimate on Transelectrica based on the choice of local index to be justified, and we continue to suggest that the best index to estimate the beta for Transelectrica is the local Romanian all share index.

Negative gearing

The last dimension CEPA assesses for robustness of its beta estimates is the existence of negative gearing. CEPA remove comparators from the sample if they have negative gearing levels.

From both a theoretical and practical aspect, we do not see negative gearing levels to be an indication of the lack of robustness of the data for the purpose of beta estimation.

In theory, the gearing level can be outside the 0-100% range. A gearing higher than 100% indicates a company with negative equity value, and a gearing lower than 0% indicates a company that has a higher level of cash reserve than its total outstanding long-term debt.

In practice, we understand from a review from recent annual reports that this is primarily driven by prudent managerial practice by the Romanian operator.[26] In particular, Transelectrica wished to retain a certain amount of liquid resources

[26] For instance the 2019 annual report: https://www.transelectrica.ro/documents/10179/10046043/2019_Annual_Report_ENG.pdf/ff053ce6-a7ce-436a-9357-ea42598393fe

(cash and cash equivalents) to manage its exposure to a range of risk factors, most notably liquidity and currency risk.

As a result, we do not consider that the existence of negative gearing justifies the qualification of Transelectrica's asset beta as less robust nor its exclusion from the European peer group.

4.8 A larger and more balanced European sample

In the round, we find that CEPA's sample selection approach, whether by accident or design, has the effect of excluding all evidence that could point to a higher beta:

- CEPA completely disregards significant differences in regime risk between the European regulatory frameworks covered by the sample. Their preferred, limited sample of six companies is further exclusively focusing on low-risk frameworks which are not comparable in the degree of return uncertainty that equity investors would expect from the RIIO-2 framework.
- CEPA argues that (subjectively identified) volatile betas over time represent estimates that should be considered less robust, omitting the fact that betas are intrinsically volatile for *all* companies – including the GB utilities.
- CEPA's assessment of beta variation when estimating them against an international index by construction leads to high differences for Transelectrica's beta, which is considered not robust on this basis. However, CEPA omits the fact that estimations against an international index are consistently characterised by inferior statistical robustness, putting in question the results compared to those betas estimated against the local index.
- Finally, CEPA uses a too restrictive assessment of regulated share of value, removing every company that has a certain degree of footprint in a competitive segment, even though the evidence on the scale of this footprint, and therefore its impact on betas, is not straightforward.

In contrast, the analyses we present above all point to a sample of European peers that is significantly larger than CEPA's preferred sample and that should *at least* encompass nine companies.

In addition, an appropriate analysis of relative regime risk allows us to gain detailed insight into the appropriate positioning of the RIIO-2 beta on the basis of the resulting European range.

As a result of this analysis, we would expect the resulting range and midpoint to be significantly above CEPA's current recommendation – this evidence should in turn be seen as an *absolute* lower bound for the GB network beta:

- In fact, the inclusion of a number of comparators for which comparability with GB energy networks on the basis of our qualitative regime risk assessment is not clear cut likely further depresses the range that CEPA proposes.
- While we do not consider it appropriate to completely remove these firms (notably Elia and REN) to avoid a too limited sample, we do stress that the interpretation of their betas – and impact on the resulting range – needs to be assessed with significant care. In the round, simply retaining a midpoint based

on simple averages when including these firms likely results in beta values that are lower than if a more refined positioning on the basis of our relative risk assessment was used.

Figure 47 below presents beta estimates for the two- and five-year estimation windows and two- and five-year averaging windows. On average, our minimum sample of nine network operators excluding Fluxys, Hera and A2A yields an average asset beta range of 0.42 to 0.45 compared to an average range of 0.34 to 0.38 in the CEPA sample. This despite retaining all low risk companies within the sample.

Figure 47 Asset beta estimates for the European peer sample (Frontier sample in bold)

Operator	2Y-2Y average	2Y-5Y average	5Y-2Y average	5Y-5Y average
Elia	**0.27**	**0.26**	**0.27**	**0.25**
Red Electrica	**0.36**	**0.38**	**0.39**	**0.39**
Terna	**0.45**	**0.42**	**0.41**	**0.38**
REN	**0.29**	**0.30**	**0.30**	**0.27**
Enagas	**0.40**	**0.38**	**0.38**	**0.37**
Snam	**0.48**	**0.44**	**0.43**	**0.40**
Enel	**0.50**	**0.50**	**0.51**	**0.49**
Endesa	**0.52**	**0.50**	**0.49**	**0.53**
HERA	*0.46*	*0.36*	*0.34*	*0.31*
A2A	*0.50*	*0.47*	*0.47*	*0.44*
Fluxys	*0.14*	*0.11*	*0.11*	*0.10*
Transelectrica	**0.80**	**0.82**	**0.81**	**0.72**
CEPA sample average	**0.38**	**0.36**	**0.36**	**0.34**
Frontier sample average	**0.45**	**0.45**	**0.44**	**0.42**

Source: Bloomberg data, Frontier Economics analysis

Note: Frontier sample includes all firms except HERA, A2A and Fluxys.

5 TECHNICAL MATTERS

In this section, we elaborate on some of the more technical aspects of the beta estimation, referred to in places in the rest of the report. We cover the following topics:

- Estimation window
- Treatment of COVID19 period
- Data frequency
- Choice of the market index
- GARCH versus OLS estimation methods
- Debt beta
- Market value of debt

One shared characteristics of these topics is that they are technical choices for the beta estimation and are made with a degree of judgement. In general, there is no one correct choice that outperforms others. The key consideration is for the impact on the beta estimates from these various choices to be understood and for the choices (in case it affects the result) to be justified given the alternatives.

We discuss these in turn below.

5.1 Estimation window

The question of the length of the beta estimation window has always been a hotly debated question, because beta estimates tend to vary potentially significantly over time making the choice of estimation window an important determinant of the final result. Unfortunately, finance theory and best practice does not provide a preferred estimation window. The choice therefore needs to be made with judgement, carefully weighing the pros and cons of adopting a longer versus shorter estimation window.

Figure 48 below summarises the key pros and cons for various estimation windows.

Figure 48 Pros and cons of long and short beta estimation windows

	Pros	Cons
Short (up to 2 years)	▪ Most up to date market conditions	▪ Can be prone to short-term market distortions ▪ Can be volatile and subject to significant changes depending on the time of estimation ▪ Depending on the data frequency, may suffer from small sample size
Medium (around 5 years)	▪ More stable estimate than short-term windows ▪ More up-to-date than long-term windows ▪ Good sample size	▪ Compromise between short and long term windows
Long (10+ years)	▪ Most stable estimates ▪ Least prone to short-term distortions ▪ Good sample size	▪ Could contain out-of-date information ▪ Could ignore structural breaks as the underlying beta can be changing over time

Source: Frontier Economics

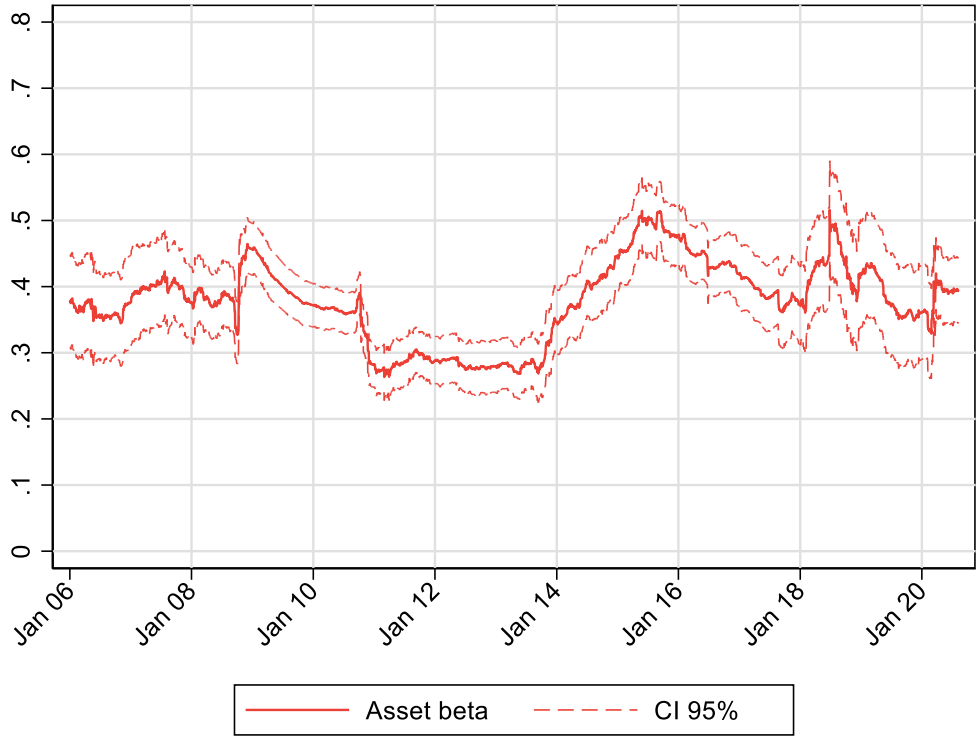
To summarise, there is a trade-off between long and short estimation window. Longer estimation windows contain more data points, which could improve the statistic robustness and could make the estimate more stable and less volatile over time. Shorter estimation windows contain the most up-to-date information and capture any potential structural breaks that may have happened in recent times.

There is no consensus on the preferred estimation window, as practitioners tend to use short, medium and long estimation windows depending on the particular circumstances of the companies and markets in question. However, this is not to say that the choice of the estimation window can be arbitrary. Special attention should be given to the following factors:

- Any reason to believe a certain past period is more or less likely to represent the future.
- Any reason to believe that data or estimates in a certain past period could be distorted.

In order to see if these factors play a role when estimating the betas for the companies at hand here, one could employ a short estimation window, but over a long period of time series (rolling window). Figure 49 below shows the time series of the NG asset beta estimated over a 2-year rolling window.

Figure 49 NG asset beta with 95% confidence interval, 2-year rolling window



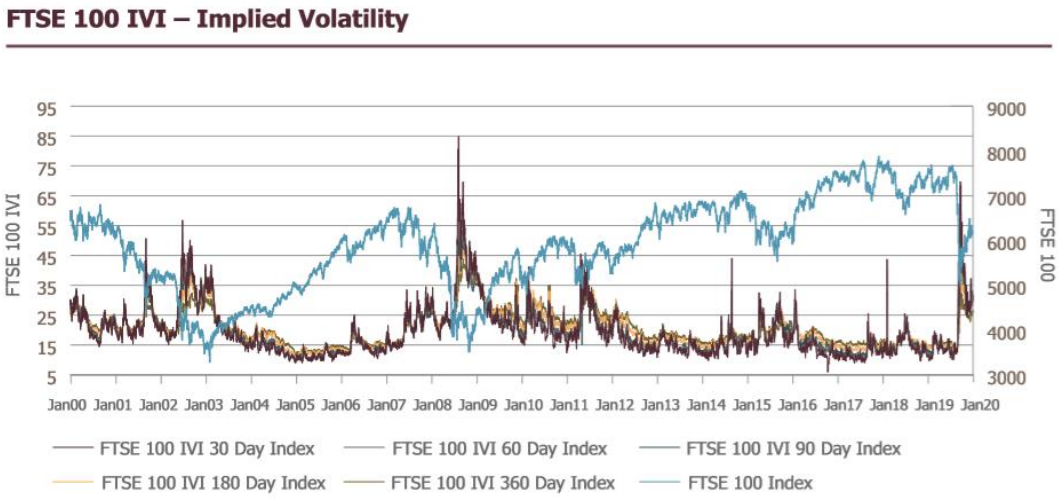
Source: Bloomberg data, Frontier analysis

Note: Debt beta assumed to be 0.125.

The graph shows that the asset beta fluctuates significantly over time, which demonstrates the drawback of the short-term estimation window. However, it also allows us to ascertain how NG's beta has evolved over time and may allow us to identify the most appropriate estimation window. One feature that stands out from the graph is that while NG's asset beta seems to vary widely between 0.3-0.5 over time, the period between 2011-2014 is associated with particularly low estimations, markedly lower than the period between 2015-2019.

It is of course hard to be definitive over what may have driven these periods of higher and lower estimations. However, a relatively well accepted thesis is that the low period may be a result of the extreme volatility experienced in the wider market during the global financial crisis between 2008-2010, and during the years thereafter as various waves of Sovereign Debt Crisis unfolded. Figure 50 below shows market volatility over the last 20 years in the UK using a range of standard measures.

Figure 50 Implied volatility on FTSE 100 index



Source: FTSE Russell Factsheet

Note: FTSE 100 IVI is a volatility index, which measures the interpolated 30,60, 90, 180 and 360 day annualised implied volatility of the underlying FTSE 100 index. Expected volatility is calculated from the prices of out-of-the money options available in the market, where the price of each option represents a market expectation of future volatility.

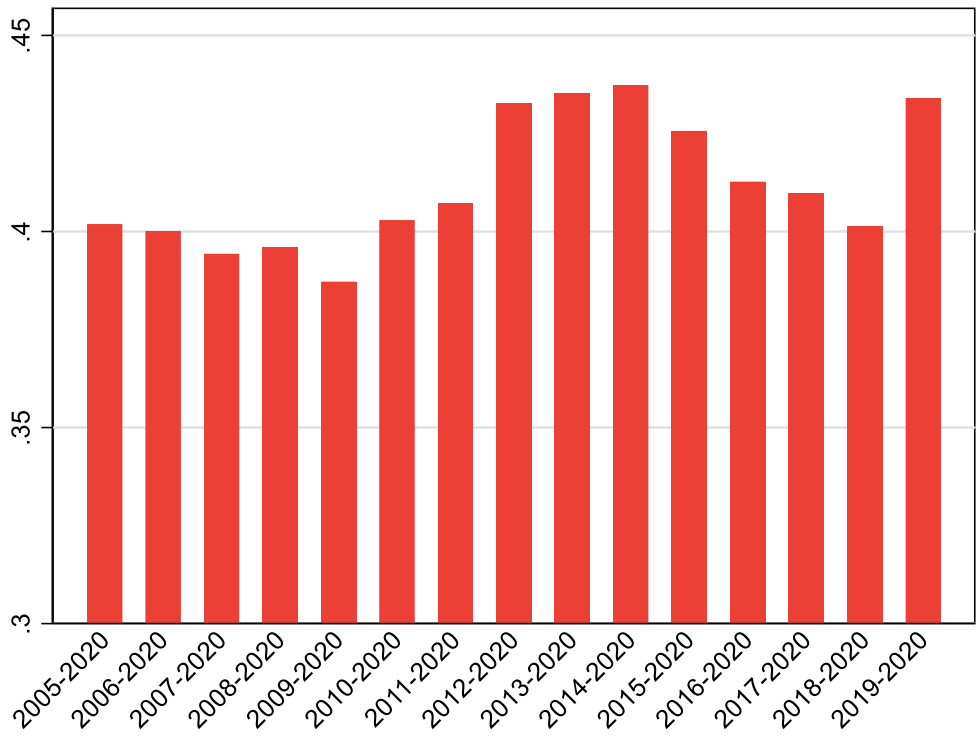
We can see heightened market volatility during the period where the stock market experienced a crisis (crash), e.g. during the dotcom bubble (early 2000s), the GFC (and the various euro zone crises to a lesser extent), and most recently the COVID19 pandemic.

It is well-known that, in times of market turbulence, some defensive stocks enjoy safe haven status (such as highly rated bonds, gold, cash etc.) and as a result exhibit low (or negative) correlation to the market return. This in turn suppresses the beta estimate for these stocks, in a temporary way that is unrelated to the intrinsic riskiness of the stock. However, given that such data can remain in beta estimates for a long time, such temporary distortions can have very long lived effects on estimated betas.

If one were to combine an estimate of the total equity market return based on long-term historic data, with an artificially low beta estimated during a period of profound market turbulence, this may lead to a counter-intuitive (and irrational) finding of a lower cost of equity for these companies during times of financial crisis.

This phenomenon is well documented in finance literature, and a prudent practitioner tends to take care not to let the low beta estimates during crisis times overly drive the overall estimate. In this context, we consider it prudent that the chosen estimation window avoids this particular period. A 10-year estimation window today could suffer from this problem (even though we do not consider 10-year estimate to be problematic in principle). Figure 51 below shows the effect of different estimation windows on the average of the UK 5 companies.

Figure 51 Effect of estimation window on estimated beta level for the average of the UK 5



Source: Bloomberg data, Frontier analysis.

Note: Horizontal axis indicates the years of data included in the regression

In the chart, the estimation window yielding the lowest result is the one that contains the information from 2009-2020, which is almost exactly the period on which Ofgem obtained its 10-year estimates. One can clearly see a downward bias here caused by the factors mentioned above.

In terms of regulatory regime, it is becoming clear that the upcoming RIIO-2 price control will be markedly different from the RIIO-1 price control, with less upside potential and more downside risks, including in particular greatly increased regulatory risk. Some of the important changes that Ofgem proposes to make include:

- Defining in much more detail and with more precision than ever exactly what a company must deliver for its allowances, thereby removing a significant proportion of the networks' flexibility in delivery. Adding greater constraints over what must be delivered, and exactly when and how, will increase risk.
- Making far greater use of Uncertainty Mechanisms (UMs) and prescriptive Price Control Deliverables (PCDs) coupled with extensive and open ended ex post review. This is likely to greatly increase regulatory risk.
- Also due to the use of these instruments, there will be a material delay in the point at which revenue can is recognised. In fact, certain activity is currently intended to trigger revenue only after ex post review as part of the close out process. This will markedly reduce funding certainty and greatly slow cash flow, together acting as a drag on the financial capacity of networks to deliver.

- Introducing an entirely novel and flawed adjustment to the headline allowed rate of return (i.e. the outperformance wedge), thereby weakening regulatory credibility and predictability.
- At the same time introducing a marked toughening in the general approach to benchmarking, with a much greater disallowance of volumes, and more extensive cost/unit cost challenges than ever before – thereby making the imposition of an out performance wedge a clear double count.
- Awarding huge penalties across all of the transmission sector through the Business Plan Incentive.
- In respect of NGET, introducing a retrospective reopening of RIIO-T1 to clawback past outperformance.

While most of these changes will, we consider, markedly increase the kinds of risks that investors care about, at the same time Ofgem is minded to:

- Generally lower the incentive; and
- Introduce indexation in a range of new areas, such as RPEs.

These last two points may moderate investor risk, but any such reduction in risk will be modest compared to the increase in risk arising from the longer list of changes set out above. Taken in the round, we consider it reasonable to say that RIIO-2 may see a reduction in exposure to certain performance risks (as a result of the lower totex sharing factor), but lead to a very large increase in regulatory/political risk.

This would also suggest that a 10-year window at the current time may not be as relevant as, for example, a 5-year window for the purpose of estimating a beta for the RIIO-2 price control, as the longer window will capture a period where the underlying risk profile may be different to the risks more recently faced by energy networks and those they may face in the future.

Lastly, it may be the case that the underlying risk drivers of the sector are also changing, e.g. as more information becomes available regarding the effect of Net Zero on energy networks and the future challenges they face. This provides a further reason to consider that long run beta estimates could misstate energy network risk at this time.

To summarise, we have considered the merit of short, medium and long-term estimation windows in this section. In our view, each has its pros and cons, and a well-balanced judgement has to be made on what weight to be given to which window.

Overall our usual approach when estimating beta is to consider a medium to long-term window for regulatory purposes, while noting that a shorter window (e.g. 2 years) can be helpful in identifying time trends and structural changes. At this time we caution that the potential distortion created by the GFC is currently still present in the 10-year estimates (and 5 year estimates averaged over long periods). Moving forward, this would become less problematic as the GFC period drops out of the 10-year sample, and a different judgement may become relevant on the trade-off between the medium and long-term windows.

5.2 Treatment of COVID19 period

The effect the of COVID19 pandemic on the global stock market has been significant. As the pandemic started in China in January 2020, the Chinese stock market was the first to become turbulent, showing significant volatility starting from late January (following the Wuhan lock-down). Other major global markets took a month or so to react, but the reaction was profound and much more pronounced than the crisis experienced in the Chinese market.

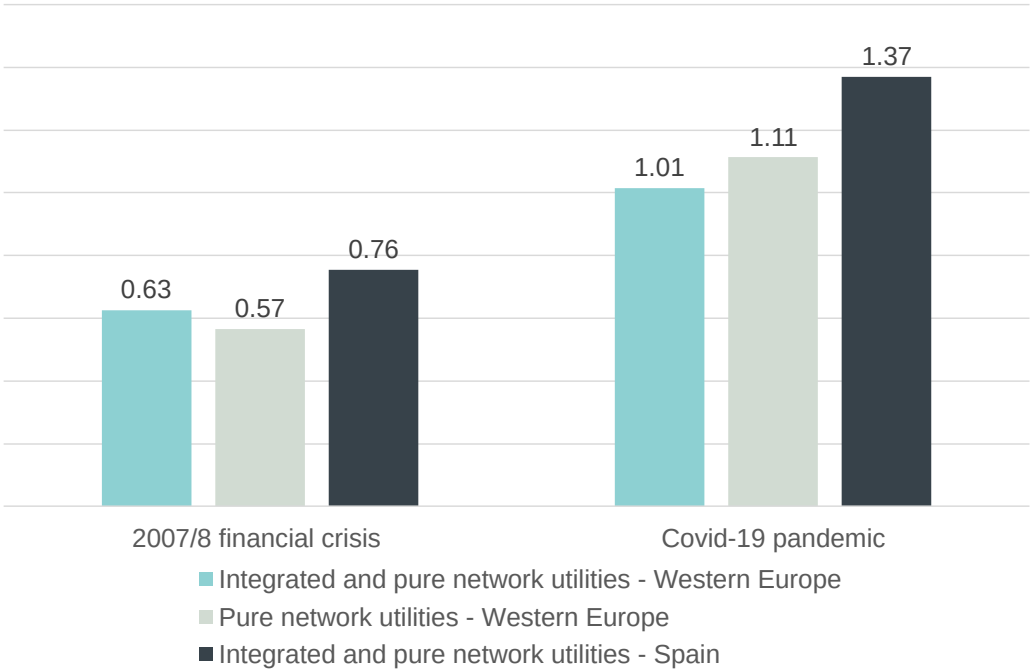
The markets that are relevant for our beta estimation, i.e. the US, UK and Continental European markets, were affected to different degrees and have to date recovered to different extents. The S&P500 index has, since the crash in March, staged an impressive comeback, unlike the FTSE and other European indices which have to date only recovered around a half of the loss incurred during the March crash.

There are also significant changes to the way utilities are affected by the COVID19 crisis, compared to previous crises. Unlike in previous crises, where utilities tended to be treated as a safe haven by investors, the pandemic and the resulting shut-down of the general economy appears to have made utilities less of a safe haven. Risk averse investors appear to have found a new destination for their investments during turbulent times – tech stocks. This includes stay-at-home stocks such as Amazon and Netflix, as well as pharmaceuticals with a stake in the research and development of the vaccine and treatments of the disease. Compared to these "COVID19 plays", utilities are now treated more like the cyclicals, and therefore have experienced a general increase in their estimated betas. The precise drivers of this change are of course unknown, but they may include a perception that utilities may be at greater risk of bad debt in the present climate should the economy slow and there be pronounced job losses. Or it may reflect a view that utilities will now get a "rougher ride" at regulatory determinations, as any perception of regulatory "generosity" may be far less palatable at a time of widespread economic dislocation.

The following charts from a recent Frontier Economics publication shows the extent to which the role for tech companies and utilities have reversed.[27] Figure 52 shows the difference between the equity beta of utilities during the GFC versus during the COVID19 crisis.

[27] Frontier Economics (2020) Have utilities caught the risk bug? Stock volatility and COVID-19

Figure 52 Equity beta of utilities: GFC versus COVID19 crisis

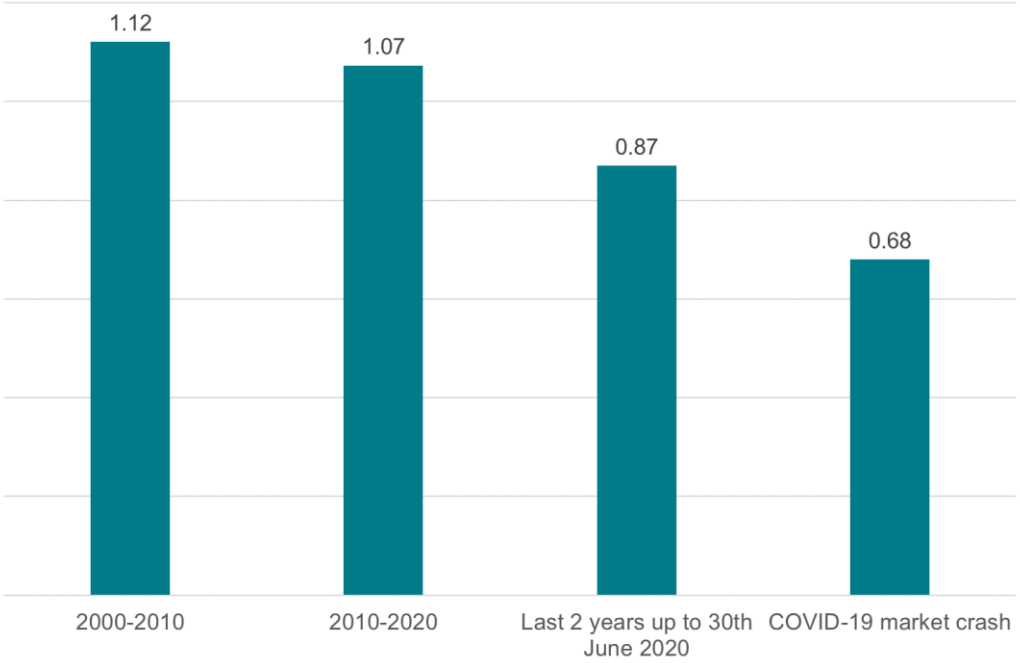


Source: Bloomberg data, Frontier analysis

Note: Exhibit taken from Frontier paper: Have utilities caught the risk bug? Stock volatility and COVID-19

Figure 53 shows the equity beta of large tech companies during the COVID19 crisis compared to before the crisis.

Figure 53 Equity beta of the 10 largest tech companies during different time periods



Source: Bloomberg data, Frontier analysis

Note: Exhibit taken from Frontier paper: Have utilities caught the risk bug? Stock volatility and COVID-19

The chart above shows that the short-term betas of tech companies have dropped dramatically (1 year or 2 year windows). Even when taking a longer estimation window, say 10 years, the estimate is still lower than during earlier time periods such as the decade between 2000-2010.

This effect is of course most pronounced in the US market, where most of these tech companies are listed. Indeed, in our sample, the US energy companies are the ones that experience the most dramatic increase in beta estimates, as shown in Figure 54 below.

Figure 54 Effect of beta from COVID19

Utilities	Window	Cut off Dec 2019	Cut off Aug 2020	Difference
European12	2 year	0.39	0.47	19%
UK5	2 year	0.37	0.4	8%
US	2 year	0.21	0.54	164%
European12	5 year	0.39	0.43	10%
UK5	5 year	0.43	0.43	-1%
US	5 year	0.29	0.48	67%
European12	10 year	0.37	0.39	5%
UK5	10 year	0.38	0.4	6%
US	10 year	0.37	0.45	24%

Source: Bloomberg data, Frontier analysis

It is clear from the table that the US companies in our sample are the most affected by a large jump in beta estimates due to COVID19. This has an important bearing on our NG decomposition results, as we rely on a robust estimate for the US activities to decompose our NG beta. We therefore caution the direct use of the latest result in this particular estimate, and defer our attention more to the pre-COVID19 period.

However, we do not propose to discard latest results from our analysis entirely, despite the potentially large impact from COVID19. There is a huge amount of uncertainty regarding whether or not the effect is temporary or a structural break. While this will become easier to discern in the intervening years to come, we do not propose to simply ignore the latest data where there is no strong evidence that the effect is distorted or short-lived. We present both pre-COVID and up-to-date results through the entire report.

5.3 Frequency

Another technical aspect in beta estimation is the choice of data frequency, including low frequency (e.g. quarterly or monthly), medium frequency (e.g. weekly or daily) and high frequency (e.g. hourly or higher).

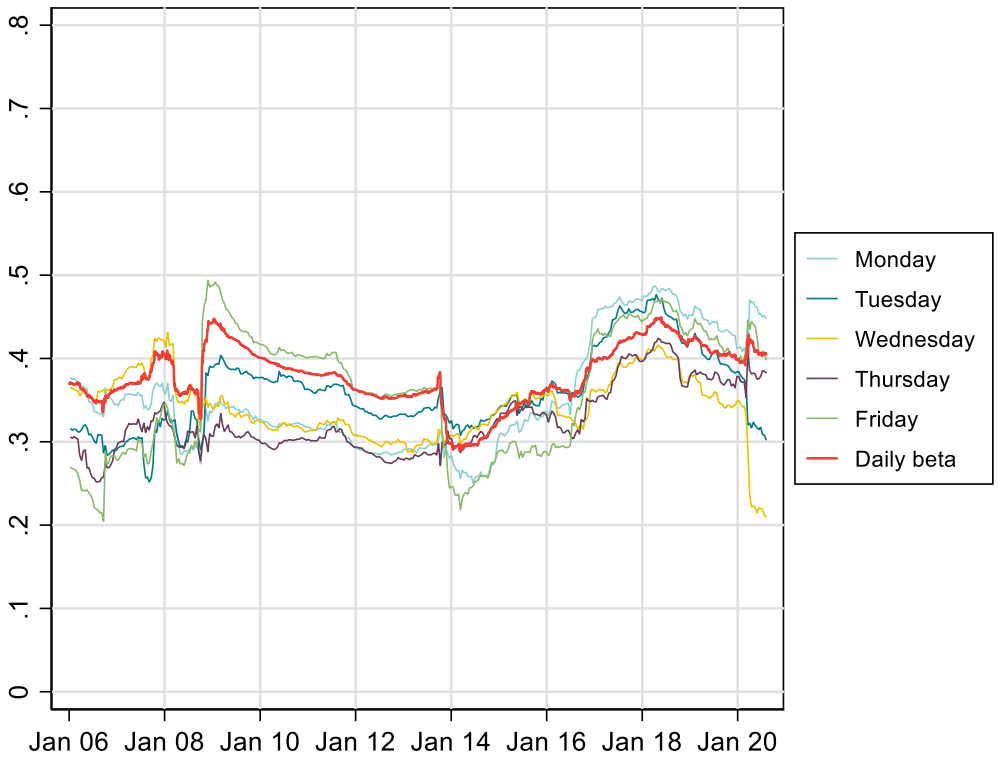
In general, high frequency data is not recommended for the purpose of beta estimation because there could be too much statistical noise in such data which might distort the estimate, and also because the data availability on high frequency trading may not be uniform across shares.

Practitioners tend to focus on low and medium frequencies, with the most preferred choices being daily, weekly and monthly.

A recent study conducted by the Professor Alan Gregory has showed that daily estimates may suffer from downward bias due to liquidity and size factors.[28] Ofgem's own advisor Indepen has also looked into the potential data issues on daily estimates and found presence of potential heteroskedasticity problems in OLS regressions based on daily data.[29]

However, weekly and monthly estimates are not without their problems. Apart from the diminished sample size and the requirement for a longer estimation window, one of the most material issues with frequencies lower than daily is the so-called reference day risk. For weekly estimate, this refers to the day of the week (i.e. Monday, Tuesday, etc.) and for monthly estimate this refers to the day of the month. Figure 55 below shows the reference day risks in NG's asset beta based on a 5-year estimation window as an example.

Figure 55 Reference day risk for weekly betas for NG (5-year window)



Source: Bloomberg data, Frontier analysis

As can be seen clearly, depending on the day in the week the analysis is based on, the estimate can be dramatically different. In the most extreme case at the latest estimation date, the Wednesday estimate is around 0.20 while the Monday estimate is around 0.45.

This raises serious questions regarding the robustness of weekly estimates. It is therefore important to take this into account before putting weight on weekly estimates. The same issue applies to the monthly estimates.

[28] Gregory A. (2015), In Search of Beta, University of Exeter Business School

[29] Indepen (2018), Ofgem Beta Study – RIIO-2 Main Report

In conclusion, therefore, we consider as a pragmatic solution that daily estimates can be relied on as the primary evidence for the purpose of beta estimation, although this can be accompanied by weekly and monthly estimates (when properly controlled for reference day risks) as additional evidence or cross checks. We also note that GARCH may provide an alternative way to control for concerns around data structure in daily estimations. This is addressed below.

5.4 Choice of market index

In this section we look into some of the relevant considerations in respect of the choice of market index in beta estimations.

The estimation of the beta is part of the CAPM framework where the cost of equity is assumed to capture the risk free rate of return plus the stock's risk premium which is the expected market excess return multiplied by the correlation between the stock return and the market return. The market therefore represents a well-diversified portfolio from which investors can assess the cost of equity of any individual asset within this market. Even though the underlying principle of this framework is clear, in practice the definition of the market is not always black and white.

Some practitioners take the main index of a market, in which the stock is traded, which is quite often a blue chip stock index, e.g. the FTSE100 for the UK, DJIA for the US, and CAC40 for France, etc. However, this approach risks constraining the "diversified portfolio" to only a small subset of the market, dominated by larger firms.

Other practitioners take the all-share index of the market, e.g. FTSE All-share for the UK, S&P 500 for the US, and so on. This is what we understand the most common approach and also the approach that we have adopted for our comparators across different market.

There are also practitioners who prefer to use a global index for comparators from different markets, such that all betas in the sample are regressed against the same index. This approach has its merits in terms of comparing observations across different markets. However, the underlying assumption of this approach is that investors of all of companies considered hold or can hold perfectly diversified global equity market portfolios.

Even though the equity markets are increasingly global, investors still face not immaterial barriers (such as currency risk, tax and regulatory requirements, local expertise and interest, etc.) when seeking to invest freely in the global market in the proportions suggested by most of the global indices. In other words, even if investors have access to the global equity market, they are likely to tilt towards local markets in their equity portfolio allocation. For example, the typical US investors and the typical UK investors are likely hold different proportions of US and UK equities, even though these two markets are in principle nearly perfectly accessible to both investors. If the majority of investors are not holding a perfectly diversified global portfolio to the proportion of the global indices, then regressing an individual stock return against the return on such global indices would create an element of random correlation and could under-estimate the beta. As a result,

we would favour the use of the local all share indices where possible for the purpose of beta estimation.

A further consideration around using global equity market index when estimating betas is whether all the companies are indeed included in the global index in question. For example, one of the most popular global equity index is the MSCI World index. But this index only contains developed markets, and excludes emerging markets. If one of the companies in the beta estimation belongs to an emerging market, then regressing a stock return against a market index in which the stock does not belong could lead to under-estimating of the true beta of such a stock.

5.5 GARCH vs OLS

In its Draft Determination Ofgem presents summary results for beta estimates derived using GARCH models. Ofgem asserts that this analysis suggests OLS findings are systemically higher than those derived from GARCH models.

GARCH is a regression model which allows the variance and covariance of the data process to change over time. This is in contrast to OLS, which assumes a constant variance over time. It is not unreasonable to explore the use of GARCH models as a way for accounting for time-varying volatility in stock returns.

However, Ofgem's conclusion that there are 'materially lower results for asset beta when using a GARCH approach rather than OLS' is incorrect.

- First, it is not clear that Robertson agrees, as he states in his report that GARCH and OLS give similar results: 'Extensive estimation and simulation showed that the estimates from these approaches [GARCH and OLS] varied little in magnitude in statistical terms'.
- Second, the results are highly sensitive to the precise specification of the GARCH model, of which there are many possible varieties that could have been used. Had Robertson selected a different (simpler) model, the estimates may have been higher (indeed even higher than OLS).

The estimates presented throughout this section are raw equity betas, estimated over a five year estimation window from 12/05/2015 to 11/05/2020. This is consistent with the estimation window used in Robertson's analysis.

There are many possible GARCH models that could be used

There are two broad classes of GARCH models: univariate and multivariate. Univariate models allow the variance to change over time, while multivariate models allow the variance and covariance between variables to change over time.

Within these classes, there are a range of specifications which differ according to how the conditional variances and covariances (in the case of multivariate models) are estimated. Univariate models are relatively simple to estimate, while multivariate models are more complex because they involve estimating more parameters.

Findings for multivariate diagonal BEKK GARCH

We understand that Robertson has used a multivariate diagonal BEKK GARCH specification[30] in his analysis. Our findings for this specification are presented in Figure 56 for BEKK and resemble those of Robertson.

Figure 56 Multivariate GARCH betas for a 5 year estimation window

	OLS	BEKK GARCH
NG	0.63	0.59
PNN	0.59	0.56
SSE	0.97	0.89
SVT	0.58	0.57
UU	0.61	0.60

Source: Frontier Economics

Univariate GARCH models give similar results to OLS

The motivation for exploring GARCH models is that they take into account possible time-varying volatility in returns when estimating betas. Univariate GARCH models address this concern and have the advantage of being simpler to estimate than multivariate models. However, Robertson does not explore any univariate models. We have estimated betas using two common univariate GARCH models:

- Standard GARCH – this assumes the volatility of returns changes in the same way in response to both positive and negative shocks
- EGARCH – allows for asymmetric reactions of volatility to positive and negative shocks

Each of these types of models must assume a particular lag structure. The lags refer to how many previous periods of shocks and volatility are relevant for explaining the volatility of stock returns in the current period. For example, in a GARCH(2,2) model, random shocks and stock return volatility from the previous two periods are assumed to affect the volatility of stock returns in the current period. We fit models with a (1,1) and (2,2) lag structure.

Figure 57 shows the beta estimates using univariate GARCH models, with full sample OLS results presented for comparison.

Figure 57 Univariate GARCH betas for a 5 year estimation window

	OLS	GARCH (1,0)	GARCH (1,1)	GARCH (2,2)	EGARCH (1,1)	EGARCH (2,2)
NG	*0.63*	0.69	0.64	0.63	0.64	0.63
PNN	*0.59*	0.66	0.66	0.65	0.66	0.65
SSE	*0.97*	0.87	0.84	0.94	0.92	0.97
SVT	*0.58*	0.65	0.66	0.64	0.65	0.63
UU	*0.61*	0.57	0.59	0.63	0.59	0.60

Source: Frontier Economics

Our key findings are as follows:

[30] Restricts conditional covariance matrices to be positive definite, and each covariance matrix element to only depend on its own past values.

- Univariate GARCH models produce similar estimates to OLS. In some cases the GARCH results are higher than OLS results over the same time period.
- The estimates are fairly consistent across the different specifications and lag structures.

Conclusions

Based on our review, we do not agree that GARCH betas are systematically lower than those derived from OLS. This result only holds for one of the many possible specifications of GARCH that could be used, and there seems to us to be no reason to suppose that the diagonal BEKK GARCH model is the only valid model. Ofgem's reliance on that one model is cherry picking. While GARCH models are no doubt an interesting potential addition to the set of things that could be estimated to inform beta levels, it is not clear that they add much beyond traditional OLS estimation.

5.6 Debt beta

In the de-levering and re-levering of the beta, there are different formulas that can be used. The one that UK regulators tend to choose is the "Harris-Pringle" formula, which includes the debt beta.

The debt beta needs to be separately estimated from the equity beta, and should be based on market information on how the return on debt moves in relation to the return in the market. We do not look into this topic in detail in this report as it sits outside our agreed scope of work. We note that this topic has been covered thoroughly by various recent studies (one study by Oxera and a recent academic study by Professor Zalewska submitted by NERL to the CMA[31] and CMA's own report on NERL).

We note that for the purpose of comparability, we have adopted Ofgem's assumption of debt beta of 0.125 for our base case beta estimates. However, for the avoidance of doubt this should not be taken as a signal that we agree with Ofgem's chosen level for debt beta. We believe that there is merit in considering a lower asset beta assumption, as suggested by the various studies mentioned above, which contain a range of strong evidence to support such a move.

Below, we show the effect of different debt beta assumptions on the cost of equity. We take, as an example, the asset beta on NG. While asset beta on the 5-year estimation window with a debt beta of 0.125 is 0.405, it would be 0.372 with a debt beta of 0.050. When re-geared and calculated into the cost of equity, using Ofgem's parameters for illustration purposes, this would increase the cost of equity by 0.24%. This is shown in the table below.

[31] Professor Zalewska, Estimation of the Debt Beta of the Bond Issued by NATS (En-Route) plc, April 2019, ('Estimation of the Debt Beta of the Bond Issued by NATS') (SOC117)

Figure 58 Impact of the debt beta assumption on the cost of equity

	Ofgem's debt beta	Oxera debt beta
NG asset beta (5-year)	0.405	0.372
Gearing	60%	60%
Debt beta	0.125	0.050
Re-geared equity beta	0.825	0.855
RFR	-1.5%	-1.5%
ERP	8%	8%
Cost of equity	5.10%	5.34%

Source: Frontier economics

The above shows that Ofgem's cost of equity based on our NG beta estimate would be understated by 0.24%, compared to the case where a more reasonable estimate of debt beta (e.g. 0.05) is used. We note that the CMA has stated in its final report for NERL that the evidence to support the debt beta from the regulator was largely speculative. It also said that NERL's analysis on the debt beta has shown significant uncertainty over the ability to measure debt beta. The CMA has therefore ultimately taken the judgement to assume a debt beta of 0.05 for NERL.

Although the CMA's choice of 0.050 debt beta for NERL's debt does not necessarily mean that it would choose precisely 0.050 for energy companies, it does illustrate that Ofgem's seemingly confident choice of a debt beta of 0.125 may be overestimated. We also note that CEPA does not directly address the question of debt beta and has simply used Ofgem's debt beta assumption.

5.7 Market value of debt

Ofgem has presented its beta estimation both with book value and market value of debt for the purpose of calculating gearing levels.

While we consider it is in principle appropriate to use the market value of debt to calculate gearing levels for the purpose of de-gearing beta comparators, we note that there are practical challenges involved with the underlying data on market value of debt. In particular, almost all of the beta comparators in the sample hold debt that is not traded on the market and it would therefore be challenging to obtain up-to-date market values. This challenge is recognised in CEPA's study "Use of market evidence annex".

In the Draft Determination, it is not clear whether Ofgem has relied its final range on the asset betas derived from the market value or the book value of debt. Furthermore, it is also not clear exactly how Ofgem has calculated the market value of debt for each comparator in the beta sample, although Ofgem refers to the methodology adopted in the SSMD.

Ofgem's proposed range seems to come from CEPA's estimate for the GB water asset beta. However, it is not clear from the CEPA report whether the range proposed for this, 0.34-0.39, is estimated using market value of debt or book value of debt.

We note that we have used the book value of debt in all of our estimates in this study, in line with common practice. We have not sought to ascertain the market

value of debt either for the GB peers or for the US and European peers. Doing so would introduce considerable uncertainty that is not necessarily required for the scope of this study. We caution that if Ofgem is to rely on the market value of debt, it should not simply use a proxy such as the method employed in SSMD, but should seek to estimate this for each peer in a sufficiently transparent manner. If it chooses to go down this route, then the approach it intends to adopt should be published as soon as possible to allow detailed analysis by stakeholders in advance of the Final Determination.

ANNEX : DECOMPOSITION ANALYSIS

This annex presents the methodology that we have followed to decompose the corporate betas of NG, SSE, and PPL, and estimate the underlying GB energy network pure play betas.

We assume that, at any point in time, the corporate beta of a company is the weighted average of the betas of each of the underlying business activities undertaken by that company. The three companies under consideration all have UK regulated activities and 'unregulated' activities, such as retail and wholesale. NG and PPL have also US regulated activities.

In formula:

$$\beta_{corporate} = \beta_{UK} \cdot w_{UK} + \beta_{US} \cdot w_{US} + \beta_{unregulated} \cdot w_{unregulated}$$

Where

- $\beta_{corporate}$ is a company's asset beta
- β_{UK} is the asset beta of a GB energy network pure play company
- β_{US} is the asset beta of a US energy network pure play company
- $\beta_{unregulated}$ is the beta of an unregulated company
- $w_{UK}, w_{US}, w_{unregulated}$ are business activity weights.

The relationship above can be inverted to estimate the GB energy network pure play beta β_{UK} as follows:

$$\beta_{UK} = \frac{1}{w_{UK}} \cdot [\beta_{corporate} - (\beta_{US} \cdot w_{US} + \beta_{unregulated} \cdot w_{unregulated})]$$

To operationalise the calculation, we estimated all terms on the right hand side of the equation:

- $\beta_{corporate}$ is a company's asset beta and estimated by first deriving an equity beta using a regression analysis of stock returns on market returns, and then converting it into an asset beta.
- β_{US}. We have estimated this beta as the average corporate beta of the five US companies in the CEPA sample. These companies have a large proportion of US regulated activities.
- $\beta_{unregulated}$. We have estimated this beta as Centrica's asset beta, given that Centrica is a fully unregulated GB utility company..
- The weights are derived from operating income segmentation data from Bloomberg and represent each company's share of UK regulated, US regulated, and unregulated activities.

We then substitute these estimates in the equation above and estimated GB energy network pure play betas. We produced four estimates, one for each of the decomposition of the corporate betas of NG (UK listed), NG (US listed), SSE, and PPL.

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