Europe Economics

The Allowed Return on Capital for the Water Sector at PR19 – Final Advice

December 2019

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Contents

1 Introduction

This document sets out our updated view on the appropriate WACC for PR19. This report builds upon the analysis conducted in our previous report published in July 2019 (henceforth the "July 2019 Report")[1] and relies on more recent market data up to 30 September 2019.

The main drivers of changes in our WACC estimates compared to the recommendations we made in July 2019 arise from:

- Changes in market data (the cut-off date used to produce estimates in this report is 30 September 2019, whilst the cut-off date used in the July 2019 Report was 28 February 2019)
- Methodological changes (these are summarised in Table 1.2).

We start by comparing our current WACC recommendations ("EE's December 2019 recommendation") to the figures we proposed in July 2019 ("EE's July 2019 recommendation").

Table 1.1: Europe Economics' current recommendation — comparison with EE recommendation in July 2019 (all figures in the table below are nominal)

	Europe Economics' July 2019 Recommendation	Europe Economics' October 2019 Recommendation	Change relative to July 2019 Recommendation
Risk-free rate	1.81%	0.84%	-97bps
Total market return	8.63%	8.63%	No change
Raw equity beta	0.62	0.60	-0.02
Market gearing	54.70%	56.40%	+1.70%
Unlevered beta	0.28	0.26	-0.02
Debt beta	0.15	0.15	No change
Asset beta	0.36	0.34	-0.02
Notional gearing	60%	60%	No change
Notional equity beta	0.68	0.64	-0.04
Cost of equity (post-tax)	**6.45%**	**5.80%**	**-65bps**
Cost of new debt	3.36%	2.54%	-82bps
Cost of embedded debt	4.52%	4.47%	-5bps
Share of new to total debt	20%	20%	No change
Issuance and liquidiy cost	0.10%	0.10%	No change
Cost of debt (pre-tax)	**4.39%**	**4.18%**	**-21bps**
Overall WACC (vanilla)	**5.21%**	**4.83%**	**-38bps**
Retail margin adjustment	0.11%	0.04%	-7bps
Wholesale WACC	**5.10%**	**4.79%**	**-31bps**

[1] Europe Economics (July 2019), "The Cost of Capital for the Water Sector at PR19", available at: https://www.ofwat.gov.uk/wp-content/uploads/2019/07/Europe-Economics-The-Cost-of-Capital-for-the-Water-Sector-at-PR19.pdf

The table below summarises the methodologies adopted in the "July 2019 Report", and sets out the methodology underpinning the proposals presented in this report and explained in the corresponding sections.

Table 1.2: Methodologies underpinning the proposals

	EE view in July 2019 (nominal)	EE recommendation for the final determination (nominal)
Risk-free rate	Range: **1.54%-1.92%** Point estimate: **1.81%**	Range: **0.58%-1.10%** Point estimate: **0.84%**
	Reflecting the view that both nominal gilts and ILGs are relevant, we calculate the lower bound from average spot values of 10/20-year ILGs gilts (-1.70% RPI-deflated value), and upper bound based on average spot values (1.62%) of 10/20-year nominal gilts. Both values are adjusted for the average expected rise in interest in the 2020-25 period (i.e. +0.28% added to the RPI-deflated value of -1.70%, which results in a RPI-deflated value of -1.42%, and thus 1.54% in nominal terms, and +0.31% added to the nominal rate of 1.62% so as to obtain a nominal rate of 1.92%) Reflecting our analysis of differences in the relative distortions of the nominal and ILG series at different maturities (described in Section [2.3] of the "July 2019 Report"), the point estimate is the average between 10-year nominal gilts (adjusted for rate change expectations) and the average between 20-year nominal gilts and ILGs (also adjusted to reflect rate change expectations).	We remain of the view that here is no strong bias for favouring either nominal gilts of ILGs, and therefore we use both instruments in order to form a view on the risk-free rate. However, instead of taking the average yields of gilts with 10-years and 20-years to maturity to obtain a risk-free rate over a 15-year horizon — as we did in our July 2019 Report — we now favour relying directly on evidence from 15-year gilts (as proposed by Frontier Economics on behalf of a number of companies in their submissions). Furthermore, in order to be consistent with the way in which we determine market implied rate change in AMP7 (this is calculated based on the average forward-minus spot rate using daily data reported by the Bank of England in September 2019), we now favour the use of average yield figures over the last month, as opposed to spot yield values at the end of the month. The lower bound is determined by the average yield of ILGs in September 2019 (-2.61%) adjusted for the average expected rate rise in interest in AMP7 (+26bps). This results in a RPI-deflated yield of -2.35%, i.e. a nominal yield of 0.58%. The upper bound is determined by the average daily nominal yield of nominal yield in September 2019 (0.85%), adjusted for the average expected rate rise in interest in AMP7 (+25bps). This result in a nominal upper bound value of 1.10%. The point estimate is the mid-point of the range.
Total market return	Range: **8.12%-9.14%** Point estimate: **8.63%**	Range: **8.12%-9.14%** Point estimate: **8.63%**
	Historical approaches based on the latest DMS data are consistent with a CPIH-deflated TMR estimate of ~6.5-7%, with a non-recession point estimate likely to be of the order of 0.2% below this.	Historical approaches based on the latest DMS data are consistent with a CPIH-deflated TMR estimate of ~6.5-7%. DGM and DDM models produce similar CPIH-deflated TMR estimates broadly within the similar 6-7% range.

	EE view in July 2019 (nominal)	EE recommendation for the final determination (nominal)
	DGM and DDM models produce similar CPIH-deflated TMR estimates broadly within the similar 6-7% range. Adjusted historical approaches suggest a CPIH-deflated value for the TMR towards the lower end of that range of around 6%. Although the average across practitioners' estimates is materially below 6 per cent, we place more weight upon the first three factors, producing a real (CPIH-deflated) range of 6-7%. When inflated by our assumed 2.0% CPIH rate, we obtain 8.12%-9.14% for the nominal TMR.	Adjusted historical approaches suggest a CPIH-deflated value for the TMR towards the lower end of that range of around 6%. Although the average across practitioners' estimates is materially below 6 per cent, we place more weight upon the first three factors, producing a real (CPIH-deflated) range of 6-7%. When inflated by our assumed 2.0% CPIH rate, we obtain 8.12%-9.14% for the nominal TMR.
"Raw" equity beta[2]	Range: **0.57-0.66** Point estimate: **0.62**	Range: **0.57-0.71** Point estimate: **0.60**
	The ranges are imputed from the unlevered beta ranges and the market gearing value. The point estimate is imputed from the unlevered beta point estimate and the market gearing value.	The ranges are imputed from the unlevered beta ranges and the market gearing value. The point estimate is imputed from the unlevered beta point estimate and the market gearing value.
Market gearing	Range: N/A Point estimate: **54.7%**	Range: N/A Point estimate: **56.4%**
	The 54.7% value is determined by the 2-year trailing average of net debt to enterprise value for SVT/UU.	The **56.4%** value is determined by the 2-year trailing average of net debt to enterprise value for SVT/UU.
Unlevered beta	Range: **0.26-0.30** Point estimate: **0.28**	Range: **0.25-0.31** Point estimate: **0.26**
	Point estimate based on 2-year OLS beta for SVT/UU using daily data. The range is a judgment call based on the fact that beta estimates are intrinsically subject to some degree of uncertainty.	The lower bound is the 2-year daily OLS estimate for the SVT/UU portfolio. Under the various methodologies (data frequencies, time horizons and estimation techniques), 0.31 and 0.32 appear roughly equally frequently at the upper end. We use 0.31 to reflect the fact that values towards the top end of our range are, in any event, less likely than values towards the lower end. This preference for the lower part of our range is supported both by the fact that we consider the 2 year daily beta the most robust estimate and by the fact that the one year daily beta lies well below our lower bound, suggesting that (mathematically) the natural tendency, *ceteris paribus*, would be for our 2 year daily beta to fall further, rather than rise. Under our favoured 2-year daily OLS methodology, SVT is 0.26, UU is 0.25, the portfolio of those two is 0.25 and when Pennon is added it becomes 0.26.

[2] We note that under our approach we form a view on the unlevered beta directly, rather than forming a view on the raw equity beta and then converting it into an unlevered beta. The "Raw" equity beta reported here is our reconstruction back of what a raw equity beta conclusion would have been had we proceeded by the latter method.

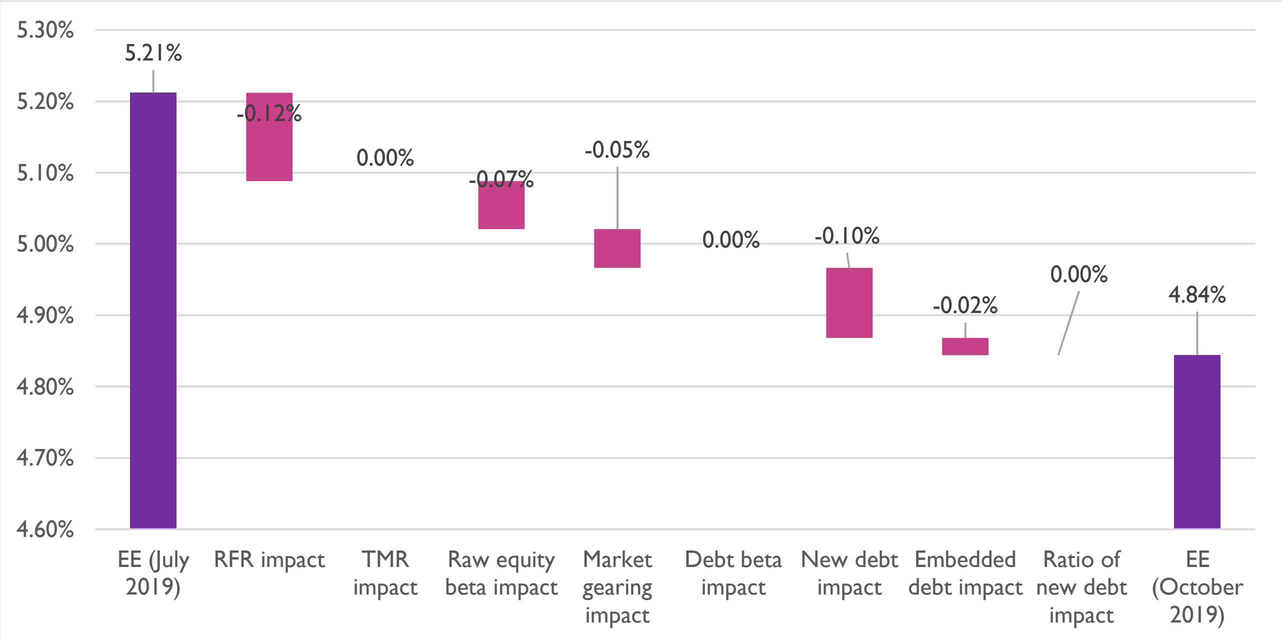
	EE view in July 2019 (nominal)	EE recommendation for the final determination (nominal)
		The SVT/UU portfolio is 0.26 under the GARCH model. We use a point estimate of 0.26.
Debt beta	Range: **0.10-0.17** Point estimate: **0.15**	Range: **0.10-0.17** Point estimate: **0.15**
	Debt beta range of 0.1-0.17, with upper bound based on spot value from the decomposition approach and lower bound based on regulatory precedents. The point estimate of 0.15 is consistent with 2-year trailing average debt beta obtained from the decomposition approach.	Debt beta range of 0.1-0.17, with the upper bound based on the 2-year trailing average value from the decomposition approach and lower bound based on regulatory precedents. The point estimate of 0.15 is consistent with the 2-year trailing average debt beta obtained from the decomposition approach.
Cost of new debt	Range: N/A Point estimate: **3.36%**	Range: N/A Point estimate: **2.54%**
	The point estimate is based on the spot yield of the iBoxx non-financials 10+ A/BBB index (3.30%) adjusted to account for expected rise in interest rate (+31bps), minus 25bps to account for companies' historical outperformance against the index.	The point estimate is based on the average yield of the iBoxx non-financials 10+ A/BBB index (2.44%) adjusted to account for expected rise in interest rate (+25bps), minus 15bps to account for companies' potential future outperformance against the index. Although our view remains that the appropriate adjustment to reflect historical outperformance would be 25bps (see below) we project forward-looking outperformance to be lower because historic WACCs, higher, relative to the actual WACC outturn over the price control period, than those we project in this review (since we are expecting a WACC in line without our recommended value), provided a comfort buffer to water company debt that may be reduced in the future.
Cost of embedded debt	Range: **4.25%-4.65%** Point estimate: **4.52%**	Range: **4.25%-4.65%** Point estimate: **4.47%**
	The point estimate is the 15-year trailing average of the iBoxx average A/BBB index (forecasted up to April 2020), minus 25bps to account for companies' outperformance against the index. The bottom end of the range is the sector weighted average cost of embedded debt (based on companies' balance and accounting only for pure-debt instruments). The top end of the range is the sector's median cost of embedded debt (again, based on companies' balance and accounting only for pure-debt instruments).	The point estimate is the 15-year trailing average of the iBoxx average A/BBB index (forecasted up to April 2020), minus 25bps to account for companies' historical outperformance against the index. The bottom end of the range is the sector weighted average cost of embedded debt (based on companies' balance and accounting only for pure-debt instruments). The top end of the range is the sector's median cost of embedded debt (again, based on companies' balance and accounting only for pure-debt instruments).
Retail margin adjustment	Range: N/A Point estimate: **0.11%**	Range: N/A Point estimate: **0.04%**

	EE view in July 2019 (nominal)	EE recommendation for the final determination (nominal)
	The retail adjustment is the post-tax annual revenue requirement expressed as a percentage of the RCV. The annual revenue requirements is calculated by applying a net retail margin of 1 per cent to the wholesale charge apportioned to household.	The retail adjustment is the *residual* post-tax annual revenue requirement expressed as a percentage of the RCV. The residual revenue requirement is calculated by subtracting the revenue required for the return on capital assets in retail and working capital from the post-tax annual retail revenue requirements. The latter is calculated assuming a 1 per cent retail margin.

1.1 Overall impact of parameters changes on the WACC

We can see that the figures recommended here represent a drop from those proposed by Europe Economics in its July 2019 Report. The figure below illustrates what contribution of the total 38bps reduction in WACC is accounted for by changes in the risk-free rate, total market return, beta, gearing, cost of embedded debt, cost of new debt, and ratio of new debt to total debt. The impact attributable to a particular WACC component was calculated by keeping all other WACC components at the Europe Economics' view July 2019 level, and changing the value of the component under consideration to the level proposed in this report.

Figure 1.1: Impact of parameters on the vanilla WACC



Source: Europe Economics

1.2 Inflation assumption

Throughout this document we use assumptions of 2 per cent for CPIH and 3 per cent for RPI, as per our July 2019 Report.

2 Risk-free rate

2.1 Introduction

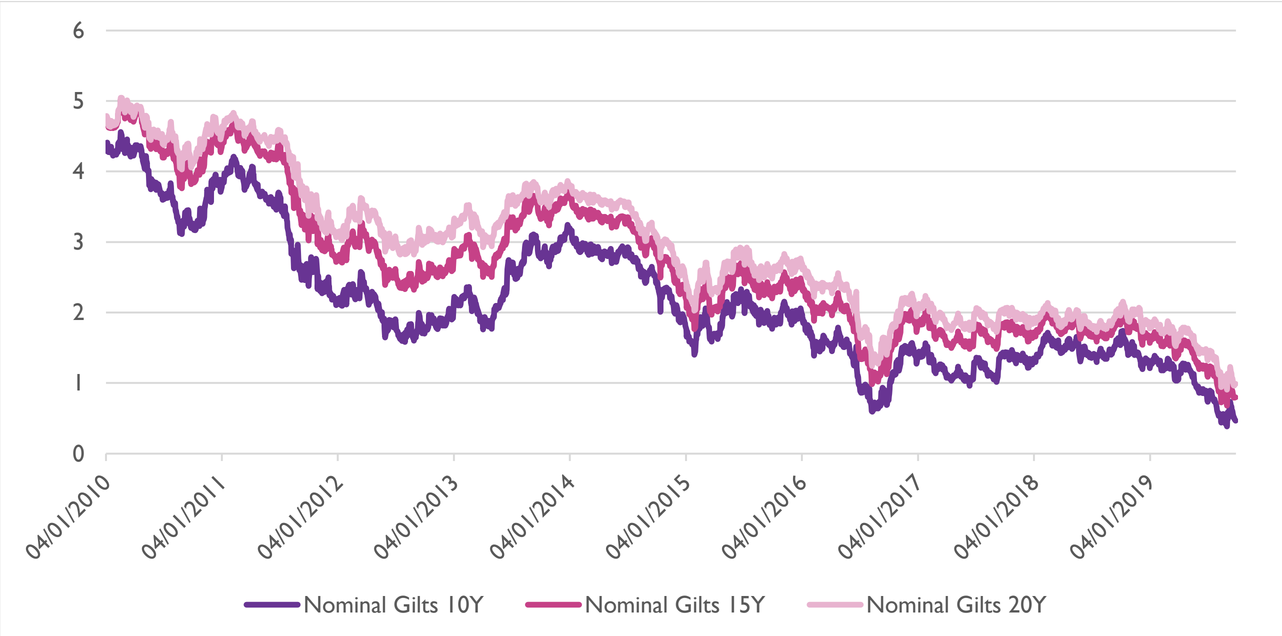
This section provides our updated view on the appropriate risk-free rate to be used in PR19. The section is structured as follows:

- In Section 2.2 we present market evidence on nominal gilts and index-linked gilts.
- In Section 2.3 we provide a recommendation as to which instrument is more relevant when assessing the risk-free rate of return.
- In section 2.4 we set out our approach to infer the market implied rate change over AMP7.
- We conclude in Section 2.5with our recommended range and point estimate for the risk-free rate.

2.2 Market evidence of nominal gilts and index-linked gilts

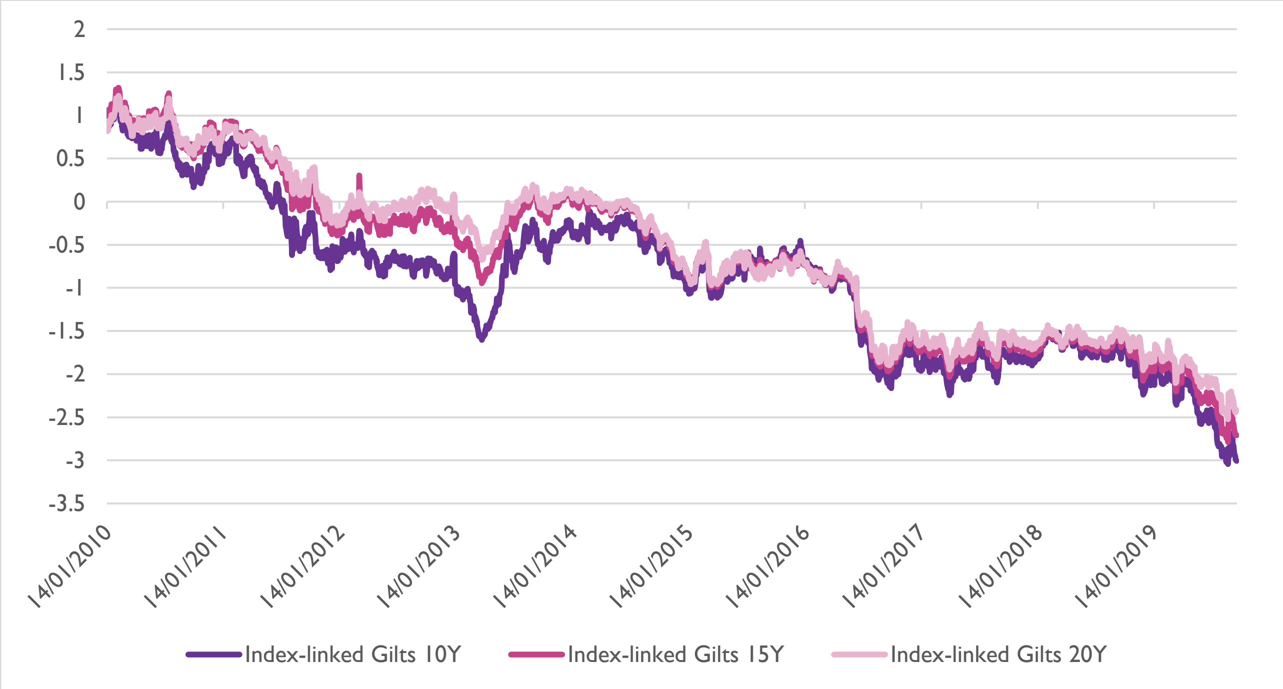
The evolution of 10-year, 15-year, and 20-year nominal gilts and 10-year, 15-year, and 20-year index-linked gilts since 2010 (i.e. after the significant market turbulence caused by the great financial crisis of 2008/09) is presented in Figure 2.1 and Figure 2.2 **Error! Reference source not found.**

Figure 2.1: 10-year, 15-year and 20-year nominal gilt yields (%)



Source: Thomson Reuters, Europe Economics' calculations.

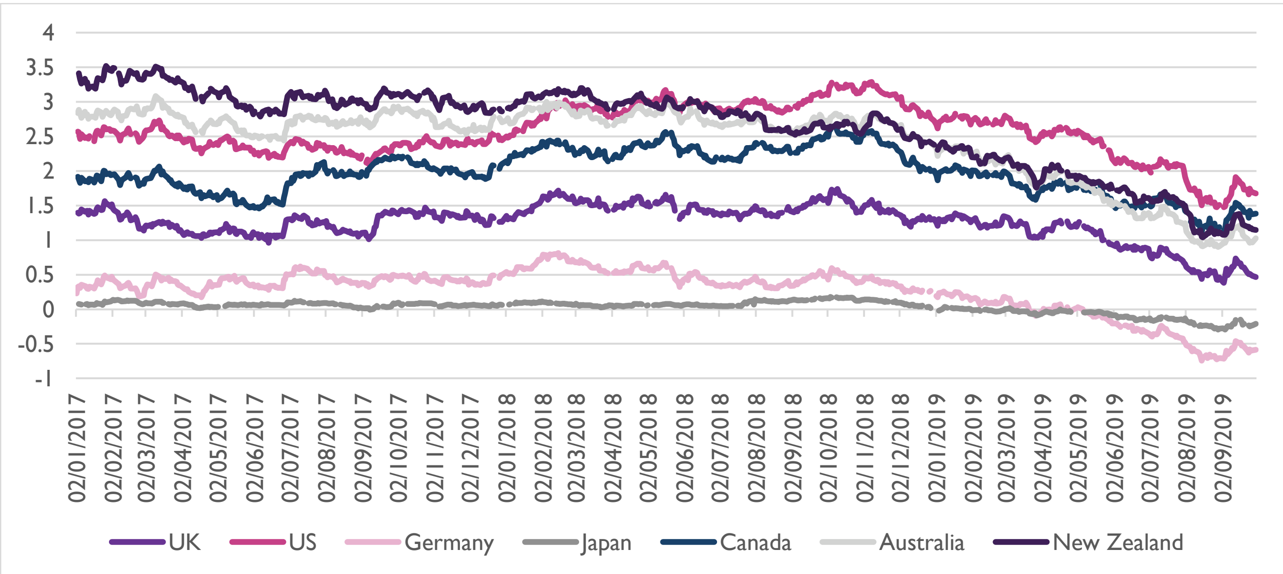
Figure 2.2: 10-year, 15-year and 20-year index-linked gilt yields (%)



Source: Thomson Reuters, Europe Economics' calculations.

We can see that yields have decreased considerably since 2010, with index-linked gilts yields being consistently negative since mid-2014. Whilst yields have remained relatively stable from January 2017 to mid-2019, over the recent months they have decreased sharply. Such a drop in yields is in line with recent movements in government bond yields, globally. The chart below shows the recent evolution of nominal yields on 10-year government bonds in a number of developed economies, namely the UK, the US, Germany, Japan, Canada, Australia, and New Zealand.

Figure 2.3: Evolution of yields on 10-year government bonds in developed economies



Source: Thomson Reuters, Europe Economics' calculations.

As we can see from the chart above, since November 2018, yields have decreased materially across developed economies. This global trend is the result of a number of concurring factors such as a deterioration of global growth prospects, and market expectations of a change in monetary policy stance among major central banks.

For example, after a series in interest rate increases, the US Federal Reserve cut rates (from 2 per cent to 1.75 per cent in October 2019) and the European Central Bank in September 2019 decreased the deposit rate (from -0.4 per cent to -0.5) per cent for the first time since 2016.

In the table below we report both spot yield and the average yield recorded over the month of September.

Table 2.1: Evidence of 10-years and 20-years gilts

Instrument	Spot yield at 30-September-2019	Average yield in September 2019
Nominal gilts yield (10yr)	0.47%	0.56%
Nominal gilts yield (20yr)	0.99%	1.05%
Nominal gilts yield (average 10yr & 20yr)	**0.73%**	**0.81%**
Index-linked gilts yield (10yr)	-3.01%	-2.89%
Index-linked gilts yield (20yr)	-2.42%	-2.35%
Index-linked l gilts yield (average 10yr & 20yr)	**-2.72%**	**-2.62%**

Source: Thomson Reuters, Europe Economics' calculations.

Table 2.2: Evidence of 15-years gilts

Instrument	Spot yield at 30-September-2019	Average yield in September 2019
Nominal gilts yield (15yr)	**0.80%**	**0.85%**
Index-linked gilts yield (15yr)	**-2.71%**	**-2.61%**

Source: Thomson Reuters, Europe Economics' calculations.

From the tables above we can see that the yields of 15-year nominal gilts are slightly higher than the average nominal yields of 10-year & 20-year gilts, whilst, the yields of 15-year ILGs are virtually identical (with a difference of is at most 1bp) to the average yield across 10-year and 20-year ILGs.

2.3 Market instruments used

In our July 2019 Report we stated that we did not have a strong basis for favouring either the nominal or index-linked gilts, but we expressed a mild preference for nominal gilts at the shorter end of the horizon. Consequently, the approach we took to form a view on the risk-free rate was as follows:

- Use nominal gilts at the 10 year horizon
- Use an average of real yields obtained from nominal and index-linked gilts at the 20 year horizon.
- Take the average of the first two steps so as to obtain 15-year risk-free rate.

In our July 2019 Repot we also acknowledge that other judgements are possible to obtain a 15-year risk-free rate.

We remain of the view that here is no strong basis for preferring either nominal gilts or ILGs, and therefore we shall use both instruments in order to form a view on the risk-free rate. However, instead of taking the average yields of gilts with 10-years and 20-years of maturity to obtain a risk-free rate over a 15-year horizon — as we did in our July 2019 Report — we now favour relying directly on evidence from 15-year gilts as this represents a more direct approach that a simple interpolation of 10-year and 20-year yields.[3]

[3] Frontier Economics (acting on behalf of a number of water companies) argued for this change and we agree with their conclusion, though not necessarily with their claim that the approach we adopted previously necessarily increases distortions. Indeed, arguably it reduces the effect of unnoticed distortions since, whereas an unnoticed distortion affecting the 15 year series would enter directly into the result, a distortion or temporary eccentric

Therefore the approach we favour in the current report is as follows:

- Using direct evidence from 15-year maturity gilts (i.e. no averaging between 10-year and 20-year gilts).
- Placing equal weight to nominal gilts and ILGs.

2.4 Market-implied rate change in AMP7

To determine future movements in the risk free rate we can make use of the yields on different maturity gilts so as to estimate the forward rates for relevant length gilts. The forward rate captures the implied future yield on an investment made in a certain number of years' time. In this case, we are interested in the yield on 15-year[4] gilts arising from investments made during the AMP7 period, or more specifically:

- 6 months from September 2019 (i.e. the beginning of AMP7).
- 3 years from September 2019 (the middle of AMP7).
- 5 and a half years from September 2019 (i.e. the end of AMP7).

The forward rates are calculated using the same approach adopted in the July 2019 Report. Also, consistently with the approach followed in the July 2019 Report, we calculate the average market implied change in rate relative to the daily spot rates recorded over the last month (i.e. September 2019). These are reported in the Table 2.3 for 15-year gilts and in Table 2.4 and Table 2.5 for 10-year and 20-year gilts.

Table 2.3: Market implied rate change for 15-year gilts (average rate change in September 2019)

Period ahead	Nominal gilts (15yr)	Index-linked gilts (15yr)
6 months from Sept. 2019	0.03%	0.03%*
3 years from Sept. 2019	0.25%	0.27%
5 ½ years from Sept. 2019	0.46%	0.49%
Average across AMP7	**0.25%**	**0.26%**

Source: Bank of England, Europe Economics' calculations. * Note: forward rate for 6-months ahead are not available for ILGs. Therefore we have used the average market implied rate change on nominal gilts as a proxy.

Table 2.4: Market implied rate change for 10-year and 20-year nominal gilts (average rate change in September 2019)

Period ahead	Nominal gilts (10yr)	Nominal gilts (20yr)	*Average 10yr & 20yr nominal gilts*
6 months from Sept. 2019	0.03%	0.02%	*0.03%*
3 years from Sept. 2019	0.28%	0.16%	*0.22%*
5 ½ years from Sept. 2019	0.59%	0.28%	*0.44%*
Average across AMP7	**0.30%**	**0.15%**	***0.23%***

Source: Bank of England, Europe Economics' calculations.

Table 2.5: Market implied rate change for 10-year and 20-year ILGs (average rate change in September 2019)

Period ahead	ILGs (10yr)	ILGs (20yr)	*Average 10yr & 20yr ILGs*
6 months from Sept. 2019	0.03%*	0.02%*	*0.03%**
3 years from Sept. 2019	0.26%	0.24%	*0.25%*
5 ½ years from Sept. 2019	0.50%	0.43%	*0.47%*

movement in the 10 year series that was not duplicated in the 20 year series would be partially mitigated in our previous method and vice versa. However, in our view the use of the 15 year benchmark is more direct and creates less risk of computational error.

[4] For reference we also report the market-implied rate increase on 10-year and 20-year gilts.

Period ahead	ILGs (10yr)	ILGs (20yr)	*Average 10yr & 20yr ILGs*
Average across AMP7	**0.26%**	**0.23%**	***0.25%***

Source: Bank of England, Europe Economics' calculations. * Note: forward rate for 6-months ahead are not available for ILGs, Therefore we have used the average market implied rate change on nominal gilts as a proxy.

From the tables above we can see that the market-implied rate increase on 15-years gilts is slightly higher than the average market-implied rate increase across 10-year and 20-year gilts.

2.5 Conclusions on the risk-free rate

In the table below we use the gilt evidence of Table 2.2 and the market-implied change rate evidence of Table 2.3 to calculate plausible risk-free rate range with a time horizon of 15-years.

Table 2.6: Risk-free rate range based on 15-years gilts

Instrument	Average yield in Sept. 2019	Market-implied rate change in AMP7	Risk-free rate (nominal / RPI-linked)	Nominal risk-free rate	CPIH-deflated risk-free rate
Nominal gilts (15yr)	0.85%	+0.25%	1.10%	**1.10%**	**-0.88%**
RPI-linked gilts (15yr)	-2.61%	+0.26%	-2.35%	**0.58%**	**-1.39%**

Source: Thomson Reuters, Bank of England, and Europe Economics' calculations.

We use ILGs to determine the lower bound of the risk free rate range, and nominal gilts to determine the upper bound of the range. The point estimate we recommend is the mid-point of the range. Therefore our risk free rate recommendation is as follows:

- A nominal **risk-free rate range** of **0.58** to **1.10 per cent**, with a **point estimate** of **0.84 per cent**.
- A CPIH-deflated **risk-free rate range** of **-1.39** to **-0.88** per cent, with a **point estimate** of **-1.14 per cent**.

For completeness we also report the risk-free rate range and point estimate that we would obtain by averaging the evidence of 10-year and 20-year gilts.

Table 2.7: Risk-free rate range based on average between 10-year and 20-year gilts

Instrument	Average yield in Sept. 2019	Market-implied rate change in AMP7	Risk-free rate (nominal / RPI-linked)	Nominal risk-free rate	CPIH-deflated risk-free rate
Nominal gilts (10yr)	0.56%	0.30%	0.86%	0.86%	-1.12%
Nominal gilts (20yr)	1.05%	0.15%	1.20%	1.20%	-0.78%
Average nominal	0.81%	0.23%	1.04%	**1.04%**	**-0.94%**
RPI-linked gilts(10yr)	-2.89%	0.26%	-2.63%	0.29%	-1.68%
RPI-linked gilts (20yr)	-2.35%	0.23%	-2.12%	0.82%	-1.16%
Average RPI-linked	-2.62%	0.25%	-2.37%	**0.56%**	**-1.41%**

Source: Thomson Reuters, Bank of England, and Europe Economics' calculations.

Based on average evidence across 10-year and 20-year gilts, we would obtain a nominal risk-free rate range of 0.56-1.04 per cent (with a point estimate of 0.80 per cent) and a CPIH-deflated risk-free rate range of -1.41 to -0.94 per cent, (with a point estimate of -1.18 per cent).

2.6 Is a negative real risk-free rate feasible?

As discussed in our 2017 WACC report for Ofwat, the approach adopted to WACC estimation in this review has been what we refer to as the "observed asset approach".[5] Under this approach we treat the notion of a "risk-free asset" as an approximation, with models deploying the idea of a "risk-free rate" being more or less representative of reality partly according to how close to risk-free some actual asset in fact is. The usual proxy chosen is a government bond. The "risk-free rate" is then simply the yield on this observed asset.

To that extent, therefore, it is arguably not necessary for us to consider how credible or otherwise a particular value (positive or negative) is for the risk-free rate. The bond yield simply is what it is. We do not need to defend its being "plausible" that it is at that level, because in fact it is so and market prices imply that it is expected to remain so.

Nonetheless, it is of some interest to consider what the implications are of risk-free rates being negative. That could, for example, matter to the question of how likely or otherwise it seems that over the period of the price control government bond yields might rise substantially. To the extent that a true underlying negative risk-free rate were unsustainable in theory, a regulator might be concerned that government bond rates would eventually — perhaps over the period of the control itself — come into line.

In financial economics theory, there have been a number of attempts to identify the drivers or "causes" of the risk-free rate of return. The two drivers most universally accepted are as follows.[6]

1. The marginal utility of income evolves through time with expectations of changes to income in the future. As we shall explain below, this factor can be either positive or negative.
2. As a purely psychological matter of taste, people prefer to have things now to having them later, so the marginal utility of consumption declines with time. This "pure time preference" factor is usually assumed to be positive (though that is by no means unambiguous, as we shall explain below).

As well as being universally accepted in their own terms, these two factors also feature in standard equations for the equilibrium risk-free rate of return in long-term economic growth models.[7]

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[5] The alternative discussed in our 2017 report was the "equilibrium concept approach". According to that, the risk-free rate is an underlying equilibrium variable in the economy, like the "natural rate of unemployment", "output gap", or many other economic variables. We cannot observe the natural rate of unemployment or output gap directly. Instead, we use various evidence and models to attempt to estimate or infer them. Those that say the risk-free rate of return should be understood as such an equilibrium concept contend that a range of evidence is relevant to its estimation — often including estimates of the medium-term sustainable growth rate of the economy (since in long-term economic growth models there is an equilibrium relationship between the medium-term sustainable growth rate and the risk-free rate of return).

[6] The earliest systematic treatment of the causes of interest is usually attributed to Eugen von Böhm-Bawerk. He in fact identified a third "cause of interest", namely a "technical superiority of present over future goods" associated with a property called "roundaboutness" — more "roundabout" production processes are more physically productive, therefore present goods (because they can be employed in processes that are more roundabout) possess a higher value (since it is always better to have more output than less). Both the reasoning supporting this "cause" and its relevance are disputed. Irving Fisher (often considered to be the father of the neoclassical theory of interest) argued that even if Böhm-Bawerk's third cause was correct, its effect would be embodied in the first "cause" in that it would give rise to more rapid growth. Paul Samuelson was more sympathetic to the third "cause" and there have been a number of recent attempts to offer qualified defences of it — eg http://austrian-library.s3.amazonaws.com/journals/scholar/Murphy4.pdf. For our purposes here we do not need to come to a definitive position on this point, since as we argue above, the signs of both of the two undisputed "causes" are ambiguous.

[7] For example, in the standard workhorse RCK growth model, there are the following equilibrium conditions:

1) The growth rate of output = $g + n$
2) $\rho > n + (1 - \theta) \times g$
3) The rate of return on capital (which is risk-free in this model) = $\rho + \theta \times g$

Let us consider these two factors in turn.

2.6.1 Evolution of the marginal utility of income through time with expectations of future growth

Consider the case of an economy expected to grow in the future. And let us make the standard assumption that individuals want to smooth their consumption over time — preferring reasonably even consumption each period to consumption that varies with every fluctuation in income.

Suppose that we considered a default case in which no saving or borrowing was possible, so that everyone consumed precisely what he or she received as income each period. Then suppose that saving and borrowing became possible. What we should expect to happen is that, since income is expected to be higher in the future, people will seek to borrow now, to consumer more than their current income, repaying the funds out of their (higher) future income. Anyone lending, instead of borrowing, is bearing a loss of utility associated with accepting a larger-than-optimal difference between their (lower) consumption today and their (higher) consumption in the future. In order for such lending to be optimal, the added return from lending today would have to at-least-compensate for that under-smoothing of consumption utility loss. That means that, in a growing economy, this driver of interest will have to be positive.

By contrast, in a shrinking economy we should expect the opposite. People will prefer to save or lend some of their funds today rather than consume, so as to have funds available to smooth consumption later. They will be willing to pay, in order to save or lend, a sum up to the value of the utility gain they make by increasing their future consumption at the cost of consumption today.

A variant of this case would be, as pointed out in the UKRN 2018 study[8], one in which, even though the economy was not expected to shrink in the future as the central case, there was an increase in the risk of its doing so, creating a precautionary motive for saving, depressing returns, would could in principle be large enough in impact to induce a negative risk-free rate overall.

2.6.2 Pure time preference

The second factor is a purely psychological observation, or observation about human taste. The claim is that people prefer to have things now to having them later, regardless of any smoothing issues. The contention is

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where
ρ = the household discount rate (pure time preference)
g = the rate of technical progress
n = the rate of population growth
θ = the coefficient of relative risk aversion

$\theta \rightarrow 1 \Rightarrow$ utility tends to a standard log form (ie there is perfect consumption smoothing). That means equations 2 and 3 become

2) $\rho > n + (1 - 1) \times g = n$
3) The rate of return on capital = $\rho + g$

It is perhaps worth observing, that if we abstract from population growth, so set $n = 0$, we also have

1) The growth rate of output = g
2) $\rho > 0$

In that case the rate of return on capital is simply the sum of our two "causes of interest".

On the other hand, if $n < 0$

1) The growth rate of output = $g + n < g$
2) $\rho > n < 0 \Rightarrow \rho < 0$ is not ruled out

[8] See p35 of https://www.ukrn.org.uk/wp-content/uploads/2018/11/2018-CoE-Study.pdf

that we can see, from introspection or practical observation, that if someone had no income and one indivisible unit of consumption, such a person would always prefer to have that indivisible unit to consume now to waiting to consume it at any future date.

In addition to this, the standard argument is that we should assume society has not achieved, and never will achieve, perfect bliss (at least in any timescale relevant to anyone alive today), and that people's happiness never becomes infinite. In, for example, a case in which we would all perfectly smooth consumption, abstracting from patience/impatience, that means that once we bring patience back in we have to be at least a little bit impatient about the future – preferring to have things today to waiting to have the same thing tomorrow. To see why, suppose we preferred to have things in the future to having them today. Then every year we could save up, and then at some far distant date consume an enormous amount, and because we thought it better to wait than to have it today, consuming that enormous amount would seem extremely attractive. Extending such an approach, at an infinite horizon, would deliver infinite bliss. But if we assume we cannot achieve infinite bliss, that means we must be at least somewhat impatient about the future.[9]

This is actually a less straightforward observation than is often assumed. Any such "pure time preference" is by no means easy to disentangle from complicating factors such as knowledge of mortality ("I might not be around to consume it later, if I wait.") or risk (eg "I might get lucky and have a second unit to consume later, in which case I will have failed to smooth consumption if I refuse to consume now" or "If I don't consume the unit now something may happen to it, and I might find it is not there to consume in the future when I had planned to have it.").[10]

Neither is it unambiguous how such "pure time preference" interacts with consumption over multiple generations. For example, suppose that an individual's ability to enjoy consumption declines over their lifetime, but they care about their children (or other such heirs) at least equally with themselves. Then they might take the view "I won't consume this now because my heir would enjoy it more than I would." This could be a particularly complicating factor when a population ages rapidly, in the sense that there is a sudden rise in longevity with no corresponding rise in the birth-rate or in below-median-age net immigration. If older people are more likely to defer consumption for their benefit of their heirs, one could envisage a situation in which the economy-wide average rate of time preference was initially positive (ie present consumption was preferred to future consumption by the average person) but then switched, for a period, to being negative (as the population aged suddenly) before reverting to a positive rate as the population age stabilised — still ruling out the possibility of infinite bliss.[11]

2.6.3 Financial frictions

A further factor identified in the UKRN study is the possibility that financial frictions, affecting the young, make them unable to borrow as much as would be optimal for them. As they put it, "Young investors, in particular, may wish to, but be unable to borrow. If they could issue risk-free debt, this would depress bond prices and boost risk-free returns. But if this constraint binds for the marginal investor, then this cannot

[9] In the RCK model set out in footnote 7, the reasoning set out in this paragraph is what underpins equation 2.

[10] It is perhaps worth observing that on such risk-based accounts of this driver of the risk-free rate, changes in mortality risk or in the balance of other risks ("something turning up" or "deferred consumption being destroyed") through time could be material drivers of a shift in the risk-free rate. Indeed, some could even become negative. For example, I could face the "risk" that I live longer than expected in a non-income-earning period of life and therefore require additional consumption without corresponding additional income. In a period in which such risks rose suddenly, there could be a large rise in the savings rate. If there were a limit on the availability of capital value-preserving savings vehicles, people might become willing to pay a fee to store their savings at low risk (beyond the certain loss associated with the fee).

[11] Indeed, in technical terms, the assumption that $\rho > 0$ applies in the case $n = 0$, as set out in footnote 7. But if the labour force is declining relative to the whole population, in a period of a sudden jump in longevity, it is arguable that that should in fact correspond to a case in which $n < 0$. But, as we showed in footnote 7, in that case we have $\rho > n < 0$, in which case $\rho < 0$ is feasible, still consistent with the no-bliss-points technical condition.

happen, depressing the risk-free return". They go on to contend that there is evidence that *"recent low real risk-free rates have actually been primarily driven by a global shortage of borrowers who actually have the capacity to issue truly risk-free debt"*.

2.6.4 Conclusion on the implications of finance theory

Whilst it is true that the traditional assumption has been that both of the orthodox "causes" of the risk-free rate of interest have a positive sign — because economies will grow in the future and people prefer to consume things now to waiting to later to consume them — neither is straightforward. If the economy were expected to contract over an extended period or if psychological or practical factors meant the rate of time preference became negative for a sufficiently large portion of the population, the equilibrium risk-free rate could in principle become negative.

It is worth observing that neither of these situations needs to be permanent. We would not require the economy to be expected to contract for ever. Nor would we need the average person to always hereafter prefer consuming tomorrow (or having their heirs consume tomorrow) to consuming today. We would merely need one or other of these factors to persist for sufficiently long that the current risk-free rate (applicable over the current investment cycle) was negative.

Of these two, the more obviously potentially relevant over the period of the PR19 price control is the internationally-observed leap in longevity (both in recent years and in terms of future expectations) with ageing populations and declining workforces, either relative to the population or in some countries in absolute terms, along with reducing working hours, in many developed economies. However, a further possibility is that there could be an anticipated period of "technical regress" if, for example, reductions in world trade, driven by political factors, or other negative policy developments, were sufficient to offset technological improvements in other areas.

We are not seeking to argue that such factors are, in fact, the key reasons for negative government bond yields. Drawing such conclusions falls beyond our scope in this study, and we adopt a position of studied agnosticism. However, our argument is that there can be no strong presumption from finance theory that negative risk-free rates, as given by the observed asset interpretation of government bond yields, are ruled out in principle.

2.6.5 Does monetary theory entail that a risk-free rate of return that is negative in real terms is not possible or not sustainable?

Next we shall consider two arguments drawn from monetary theory towards the claim that negative risk-free rates, in real terms, are not possible.

- Negative risk-free rates are not sustainable, when inflation rates are sufficiently low, because there will always be a substitute asset available that has a zero nominal rate of return.
- Negative risk-free rates are not feasible because central bank policy rules forbid them in the current macroeconomic environment.

Let us consider these in turn.

2.6.6 The option of a zero nominal rate of return substitute asset

There was a traditional argument in the so-called "liquidity trap" literature that economy-wide nominal interest rates could not go below zero because people would always have the zero nominal return option of holding cash. This argument usually focused on cases in which there was deflation, with the implication that the return on cash would become positive in real terms so anyone holding an asset with a declining nominal value could switch into cash instead.

Such an argument could perhaps still have some relevance in cases where deflation rates were very high (say, 20 or 50 per cent), but is much more difficult to sustain in any modern economy. First, the total cash base is typically only a small percentage (much less than 10 per cent) of the total monetary stock, with the implication that it would be simply infeasible for a large proportion of total assets to be transferred into cash (though it could perhaps be argued that in such a case if there were sufficient demand for additional cash the central bank might accommodate it).

Second, whilst an investor seeking assets in the low millions of pounds might find it feasible to store cash at low risk at fairly low cost, significant large-scale investors in a modern finance system, many of whom have investment portfolios in the hundreds of millions to tens of billions range, and in the case of certain derivatives investments many orders of magnitude greater than that, could not hope to store such sums in cash without enormous security risks — eg theft, fire, flood — that would in turn entail very significant expenditures on storage security systems. So even if there were no other risks with the holding of cash (which is not true, as we shall consider below), the return would be negative at least to the cost of maintaining secure storage.

A third point is that, even setting aside security risks, cash may be by no means risk-free. Governments may inflate, or redenominate (think of the Eurozone crisis) or have a currency revaluation. Although governments may also affect bond returns (even defaulting in the limiting case), and inflation will affect nominal returns, investors may trust government bonds more than they trust cash (especially if, for example, government bonds contracts are under the law of another country and are inflation index-linked), and be willing to sacrifice real return into order to hold such bonds instead of cash.

2.6.7 Central bank policy rules and negative interest rates

One version of this argument contends that a standard model of central bank interest-rate-setting is the "Taylor Rule". The Taylor rule states that interest rates should vary from an equilibrium real risk-free rate by an amount determined by the gap between actual and target inflation and the gap between actual output and potential output. If an economy is operating at far below its potential level of output or inflation is far below target, real interest rates could in principle be set at a negative level, but if the economy is close to potential output and target inflation, the interest rate will be close to its equilibrium level. So unless even the equilibrium real interest rate can be negative, policy rates could not be negative under such a scenario.

There are a number of objections that one can raise against this argument, as follows.

- First, even if it were true that the interest rate would be at its equilibrium under such a scenario, we have already argued above that even the equilibrium interest rate could be negative.
- Second, the Taylor Rule is by no means the only characterisation of central bank policy[12], and it functions mainly as a recommended rule rather than as a putative description of actual policy.
- Third, the bank's policy rate will not necessarily be definitive of market interest rates. The past decade has seen periods of very considerable deviation between policy rates and money market or bond market rates, especially when the Bank has been seeking to adjust the money stock (eg via quantitative easing) at the same time as setting a policy rate.
- Fourth, the argument assumes a closed economy. In an open economy the real interest rate will be affected not only by domestic factors (including potentially the output gap and the inflation rate relative

[12] For example, an alternative "ideal" is the "productivity norm" developed by David Davidson in the 1920s and 1930s, under which monetary authorities should decompose the price index between supply factors and monetary/demand factors, reacting only to demand factors not supply factors. Discussions of this distinction were particularly prominent in the 1970s and early 1980s during periods in which oil price rises were important factors in rising inflation.

to target) but also by international factors. So, for example, even if the UK economy were operating at close to the inflation target and with a near-zero output gap, if the Eurozone economy were operating at below-target inflation and a large output gap, Euro Area real interest rates could be driven well below zero, by a Taylor Rule, driving UK real interest rates down in turn.

- A fifth objection is that this argument rather misses the point that the economy will respond to the policy. If there is an output gap and inflation is below target, and interest rates are cut in response, then the output gap will shrink and inflation will rise back towards target. Now perhaps if the output gap is eliminated and inflation returns to target, the central bank *ought* then to seek to raise rates, even at a cost in terms of a rising output gap and inflation falling below target, but it is by no means clear that it *will* do that. Central banks are very often set mission objectives in terms of inflation and output. Other issues, such as maintaining the efficiency of intertemporal substitution (or, less prosaically, intergenerational social justice) are often discussion points for central banks in speeches and papers, but what they are typically *instructed* to do is to keep the output gap low and inflation close to target. That could be achievable with negative real rates of return even if such rates are not optimal in long-run economic welfare terms.

2.6.8 Pragmatic *de facto* objection to the arguments in this section

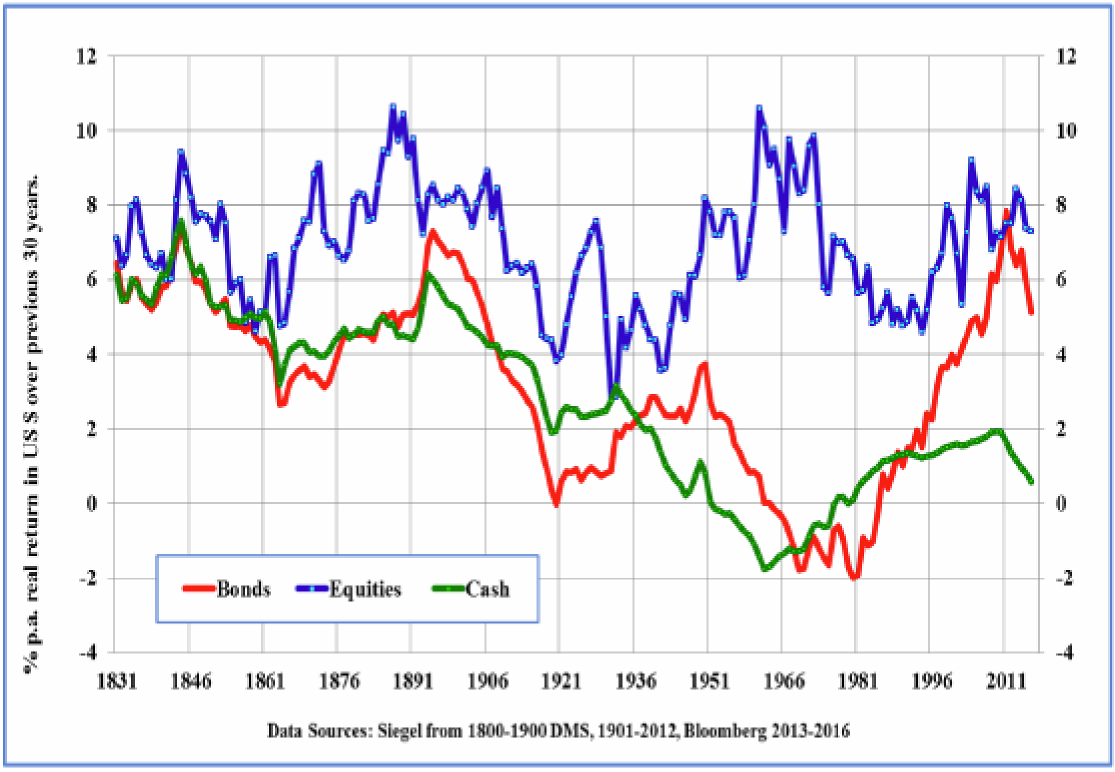
We have set out above a number of theoretical responses to the contention that monetary theory or monetary policy-making theories imply some difficulty with a negative risk-free rate of return, especially in a period in which potential output is close to zero and inflation is close to target. But a more mundane counter-argument is this: central banks *do* set certain of their policy rates negative in both nominal and real terms.

- The European Central Bank deposit rate was -0.5 per cent in nominal terms, as of its September 2019 meeting, at a time when Euro Area inflation was +1.0 per cent.
- The Bank of Japan's main short-term interest rate was -0.1 per cent (as of its July 2019 meeting), whilst the latest annual inflation figure was +0.5 per cent.
- The Swedish Riksbank repo rate was -0.25 per cent as of September 2019, whilst Swedish inflation was 1.4 per cent in the year to August.
- The Swiss National Bank has a policy rate of -0.75 per cent whilst inflation is +0.3 per cent.

Thus, it is simply incorrect to claim that monetary policy-makers cannot or do not set negative interest rates, even in nominal terms and certainly in real terms.

Furthermore, it was pointed out in the 2018 UKRN cost of capital study that "while the recent period may be historically unprecedented in nominal terms, it is far from unprecedented in *real* terms: i.e., the ex-post real interest rate was distinctly more negative in the 60s and 70s than it has been in recent years."

Figure 2.4: 30 year compound average returns in the USA: 1801-2016



Source: Figure 4.4 of Estimating the cost of capital for implementation of price controls by UK Regulators, UKRN (2018)[13]

[13] https://www.ukrn.org.uk/wp-content/uploads/2018/11/2018-CoE-Study.pdf

3 Total Market Return

3.1 Introduction

This section sets out our view on the appropriate Total Market Return (TMR) value to be used in PR19. As we shall see, despite the availability of updated evidence from dividend growth (DGM) model and dividend discount model (DDM), our overall view on the appropriate TMR for PR19 has not changed from the July 2019 Report. Like we did in our July 2019 Report, we form our judgment on the TMR based on a variety of approaches. Consequently, this section is organised so as to reflect the evidence available from different approaches.

- In Section 3.2 we present TMR estimates obtained under the historical "ex-post" approach.
- In Section 0 we present TMR estimates obtained under the adjusted historical "ex-ante" approach.
- In Section 0 we provide an overview of TMR estimates sourced from finance professionals and practitioners.
- In Section **Error! Reference source not found.** we present the result of our dividend growth (DGM) model and dividend discount model (DDM).
- Section **Error! Reference source not found.**3.6 provides our TMR recommendation.

3.2 Evidence from "ex-post" historical approaches

The primary evidence from "ex-post" historical approaches is unchanged from our July 2019 Report, therefore we simply report it again here for completeness.

First, we report the average historical real TMR (real returns on equities) estimates — for different geographies and averaging methods (geometric and arithmetic) — provided by the Dimson, Marsh and Staunton (DMS) in the 2019 Credit Suisse Yearbook.

Table 3.1: DMS estimates by geography and by averaging method, based on data 1900 to 2018

	Geometric mean	Arithmetic mean
UK	5.4%	7.2%
Europe	4.2%	6.0%
World	5.0%	6.5%

Source: Dimson, Marsh and Staunton (2019), "Credit Suisse Global Investment Returns Yearbook 2019".

The figures provided in Table 3.1 are real figures based on the inflation measure proposed by DMS which (for the UK) uses the Cost of Living Index (COLI) up to 1949, ONS's back-cast measure of CPI since 1949, and CPI from 1988 onwards.

An alternative inflation series which is also appropriate for the purpose of obtaining CPIH-deflated figures, is the Bank of England's 'original' CPI series based on the "Millennium dataset".[14] This inflation measure uses an implied consumption expenditure deflator constructed using national accounts data up to 1949, the ONS's back-cast measure of CPI since 1949, and CPI from 1988 onwards).[15] In the table below we report real TMR

[14] Office for National Statistics, 'Consumer Price Indices Technical Manual, 2007 edition', p73

[15] This is the 'original' version of the Millennium dataset series. There is also a Millennium dataset 'preferred' CPI inflation: This is the same as the 'original' Millenni̶um dataset apart from the period 1900-1914, which replaces the O'Donoghue et al. (2004) series with a series from a paper by Feinstein (1991). The distinctions between the 'original' and 'preferred" series are not relevant to us for our purposes here.

estimates for the UK based on DMS data, but using two different inflation measures (namely the DMS inflation series and the Bank of England 'original' CPI series), and different assumptions concerning the investment holding period.

Table 3.2: Historical TMR estimates based on DMS annual data[16] (1900-2018)

Holding period	BoE original CPI series		DMS inflation series	
	Arithmetic mean	*Geometric mean*	*Arithmetic mean*	*Geometric mean*
1-year	6.89%	5.14%	7.25%	5.44%
5-year	6.77%	5.34%	7.06%	5.65%
10-year	6.72%	5.39%	7.00%	5.71%
15-year	6.85%	5.48%	7.12%	5.83%
20-year	6.81%	5.71%	7.08%	6.10%
Min.	**6.72%**	**5.14%**	**7.00%**	**5.44%**
Max.	**6.89%**	**5.71%**	**7.25%**	**6.10%**

Source: 2019 Credit Suisse Equity Returns Yearbook and Bank of England data, Ofwat and Europe Economics calculations

Based on the evidence provided above, we note that:

- DMS estimates of the TMR range from 6.0 per cent (Europe) to 7.2 per cent (UK), with the figure for the World (6.5 per cent) lying somewhere in between.
- Depending on the investment horizon chosen, the real TMR estimates based on the arithmetic mean (which remains our preferred averaging option for the same reasons set out in the July 2019 report) imply a preferred range of 7.00-7.25 per cent under the DMS inflation series, and 6.72-6.89 per cent under the BoE series.

3.3 Evidence from adjusted historical "ex-ante" approaches

As we already noted in our July 2019 Report, one key potential disadvantage of the use of historical data to create a proxy expectations distribution is that there could be structural changes in the distribution of returns over time. Therefore, there is some reason to question to what extent historical data gives an unbiased sample of the distribution of expected returns and, even if it were an unbiased sample, to what extent certain of the returns periods in the past might be repeated in the future. The purpose of adjusted historical "ex-ante" approaches it to attempt to correct these issues. For example, the 2017 DMS sourcebook and its accompanying slide pack attempted to estimate what proportion of long-term global returns were the product of such unanticipated or non-repeatable events. DMS contended that from the average geometric return of 5.1 per cent one should subtract around one per cent to account for unusually high dividend growth in 2nd half of 20th century and increase in price-to-earnings ratio. Insofar as a similar downwards adjustment were justified for the UK, that would suggest a forward-looking total market return of around 6.-6.25 per cent in real (i.e. CPIH-deflated) terms on the DMS basis and around 5.7-5.9 on the BoE series basis.[17]

We also note that in its Final Methodology Ofwat provided evidence from a number of studies that use an ex-ante approach, and noted that the TMR estimates obtained under this approach tend to be lower than those obtained under the traditional historical ex-post approach. We refer to our July 2017 Report for more

[16] Source: Credit Suisse Global Investment Returns Yearbook (2019), ONS

[17] 7.0 to 7.25 minus 1 equals 6.0 to 6.25. 6.72 to 6.89 minus 1 per cent is about 5.7 to 5.9. In each case we are using rough indicative figures for the adjustment.

details about such studies and note here that, since these studies are relatively old (i.e. they are dated 2007), we place most weight on the other more recent studies mentioned above.

3.4 Evidence from finance and professional practitioners

The evidence from finance and professional practitioners we quoted in our July 2019 report remains unchanged and is as follows:

- Fernandez Survey – the paper by Fernandez et al. (2019)[18] results suggest a nominal TMR for the UK Kingdom of 8.3 per cent in nominal terms. This corresponds to a CPIH-deflated TMR of 6.18 per cent.
- Practitioners' forecasts – In its recent methodology paper for RIIO-2, Ofgem provides an overview of asset managers' estimates of medium-term and long-term nominal UK TMR.[19] These estimates indicate that, on average the nominal TMR is 7.19 per cent (and 7.66 per cent after excluding estimates that — based on Ofgem's judgment — are likely to underestimate actual equity returns[20]).

3.5 Forward-looking approaches based on Dividend Growth Models (DGM) and Dividend Discount Models (DDM)[21]

We have updated the multi-stage Dividend Growth Model based on GDP with data up to September 2019. The results of the updated model are reported below. In Table 3.3 we also compare the new estimates with those obtained using data up to February 2019 (as reported in our July 2019 Report).

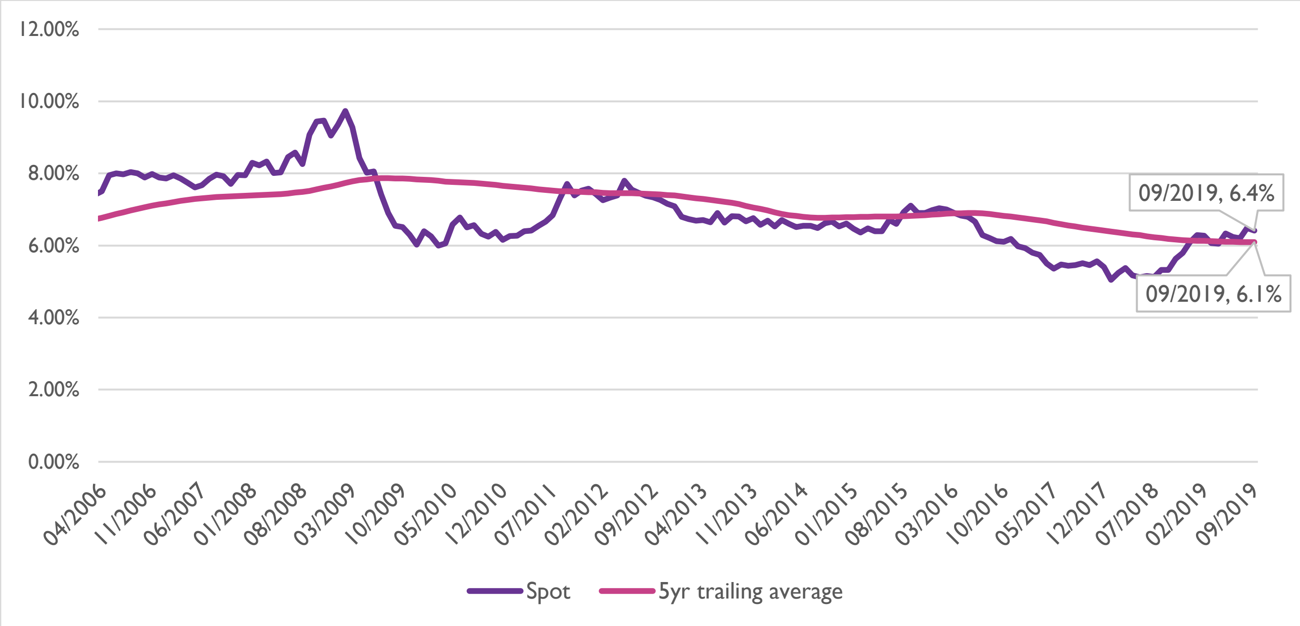
[18] Fernandez, Martinez, and Acin (2019) "Market Risk Premium and Risk-Free Rate used for 69 countries in 2019: a survey"

[19] The original investment managers' figures are expressed in geometric terms, and Ofgem applied a 1 per cent uplift to translate the geometric means in in arithmetic means.

[20] Ofgem excluded the estimates of two asset managers because was based on a portfolio with a significant bond component and the other referred to hedged returns.

[21] What we term the "DGM model" here uses recent historic dividend (and buyback) yields and then uses projections of GDP growth as a predictor of dividend returns. What we term the "DDM" model uses recent historic dividend (and buyback) yields and then uses analyst predictions of dividend yields for future dividend returns, potentially with a volatility adjustment (though we argued in our 2017 report that that volatility adjustment might be nugatory in practice).

Figure 3.1: Multi-stage DGM based on GDP growth



Source: Bloomberg, Thomson Reuters and Europe Economics calculations.

Table 3.3: TMR estimates of multi-stage DGM based on GDP growth (Sep-2019 vs Feb-2019)

	Estimates at 28-Feb-2019	Estimates at 30-Sep-2019
Spot TRM estimate	6.26%	6.41%
5-year trailing average	6.12%	6.09%

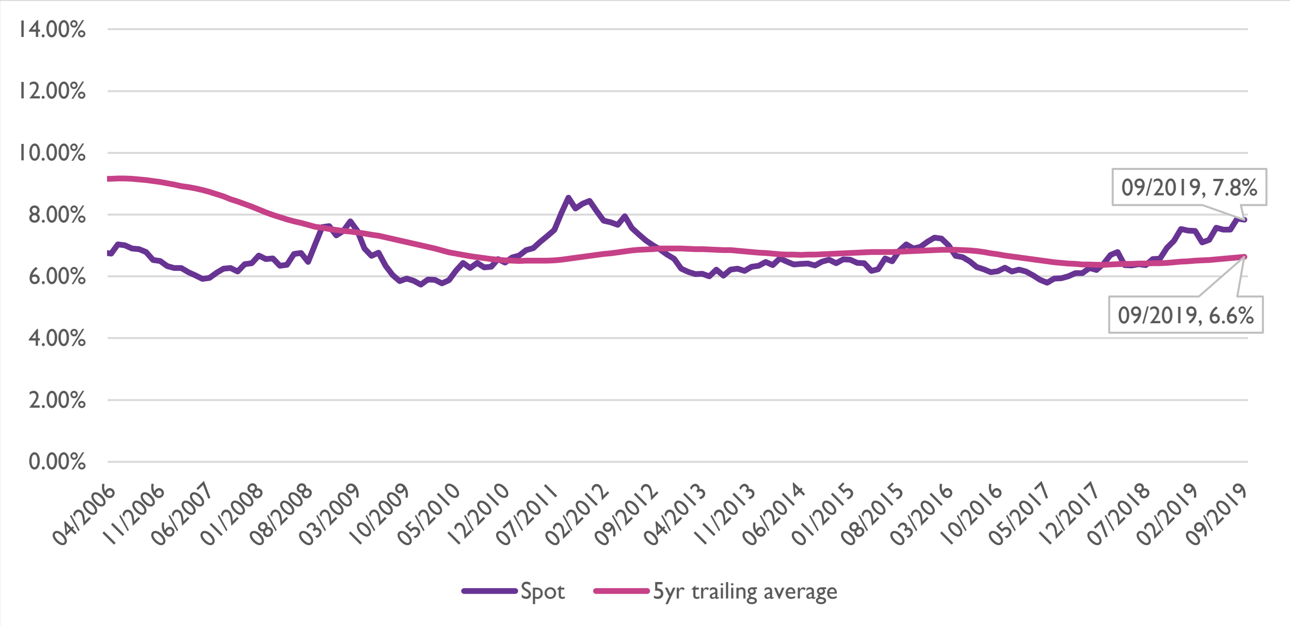
Source: Bloomberg, Thomson Reuters and Europe Economics calculations.

The spot value of the updated DGM based on GDP growth in September 2019 is 6.41 per cent, whilst the 5-year trailing average is 6.09 per cent. The preferred rolling 5 year average-based forecast[22] from our DGM model implies that, since February 2019, the TMR has remained virtually unchanged. However but in recent months (e.g. since February 2019) the spot value estimates of TMR has risen of 15bps (namely from 6.26 to 6.41 per cent).

The update of the multi-stage DGM model based on growth in dividends and buybacks is reported below.

[22] In our 2017 report we demonstrated quantitatively that the 5 year average was a better predictors of future returns than the spot return. This was in line with the conclusions of previous academic studies on the same point.

Figure 3.2: Multi-stage DGM based on Dividend and buy-backs growth



Source: Bloomberg, Thomson Reuters and Europe Economics calculations.

Table 3.4: TMR estimates of DGM based on dividend and buy-backs growth (Sep-2019 vs Feb-2019)

	Estimates at 28-Feb-2019	Estimates at 30-Sep-2019
Spot TRM estimate	7.47%	7.83%
5-year trailing average	6.51%	6.63%

Source: Bloomberg, Thomson Reuters and Europe Economics calculations

The spot value of the DGM model September 2019 is 7.83 per cent, i.e. an increase of around 36bps from the 7.47 per cent figure of February 2019. The 5-year trailing average value in September 2019 is 6.63 per cent, i.e. an increase of 12bps from the 6.51 per cent estimate of February 2019.

We note that, considering both spot value and 5-years trailing average values, our two DGM models produce a CPIH-deflated TMR estimate range of 6.09-7.83 per cent. However, if we focus on our preferred forecasts based on 5-years trialling average, we obtain a narrower CPIH-deflated TMR estimate range of 6.09-6.63 per cent.

3.6 Conclusions on TMR

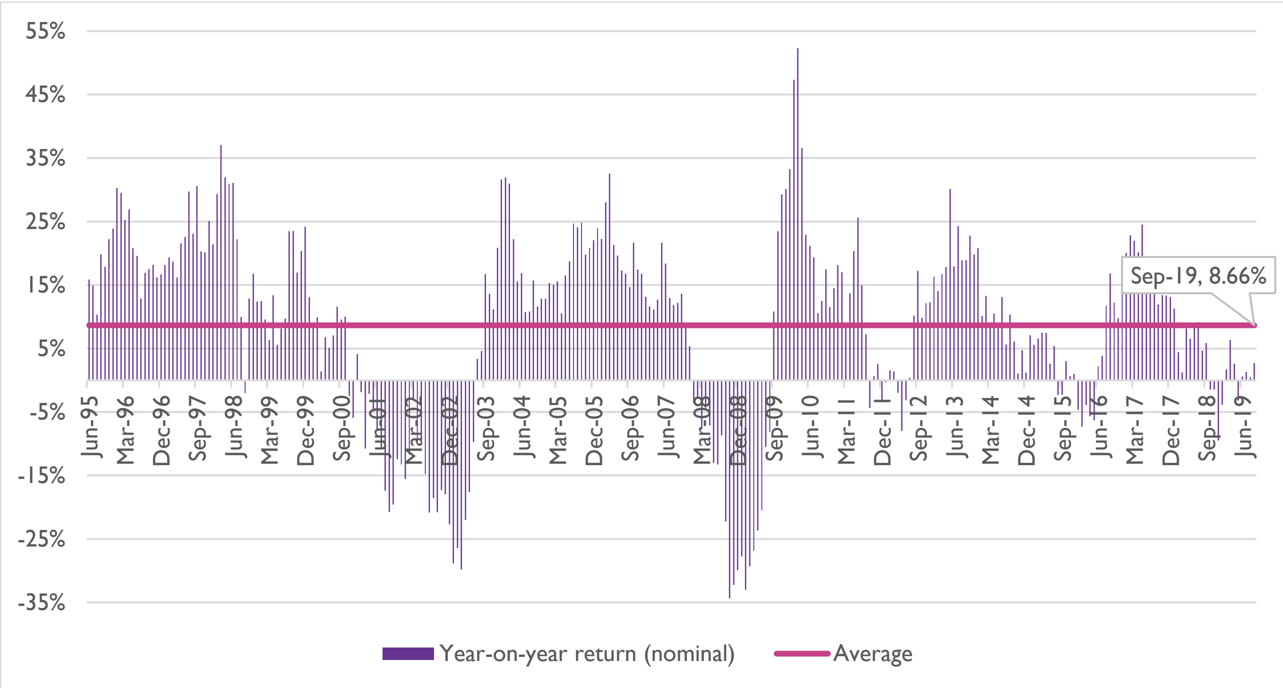
We note that:

- Ex-post and ex ante approaches based on the latest DMS data, subject to appropriate adjustments, are consistent with a CPIH-deflated TMR estimate of around 5.7-7.25 per cent.
- Our preferred DGM and DDM models produce a CPIH-deflated TMR estimate of 6.09-6.63 per cent, but with the most recent data suggesting that these figures could rise.
- Ex-ante approaches suggest a CPIH-deflated value for the TMR towards the lower end of that range of around 6 per cent.
- Practitioners' estimates are consistently materially below 6.8 per cent (in CPIH-deflated terms).

The preponderance of this evidence is consistent with a **CPIH-deflated TMR range** of **6.0-7.0 per cent**, i.e. implying a drop at the lower end compared with our 2017 recommendation. That would be consistent with a **point estimate** for the **CPIH-deflated TMR 6.50 per cent**. At 2 per cent assumed CPIH that would imply a **nominal TMR range** of **8.12-9.14 per cent** with a **nominal TMR point estimate** of **8.63 per cent**.

In order to sense-check the TMR figures we are proposing here, we have also calculated what average return an investor would have achieved over recent decades by investing in the UK FTSE All Share index. We have monthly data for the FTSE All Share total Return index starting from June-1994. We have used this data to calculate monthly year-on-year returns for the period June-1995 to September-2019. The monthly year-on-year returns and the average over the entire period are reported below. As we can see the average nominal annual return on the FTSE All Share for periods ending June-1995 to September-2019 has been 8.66 per cent, i.e. broadly in line with the point estimate TMR figures we propose here.

Figure 3.3: Nominal year-on-year returns on the FTSE All Share



Source: Thomson Reuters and Europe Economics calculations

4 Beta and the cost of equity

4.1 Introduction

This section provides our updated view on the appropriate beta estimate for the UK water sector in PR19. It is structured as follows:

- Section 4.2 sets out the key methodological considerations
- Section 4.3 provides the main raw equity beta evidence based on OLS estimation method.
- Section 4.4 provides raw equity beta evidence based on ARCH/GARCH estimation methodology.
- Section 4.5 provides evidence on gearing and unlevered betas.
- Section 4.7 provides an empirical analysis on the predictive ability of betas estimated over different time horizons.
- Section 0 provides our recommendation on unlevered beta.
- Section 4.9 provides evidence and recommendation on debt beta.
- Section provides present evidence and recommendations on asset betas and the equity beta at the notional gating level.
- In Section 4.10 we conclude with our recommended range and point estimate for asset beta notional equity beta and overall the cost of equity.

4.2 Methodological considerations

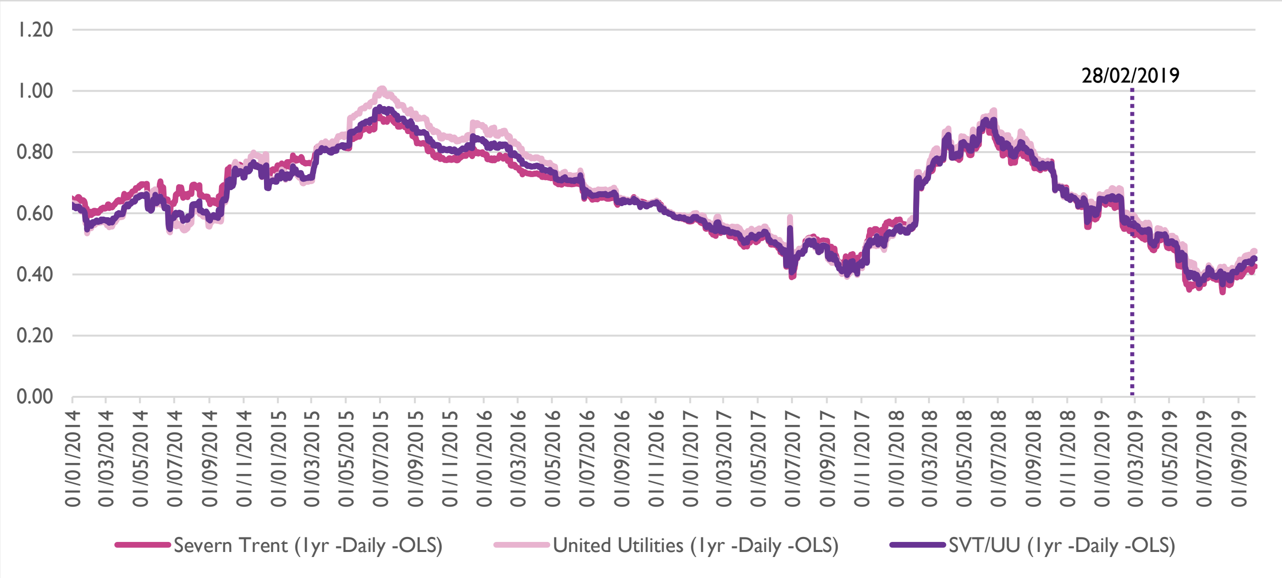
- For the market index, our preference is to use the FTSE All Share Total Market Return index, as this represents the broadest UK market index. We also note this is confident with the choice made in our previous reports[23].
- As regards to the time/date at which prices are calculated, we follow the convention of using closing trading prices. This means: closing daily prices for daily data, closing prices on Fridays for weekly return data, and closing prices on the last day of the month for monthly data.
- We place the most weight on betas estimated based on daily return data, and we estimate betas based on both ordinary least squares (OLS) and the ARCH/GARCH framework. We have considered whether there is a merit in favouring lower frequency data (e.g. weekly or monthly data), but the empirical evidence suggest that the there is no obvious advantage in doing so (see Section 4.6).
- We estimate betas using returns data of different frequencies (daily, weekly and monthly) and over different estimation horizons (1-year, 2-years and 5-years). We have conducted additional empirical analysis (see Section 4.7) to support placing the most weight on 2-year beta estimates obtained using daily data.
- The gearing measure used to unlevered raw equity betas is net debt over enterprise value (ND/EV) as available from Thomson Reuters. When un-levering raw equity betas we use a rolling average of ND/EV over the same time horizon of the raw equity beta that we un-lever. So for example, in order to un-lever a 2-years raw equity beta we use a 2-years trailing average of ND/EV.
- For the purpose of estimating debt beta we favour the decomposition approach over the regression approach.

[23] We used the FTSE All Share total Market Return Index also in our July 2019 Report and in our December 2017 Report.

4.3 Raw equity betas based on OLS

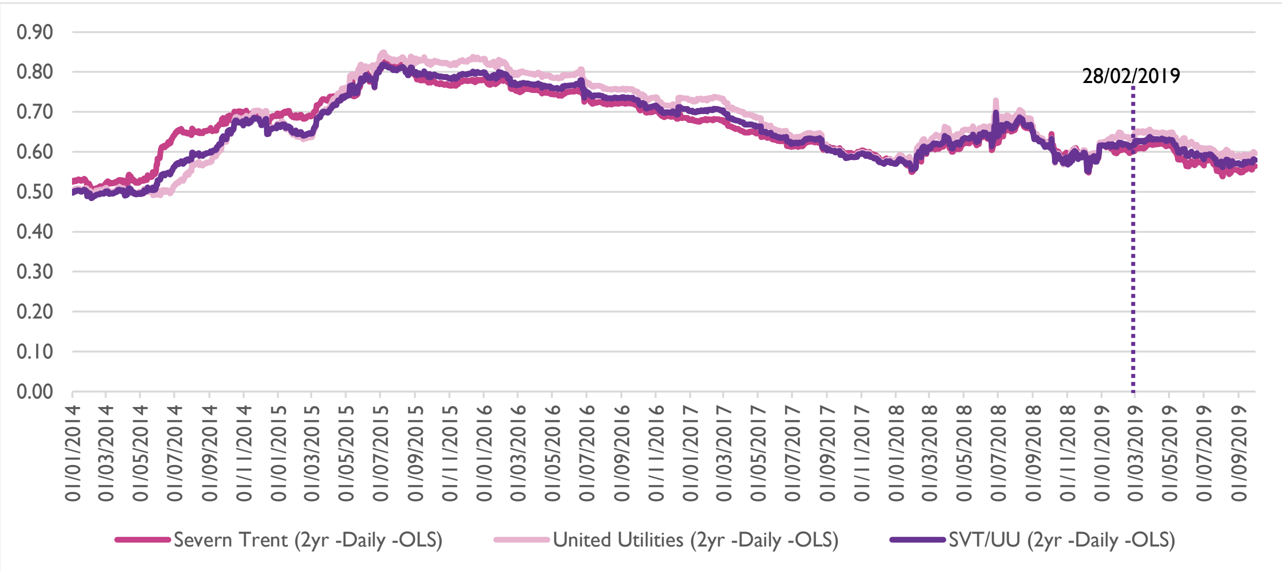
In this section we provide the main evidence regarding raw equity betas. We show the evolution of raw equity betas using data of different frequencies and different trailing windows for the analysis. We start by raw equity betas for Severn Trent, United Utilities, and a portfolio[24] of two water companies (denoted as SVT/UU) based on daily data and different time horizons (i.e. 1-year, 2-years, and 5-years) with different frequencies and different trailing windows. These are reported in Figure 4.1, Figure 4.2, and Figure 4.3.

Figure 4.1: Daily raw equity betas — 1yr trailing window (OLS)



Source: Thomson Reuters, Europe Economics' calculations

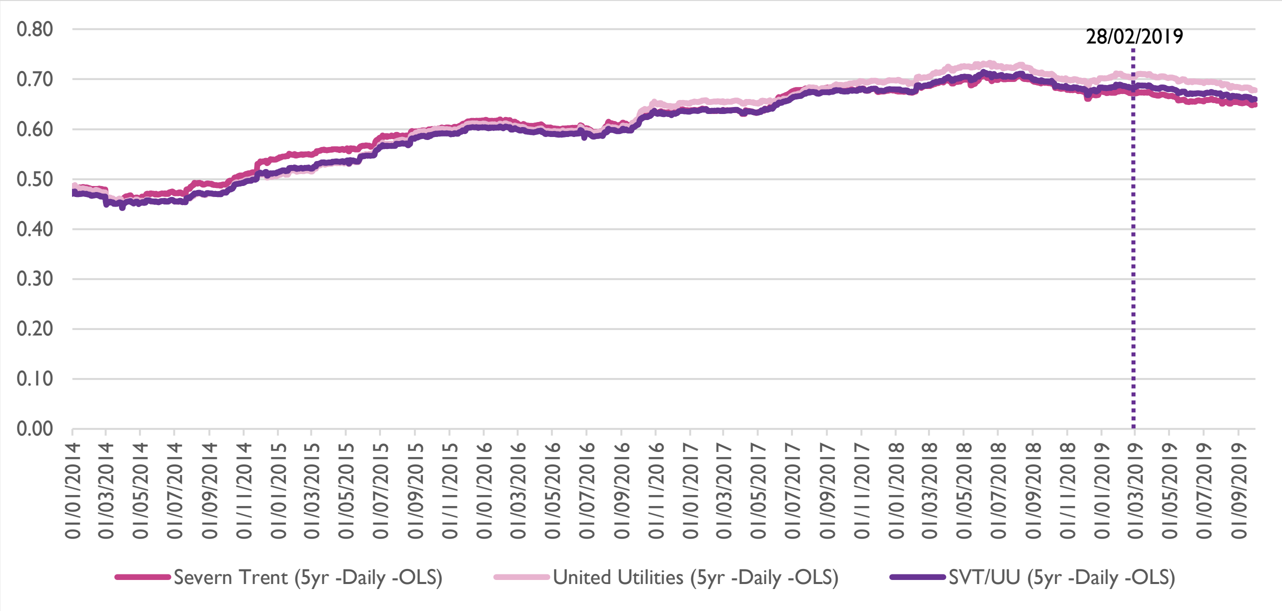
Figure 4.2: Daily raw equity betas — 2yr trailing window (OLS)



Source: Thomson Reuters, Europe Economics' calculations

[24] The portfolio's beta is estimated using weighted average returns of the portfolio's constituents, where the weights are proportional to the companies' market capitalisations.

Figure 4.3: Daily raw equity betas — 5yr trailing window (OLS)

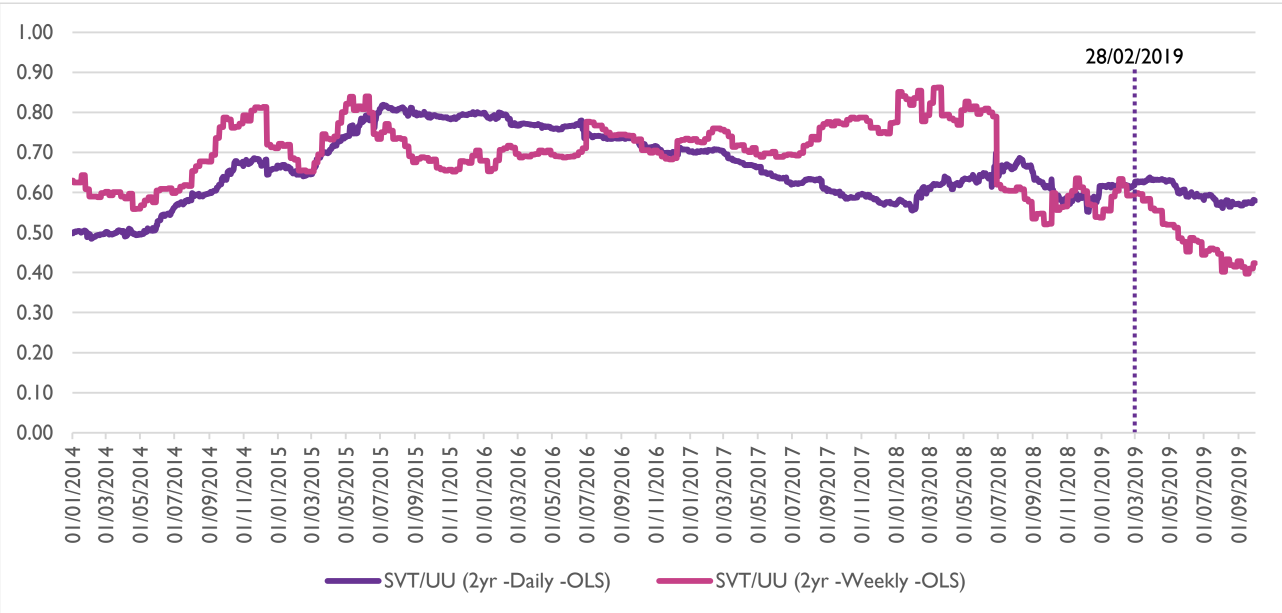


Source: Thomson Reuters, Europe Economics' calculations

We can see that, irrespective of the time horizon used for estimation, daily raw equity betas have decreased since February 2019 (with 1-year daily betas displaying the biggest drop).

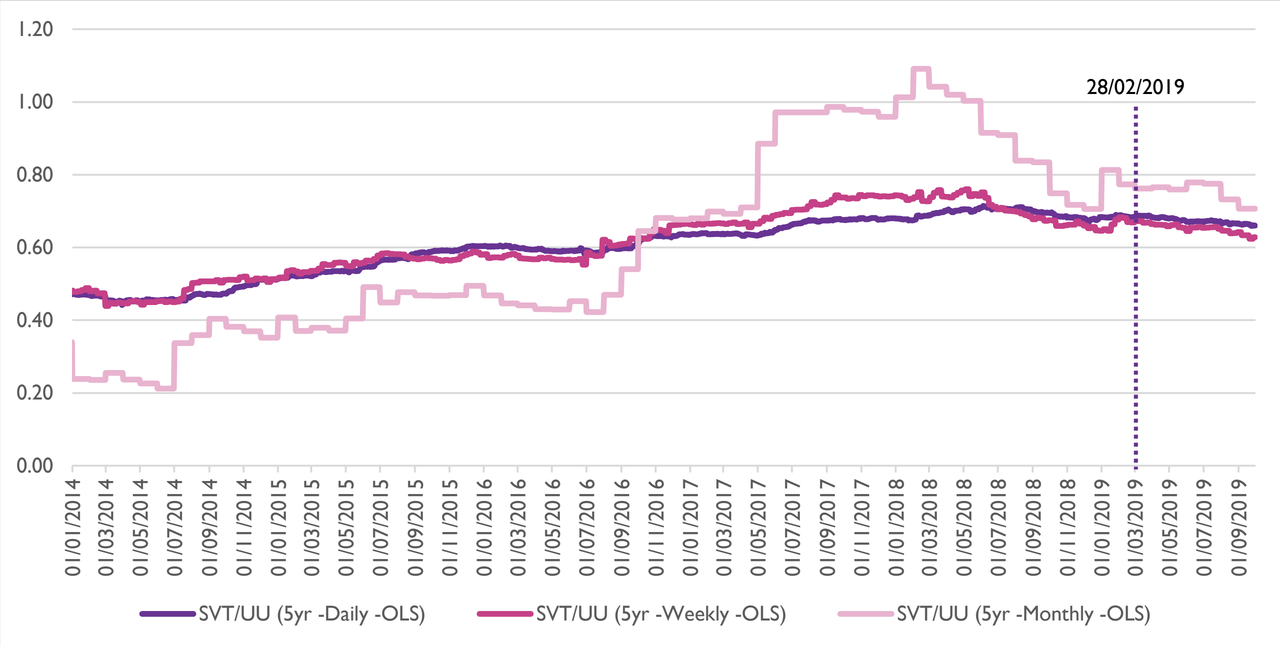
We now compare the raw equity betas of the portfolio obtained using the same trailing windows, but data of different frequencies.

Figure 4.4: Daily and weekly SVT/UU raw equity betas — 2yrs trailing window (OLS)



Source: Thomson Reuters, Europe Economics' calculations

Figure 4.5: Daily, weekly and monthly SVT/UU raw equity betas — 5yrs trailing window (OLS)



Source: Thomson Reuters, Europe Economics' calculations

The table below compares the spot beta estimates (at the end of February-2019, and at the end of September 2019) obtained over different time horizons and data frequencies. For completeness we report also beta estimates for Pennon, and for a portfolio which includes Pennon, Severn Trent, and United Utilities (denoted below as PNN/SVT/UU).

Table 4.1: Summary of raw beta estimates (spot at end Feb-2019 and at end Sep-2019) based on OLS

Company	Data frequency	1-yr beta		2-yr beta		5-yr beta	
		Feb-2019	*Sep 2019*	*Feb-2019*	*Sep 2019*	*Feb-2019*	*Sep 2019*
Pennon	Daily	0.54	0.42	0.63	0.55	0.67	0.66
	Weekly	-	-	0.68	0.48	0.67	0.68
	Monthly	-	-	-	-	0.76	0.68
Severn Trent	Daily	0.53	0.43	0.60	0.56	0.67	0.65
	Weekly	-	-	0.58	0.39	0.66	0.62
	Monthly	-	-	-	-	0.76	0.71
United Utilities	Daily	0.58	0.47	0.64	0.60	0.70	0.68
	Weekly	-	-	0.60	0.46	0.67	0.64
	Monthly	-	-	-	-	0.78	0.70
SVT/UU	Daily	0.56	0.45	0.62	0.58	0.68	0.66
	Weekly	-	-	0.59	0.42	0.67	0.63
	Monthly	-	-	-	-	0.77	0.71
PNN/SVT/UU	Daily	0.55	0.44	0.62	0.57	0.68	0.66
	Weekly	-	-	0.62	0.44	0.67	0.64
	Monthly	-	-	-	-	0.77	0.70

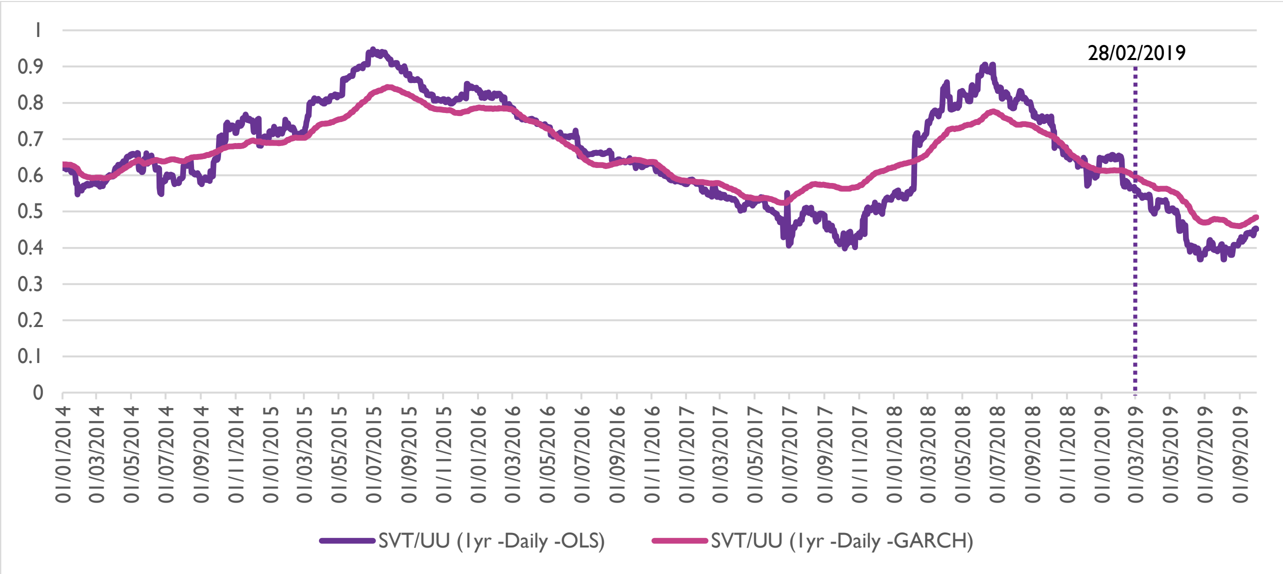
Source: Thomson Reuters, Europe Economics calculations.

As we can see from the table above, for all companies/portfolios and estimation methods (i.e. data frequency and time horizon) betas have decreased since February 2019. The sharpest decrease is observed for 2-year betas estimated with weekly frequency (the decrease is between 0.15 and 0.20), whilst the smallest decrease is for 5-year betas estimated with daily data (the decrease is between 0.01 and 0.03).

4.4 Raw equity betas based on ARCH/GARCH

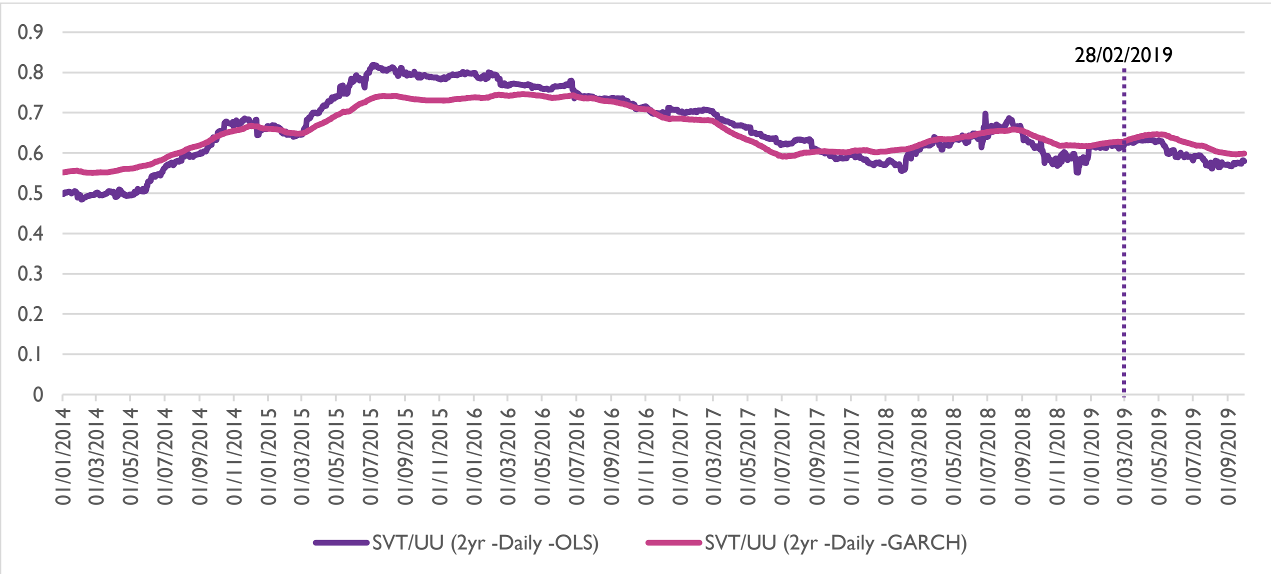
We report below the charts comparing raw equity betas obtained through OLS with those obtained through ARCH/GARCH framework. These are reported only for the portfolio SVT/UU and for various trailing windows and data frequencies.

Figure 4.6: Daily SVT/UU raw equity beta (OLS vs ARCH/GARCH) — 1yr trailing window



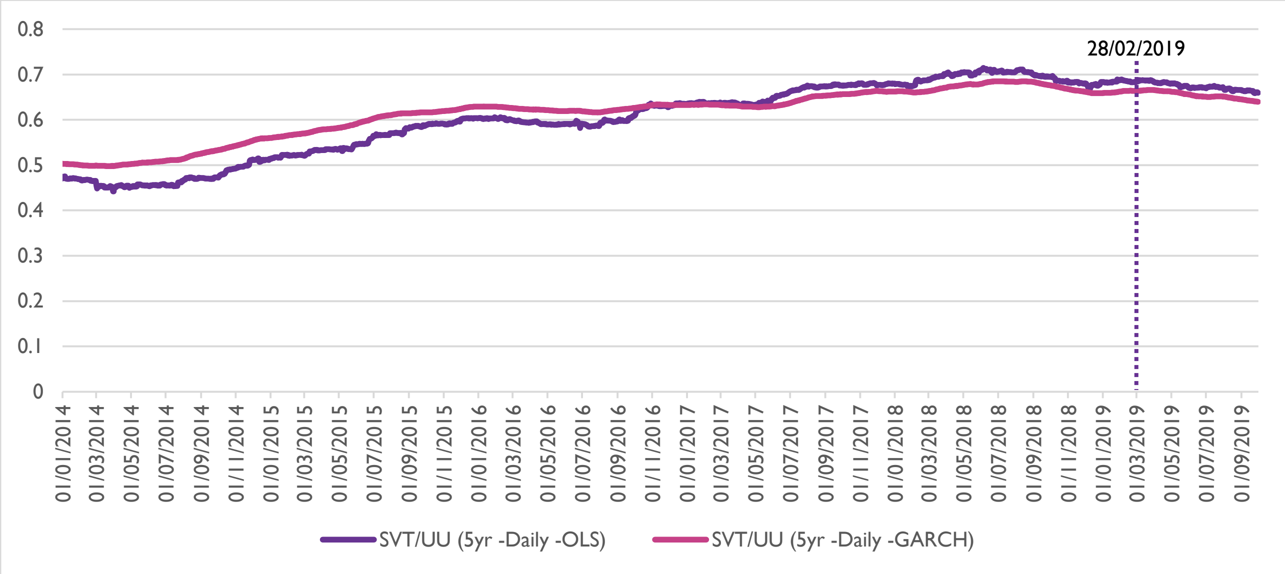
Source: Thomson Reuters, Europe Economics calculations.

Figure 4.7: Daily SVT/UU raw equity beta (OLS vs ARCH/GARCH) — 2yr trailing window



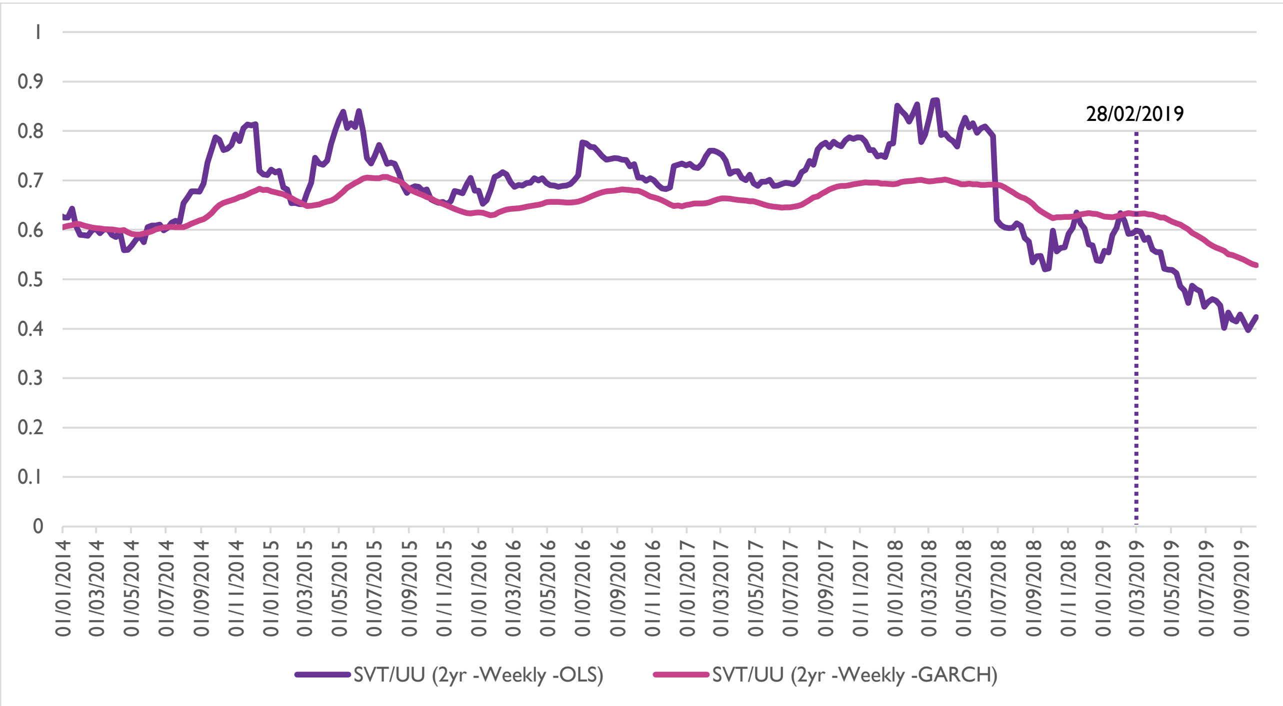
Source: Thomson Reuters, Europe Economics calculations.

Figure 4.8: Daily SVT/UU raw equity beta (OLS vs ARCH/GARCH) — 5yr trailing window



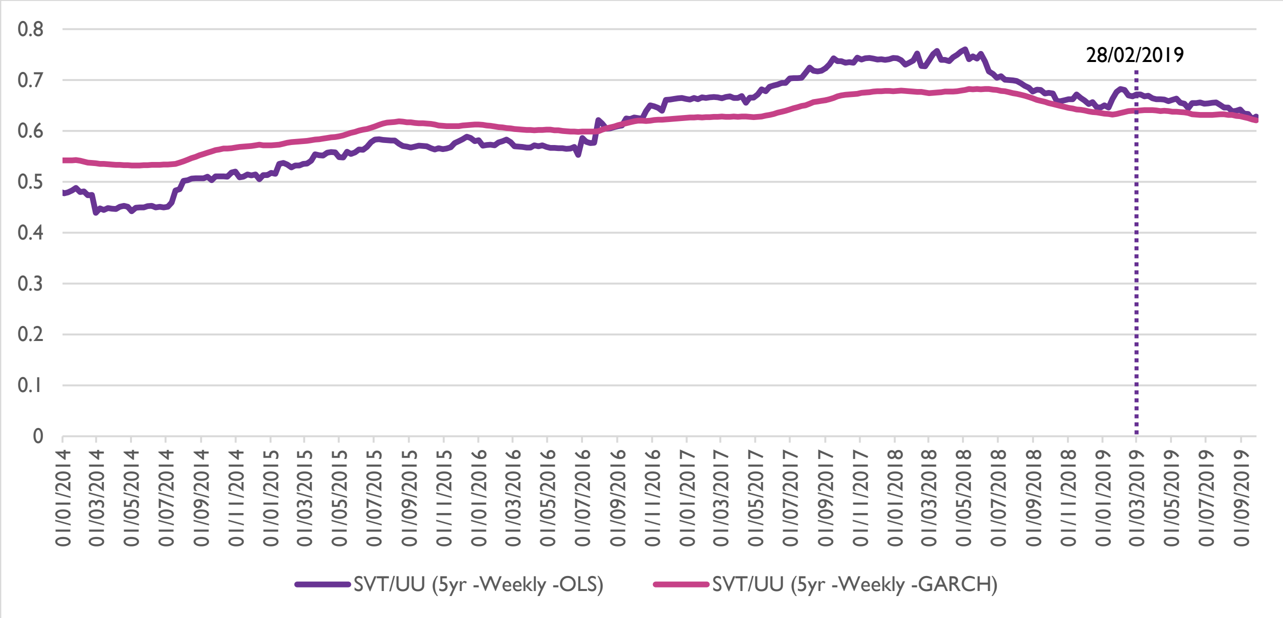
Source: Thomson Reuters, Europe Economics calculations.

Figure 4.9: Weekly SVT/UU raw equity beta (OLS vs ARCH/GARCH) — 2yr trailing window



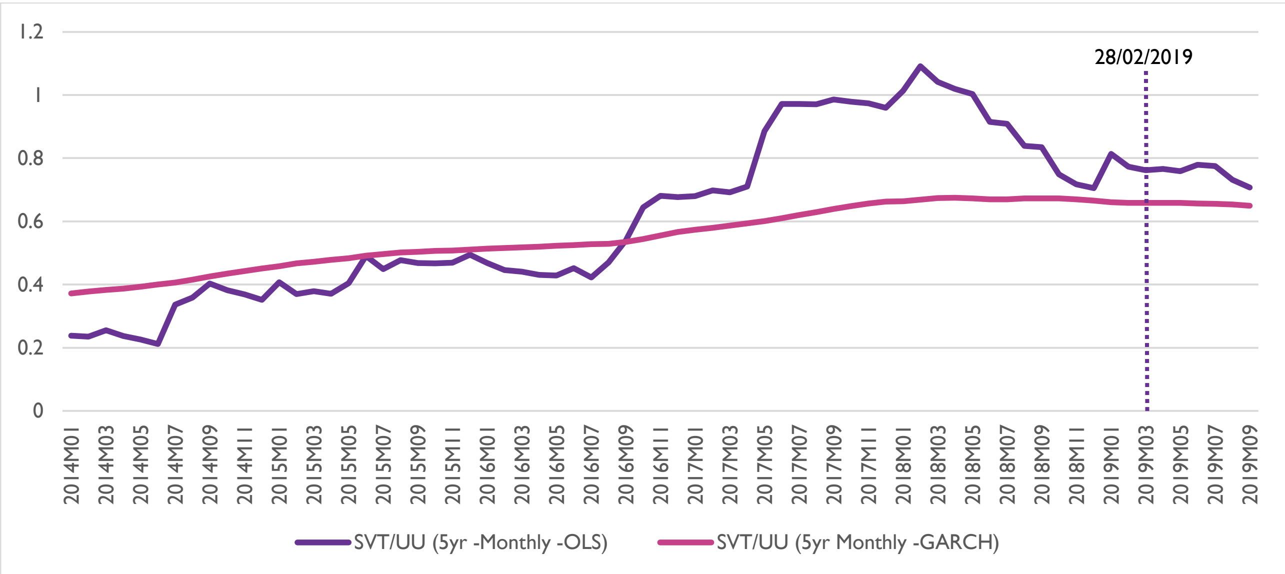
Source: Thomson Reuters, Europe Economics calculations.

Figure 4.10: Weekly SVT/UU raw equity beta (OLS vs ARCH/GARCH) — 5yr trailing window



Source: Thomson Reuters, Europe Economics calculations.

Figure 4.11: Monthly SVT/UU raw equity beta (OLS vs ARCH/GARCH) — 5yr trailing window



Source: Thomson Reuters, Europe Economics calculations.

As we can see from the charts above betas estimated though ARCH/GARCH exhibit lower volatility, as one would expect, compared to those estimated through OLS. However the general patterns in betas is very similar across the two estimation approaches. More specifically.

- GARCH estimates confirm that raw equity betas have decreased since February 2019, and this is true irrespective of the data frequency and time horizons used for estimation (see Table 4.2 below)
- As of 30 September 2019, the spot values of daily ARCH/GARCH equity betas are similar to that of OLS betas, with the only exception being represented by 2-years weekly betas where the GARCH estimate is significantly higher (0.11 higher) than the OLS estimate (see Table 4.3).

Table 4.2: Summary of raw equity beta estimates (spot at end Feb-2019 and at end Sep-2019) based on ARCH/GARCH

Company	Data frequency	1-yr beta		2-yr beta		5-yr beta	
		Feb-2019	*Sep 2019*	*Feb-2019*	*Sep 2019*	*Feb-2019*	*Sep 2019*
SVT/UU	Daily	0.60	0.48	0.63	0.60	0.67	0.64
	Weekly	-	-	0.64	0.53	0.64	0.62
	Monthly	-	-	-	-	0.67	0.65

Source: Thomson Reuters, Europe Economics' calculations.

Table 4.3: Comparison of OLS and ARCH/GARCH raw equity beta for SVT/UU (spot at end Sep-2019)

Company	Data frequency	1-yr beta		2-yr beta		5-yr beta	
		OLS	*GARCH*	*OLS*	*GARCH*	*OLS*	*GARCH*
SVT/UU	Daily	0.45	0.48	0.58	0.60	0.66	0.64
	Weekly	-	-	0.42	0.53	0.63	0.62
	Monthly	-	-	-	-	0.71	0.65

Source: Thomson Reuters, Europe Economics' calculations.

4.5 Gearing and unlevered betas

A summary of the various gearing measures (including, for completeness, also that of the Pennon and the PNN/SVT/UU portfolio) is reported in the table below.

Table 4.4: Summary of gearing measures

Company	1-yr trailing average of ND/EV		2-yr trailing average of ND/EV		5-yr trailing average of ND/EV	
	Feb-2019	*Sep 2019*	*Feb-2019*	*Sep 2019*	*Feb-2019*	*Sep 2019*
Pennon	49.1%	49.8%	47.2%	49.1%	43.9%	44.6%
Severn Trent	54.7%	54.9%	52.2%	54.2%	49.6%	50.2%
United Utilities	59.2%	58.1%	56.9%	58.4%	53.0%	53.8%
SVT/UU	57.1%	56.6%	54.7%	56.4%	51.4%	52.2%
PNN/SVT/UU	55.2%	55.0%	52.9%	54.7%	49.7%	50.4%

Source: Thomson Reuters, Europe Economics' calculations.

As we can see from the table above, whilst the 1-year trailing average of ND/EV has changed little since February 2019, the figures obtained over longer time horizons indicate an increase (albeit small) in gearing levels.

Based on the raw equity betas of Table 4.5 and the gearing measures reported in Table 4.4, we can we provide below the overall evidence on unlevered betas (based on OLS estimation).

Table 4.5: Summary of unlevered beta estimates (spot at end Feb-2019 and at end Sep-2019) based on OLS

Company	Data frequency	1-yr beta		2-yr beta		5-yr beta	
		Feb-2019	*Sep 2019*	*Feb-2019*	*Sep 2019*	*Feb-2019*	*Sep 2019*
Pennon	Daily	0.28	0.21	0.33	0.28	0.38	0.36
	Weekly	-	-	0.36	0.25	0.38	0.38
	Monthly	-	-	-	-	0.43	0.38
Severn Trent	Daily	0.24	0.19	0.29	0.26	0.34	0.32
	Weekly	-	-	0.28	0.18	0.33	0.31
	Monthly	-	-	-	-	0.39	0.36
United Utilities	Daily	0.24	0.20	0.28	0.25	0.33	0.31
	Weekly	-	-	0.26	0.19	0.32	0.29
	Monthly	-	-	-	-	0.37	0.32
SVT/UU	Daily	0.24	0.20	0.28	0.25	0.33	0.32
	Weekly	-	-	0.27	0.18	0.32	0.30
	Monthly	-	-	-	-	0.38	0.34
PNN/SVT/UU	Daily	0.25	0.20	0.29	0.26	0.34	0.33
	Weekly	-	-	0.29	0.20	0.34	0.32
	Monthly	-	-	-	-	0.39	0.35

Source: Thomson Reuters, Europe Economics' calculations.

Movements in unlevered betas are comparable to those observed for raw equity betas. More specifically, we can see a decrease in unlevered betas since February 2019 across all data frequencies and time horizons, with the sharpest fall being observed for 2-years betas estimated with weekly frequency.

We conclude by comparing unlevered betas obtained through OLS and ARCH/GARCH for the SVT/UU portfolio.

Table 4.6: Comparison of OLS and ARCH/GARCH unlevered beta for SVT/UU (spot at end Sep-2019)

Company	Data frequency	1-yr beta		2-yr beta		5-yr beta	
		OLS	*GARCH*	*OLS*	*GARCH*	*OLS*	*GARCH*
SVT/UU	Daily	0.20	0.21	0.25	0.26	0.32	0.31
	Weekly	-	-	0.18	0.23	0.30	0.30
	Monthly	-	-	-	-	0.34	0.31

Source: Thomson Reuters, Europe Economics' calculations.

4.6 Preference for daily data

The main advantage of estimating betas based on daily data is represented by the large samples size over which estimates are obtained. However, a potential shortcoming associated with the use of high frequency data arises from the possibility that market-wide information is reflected into stock prices with some delay (a phenomenon also known as "thin-trading"). If the information-updating process that leads to movements in the stock price is materially slower than the information-updating process that leads to movements in the market index (e.g. it takes more than a day for new information to be fully reflected in the stock price), then daily beta estimates would be downward biased.

A variant of this case would be one in which even though trade occurs each day, the time of day at which it occurs varies. Consider a case in which a stock trades at 9am on one day and then 5pm the next day, whilst the market is unchanged until 9am then rises 10 per cent between 9am and 5pm on both days. And suppose that the actual beta for the stock were 1. Then if the stock had traded at 5pm on the 1st day it would have been 10 per cent higher. Instead, the observed close-of-day price is unchanged on the 1st day but then rises by over 20 per cent on the second day.[25]

Since both United Utilities and Severn Trent are blue-chip stocks and constituents of the FTSE 100 one should not expect thin-trading to be an issue generally affecting the validity of beta estimates. In order to test this hypothesis we have estimated a variant of the 2-year beta equation where the companies' daily returns are regressed against, both the current value (same day) and the lagged value (previous day) of the market return. This variant of the beta regression is also known as the "Dimson adjustment" and is formally defined as follows:

$$R_{i,t} = \alpha + \beta_1 R_{M,t} + \beta_2 R_{M,t-1} + \varepsilon_t$$

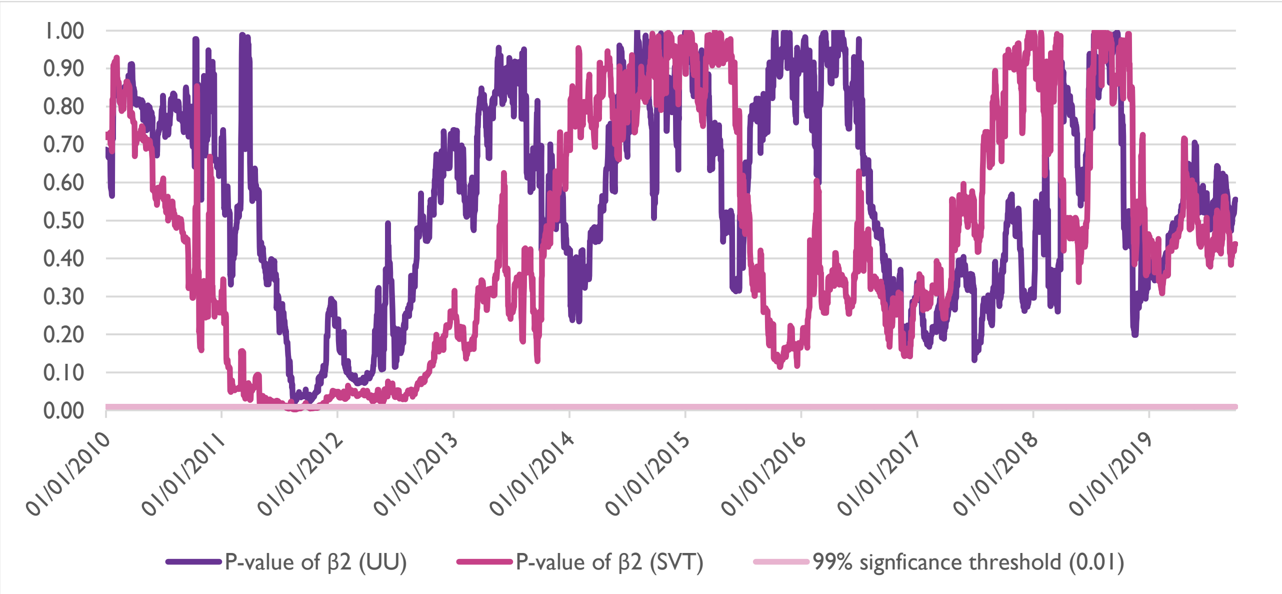
where:

- $R_{i,t}$ is the company's return in day *t*
- $R_{M,t}$ is the market return in day *t*
- $R_{M,t-1}$ is the market return in day *t-1*

If thin-trading is an issue, then the coefficient of β_2 must be statistically significant (this is called the "Dimson test"), and the correct and the unbiased daily beta estimate is given by $\beta_1 + \beta_2$.

In the chart below we display the significance value (p-values) of the β_2 coefficient together with the 99 per cent significance level (note that in order for β_2 to be significant — and thus for the Dimson adjustment to be justifiable — the p-values must be lower than 0.01).

Figure 4.12: P-values and significance level of Dimson adjustment for 2-years daily beta of SVT and UU



Source: Thomson Reuters, Europe Economics' calculations

As we can see from the chart above, with the exception of short period between July and October 2011 in in which the p-value for SVT was below the 99 per cent significance threshold, the p-values have always been well above 0.01 and therefore there is no evidence of recent beta estimates being downward biased and requiring a Dimson adjustment.

[25] This is sometimes referred to as the "Epps effect".

4.7 The predictive ability of beta estimates

In our July 2019 Report we expressed our preference for estimating beta based on two years of daily data. This choice is justified by the need to strike the right balance between two opposing factors:

- On the one hand, an excessively long time horizon (eg one that spans multiple price control periods with different regulatory frameworks) includes old, probably obsolete market information and therefore increases the risk that the estimates obtained are not sufficiently forward looking.
- On the other hand, an excessively short time horizon involves a smaller number of data points and is thus both exposed to purely statistical volatility and (again as a consequence of the smaller number of data points) is more vulnerable to being materially distorted by very short-term disturbances that died away quickly (eg errant market opinions, or perhaps even mis-pricing, that was corrected after a few days or weeks and does not reflect the forwards-looking opinion of markets by the end of the data window).

The use of a 2-year window has long been considered by UK regulators as providing a good balance between these factors.[26] We now reinforce that view as to the right balance with the following thought experiment. Suppose one believed that the 2-year daily beta is the best representation of a firm's "true" beta. What concept of beta is the best *forecaster* of future betas? After all, in estimating the WACC for firms we are not in principle aiming to estimate their WACC *now*. Rather, we are attempting to estimate what the WACC will be over the period of the price control. (That is, after all, why, for example, we use forward curve estimates for future changes in bond yields.) In principle, even if we regard the 2-year daily beta as the best concept of what beta is *now*, that is a conceptually separate question from what concept of the beta now provides the best forecast for what the 2-year daily beta will be over the period of the price control.

We consider two variants of this thought experiment:

- What concept is the best predictor of future betas for firms in general, over any timescale?
- What concept is the best predictor for a regulated water company, just prior to the making of a price control determination?

The first variant has been conducted using beta values of FTSE100 constituents, and it is structured as follows:

- Step 1. First, for each day *t* in our sample[27] we defined the "future beta" as the average value that the 2-year beta takes over the subsequent 5-years.
- Step 2. We then measure recursively, (i.e. for each day in our sample) the absolute difference between the "spot beta" (i.e. the beta estimated at day *t* using a certain amount of past return data) and the "future beta" so as to calculate the average error of prediction of the "spot beta". The "spot betas" we have considered are daily betas estimated based on 1,2,3, and 5 years of past returns data.
- Step 3. The steps above allow us to determine the average error of prediction of different "spot betas" (i.e. estimated with different time horizons) but only for one asset. Therefore, in order to increase the statistical representativeness of this experiment, we have replicated Step 2 for each constituent (as of 18 September 2019) of the FTSE100.
- Step 4. The average predictive errors of different "spot betas" have then been calculated across all FTSE100 companies, and across subsets thereof.

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26 For example, Smithers & Co (2003),"A Study into Certain Aspects of the Cost of Capital for Regulated Utilities, in the UK" recommend using between one year and two years of daily data to estimate rolling betas. Ofcom, in the 2018 WLA Statement, used a 2-year time horizon for estimating the asset beta BT Group and, in footnote 264, noted that *"[it] placed most weight on equity betas calculated over a two-year period of daily returns because [it] consider(s) it provides the most appropriate balance between a short enough estimation period to remain relevant on a forward-looking basis whilst having enough data points to be sufficiently statistically robust*". (In its 2019 BCMR Ofcom has shifted to a 5-year daily estimate, citing Brexit and other political uncertainty.) Finally, the CAA's approach in its RP3 review (for the regulation of NERL) also relies on beta estimates obtained from 2-year daily data.

27 The samples contains daily data starting from 1 January 2000 to 17 September 2019.

The results are summarised in the table below (the lowest prediction errors are indicated in pink).

Table 4.7: Predictive ability of betas estimated over different time horizons (FTSE Analysis)

	1-year spot	2-year spot	3-year spot	5-year spot
FTSE100 All Companies	0.157	**0.151**	0.160	0.179
Non-financials	0.158	**0.154**	0.163	0.180
Financials	0.154	**0.140**	0.149	0.173

Source: Thomson Reuters, Europe Economics calculations.

The results of Table 4.7 indicate that — for the FTSE100 as a whole and for key subsets thereof (e.g. non-financials, financials) — at any point in time, the spot value of a 2-year beta is better at predicting the "future value of beta" compared to spot betas estimated on other time horizons (e.g. 1-year, 3-years, and 5-years).

In the second variant, we consider the prediction of water company's betas just prior to the making of a price control decision. More specifically, we compared the spot values of different betas (1-year beta, 2-year beta, 3-year beta, and 5-year beta) at the end of August 2004, August 2009, and August 2014,[28] with the average values of 2-year betas over the following periods: April 2005-March 2010 (i.e. PR04), April-2010- March 2015 (i.e. PR09), and April 2014-mid-Sep 2019 (i.e. PR14)[29]. The results of this second exercise are reported below (the lowest prediction errors are indicated in pink).

Table 4.8: Average error when predicting average 2yr beta measured over a 5 year period (water companies' analysis)

Price control	Company	1-year spot	2-year spot	3-year spot	5-year spot
PR04	UU	0.198	0.095	0.081	0.095
	SVT	0.162	0.055	0.084	0.118
	Average	**0.180**	**0.075**	**0.082**	**0.106***
PR09	UU	0.091	0.139	0.158	0.146
	SVT	0.030	0.051	0.075	0.085
	Average	**0.060**	**0.095**	**0.116**	**0.116**
PR19	UU	0.070	0.063	0.117	0.116
	SVT	0.019	0.009	0.079	0.098
	Average	**0.044**	**0.036**	**0.098**	**0.107**

Source: Thomson Reuters, Europe Economics calculations. * Note: Due to historic data limitations these PR04 figures are based on the longest possible time window of approx. 3.7 years.

The results of Table 4.7 indicate that, around the time where which the last three price control determinations were made, betas estimated over on shorter time horizons (1-year or 2-year) turned out to be better predictors of the average beta that prevailed over the subsequent control periods.

In our view, for water companies the most relevant value is that just prior to a price control being made. Otherwise longer data windows can span across more than one price control period, and be heavily influenced by changes in regulatory frameworks or by changes to the determined WACC. We can illustrate that problem by considering the original thought experiment from Table 4.7 applied to a range of different utilities with differing price control lengths.

[28] These dates are around the time at which draft determinations were made for PR04, PR09, and PR14 respectively.

[29] The first two periods correspond to the PR04 and PR09 control periods, whilst the last period corresponds to the PR14 control period up to the latest available data used for this analysis.

Table 4.9: Predictive ability of betas estimated over different time horizons (regulated entities' analysis)

	1-year spot	2-year spot	3-year spot	5-year spot
Regulated firms*	0.120	**0.117**	**0.117**	0.118
Utilities ex. telecom*	0.099	0.094	0.089	**0.079**
Water companies*	0.090	0.087	0.084	**0.074**

Source: Thomson Reuters, Europe Economics calculations. * Note: Regulated firms include: BT, Vodafone, Centrica, National Grid, SSE, Severn Trent, and United Utilities. Utilities ex. telecom include: Centrica, National Grid, SSE, Severn Trent, and United Utilities. Water companies include: Severn Trent, and United Utilities.

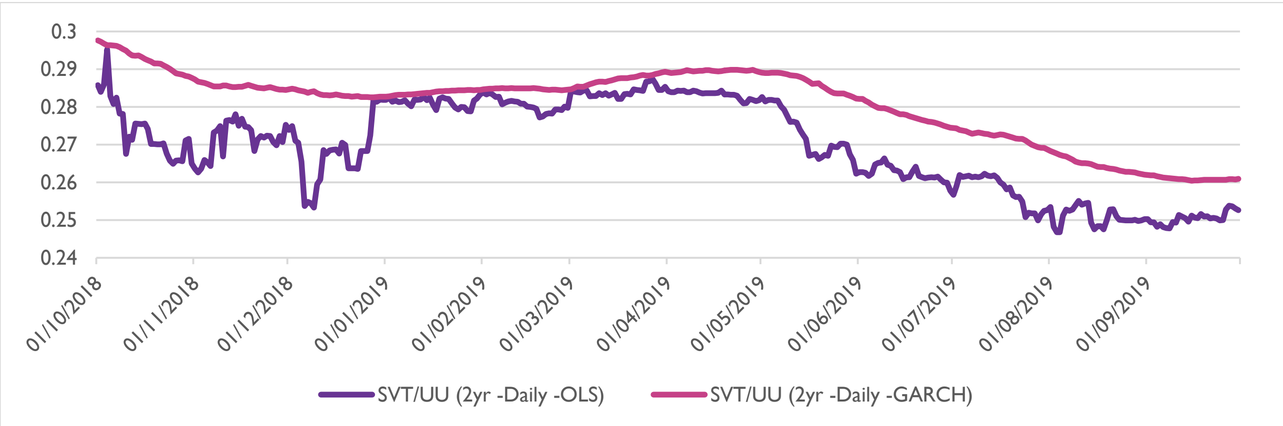
We can see here that, when we take an average of daily estimates over the full span of years, for regulated firms as a whole, which include firms with 3 year price controls, 5 year price controls and 8 year price controls, the 2-year and 3-year spot values are equal best predictors. But when we exclude the telecoms firms (which have shorter control periods), the 5-year spot values become the best predictors — even though the 2-year spot values are the best predictors just prior to price control decisions being made. In our view the natural interpretation of this is clearly that it is a result of price control periods overlapping the relevant window. However, this result does suggest that, earlier in price review processes it might be appropriate to place more weight upon longer-data-window betas than at the point of the decision itself.

4.8 Conclusions on unlevered beta

The analysis provided in Section 4.7 supports our choice of placing most weight on the 2-years beta estimated on daily return data, whilst noting also the 1-year and 5-year figures. In forming a judgment on the appropriate unlevered beta range and point estimate we note that:

- The 2-year daily unlevered beta of SVT/UU obtained through OLS is 0.25, whilst that obtained through ARCH/GARCH is 0.26 (see Table 4.6).
- The 1-year and 5-year OLS daily unlevered betas of SVT/UU are respectively 0.20 and 0.32 (see Table 4.5)
- The 90 per cent confidence interval around the OLS 2-year daily beta estimate of SVT/UU is 0.19-0.32.
- Over the past 12 months, the 2-year OLS daily unlevered beta of SVT/UU has been persistently below 0.30, reaching a minimum value of approximately 0.25, , whilst the 2-year ARCH/GARCH daily unlevered beta of SVT/UU has varied between 0.26 and 0.30 (see chart below).

Figure 4.13: Evolution of unlevered beta over past 12 months



Source: Thomson Reuters, Europe Economics calculations

In the round, based on evidence provided above, we recommend a **point estimate** for **unlevered beta** of **0.26** with a range of **0.25-0.31**. It is perhaps worth noting here that our point estimate is not selected from our range. Our point estimate is derived from our preferred estimation methods, whilst our range is our recommendation as to the range within which a value might reasonably be chosen, drawing on the various estimation methods. One could perhaps argue that the bottom end of our range could be lower, at 0.20, reflecting the 1-year beta estimate. Indeed, that would also be very similar to the range produced by the 90 per cent confidence interval around the OLS 2-year daily beta estimate of SVT/UU (0.19-0.32). And of course in that case our recommended point estimate would lie at the mid-point of our range. However, we would caution against adopting a point estimate as low as 0.20 at this stage, because the one-year series is volatile, potentially vulnerable to short-term market sentiment that in this period could have been relevant (eg short-term responses to media stories about nationalisation) and its values are out of line with those in other series. In our view it is better to use a range with a lower end drawing on the lower value coming from our preferred estimation methods (0.25) and to note that the 1-year beta evidence suggests that the direction of travel for the 2-year daily beta may yet be further down, hence supporting the view that the point estimate is likely to lie lower within our range rather than in the upper part.

4.9 Debt beta

In our July 2019 Report we estimated debt beta based on two alternative approaches:

- A decomposition approach where the debt beta is calculated through a CAPM-derived mathematical formula that relates the debt beta to the debt premium, the probability of default, the loss given default and the CAPM generic parameters (i.e. the risk-free rate and the ERP)
- A regression approach where the returns on a companies' bonds, (or an appropriate bond index) are regressed against the returns of a broad market index in the same way equity betas are estimated.

As already stated in the July 2019 Report, the regression approach is prone to well-known weaknesses and tend to produces estimates that are highly volatile. In fact, the estimation results we obtained through this approach the July 2019 Report were very sensitive to the time horizon and data frequency chosen, they were most of the time not statistically significantly different from zero,[30] and often produced negative values. For these reasons we consider the evidence based on the regression approach to be, to a large extent, inconclusive. In the July 2019 Report we also noted that, due to the poor statistical properties of the regression approach, the Competition Commission, when it considered debt betas in its key recommendation of 2007[31], favoured the use of the decomposition approach.

We note that as part of its submissions to the CAA's price review for NERL, NATS presented a paper by Prof Ania Zalewska.[32] The aim of the Zalewska debt beta paper is to estimate the market risk of the bond issued by Nats (En-Route) plc (referred to as the NATS-bond), and assess whether it is greater than 0.1. The

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30 In fact, amongst the debt beta estimated based in the iBoxx A/BBB indices, only the 5-year daily beta and the 5-years monthly betas were statistically significant (at the 99 per cent level) with values -0.08 and 0.4 respectively. Similarly, amongst debt betas estimated based on water bonds, we obtained some statistically significant values (i.e. for some but not all bonds) only for 5-year daily betas and 5-year monthly betas. The average across water bonds (where we assign a value of zero in case of insignificance) is -0.09 for 5-year daily debt beta, and 0.08 for 5-year monthly beta.

31 See p F24, paragraph 92, of https://webarchive.nationalarchives.gov.uk/20140402235745/http:/www.competition-commission.org.uk/assets/competitioncommission/docs/pdf/non-inquiry/rep_pub/reports/2007/fulltext/532af.pdf
In addition to poor statistical properties, the Competition Commission added some issues related to:
- Data quality: in particular, "the relatively poor quality of the data that we have on returns to debt holders",
- Thin trading: which "affect[s] debt beta estimates more seriously than equity beta estimates even for large firms",
- Differences in gearing levels used: "the difference between historical and assumed [regulatory period] gearing levels".

For these reasons, the Competition Commission stated "These factors have led us to favour the indirect, decomposition method, where we can be much more confident that we are correctly observing how much compensation lenders are asking for in exchange for bearing systematic risk."
This judgement was particularly influential since it was the first time the CC had considered the question of whether it was appropriate to use a non-zero debt beta and the first full debate about whether the debt beta should be non-zero in UK regulation. It is also key in that all subsequent UK regulatory analyses of debt beta have appealed to it as an authority.

32 Professor Ania Zalewska (April 2019) — "Estimation of the debt beta of the bond issued by Nats (En-Route) plc"

analysis is performed within the CAPM framework using three different methods: OLS, ML-GARCH(1,1) and the Kalman Filter. According to the paper, the results strongly support the thesis that the NATS-bond's beta is negative (and statistically significant) and not different from zero in recent years. The conclusions are that the insignificance of the betas (i.e. their being statistically not different from zero) indicate that the returns on the NATS-bond are determined by the risk free-rate and the idiosyncratic risk of the bond (e.g. default risk) but not the performance of (returns on) the market portfolio.

As well as the general drawbacks of econometric estimates of the debt beta noted by the Competition Commission since 2007, which we have referred to above, and various technical issues with the econometrics itself, we note that the Zalewska analysis "proves too much". Its overall finding is that investment-grade corporate debt as a whole (not simply NATS's debt or Heathrow's debt — all investment-grade corporate debt) has a non-positive debt beta (zero or negative). That should be seen less as a radical comprehensive finding about UK debt markets and more as a *reductio ad absurdam* of the methodology. To restate the point: the paper does not simply conclude that NATS has a zero or negative debt beta. It concludes that *all* investment-grade corporates do.

The author explicitly invites us to interpret all debt premiums as arising from idiosyncratic risk of default — i.e. driven by the wedge between expected returns and promised returns. Even for half of typical debt premiums to be attributable to this effect would imply that each year over 80 per cent of investment-grade corporate debt was expected to default.[33] We do not consider this credible.

The theme of the Zalewska paper, that debt betas were negative a few years ago and in recent times are sufficiently volatile that they are empirically difficult to distinguish from zero via econometric methods, is not materially different from a message one might have drawn from the empirical analysis we set out in our Draft Determinations report. However, the conclusion that therefore we should assume debt betas are in fact zero (indeed, zero for all corporates) seems to us to stretch the point too far.

Noting we have updated the debt beta using only the decomposition approach.

We recall that the decomposition approach is based on the following formula (see Section **Error! Reference source not found.** of the July 2019 Report for more details on how this is derived):

$$\beta_D = \frac{(1 - \text{prob(default)}) \cdot (\text{debt premium} - \text{liquidity risk premium}) - \text{prob(default)} \cdot (\text{RFR} + \%\ \text{loss given default})}{\text{ERP}}$$

Consistently with the treatment of the parameters in this report, the values of the inputs used to populate the formula above are as described below:

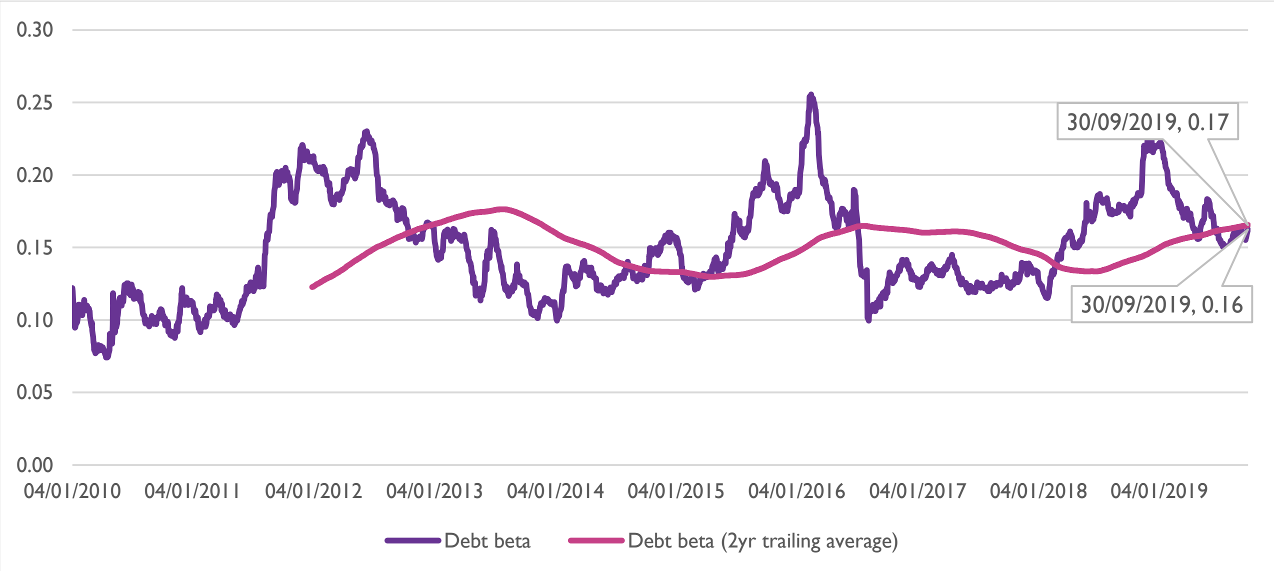
- Risk-free rate — spot yields of 15-years nominal gilts (consistently with our risk-free rate analysis which is also is based on 15-year gilts).

[33] We see that mathematically as follows.
Debt beta = ((1 – probability of default) x Debt Premium - probability of default (risk-free rate + loss given default)/ERP
This can be decomposed into two components:
probability of default (risk-free rate + loss given default)/ERP, which is the deduction effect because of the wedge between the promised and expected return
(1 – probability of default) x Debt Premium/ERP, which is the debt beta-driving effect
So if more than half the debt premium is attributable to the deduction effect, we have
(1 – probability of default) x Debt Premium > probability of default (risk-free rate + loss given default)
If we assume the Debt Premium is 100 bps and the sum of the risk-free rate and loss given default are 20 per cent (typical bankruptcy losses given default are near 20 per cent and the risk-free rate is currently near zero), then we have
(1 – probability of default) x 1 > probability of default (0.2)
⇒ probability of default > 1/1.2 = 83.3%.

- ERP — the difference between 5-years trailing average of the returns produced by our DGM based on GDP growth of Section 3.5 (expressed in nominal terms) and the nominal risk-free rate.[34]
- Debt premium — this is calculated as the spread between the average nominal yield of A/BBB 10-year+ iBoxx non-financial indices (this is the same index we use to estimate the cost of debt, see Section 0) and the nominal risk free rate. Consistent with the methodology used for the cost of debt, the spread has been also adjusted by subtracting 15bps to account for water companies' outperformance (see Section 5.1).
- Liquidity risk premium in corporate bonds[35] — is assumed to be 30bps as per estimates by the Bank of England.[36]
- Percentage loss given default — this is assumed to be 20 per cent.[37]
- The probability of default — this is 0.2 per cent and is based on the (rounded) median value of default probability in the utilities sector as pe+r S&P 2018 Global Corporate Default Study.[38]

The debt beta series obtained from the inputs listed above is reported in the chart below.

Figure 4.14: Debt beta obtained through the decomposition approach



Source: Thomson Reuters, and Europe Economics' calculations.

As we can see from the figure above, since 2010 the debt beta we obtained through the calibrated decomposition approach ranges broadly between 0.10 and 0.25 and, as of 30 November 2019, has a value of 0.16. The two-years trailing average ranges broadly between 0.125 and 0.175, and as of 30-November-2019 has a value of 0.17.

[34] We use the 5 year trailing average from the DGM as that is our preferred model. However, as a cross-check we have estimated the debt beta using also spot TMR figures. The debt beta calculated in this way are more volatile but the spot value and 2-years rolling average at the end of September 2019 are comparable to those of Figure 4.14 (i.e. they are respectively 0.15 and 0.16).

[35] This should not be confused with the liquidity premium on government index-linked bonds that, as already discussed, is close to zero.

[36] https://www.bankofengland.co.uk/-/media/boe/files/financial-stability-report/2014/june-2014.pdf

[37] The 20 per cent is a typical estimate of "costs of bankruptcy" across many sectors. There would be almost no difference to the results if, for example, loss given default were to be 10 per cent.

[38] S&P Global (2019), "2018 Annual Global Corporate Default Study And Rating Transitions" available at: https://www.spratings.com/documents/20184/774196/2018AnnualGlobalCorporateDefaultAndRatingTransitionStudy.pdf

4.9.1 Conclusions on debt beta

The decomposition approach indicates that daily debt beta tend to range between 0.1 and 0.25, whilst the two-years trailing average falls within a narrower band of around 0.125-0.175. As of 28-February-2019 the value of the debt beta obtained with the decomposition approach is 0.16, whilst the value of the two-years trailing average value is 0.17. Taking this evidence altogether, we recommend a **debt beta range** of **0.1-0.17**. Noting that both the concept of and extent of adjustment for a liquidity risk premium are questionable[39], we favour the upper half of our range, retaining our recommendation for a debt **point estimate** of **0.15**.

4.10 Asset beta and notional equity beta

Based on the unlevered beta recommendations set out in Section 0, the debt beta recommendations set out in Section 4.9.1and the market gearing presented in Table 4.4 (i.e. the 2-year trailing average ND/EV for SVT/UU, which is 56.4 per cent)**Error! Reference source not found.**, the **asset beta range** we propose is **0.31-0.41** with a **point estimate** of **0.34** (see table below).

Table 4.10: Asset beta range and point estimate

	Low	High	Point estimate
Raw equity beta (derived from unlevered beta and market gearing)	0.57	0.71	0.60
Market gearing	56.4%	56.4%	56.4%
Unlevered beta	0.25	0.31	0.26
Debt beta	0.10	0.17	0.15
Asset beta	**0.31**	**0.41**	**0.34**

Thomson Reuters, Europe Economics' calculations.

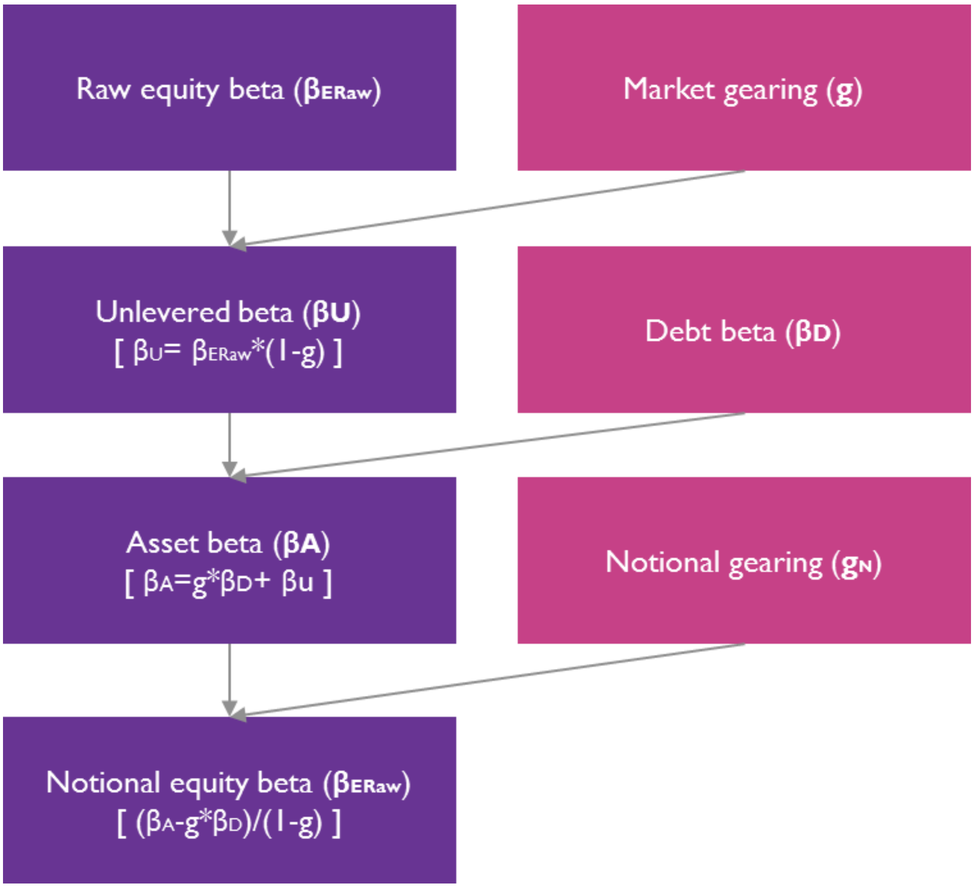
Now the appropriate asset beta value, β_A, has been determined, we can obtain a notional equity beta, β_{EN}, through a re-levering exercise which makes use of a notional gearing level. That uses the following formula:

$$\beta_{EN} = \frac{\beta_A - g_N\beta_D}{(1 - g_N)},$$

where g_N is the notional gearing for the regulated entity. The value of debt beta will directly affect the asset betas and the re-levered equity betas. Gearing is denoted g, and is calculated on the basis of companies' net debt to enterprise value. The notional gearing level, used to re-lever asset betas into notional equity beta, is denoted by g_N. These steps required to calculate the notional equity beta starting from the raw equity beta are summarised in the diagram below.

[39] Strictly speaking, in the CAPM there is no role for a liquidity risk premium. Its presence in debt beta analysis can be seen as a form of pragmatic concession, with the implication that, when selecting from ranges one should tend to err towards the end of the range that assumes the liquidity risk premium is lowest.

Figure 4.15: Calculations to obtain notional equity beta from raw equity beta



Source: Europe Economics

Consistently with the view expressed by Ofwat Draft Determination, we calculate the equity beta at a notional gearing level of 60 per cent. This results in a **notional equity beta range** of **0.62-0.76** with a **point estimate** of **0.64**.

Table 4.11: Notional equity beta range and point estimate

	Low	High	Point estimate
Asset beta	0.31	0.41	0.34
Notional gearing	60%	60%	60%
Debt beta	0.10	0.17	0.15
Notional Equity beta	**0.62**	**0.76**	**0.64**

Source: Thomson Reuters, Europe Economics calculations.

4.11 Overall cost of equity

Based on the risk-free rate recommendation set out in Section2.5, the TMR recommendation set out in Section 3.6, and the gearing and beta figures presented in Table 4.10 and Table 4.11:

- The **post-tax nominal cost of equity range** is **5.22-7.21** per cent, with **a point estimate** of **5.80 per cent**.
- The **post-tax CPIH-deflated cost of equity range** is **3.16-5.11 per cent**, with a **point estimate** of **3.72 per cent**.

Table 4.12: Post-tax cost of equity

	Nominal			CPIH-deflated		
	Low	*High*	*Point estimate*	*Low*	*High*	*Point estimate*
Risk-free rate	0.58%	1.10%	0.84%	-1.39%	-0.88%	-1.14%
TMR	8.12%	9.14%	8.63%	6.00%	7.00%	6.50%
ERP	7.54%	8.04%	7.79%	7.39%	7.88%	7.64%
Raw equity beta	0.57	0.71	0.60	0.57	0.71	0.60
Market gearing	56.4%	56.4%	56.4%	56.4%	56.4%	56.4%
Unlevered beta	0.25	0.31	0.26	0.25	0.31	0.26
Debt beta	0.10	0.17	0.15	0.10	0.17	0.15
Asset beta	0.31	0.41	0.34	0.31	0.41	0.34
Notional gearing	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%
Notional equity beta	0.62	0.76	0.64	0.62	0.76	0.64
Cost of equity (post-tax)	**5.22%**	**7.21%**	**5.80%**	**3.16%**	**5.11%**	**3.72%**

4.11.1 Cross-checks to the cost of equity

As pointed out by Frontier Economics on behalf of a number of companies in their submissions, there are a number of cross-checks that could be implemented to complement the cost of equity estimate obtained through the CAPM approach. Among the cross-checks proposed by Frontier Economics the ones we shall discuss here are[40]:

- Dividend growth models of listed water companies (i.e. Pennons, Severn Trent, and United Utilities);
- A comparison of premium on equity and debt;

Before discussing the merit of the above cross-checks it is important to stress that Frontier Economics recognise that each of the cross-checks proposed is subject to limitations and that that Frontier Economics acknowledges that estimating the cost of equity through the CAPM approach represents a standard and well stablished in regulatory practice.

With regard to the use of DGM models, our view is that the application of dividend growth models (DGM) and dividend discount model (DDM) applied to single companies is problematic for a number of reasons. First, DGM/DDM estimates can be highly volatile thus reducing the degree of confidence that can be placed on the resulting estimates. Second, there is a potential circularity issue in applying GMD/DDM models to regulated utilities because certain inputs used in DGM/DDM models (such as, e.g., analysts' expectations) are arguably influenced by regulatory decisions.

Furthermore, we note that the share price data used in Frontier's models are in some cases rather old (going back into 2018), and indeed Frontier does not use the same date in its models for different companies. It is likely that the results are sensitive to the precise date chosen and so cross-checks based on obsolete data are of less relevance or robustness.

[40] Additional cross-checks considered by Frontier Economics are a notional financeability assessment and market-to-asset ratio analysis.

For the reasons set out above we conclude that the cross-checks estimates produced by company-specific DGM/DDM do not provide sufficient and reliable evidence to move away from the cost of equity estimate we propose.

The second cross-check proposed by Frontier Economics, consists in a though experiment where the debt premium is compared to the equity premium of a notional company that is fully equity financed. Frontier Economics concludes that Ofwat's Draft Determination implies that the cost of equity of a 100 per cent equity funded water company would be only 0.22 higher than the cost of debt. Frontier argues that this differential is implausibly low and that, based on other precedents, it should be well above 1 per cent.

We have a number of responses to this.

- First, we note that for the figures presented in this report, the differential between an all-equity-funded entity and the cost of new debt would be 0.95 per cent (3.49 per cent minus 2.54 per cent, in nominal terms). At PR14 the differential was 0.93 per cent (5.78 per cent minus 4.89 per cent, in nominal terms). Frontier miscalculates the all-equity-funded cost of equity by basing its calculation on the unlevered beta instead of the asset beta (and also makes a mistake in the unlevered beta, using a figure of 0.28 instead of Ofwat's 0.29), resulting in a considerable understatement of the all-equity-funded cost of equity at PR19 DD (it estimates 0.51 per cent in RPI-deflated terms, equivalent to 3.52 per cent in nominal terms versus the correct value of 4.09 per cent). Frontier comments that "Asset betas converted to the equivalent of zero debt beta, as debt betas from the determinations were appropriate for the notional gearing levels and not for 0% gearing level", but this is a conceptual error. The asset beta reflects the company beta risk. That risk is apportioned between debt and equity at a given level of gearing, but shifting to an all-equity funding model would not eliminate such beta risk. It is the asset beta, not the unlevered beta, that is the relevant basis for estimating an all-equity funded cost of equity for the same reason that it is the asset beta, not the unlevered beta, that is used for adjusting to any other level of gearing. Frontier also does not use the cost of new debt from either the PR14 determination or the PR19 DD, instead preferring to use iBoxx figures. This reduces the comparability of the values further. The implication is, therefore, that — contrary to what Frontier claims — the differential at draft determination stage was 0.73 per cent. That was indeed a slightly lower differential than the 0.93 per cent at PR14, but our Final Determination recommendation here involves a slightly higher differential (0.95 per cent).
- For completeness, we also note that based on Frontier Economics' own preferred cost of capital parameters, the resulting differential would be 0.94 per cent versus their quoted iBoxx average or 0.61 per cent using their preferred cost of new debt (see Table below) — ie less than either the DD differential or our differential here.

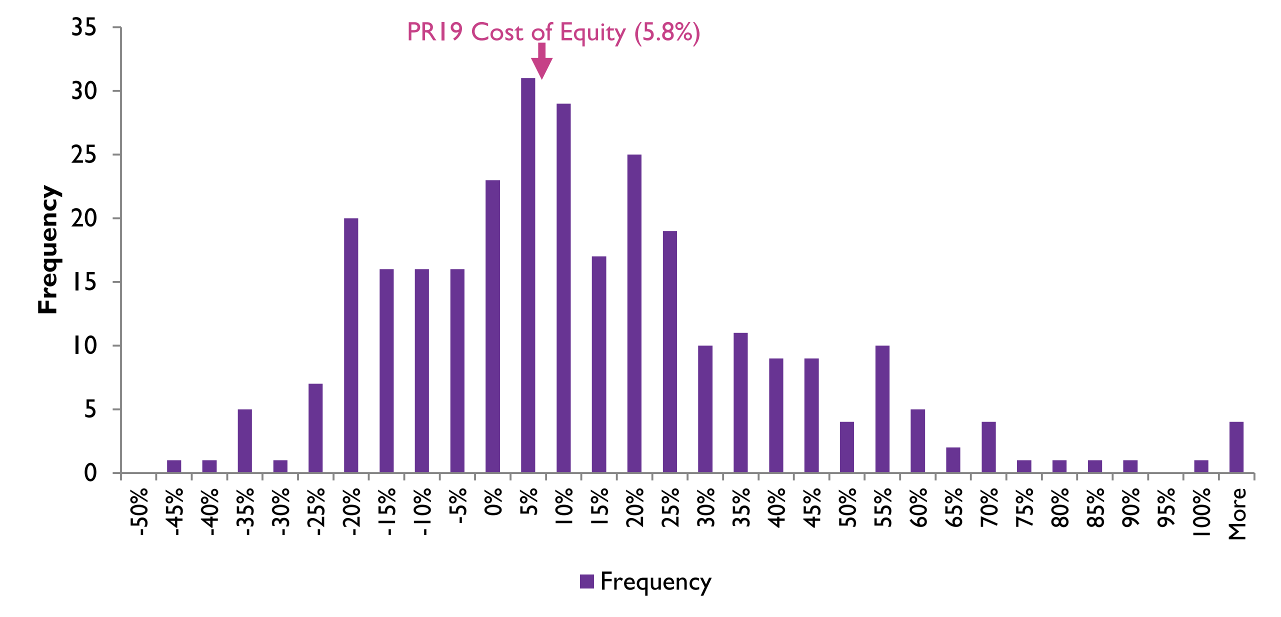
Table 4.13: Assessment of differential between debt premium and equity premium for a company that is fully equity financed

	Frontier's preferred values (RPI-deflated)	Frontier's preferred values (converted to nominal at 3% RPI)
TMR	6.16%	9.34%
Risk-free rate	-1.05%	1.92%
"Asset beta" (ie unlevered beta)	0.315	0.315
Cost of equity at 0% gearing	1.22%	4.26%
iBoxx average (Frontier figure)*	0.29%	3.30%
Differential (iBoxx version)	0.93%	0.94%
Cost of new debt	0.63%	3.65%
Differential (Cost of new debt version)	0.59%	0.61%

*Source: Frontier report, Figure 13

Finally, in order to contextualise the cost of equity estimate we propose here (i.e. the point estimate of 5.8 per cent in nominal term), we have calculated the distribution of annual return of FTSE100 companies over a period of three years, (i.e. the period 2015-2018).

Figure 4.16: Distribution of nominal annual returns over the period 2015-2018



Sucre: Thomson Reuters and Europe Economics calculations. NOTE: in the chart above the annual return of each company over the different years are treated as independent observations (so the for example the annual return of Company A for 2015-2016, the Company A for 2016-2017, and the annual return of Company A for 2017-2018, are treated as separate observations. The percentage values on the X-axis should be interpreted as "returns below that percentage value". So, for example, the bar at 10% value on the X-axis represents the percentage of returns greater than (or equal to) 5% but lower than 10%.

As we can see in Figure 4.16, the cost of equity value of 5.8 per cent is comfortably close to the mode of the distribution and, as we should expect from a regulated utility sector, below the median value of the distribution which is 7.6 per cent.

5 Cost of debt

5.1 Introduction

This section provides an updated view on the cost of debt. The section is organised as follows:

- Section 5.2 sets out the key methodological considerations.
- Section 5.3 provides an updated on the cost of embedded debt.
- Section 5.4 sets out the methodology for the cost of new debt and its estimation.
- Section **Error! Reference source not found.** provides evidence on the appropriate ratio of new debt to embedded debt.
- Section **Error! Reference source not found.** sets out the overall cost of debt.

5.2 Methodological considerations

In estimating the cost of debt we retain the main methodological approaches adopted in the July 2019 Report. More specifically:

- We determine the point estimate for cost of embedded debt based on the historical value of an appropriate benchmark index (in the July 2019 Report we referred to this approach as “benchmark index approach”) adjusted to account for companies’ historical outperformance against the index. We use the cost of debt instruments contained in the companies’ balance sheets (in the July 2019 Report we referred to this approach as “balance sheet approach”) to determine the range of the cost of embedded debt.
- The cost of new debt is determined based on the recent value of an appropriate benchmark index, adjusted to account for expected rise in interest rate, and to account for companies’ potential future outperformance against the index.

However the current report departs partially from the July 2019 Report in two aspects:

- As we did in our July 2019 Report, we assume a baseline historic outperformance level of 25 bps, and we retain this figure for the purpose of estimating the cost of embedded debt. However, when estimating the cost of new debt we reduce the outperformance wedge to 15bps. The rationale behind this choice is as follows. We assume that a portion of historic debt had comfort to its credit rating, above the investment grade boundary, arising from the WACC (even if it was *ex ante* correct) being set at a level above what the actual WACC turned out to be over the price control period. Since our recommended WACC lies as our central *ex ante* expectation, the actual WACC is as likely to be above as below our recommended value, and hence we cannot assume that this historic source of comfort will be duplicated in future. This could justify a reduction of the outperformance wedge.
- We have also conducted additional empirical analysis (see Section 5.4.1) which confirms that a 10bps reduction of the outperformance wedge (i.e. from 25bps recommended in the July 2019 Report to the 15bps we recommend now) is appropriate.
- We have reviewed a more extensive analysis conducted by Ofwat on ratio of new debt to embedded debt. Based on this review we maintain the position that a ratio of new to embedded of 20:80 is appropriate.

5.3 Cost of embedded debt

Like we did in our July 2019 Report, we base our point estimate on the 15-year trailing average of the iBoxx average A/BBB index[41] (forecasted up to April 2020) minus 25bps to account for companies' historic outperformance against the index (we refer to Section 6.2.2 of the July 2019 Report for evidence underpinning the outperformance figure chosen). Also, consistently with the July 2019 Report:

- We determine the bottom end of the range based on the sector weighted average cost of embedded debt (based on companies' balance and accounting only for pure-debt instruments).
- The top end of the range is the sector's median cost of embedded debt (again, based on companies' balance and accounting only for pure-debt instruments).

For completeness we report below the median cost of embedded debt across companies, the arithmetic average cost of embedded debt across companies[42], and the debt-instruments weighted average cost of embedded debt within the water sector, where the average is weighted by the principal issue amount.

Table 5.1: Weighted average, average and median cost of embedded

	Weighted average	Arithmetic average	Median
Water sector	**4.25%**	**4.63%**	**4.65%**
WaSCs & Large WoCs	4.23%	4.25%	4.45%
Small WoCs	5.60%	5.76%	5.47%

Source: Analysis of PR19 Business Plan data.

We report below the evolution of the iBoxx non-Financials A/BBB index together with the 10- year and 15-year trailing averages. Since the cut-off date for this report is 30 September 2019, the iBoxx A/BBB index values for the period 1 October 2019 to 31 March 2020 have been forecasted as follows:

- The spot value of the iBoxx average A/BBB index at 30 September 2019 is 2.42 per cent.
- The average market implied increase in interest rate on 15-year nominal gilts yields in April 2020, as recorded in September 2019, is 3bps (see Table 2.3).
- We have then added 3bps to the iBoxx A/BBB index spot value at 30 September 2019 to infer the value of the index in April 2020 (i.e. 2.45 per cent), and we have interpolated linearly the values in between these dates.

[41] This is a synthetic index calculated as the simple average between the *iBoxx 10+ Non-financial A index* (an index based on A-rated bonds of non-financial companies with maturity of at least 10 years) and the *iBoxx 10+ Non-financial BBB index* (an index based on BBB-rated bonds of non-financial companies with maturity of at least 10 years).

[42] This is the arithmetic average across companies, with the cost of embedded debt of each company being calculated as a weighted average with weights proportional to the debt instruments' amounts.

Figure 5.1: Evolution of the iBoxx A/BBB index (with values forecasted up to April 2020)

Source: Thomson Reuters, Band of England, and Europe Economics' calculations.

The forecasted values of the iBoxx A/BBB index and the 10-year and 15-years trailing averages as of April 2020 are reported in the table below.

Table 5.2: IBoxx A/BBB values in April 2020

	Spot values in April 2020
iBoxx A/BBB spot value (forecast)	2.45%
iBoxx 10yr trailing average	4.02%
iBoxx 15yr trailing average	**4.72%**

Source Thomson Reuters, Bank of England, and Europe Economics' calculations.

5.3.1 Conclusions on the cost of embedded debt

Base on the information provided in the section above, and assuming an outperformance wedge of 25bps, we recommend using a value of **4.47 per cent** for the **nominal cost of embedded debt**, with a **range** of between **4.25 per cent** (the weighted average under the balance sheet approach) and **4.65 per cent** (the median under the balance sheet approach). This corresponds to a **CPIH-deflated cost of embedded debt** of **2.42 per cent**, with a **range** between **2.21 per cent** and **2.60 per cent**.

Table 5.3: Cost of embedded debt

	Nominal	CPIH-deflated
iBoxx A/BBB spot value (forecast spot value in April 2020)	4.72%	2.67%
Outperformance adjustment	-0.25%	-0.25%
Point estimate cost of debt	**4.47%**	**2.42%**
Lower bound cost of debt (water sector weighted average)	**4.25%**	**2.21%**
Upper bound cost of debt (water sector median)	**4.65%**	**2.60%**

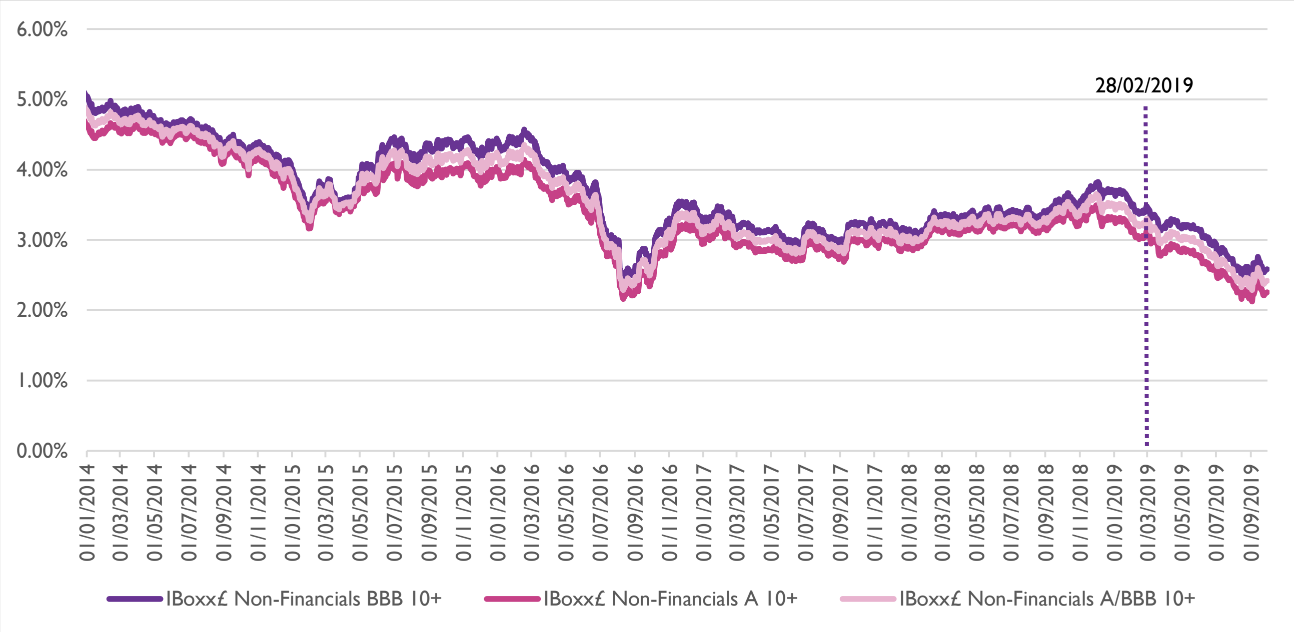
Source Thomson Reuters, Ofwat, Bank of England, and Europe Economics' calculations

5.4 Cost of new debt

Consistent with our July 2019 Report, we estimate the cost of new debt based on the average yield between the *iBoxx 10+ Non-financial A index* and the *iBoxx 10+ Non-financial B index*. We refer to the average between the two indices as *iBoxx Non-financial A/BBB* index.

The evolution of the iBoxx indices is reported in the chart below. As we can see the yields of iBoxx indices has come down considerably since February 2019. More specifically, as of 30 September 2019 the spot yields of the iBoxx non-financial A/BBB index are 88bps lower than they were at the end of February 2019 (see Table 5.4).

Figure 5.2: Evolution of iBoxx non-financial indices



Source Thomson Reuters, and Europe Economics' calculations

Table 5.4: Summary of evidence from iBoxx non-financial indices

	Spot yield at 28 February 2019	Spot yield at 30 September 2019	Average yield in September 2019
iBoxx 10+ Non-financial A	3.12%	2.26%	2.28%
iBoxx 10+ Non-financial BBB	3.48%	2.58%	2.61%
iBoxx 10+ Non-financial A/BBB	**3.30%**	**2.42%**	**2.44%**

Source Thomson Reuters, and Europe Economics' calculations

For the cost of new debt, given the indexation mechanism and the truing process, there is no need for a range — only a point estimate is required. For the purpose of determining that point estimate we place most weight on the average yield recorded in September 2019 (i.e. 2.44 per cent). This is a move away from the use of spot yield adopted in the July 2019 Report, and it is justified on the ground of consistency. Since the market implied rate change in AMP7 is calculated based in the average forward-minus spot rate reported by the Bank of England in September 2019, we consider appropriate to express the yield as an average calculated over the same time period.

Since future movements in the yields of the iBoxx A/BBB index are likely to match movements in gilts yields very closely, we uplift the spot yield by 25bps, i.e. the market-implied rate increase in AMP7 for 10 year nominal gilts (see Table 2.3).

5.4.1 Outperformance wedge for the cost of new debt

As we explained earlier, a consequence of the proposed reduction in allowed returns relative to previous price controls, is the potential for some deterioration in water companies' credit ratings. If such downgrading were to materialise, this could result in higher debt financing costs and therefore in a reduction of the outperformance that has been historically observed.

One thought experiment to estimate how much the outperformance wedge would be reduced by this effect would be as follows. Let us suppose that the WACC comfort effect resulted in more water company debt being rated at notches above investment grade, but did not result in any debt that would not otherwise have been investment grade becoming so. Or, conversely, that the loss of comfort would not result in any currently investment-grade debt ceasing to be so, but would instead merely reduce the rating of debt that is currently above investment grade. So, for example, if debt would previously have been rated at A- (with comfort) it would now be rated at BBB+ (without comfort), but we would not have BBB- debt cease to be investment grade. That means that credit rating downgrade only applies to a portion of water company debt, not the whole sum.

If we assume that around 40 per cent of debt would be at ratings sufficiently high that they would experience a one-notch reduction, and that the "cost of a notch" at these ratings is around 25bps[43], that implies that across all water company debt the average reduction would be 10bps.[44]

As a cross-check to this thought experiment-based calculation, we have also considered specific recent market evidence from of Southern Water's bonds.[45]

On 27 September 2019, Moody's downgraded the senior secured debt ratings of Southern Water Services (Finance) to Baa3 from Baa2 (this corresponds to a downgrade from BBB to BBB- under S&P rating system). Any change in spread following the downgrade can provide useful insights on the magnitude of any adjustment to the historical outperformance wedge.

For eight Southern Water's bonds we report below the average spread[46] for the month preceding the downgrade (i.e. the period 26-August to 26-September) and for the month following the downgrade (i.e. the period 30-September to 31-October).

Table 5.5: Evidence from SRN bonds

	Amount at issuance	Index-linked	Average spread pre-downgrading	Average spread post downgrading	Increase in average spread
SRN bond maturing 31-Mar-2021	£406,461,817	No	0.81%	0.87%	0.06%
SRN bond maturing 31-Mar-2023	£174,197,921	Yes	2.03%	2.07%	0.04%
SRN bond maturing 31-Mar-2026	£406,461,817	No	1.32%	1.37%	0.05%
SRN bond maturing 31-Mar-2029	£406,461,817	No	1.16%	1.19%	0.03%
SRN bond maturing 31-Mar-2034	£174,197,921	Yes	1.41%	1.46%	0.05%

43 This value is consistent with the evidence provided in the credit note titled "The Cost Of A Notch" and published by S&P Global Market Intelligence on 26 March 2019.

44 25 x 0.4 = 10.

45 We note that, in this case the rating reduction was for bonds closer to the investment grade boundary than assumed above. That may imply that the thought experiment above is conservative — ie that it could be argued that the reduction in outperformance will be greater than that we assume (ie more than 10bps). Conversely, the "cost of a notch" here is less than the 25bps we assume above, hence in that sense offsetting the conservativeness of the portioning assumption.

46 Spreads have been calculated by reference to the appropriate gilt (i.e. nominal gilts for non-index linked bonds and index-linked gilts for index-linked bonds) with the closest maturity.

SRN bond maturing 31-Mar-2041	£174,197,921	No	0.99%	0.97%	-0.02%
SRN bond maturing 31-Mar-2052	£232,263,895	No	1.12%	1.15%	0.04%
SRN bond maturing 31-Mar-2056	£348,395,843	No	1.07%	1.14%	0.07%
Simple average					**0.04%**
Weighted average					**0.04%**

Source: Thomson Reuters, Europe Economics calculations

As we can see from the table above, following the downgrade, there is a rise in spreads of around 4bps.

The key implication of this analysis is that the change in credit rating does indeed imply a rise in spreads. In our judgement, the number and range of bonds in this case is too limited for use to use this as a precise basis for estimate the scale of the increase. At 4bps, it does, however, reinforce the approximate order of magnitude that we derived above (i.e. 10bps).[47]

5.4.2 Conclusions on the cost of new debt

Base on the information provided in the section above, and assuming a forward-looking outperformance wedge of 15bps, we recommend using a value of **4.54 per cent** for the **nominal cost of new debt**. This corresponds to a **CPIH-deflated cost of new debt** of **0.53 per cent**.

Table 5.6: Cost of new debt

	Nominal	CPIH-deflated
iBoxx 10+ Non-financial A/BBB (average in November 2019)	2.44%	0.43%
Market-implied rate change in AMP7	0.25%	0.25%
Outperformance adjustment	0.15%	0.15%
Cost of new debt	**2.54%**	**0.53%**

5.5 The ratio of new to total debt

The ratio of new to total debt is calculated based on companies' balance sheets for each years of the PR19 price control (from 2020/21 to 2024/25) as the ratio of new debt stock over total debt stock, where:

- New debt stock is the cumulative amount of new debt issued from 2020/21 onwards.
- Total debt is the sum of new debt stock and embedded debt stock, where embedded debt stock is the previous year figure of embedded debt plus indexation for index-linked debt instruments minus debt repaid.

In Ofwat's Draft Determination and in our July 2019 Report, the split between new and embedded debt was revised downwards to a ratio of 20:80. This updated figure was informed by the following evidence (we refer to Section 6.3 of the July 2019 Report for more details):

- The simple average ratio of new debt to total debt across the companies was ~~is~~ 17 per cent.

47 We note that the "outperformance wedge" could arise from a combination of outperformance in some dimensions (eg tenor) but underperformance in others (eg degree of comfort relative to price control decisions). So our assumption of 15bps outperformance here does not, for example, depend on the degree of comfort from the overall WACC now to be greater than or in line with the degree of comfort for other utilities in the past — water companies could under-perform in terms of degree of comfort but outperform in terms of tenor, with the net effect being outperformance.

- The industry average split (across the PR19 period) was 22 per cent.

We note that the average between this two figures is 19.5 per cent.

Since the time of the Draft Determination, more details analysis on the appropriate split between new and embedded debt has been carried out by Ofwat. The analysis make use of three different approaches

- Notional approach.
- Company data-led approach.
- Notional-actual hybrid approach.

The notional approach assumes that, for debt of a given holding period, the proportion of debt refinanced each year of the control is calculated equal to following simple formula:

$$\text{Proportion of new debt} = \frac{1}{\text{holding period}} * \text{years of price control}$$

The sector's March 2019 reported weighted average years to maturity of borrowings is 13.9 years, with the average across companies 14.2 years. Assuming these figures can be used as holding periods, the formula above gives a range for the share of new debt at the end of the price control period of 36% to 37%. (e.g. (1/13.9)*5=0.36). This figure is an underestimate, however, as it does not capture new RCV formation financed by debt. Assuming that new RCV is 60% financed by new debt gives an end-of-period new debt range of 40% to 42%. We divide these two figures by two to derive the midpoint of the period (which we take to be equivalent to the average). This results in a sector weighted average figure over 2020-25 of 20 per cent new debt, and a company-level average of 21 per cent.

The company data-led approach derives rolling year-average new and embedded balances which are founded entirely on company data for 2020-25. It assumes, firstly, that embedded debt evolves according to the company forecast profile of debt paid down and accretion of index-linked debt. Secondly, it assumes that new debt evolves according to the company forecast profile of new debt issuance. This results in a sector weighted average figure over 2020-25 of 17 per cent new debt, and company-level average of 14 per cent.

The notional-actual hybrid approach derives rolling year-average new and embedded balances by assuming again that embedded debt evolves according to company proposals to pay down debt and accretion of index-linked debt. For new debt, it assumes a 'bottom-up' estimate of debt issuance based on the assumption that debt instruments falling due over 2020-25 are refinanced as new debt, and also that RCV growth is financed by new debt, minus the assumed notional contribution of equity. This results in a sector weighted average figure over 2020-25 of 18 per cent new debt, and company-level average of 17 per cent

5.5.1 Conclusion on the ratio of new to total debt

We do not consider the figures arising from the company data-led approach to be appropriate for determining the correct split assumption because do not reflect the increase in totex allowances at Final Determination relative to the initial assessment of plans stage (on which company proposals are based).[48] We also consider that the notional and notional-actual hybrid approaches are more consistent with other assumptions in Ofwat's cost of capital framework (e.g. equity contributions, and a notionally-derived cost of debt allowance). As the resultant figures from this method are closer to the original 20 per cent of the Draft Determination than the 15 per cent we concludes that, overall there is insufficient evidence to move away from the 20:80 split between new and embedded debt proposed in our July 2019 Report. Therefore we continue to propose a **share of new debt** figure of **20 per cent**.

[48] This increase is this from £48.8bn to £49.7bn.

5.6 Overall cost of debt

In the July 2019 Report we proposed a 10bps allowance for issuance and liquidity costs. We consider this value still appropriate and therefore we apply an uplift of 10bps to the overall cost of debt. Therefore, based on evidence presented above we propose:

- A **nominal cost of debt** of **4.18 per cent**, with a **range** of **4.01-4.33 per cent**.
- A **CPIH-deflated cost of debt** of **2.14 per cent**, with a **range** of **1.97-2.28 per cent**.

Table 5.7: overall cost of debt

	Nominal			CPIH-deflated		
	Low	*High*	*Point estimate*	*Low*	*High*	*Point estimate*
Cost of new debt	2.54%	2.54%	2.54%	0.53%	0.53%	0.53%
Cost of embedded debt	4.25%	4.65%	4.47%	2.21%	2.60%	2.42%
Share of new to total debt	20%	20%	20%	20%	20%	20%
Issuance and liquidity cost	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%
Overall cost of debt	**4.01%**	**4.33%**	**4.18%**	**1.97%**	**2.28%**	**2.14%**

6 Overall WACC

6.1 Appointee vanilla WACC

Based on the cost of equity recommendations provided in Section 4.11, the cost of debt recommendations provided in Section 5.6, and the notional gearing level of 60 per cent, our proposed range and point estimate for the overall vanilla WACC are as follows:

- A **nominal appointee WACC** of **4.83 per cent**, with a **range** of **4.49-5.48 per cent**.
- A **CPIH-deflated appointee WACC** of **2.77 per cent**, with a **range** of **2.45-3.41 per cent**.

	Nominal			CPIH-deflated		
	Low	*High*	*Point estimate*	*Low*	*High*	*Point estimate*
Risk-free rate	0.58%	1.10%	0.84%	-1.39%	-0.88%	-1.14%
TMR	8.1%	9.1%	8.6%	6.0%	7.0%	6.5%
ERP	7.54%	8.04%	7.79%	7.39%	7.88%	7.64%
Raw equity beta	0.57	0.71	0.60	0.57	0.71	0.60
Market gearing	56.4%	56.4%	56.4%	56.4%	56.4%	56.4%
Unlevered beta	0.25	0.31	0.26	0.25	0.31	0.26
Debt beta	0.10	0.17	0.15	0.10	0.17	0.15
Asset beta	0.31	0.41	0.34	0.31	0.41	0.34
Notional gearing	60.0%	60.0%	60.0%	60.0%	60.0%	60.0%
Notional equity beta	0.62	0.76	0.64	0.62	0.76	0.64
Cost of equity (post-tax)	**5.22%**	**7.21%**	**5.80%**	**3.16%**	**5.11%**	**3.72%**
Cost of new debt	2.54%	2.54%	2.54%	0.53%	0.53%	0.53%
Cost of embedded debt	4.25%	4.65%	4.47%	2.21%	2.60%	2.42%
Share of new to total debt	20%	20%	20%	20%	20%	20%
Issuance and liquidiy cost	0.10%	0.10%	0.10%	0.10%	0.10%	0.10%
Cost of debt (pre-tax)	**4.01%**	**4.33%**	**4.18%**	**1.97%**	**2.28%**	**2.14%**
Overall WACC (vanilla)	**4.49%**	**5.48%**	**4.83%**	**2.45%**	**3.41%**	**2.77%**

6.2 Retail margin and wholesale WACC

In this section, we set out the approach taken to determine the retail margin adjustment to calculate the wholesale WACC. The main steps taken are as follows:

- Net retail margin — in 2017 we provided evidence on the EBIT margins for a set of comparators and regulatory precedents on retail margins. We concluded that such evidence points towards a fairly wide range[49], that that the calculation of retail margins is subject to considerable methodological challenges,

[49] These were 0.5 per cent to 3.97 per cent for household retail margin, and 1.36 per cent to 3.41 per cent) for non-household retail margins.

and the basis for changing or challenging retail margins is fairly limited. Eventually we proposed using a retail margin of 1 per cent. We remain of the view that this figure is appropriate and therefore we propose a retaining a net retail margin assumption of 1 per cent

- Annual revenue requirements — by applying the net retail margin (1 per cent) to the wholesale charge apportioned to household, Ofwat's financial model produces (after adjustments to reflect the effective tax rate) a nominal figure for the post-tax average annual retail margin revenue requirement 2020-25 of £93m.
- Revenue required for retail return on capital and working capital — Ofwat has also estimated:
    - The required revenue for retail-specific capital costs — this estimate is £19m and is obtained based on Ofwat' financial models and Ofwat's latest appointee cost of capital figure (which is 5.02 per cent). We note that if we apply our appointee WACC estimate of 4.86 per cent, the revenue figure would remain (up to rounding errors) in the region of £19m.
    - The required revenue from return on working capital — this estimate is £40m and is derived from companies' submissions, Ofwat's financial model and working assumption about the working capital refinancing rate of 3.06 per cent based on companies' submissions.
- Residual revenue requirement — the revenues required for retail return on capital and working capital (i.e. £59m = £19m + £40m) have then been subtracted from three annual revenues requirement to obtain a residual value of the revenues requirement equal to £34m (£93m-£59m).
- RCV — the average annual RCV from the Draft Determination's published models is £84,125m.
- Margin adjustment — the retail **margin adjustment** is the average residual post-tax annual requirement expressed as a percentage of the average RCV, i.e. **0.04 per cent**. The margin adjustment is then subtracted from the vanilla WACC to obtain the wholesale WACC.

Based on the information above, the wholesale WACC we recommend is a follows:

- A **nominal wholesale WACC** of **4.79 per cent**, with a **range** of **4.45-5.44 per cent**.
- A **CPIH-deflated appointee WACC** of **2.73 per cent**, with a **range** of **2.41-3.37 per cent**.

Table 6.1: 5 Retail margin and the wholesale WACC

	Nominal			CPI-deflated		
	Low	High	Point estimate	Low	High	Point estimate
Vanilla WACC	**4.49%**	**5.48%**	**4.83%**	**2.45%**	**3.41%**	**2.77%**
Retail margin adjustment	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%
Wholesale WACC	**4.45%**	**5.44%**	**4.79%**	**2.41%**	**3.37%**	**2.73%**

Source: Europe Economics