

# Things can only get beta

An opportunity to get financing costs  
right for consumers



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# Summary

Much of the basic infrastructure of our economy - the pipes and wires that take electricity, gas and water to your home, many of the cables that provide our internet connections, our sewers, our rail tracks, our larger airports - are natural monopolies.

Competition here is limited: while there can be competition at the retail end over (for example) customer service and the cost of energy, it doesn't make sense to build competing wires and pipes to connect these services to your home. Regulators therefore set limits on the amount of revenue these infrastructure companies are allowed to collect<sup>1</sup>.

This paper focuses on the cost of financing this infrastructure - in particular, the underlying risks that are one of the primary drivers of how much it costs to attract investment - and, consequently, of household energy bills. Specifically, it deals with a concept in financial theory called *the equity beta* - a numerical measure of risk.

Regulators have a duty to set prices at a rate that enables necessary investment, but does not overreward investors at the cost of consumers. It is a duty they have not succeeded in: as the previous Chief Executive of Ofwat, the water regulator, has argued, "*over the past twenty years, the direction of error has been consistently in favour of companies rather than customers.*"<sup>2</sup>

As they decide the next round of price agreements with companies, regulators have the opportunity to - arguably for the first time - err on the side of consumers. Early signs are positive: both Ofgem, the energy regulator, and Ofwat have indicated that firms should expect far lower profits. Many energy network companies have already recognised that their profits are excessive and voluntarily returned or deferred investment, reducing consumers' current bills by £390m<sup>3</sup>.

But more needs to be done. In particular, regulators still overestimate the underlying risk of these monopoly businesses. It has always been intuitively plausible that these are low risk businesses: their revenue is all but guaranteed by regulators. And as lower risks require lower reward, this has material consequences. Regulators assumed a much higher risk than can be justified, with higher bills as a consequence.

A landmark study into capital costs, commissioned by regulators, suggests where they may have been going wrong. Three of its authors suggest that the risks to investors - the equity beta - could be significantly lower than previously thought. Using an alternative methodology, the best estimate of underlying risk falls significantly. For the energy market alone, we estimate that the additional consumer savings could be **up to £4.1bn** - that is, over and above the £5bn reduction in company profits that Ofgem has already indicated is plausible.

This study is particularly important for Ofgem, who will soon decide its methodology for the next price agreement. Most importantly, the alternative methodology is implementable and defensible and commands the agreement of the majority of experts commissioned to study

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<sup>1</sup> This is even true of the infrastructure that is in government hands (like Scottish Water & Network Rail): their revenue is set by an independent regulator like privately owned assets.

<sup>2</sup> [Future of Utilities - Water 2017](#), Cathryn Ross, 2017

<sup>3</sup> [The postcode lottery in energy profits](#), Citizens Advice, 2018

this question. Having commissioned experts to study the best available evidence, Ofgem should follow their recommendations.

These would represent a very significant reduction in energy network companies' returns to equity and Ofgem would rightly need to examine whether such adjustments were consistent with their duty to make sure that these companies are financeable. However, this cannot be an excuse for ignoring the empirical evidence. If the data indicates that the cost of equity is indeed this low, Ofgem should not be constrained by financeability tests or concerns. A separate assessment on financeability can be made following its cost of equity decision.

## Recommendations

Subject to satisfactory further research, we recommend adopting the alternative approach outlined in the UK Regulators Network cost of capital investigation<sup>4</sup>, as it forms the best available evidence on the subject. However, there are outstanding questions to answer - and these questions deserve full and prompt analysis. A full description of what research we think is required is included in subsequent sections, but in brief we recommend Ofgem, in collaboration with other regulators:

1. Extend the analysis beyond the two listed companies (Severn Trent & United Utilities) considered to all relevant comparator companies.
2. Conduct further, robust statistical tests on the appropriateness of the proposed beta estimation, including the use of lower frequency data and a longer time series of stock returns.
3. Analysis points to strong evidence that a core assumption of the current method of beta estimation for high-frequency data is violated, and therefore the use of the method is not defensible. Further research should be undertaken to establish whether the existing methodology is as flawed as this suggests.

Collectively, these steps will refine the methodology for estimating the raw beta. However, the analysis contained in the UKRN report also casts doubt on the current practice of adjusting the raw beta estimate in line with regulatory assumptions regarding the balance between debt & equity funding. We therefore also recommend:

4. Following their decision on raw beta estimation, Ofgem should examine whether the benefits of reduced near-term consumer bills by using raw beta data are outweighed by the *potential* long-run effects on company incentives.

These are difficult questions and reaching an answer will require judgement alongside statistical estimation. But Ofgem has the time to conduct this research: the next price agreements don't formally begin until 2021 at the earliest. If this did require making decisions on capital costs later in the process, so be it - the size of the potential prize is considerable.

Regulators have got these decisions wrong in the past. This is not (just) an academic debate over correct econometric techniques. These add to energy bills that households can't avoid and - often - can't afford. It's time to get it right.

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<sup>4</sup> [Estimating the cost of capital for implementation of price controls by UK regulators](#), Wright et al., 2018

# Why does the cost of investment matter?

Much of the basic infrastructure of our economy - the pipes and wires that take electricity, gas and water to your home, much of the vast network of cables that provide our internet connections, our sewers, our railways, our larger airports - are natural monopolies. This paper focuses on the cost of financing this monopoly infrastructure - in particular, the underlying risks (the *equity beta*) that are one of the primary drivers of how much it costs to attract investment.

Starting in the late 80s, policy makers began to place many of these assets in private hands. This wasn't because they thought there would be effective competition between rival assets, but because they hoped that - if strict limits were placed on their prices - private companies might deliver more efficiently than the previous state-run monopolies had.

And limits on prices are the crucial part of this: otherwise monopoly companies would just do what is in their shareholders' best interest - charge a monopoly price. That is, rather than charge a price that reflects the cost of providing these services, they would charge the price that maximises their own bottom line. Given how much we need these essential services, left unchecked that price could be very high indeed. The regulator's role as watchdog of prices and scrutiniser of profiteering is therefore crucial to the whole model of private provision working.

Pylons and sewers and airports are, however, very expensive. They require a lot of capital investment and that capital has a cost - investors and creditors still require a certain return. If they don't get that return, they won't invest or lend money. Getting the balance between minimising the cost of investment for consumers while making sure that the necessary investment takes place is one of the key challenges regulators face.

## What is the cost of equity?

Companies finance themselves in two ways: through loans with agreed repayments, or through selling a share in the business, guaranteeing investors a proportion of the profits, if such profits materialise.

Returns to investors form the majority of the cost of capital - because, while only a minority of capital is financed by equity (35%-45% in most regulated monopolies), it requires a much higher return than debt. It's therefore a major driver of consumers' costs.

## What makes up the cost of equity?

Regulators tries to estimate the cost of equity to decide what a reasonable rate of return for investors is. There are three elements to the cost of equity:

1. **The risk-free rate** - this is the hypothetical return on an entirely safe investment. In principle, an investor wants some return to put their money even in the safest investment, to compensate them for foregoing the opportunity to spend that money today. The proxy usually used for estimating this is the return on Government's bonds (the closest to risk-free you can usually get).
2. **The equity premium** - this is the average market return on investment, over and above the risk free rate. This makes sure that investors are getting sufficient return compared to what else they could invest their money in. If they don't, investors will vote with their feet and our infrastructure won't get the investment it needs.
3. **The equity beta** - The equity beta is intended to capture the riskiness of an investment. The higher the risk, the more you want the expected return to be - after all, there's a higher chance that you end up with nothing. The equity beta is a numerical measure of this risk: specifically it compares a stock's volatility to the volatility of the whole market. You multiply the beta by the equity premium to arrive at the risk-adjusted return. If the beta is higher than 1, then the investment is riskier than the average market investment. If it's lower than 1, it's lower than average risk.

Regulators take these three concepts, and calculate the cost of equity as:

$$\text{Cost of equity} = \text{risk-free rate} + (\text{equity premium} * \text{equity beta})$$

This paper focuses on that last concept: if the beta's very high, then you'll expect better returns than the average stock return. On the contrary, if it's very low, you should expect returns that are much more modest. And the decision you make about this value has a big impact on consumers' bills: in *Energy Consumers' Missing Billions*<sup>5</sup>, we argued that setting it at a more appropriate level could take £3bn off consumers bills in the current price agreement.

## How risky are monopolies?

Monopolies should be significantly less risky investments than companies in truly competitive markets. After all, for many of these businesses, revenue is all but guaranteed - the regulator has set the price, and most consumers can't opt out of lighting and warming their home. The risk to revenue is low.

And while there can be greater uncertainty over costs - the cost of copper for wires, say, fluctuates beyond companies' control - in practice this uncertainty has been to companies' benefit. Companies know much more about their actual costs than regulators do and regulators have often overestimated companies' costs as a result. In the current price control, energy network companies have had a windfall of £900m due to costs being lower than was expected<sup>6</sup>.

Perhaps most importantly, it is very difficult to imagine government or the regulators ever letting the businesses that run these services fail. The government ultimately wants to

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<sup>5</sup> [Energy Consumers' Missing Billions](#), Citizens Advice, 2017

<sup>6</sup> [Energy Consumers' Missing Billions](#), Citizens Advice, 2017

keep the lights on and water running. These political incentives matter to the assessment of risk.

So it would be surprising if investors actually thought these investments were as risky as the average company. And while no comprehensive survey on investor expectations exists, Barclays has noted that the increase in National Grid's valuation had been driven by higher returns compared to other similarly low risk investments. Regulators have also suspected that the actual risk is lower than their modelling suggested<sup>7</sup>.

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<sup>7</sup> Both noted in [Estimating the cost of capital for the implementation of price controls by UK regulators](#), Appendix L Terms of Reference, Wright et al., 2018

# The current regulatory approach

Despite this, most regulators have assumed that these companies are close to the risk of the average company (an equity beta of 1). Why has this happened?

Partly, this is because they've been too attuned to firms' interests and not enough to consumers' interests. Regulators have taken the very upper values of what could possibly be justified by standard econometric approaches, and placed less weight on evidence suggesting markedly lower betas. As an Ofgem review found in 2010<sup>8</sup>, there is 'strong evidence' that it is much closer to around 0.5 using standard measures. This adjustment was never implemented.

But it's also possible that the standard estimation technique was wrong. Regulators, to their credit, commissioned a study to look into whether they've been estimating these costs in the right way all these years<sup>9</sup>. And three of its authors suggest that they haven't, in two specific ways:

- 1) The standard econometric approach to beta estimation may be wrong
- 2) An upward adjustment to the beta that regulators apply to reflect their assumptions on company financing could be unjustified

To understand both these issues, we'll need to examine the standard approach to estimating the equity beta first. The approach that regulators use to estimate betas has the following relevant features:

- 1) They use a linear regression model, on high-frequency (daily or weekly) returns data over a short-time frame (3-5 years)
- 2) They then adjust the estimated beta to reflect companies' assumed financial structure

## The standard regression model

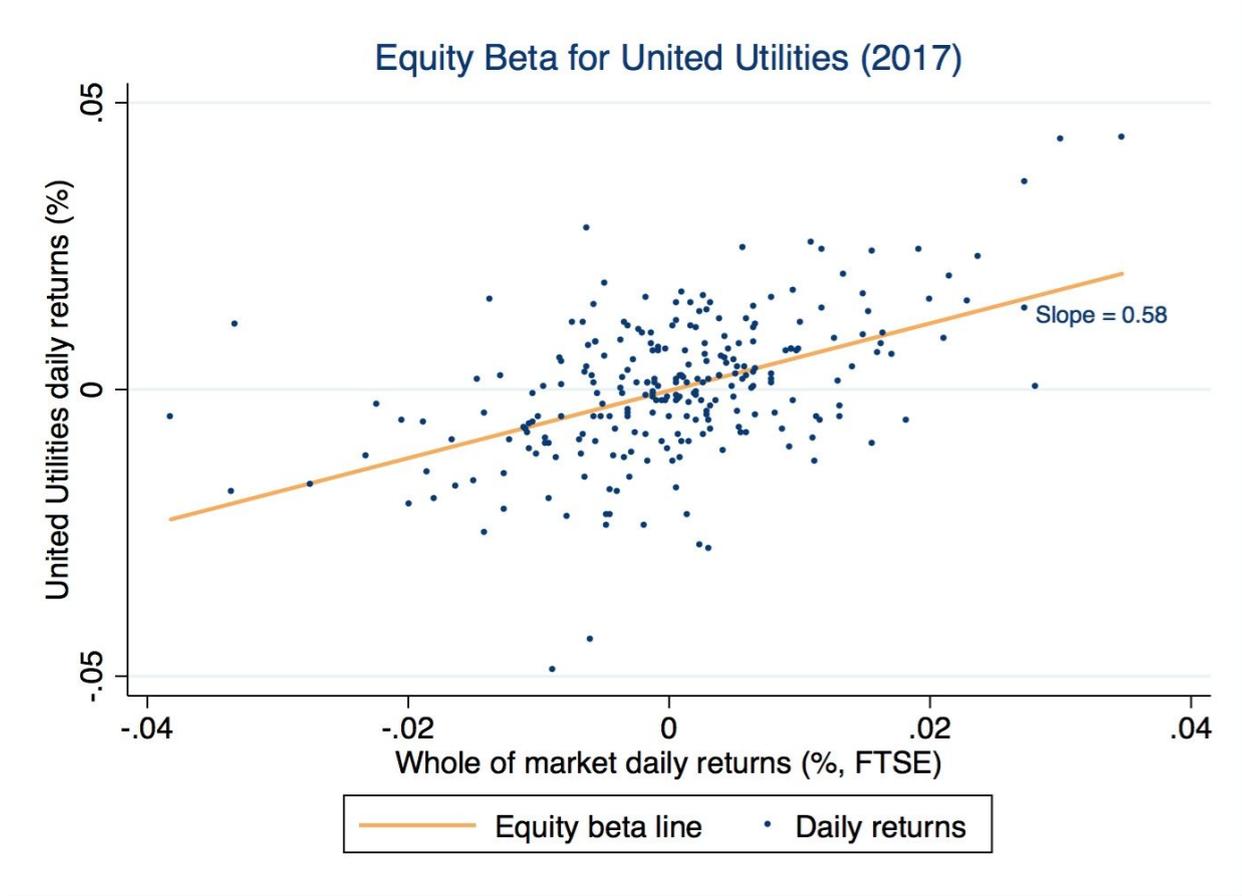
The most common approach to estimating the equity beta for a company is to plot a line of best fit between the daily returns of the company's stock and the daily returns of the stock market, using an Ordinary Least Squares linear regression model. In Figure 1, this is illustrated for the daily returns for United Utilities and for the whole market in 2017.

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<sup>8</sup> [The Cost of Equity Capital for Regulated Companies: A Review for Ofgem](#), Wright & Smithers, 2010

<sup>9</sup> [Estimating the cost of capital for the implementation of price controls by UK regulators](#), Wright et al., 2018

Figure 1: Equity Beta for United Utilities in 2017



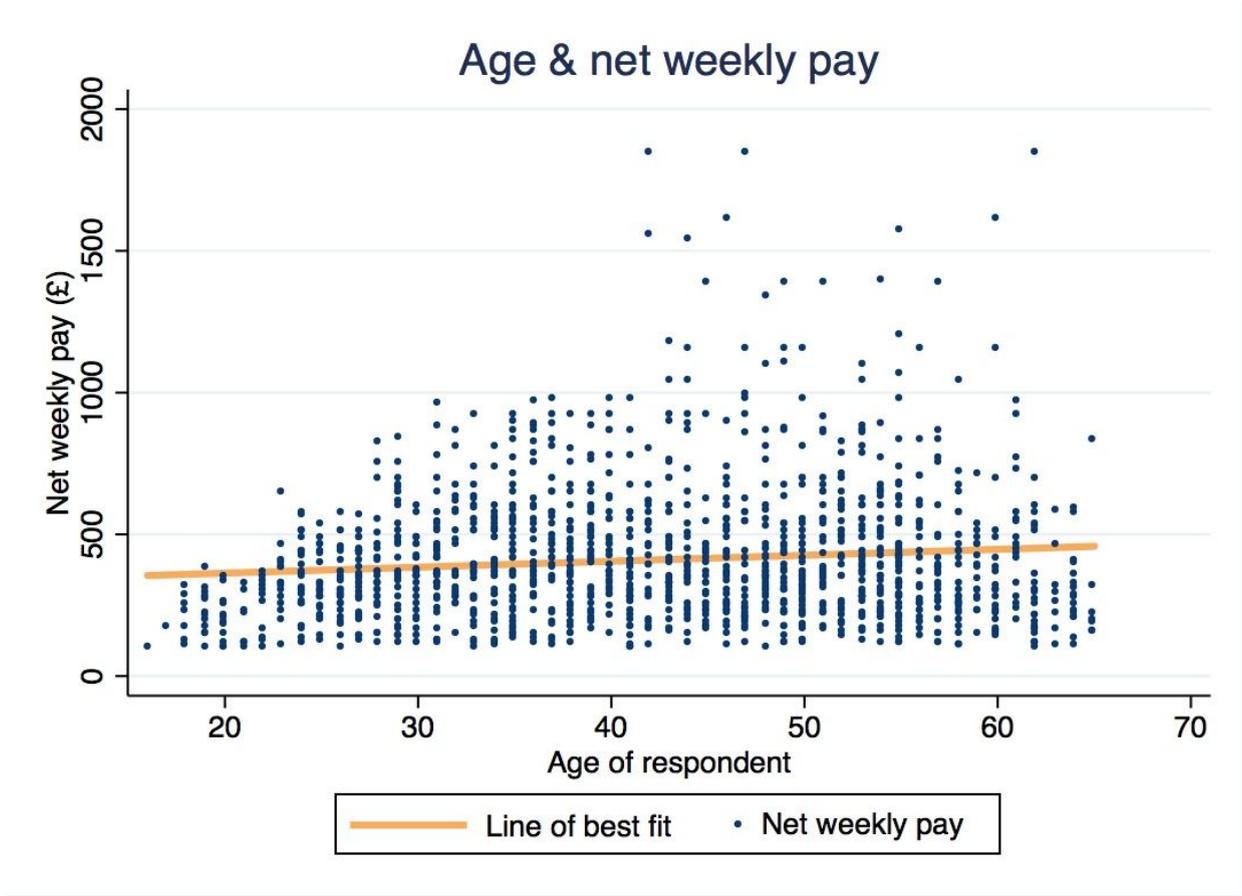
The *slope* of this line of best fit - how much change in United Utilities' return *we should expect* for a given change in the stock market's return - gives us the stock's beta (in this simple illustration, 0.58 in 2017). This provides us the line that has the 'least squares' distance from each of the observations<sup>10</sup>. For any given value in the stock market's return, the slope gives us the best prediction of the stock's return.

This model is appropriate in many cases. But one of the crucial assumptions required for it to be a good prediction is that the variance in the relationship between the variables will be similar over time. To see why this is so, consider a different case - the regression between age and income (Figure 2).

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<sup>10</sup> In practice, regulators often estimate a 'rolling beta', which performs the same calculation many times over overlapping time periods, but the underlying principle is the same.

Figure 2: Age and weekly net pay<sup>11</sup>



You would expect teenagers to all be earning low, entry-level wages. But as you get older, incomes diverge: some people earn drastically more while others remain on lower wages. The prediction, therefore, gets less good over time: age is a very good predictor of a person's income when you're young; as you become older, it becomes somewhat less so. No statistical model is precisely correct, but the 'error rate' should be consistent over time. In statistical terms, the errors need to be *homoskedastic*. As discussed below, the assumption that they are for these companies is extremely questionable.

### The asset beta

This isn't the final step regulators take in equity beta estimation. Because the level of debt a company has impacts their risks, regulators decompose the observed beta further: the underlying risk of their assets or business (the asset beta), and the risk associated with the amount of debt the company has. The greater the debt, the higher the equity beta tends to be.

Each company decides how much of its business to fund by debt and by equity, trying to find the best combination of cheap financing (debt) and lower risk to cash flows (equity). The proportion of debt financing is known as a company's *gearing*.

<sup>11</sup> From stylised sample of UK Labour Force Survey, January-March 2018.

Regulators have traditionally left actual capital structures to companies to manage themselves. But debt & equity have different costs so, when setting companies' allowed revenue, they assume a *notional gearing*.

It's worth understanding the purpose behind notional gearing in the first place. Regulators assume a *particular* capital structure for a reason: given debt and equity have different costs, part of determining what the overall costs are involves deciding what the balance between these two should be (at least using their existing methodology).

And there's good reason not to just take the capital costs companies *in fact* have at face value: all other things being equal, shareholders would *prefer* not to take on more debt, as this dilutes their claims on future cash flows and increases risks of default when revenues are low. If regulators just relied on actual capital costs, companies would take on less debt - and this would drive up costs for consumers, given debt is cheaper than equity. There's therefore solid reason to adopt some notional split, to protect from this outcome.

But regulators don't just apply this reasoning to the funding split - they've applied it to the equity beta as well. Regulators have therefore taken the asset beta from the observed *actual* equity beta, and recalculated the notional equity beta that you would see in the market if companies funded themselves in accordance with the notional gearing. Regulators have generally assumed somewhat higher levels of gearing than is used by listed comparator companies, leading to a higher equity beta overall.

As the next section argues, both the methodological approach chosen for beta estimation and re-gearing this estimate to a notional capital structure may be wrong.

# What regulators get wrong

The UKRN report is a collaborative attempt by academics and experts to review current regulatory practice for setting the cost of capital for regulated monopolies. It has four principal authors. This section sets out the critique from three of these authors - Mason, Pickford & Wright (hereafter MPW), who conclude that regulators may have erred and that the equity beta should be lower as a result. One author, Burns, dissents from the majority view on beta estimation but agrees that further research is appropriate.

This section sets out the critique from MPW. Firstly, they draw on evidence that the rolling regression model used by regulators is inappropriate for the two 'pure' monopoly stocks listed on the UK stock exchange (Severn Trent & United Utilities), because the assumption that the volatility of these stocks is constant over time doesn't hold.

Financial markets vary in volatility - markets are riskier at some times than others. But MPW point to evidence that shows there is significant variation in volatility for Severn Trent & United Utilities as well and that these changes in volatility do not match the changes in volatility for the whole stock market:

*'There is extremely strong evidence of time variation in volatility, particularly at high frequencies.'*

Therefore, if these stocks are good comparators for other utilities, the standard model of beta estimation should not be used. In particular, it means that short-run estimates of the beta are inadvisable, because the frequent changes in variation patterns indicate that they are likely to be poor predictors of future equity betas.

**This is an important result.** It would mean decades of regulatory decisions, covering tens of billions of consumers' money, are econometrically unsafe. As the analysis concludes: *'our results cast strong doubt on the whole approach of using rolling Ordinary Least Squares beta estimation (which has indeed always been known to be difficult to defend econometrically).'*

An alternative approach to beta estimation is also proposed<sup>12</sup>, which MPW argue implies that regulators should take seriously the prospect of lower betas. The approach proposes:

- 1) If using high frequency data, use a model that takes the time varying volatility of returns into account - the Generalised Auto-Regressive Conditional Heteroskedasticity Model, or GARCH (a common approach in financial literature and practice).
- 2) Using a lengthier dataset to estimate the equity beta (going back to 2000). Both regulators and many investors in these businesses have a long horizon - so it makes sense to try and capture the long-run beta for these businesses.

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<sup>12</sup>Appendix G Beta Estimation for CAPM-WACC at Long Horizons (Stephen Wright and Donald Robertson), Estimating the cost of capital for implementation of price controls by UK Regulators, 2018

- 3) If using the standard Ordinary Least Squares model, use low frequency data, as the time-varying volatility of returns largely disappear when using quarterly data.

If these adjustments are applied to a longer time period, betas of between 0.3 and 0.5 are derived for Severn Trent & United Utilities, depending on the frequency used.

A summary of the different methods' implications for Severn Trent is shown in Table 1 (adapted from Appendix G: Beta Estimation for CAPM-WACC at Long Horizons; excludes some results). United Utilities' results are highly similar.

**Table 1: Different beta estimates from different methods**

Severn Trent	GARCH Model	OLS Model (full sample)	OLS Model (rolling, five-year estimate)
Daily returns	0.44	0.53	0.67
Weekly returns	0.36	0.46	0.74
Monthly returns	0.40	0.36	1
Quarterly returns	0.32	0.29	0.2

At quarterly returns, all the results are fairly similar, because the time-varying volatility of returns disappears within quarters. When using the full sample of data (to 2000), the beta is significantly lower. Therefore, the more you correct for time-varying volatility and the more you extend the time series, the lower the beta tends to be.

For simplicity's sake, we illustrate the consumer bill impacts below using 0.3 and 0.5 actual beta estimates only.

### The case for using observed beta estimates

MPW also argue that, in contrast with existing regulatory practice, re-gearing to a notional is not justified on the econometric merits and that there is a case for using observed betas. That's because the point of estimating the equity beta is to determine the marginal cost of equity that firms *actually face* - if they are trying to raise capital to finance an increase in investment, it is the beta of their *actual, traded shares* that determine the return on equity. The notional gearing structure never enters into it.

The main challenge this poses is that using the actual equity beta could create perverse incentives to acquire more debt, with companies hoping they can artificially elevate their actual observed beta, and therefore their allowance for it in future price controls.

However, there are reasons to think that the incentive to acquire more debt would be dampened. Firstly, increasing debt reduces shareholders' claim on future cash flows, so increases in debt would be expected to be met by an increase in the cost of equity and/or a reduction in future dividends. Secondly, the marginal cost of debt increases as you take on more of it - particularly as credit ratings come under risk. Thirdly, the suggested methodology estimates the equity beta over the longest sample - so companies would have to have a highly increased debt burden for a long time for it to be plausibly worth it.

Finally, nothing about decisions at this price control binds regulators' hands at future ones. Firms would have to be confident that over-leveraging would be a successful regulatory gaming strategy. But if firms are engaging in gaming that benefits themselves at the expense of consumers, then regulators are free to penalise them at the next price control. We recommend that regulators should never set a beta higher than the observed beta, which would preserve the necessary flexibility to deal with these challenges. Collectively, these factors are adequate protection against the (hypothetical) perverse incentives.

# What does this mean for consumers?

This matters because of its impact on people's bills: set the equity beta too high and consumers will end up overpaying for the unnecessary profit of investors. To illustrate the impacts of the downward adjustments to the equity beta implied by Mason, Pickford & Wright (MPW), we modeled the reduction in consumers' bills using the analysis of Severn Trent & United Utilities as a reference point.

We modeled two versions of this adjustment:

- 1) Only making the methodological adjustments to raw beta estimation**
- 2) In addition, following their recommendation not to re-lever the beta to notional gearing**

We modeled these adjustments separately because they are separate decisions: the first step should be to estimate the raw betas in a robust fashion, before making a decision about whether notionalisation is appropriate.

To quantify the consumer bill impact of these adjustments we used the following data:

- We took the forecast Regulatory Asset Values (RAV) for each company for the last year of the current price controls, adjusted to today's prices, from Ofgem's Price Control Financial Model. The cumulative annual RAV across businesses is £70bn. We assumed a price control of five years, but held the asset values constant in each year. In practice, this is likely to be a conservative assumption, as companies' RAVs have tended to increase over time.
- To arrive at a share of the RAV funded by equity, we used the gearing figures for the current energy network price controls, also taken from Ofgem's Price Control Financial Model.

We then subtracted the cost of equity returns implied by MPW's lower beta figures from the cost of equity returns implied by the Ofgem mid-point estimate to arrive at the potential consumer bill savings.

## Implementing methodological adjustments to beta estimation

For the purposes of comparison, we used the midpoint of the cost of equity ranges estimated by CEPA, contained in Ofgem's RIIO-2 Draft Framework consultation. The document does not provide an explicit figure for the equity risk premium, so this is calculated by subtracting the risk-free rate from the total market return.

We first modeled the impact of implementing just the methodological adjustments, but re-levering to the notional gearing implied by the current price controls, as accords with current regulatory practice. Because different energy networks have different notional

gearing, the recalculated beta varies accordingly. The implications on the cost of equity are shown in Table 1.

**Table 1: Implications of methodological adjustments to beta estimation**

Cost of equity component	Ofgem mid-point estimate	MA (low estimate)	MA (high estimate)
Risk-free rate	<b>-1.18%</b>		
Total Market Return (TMR)	<b>5.75%</b>		
Implied equity risk premium (TMR - risk-free rate)	<b>6.93%</b>		
Equity beta (varies according to assumed gearing)	0.75	0.36-0.42	0.61-0.69
Real cost of equity	4%	1.3%-1.7%	3%-3.6%

When applied to the asset values, Ofgem’s mid-point estimate leads to expected equity returns of £5.3bn. The lower beta range implied by methodological adjustments leads to £2bn while the higher beta range leads to £4.4bn.

In turn, this leads to potential consumer savings of between £0.9bn and £3.3bn over the five year period (compared to Ofgem’s current mid point estimate). This is shown in Table 2.

**Table 2: Implications of methodological adjustments to consumers’ bills**

Equity returns	Ofgem mid-point estimate (bn)	MA (low estimate, bn)	MA (high estimate, bn)
Electricity & Gas Transmission	£2,110	£700	£1,575
Electricity Distribution	£1,810	£760	£1,615
Gas Distribution	£1,380	£580	£1,230
<b>Total</b>	<b>£5,300</b>	<b>£2,040</b>	<b>£4,420</b>

**Implementing methodological adjustments without re-levering**

We next implement both recommendations, including the recommendation not to re-lever the equity beta. This gives the cost of equity estimates arrived at in Table 3.

One thing to note here is that on the low estimates, the real cost of equity falls to such a low figure that it may give financeability concerns regarding companies’ cash flow. Partly this indicates the need for further research. But, if further research does indicate that both Ofgem’s mid-point estimate for the other elements of the cost of equity is correct and that the beta should be lowered, Ofgem should not be afraid of following the econometric evidence. A separate assessment on financeability should then be made.

**Table 3: Implementing methodological adjustments without re-levering**

Cost of equity component	Ofgem mid-point estimate	MA (low estimate)	MA (high estimate)
Risk-free rate	<b>-1.18%</b>		
Total Market Return (TMR)	<b>5.75%</b>		
Implied equity risk premium (TMR - risk-free rate)	<b>6.93%</b>		
Equity beta	0.75	0.3	0.5
Real cost of equity	4%	1%	2.3%

As above, when applied to the asset values, Ofgem’s mid-point estimate leads to expected equity returns of £5.3bn. The lower beta range implied by methodological adjustments leads to £1.2bn while the higher beta range leads to £3bn.

In turn, this leads to potential consumer savings of of between £2.3bn and £4.1bn over the five year period (compared to Ofgem’s current mid point estimate), as shown in Table 4.

**Table 4: Impact of methodological assumptions without re-levering on consumers’ bills**

Equity risk premium returns	Ofgem mid-point estimate (bn)	MPW (low estimate, bn))	MPW (high estimate, bn))
Electricity & Gas Transmission	£2,110	£470	£1,190
Electricity Distribution	£1,810	£400	£1,020
Gas Distribution	£1,380	£310	£780
<b>Total</b>	<b>£5,300</b>	<b>£1,180</b>	<b>£2,990</b>

Ultimately, whichever approach ultimately proves correct, the sums are considerable - in the lowest case, £0.9bn and in the highest £4.1bn. This is in a context where regulators have consistently over-estimated the cost of capital over many years. These mistakes have been highly regressive: energy consumption is very flat by income, so these costs will hit poorer people hardest as a proportion of their income. Getting this right in future could make a big impact for those who have the hardest time making ends meet.

# Recommendations

Subject to satisfactory further research, we recommend adopting the alternative approach outlined in the UK Regulators Network cost of capital investigation, as it forms the best available evidence on the subject. However, there are outstanding questions to answer - and these questions deserve full and prompt analysis and the case for using raw betas estimated via the alternative methodology seems strong.

Such research is feasible before the next round of price controls begins and could have a significant, material impact on consumers' bills. In particular, as it is in the process of deciding its cost of capital methodology for energy networks, Ofgem should ensure it has robust answers on the following issues:

- 1) The analysis should be extended beyond the two pure play utilities, Severn Trent and United Utilities - both water utilities. In the past it has been argued that energy networks face higher overall risks (though we are unconvinced that this can in fact be justified by the data). This analysis should be extended to all listed utility companies and potentially include international comparators where appropriate.
- 2) Further empirical work should be done to estimate the appropriateness of the GARCH model and/or the use of the OLS model at lower frequencies where time-varying volatility in returns is not present. As the UKRN report argues, *'a wider set of variants of the GARCH model [should be examined]...using Monte Carlo simulation analysis to test how well each specific GARCH model actually estimates the unconditional betas for each stock'*.
- 3) Compelling evidence is offered that volatility of the pure play utilities varies over time for high frequency data (i.e. they are heteroskedastic), indicating the OLS model is inappropriate. Regulators should consider whether continued employment of the standard OLS model for daily data can be econometrically justified and what frequency of data and time series should be used.
- 4) The results we present here assume a debt beta of zero, which is consistent with existing beta estimation practices. However, the alternative approach indicates that, for lower frequency data, the debt beta may be higher than zero. Further work should be done to examine whether this is the case and if it has a material impact on estimation.
- 5) MPW argues that the re-gearing of the equity beta to its notional value cannot be justified econometrically. Further research should be done to consider, and if possible measure, the extent to which the reduced equity costs associated with using an observed beta is offset by the negative incentives it could give companies regarding their capital structure.

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