NERA
ECONOMIC CONSULTING

A Review of the CAA's Approach to Estimating the WACC at Q6

A Report for Heathrow

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Executive Summary

Heathrow Airport Limited (HAL) asked NERA to provide a methodological review of the CAA's approach to estimating the cost of capital (WACC) in its Initial Proposals for Heathrow for Q6. HAL has asked us to review the CAA's approach to estimating three specific WACC components, namely:

- the cost of new debt;
- total market returns; and
- the risk free rate.

We focus our analysis on inconsistencies and weaknesses in the CAA's and its consultant's (PwC's) calculations and methodology. We highlight areas which we believe are inconsistent with best practice and/or regulatory precedent. We also provide our view on how the three above parameters should be estimated for Q6.

PwC's methodology for estimating the cost of new debt produces volatile results and poses a high risk of mis-estimating the cost of new debt during Q6

PwC estimates the cost of new debt over the Q6 period of 1.6% to 2.1%. This is extremely low by comparison to previous regulatory precedent and is based largely on very recent evidence from the bond markets.

To calculate the expected future cost of debt, PwC takes the benchmark A and BBB yields on the 28th March 2013 of between 3.8% and 4.4% and then applies a 60 bps uplift to account for the expected increase in yields over the Q6 period. The uplift is based on a) an assumed increase in the gilt yields of 100 bps based on forward rate evidence up to 2016, adjusted by b) a correlation factor of 0.6 between gilt and benchmark index yields.[1] PwC's correlation factor is derived from 2 years of historical data.

We have not seen this approach taken before to derive an estimate of the future cost of debt. In particular, we have not seen any regulatory cost of debt estimate based on forward rate evidence on government bond yields *at a single point in time* adjusted by an *assumed correlation* between government bond yields and corporate bond yields.

We identify the following weaknesses with the PwC approach:

- First, PwC's starting point for estimating the future cost of debt is to take yields at a single point in time (28th March 2013) when debt spreads were significantly lower than over the previous five years. PwC has also ignored the biases and distortions caused to bond yields by recent macro-economy policy measures such as QE. We show that the overall PwC approach yields unstable results which differ significantly when estimated at different points in time only a few months apart.

[1] i.e. a 1 percentage point increase in the gilt yield will result in a 0.6 percentage point increase in benchmark yields.

- Second, the method PwC uses to derive the relationship between gilt and bond yields is flawed. By contrast we find little evidence for a negative correlation between bond spreads and government bond yields when examining data over different periods of time.[2] Correcting this error would increase PwC's assumed cost of debt range by 0.4% to 4.8% to 5.4% nominal and 2% to 2.6% real.

- Third, PwC proposes a final range for the cost of new debt from 1.6% to 2.1%, where the upper end is lower than average yield for BBB rated debt over the past 12 months. This is inconsistent with wider market evidence that shows the market predicts government bond rates and interest rates to rise over the Q6 period.

We propose an alternative approach to estimating the cost of new debt which is based on recent Competition Commission (Bristol Water, 2010) precedent, where the future cost of debt is estimated as the sum of recent debt spreads (smoothed over a period of 12 months) and a forward looking measure of the benchmark gilt rate. This provides a real cost of new debt estimate of 1.7% to 2.6% for Q6. We note that the CC has previously recommended using a cost of debt assumption at the top end of the plausible range to deal with asymmetric consequences of errors.

The CAA's estimate of expected returns on equity markets is based on a flawed methodology and is significantly lower than published estimates of equity market returns from the Bank of England and Bloomberg.

A key component of the overall cost of capital is the assumption made on expected "total market returns" on equity, which is the sum of the risk free rate and the ERP in the CAPM formula.

PwC concludes that Total Market Returns (TMR) appear to be lower than when the CAA last set prices for the London airports in 2008/09, and recommends a range of 6.25% to 6.75% (by comparison to the point estimate of 6.8% PwC reports for the CAA's Q5 decision). PwC's conclusion is based on a review forward-looking evidence as well as PwC's reading of changes in regulatory precedent.

We identify the following errors and inconsistencies in PwC's approach to estimating TMR:

- First, PwC appears to misinterpret recent evidence on regulatory precedent, which leads to the unjustified conclusion that there is a downward trend in regulatory allowances of TMR over time. By contrast, our analysis shows that regulatory estimates of TMR have been broadly stable over the past 5 years.
- Second, PwC constructs a simple Dividend Growth Model (DGM) to estimate the cost of equity for the UK stock market over a period from 2007 to 2013. However, PwC's simple model is flawed and contains a number of well documented errors that will lead to downward biases in results.

[2] PwC's finding of a slope coefficient of less than 1 for its regression of bond yields on gilt yields suggests that there is a negative correlation between bond *spreads* and gilt yields.

- Third, PwC ignores recent published market evidence based on more sophisticated DGM models provided by Bank of England and Bloomberg which support a figure of at least 7% for forward looking total market returns

Our view has been shared by most UK regulators who have recently set their allowances for total market returns at or above 7% (for example Ofgem allowed 7.25% for total market returns at its most recent RIIO GD1 and T1 review).

The proposed risk free rate is biased downwards

PwC proposes a range for the risk free rate of 0.25% to 0.75% over the Q6 period. This is based on very recent data from the gilt market that has been highly distorted by the effects of QE and policy measures to stimulate recovery from the Global Financial Crisis (GFC), and is significantly lower than any prior regulatory precedent.

We believe that it would be more appropriate for PwC and the CAA to take a long-run view on both ERP and risk-free rate. Our view has been shared by all other UK regulators who have used more long-run evidence to determine the risk-free rate. E.g. the CC in its Bristol Water (2010) decision explicitly set its allowance above recent market evidence implied by forward rates for gilts because it considered there were biases in the gilts market affecting both the short and long end of the yield curve.[3]

[3] UK Competition Commission (2010): Bristol Water Price Determination, p.N19.

1. Introduction

Heathrow Airport Ltd (HAL) asked NERA to provide a methodological review of the CAA's approach to estimating WACC in its Initial Proposals for Heathrow for Q6 focusing on three specific WACC components, namely:

- the cost of new debt;
- total market returns; and
- the risk free rate.

The remainder of the report is structured as follows:

- Chapter 2 provides our assessment of the CAA/PwC methodology to estimating the cost of new debt;
- Chapter 3 provides our assessment of the CAA/PwC methodology to estimating total market returns;
- Chapter 4 provides our assessment of the CAA/PwC methodology to estimating the risk free rate; and
- Chapter 5 concludes.

2. Cost of New Debt

2.1. Overview of PwC Approach

This section describes our assessment of the CAA methodology for estimating the cost of new debt in its Initial Proposals for Q6.

The CAA proposes a range from 1.6% to 2.1% for the (real) cost of new debt. The proposed range is based on the recommendation of its consultant (PwC).

To derive the cost of new debt, PwC calculates yields on A/BBB rated benchmark indices with 10-15Y maturity as of the 28th March 2013 and applies a constant uplift to capture the expected increase in the future cost of debt over Q6. PwC estimates benchmark yields on the 28th March 2013 to be between 3.8% and 4.4%. It then applies a 60 bps uplift to account for the expected increase in yields on benchmark indices in the future to derive an assumed nominal cost of debt of 4.4% to 5.0%. The uplift is based on a) an assumed increase in the gilt yields of 100 bps based on forward rate evidence up to 2016, adjusted by b) a correlation factor of 0.6 between gilt and benchmark index yields. PwC's correlation factor is derived from 2 years of historical data.

PwC then assumes 2.8% RPI inflation, yielding a 1.6% to 2.2% range for real cost of new debt.[4]

PwC proposes a final range for cost of new debt from 1.6% to 2.1%. PwC does not justify the downward adjustment of 10 bps in the upper end of its initial range calculated from benchmark indices.

2.2. High Level Comments

We identify the following errors and inconsistencies in the CAA/PwC approach:

- First, PwC's starting point for estimating the future cost of debt is to take yields at a single point in time (28th March 2013) when debt spreads were significantly lower than over the previous five years. It also ignores the biases and distortions caused to yields by recent macro-economy policy measures such as QE. The overall PwC approach yields unstable results which differ significantly when estimated at different points in time only a few months apart as we show in Figure 2.1.

- Second, the method for interpreting the evidence that PwC has considered on the relationship between the change in debt yields and the risk free rate is flawed. By taking a longer view, we find little evidence of a persistent correlation between debt spreads and the risk free rate.[5] Correcting this error would increase PwC's assumed cost of debt range by 0.4% to 4.8% to 5.4%.

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[4] PwC also analyses yields of HAL bonds, resulting in a proposed range between 1.4% and 2.2 % for the cost of new debt.

[5] Embodied in PwC's 0.6 "beta" factor for the regression between bond yields and gilt yields is the assumption that there is a negative association between debt spreads and the gilts, which is why corporate bond yields move less than gilts

- Third, PwC proposes a final range for cost of new debt from 1.6% to 2.1%, where the upper end is lower than average BBB rated debt over the past 12 months. This seems intuitively implausible and is inconsistent with other evidence presented by PwC that shows that gilt yields are expected to rise significantly.
- Fourth, PwC make an arbitrary and unjustified 10 basis points downward adjustment to the top of their proposed range.

We expand on these issues below.

2.3. PwC Approach Produces Volatile Results and Ignores Biases Caused by QE

PwC's starting point for the cost of new debt is Table 6.3 of their report, reproduced in Table 2.1 below.

Table 2.1
PwC's Estimates of Yields on Benchmark Indices

Nominal yield (%)	10-15 year A rated	10-15 year BBB rated
Spot rate (28th March 2013)	3.8	4.4
6 month average	3.8	4.7
1-year average	4.1	5.2
3-year average	5.2	5.8
5-year average	6.3	7.2

Source: PwC (April, 2013): Estimating the cost of capital in Q6 for Heathrow, Gatwick and Stansted, p. 33;

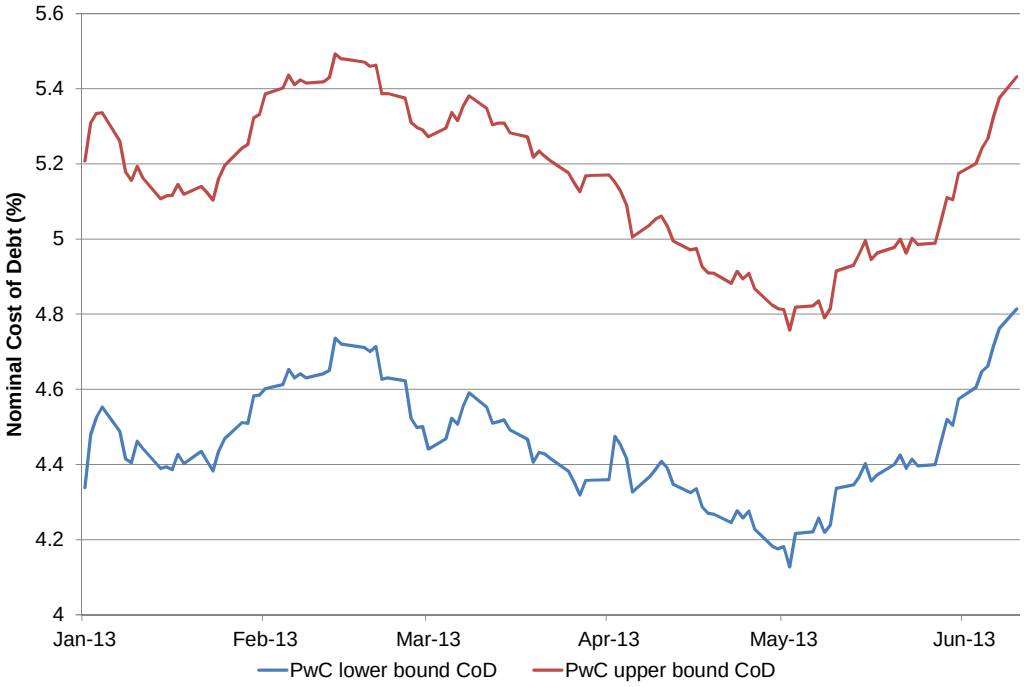
From this data, PwC then note that "*yields on A and BBB rated benchmark indices suggest a current nominal cost of debt of 3.8-4.4%...*".

However, it is clear from Table 2.1 that, when looked at over different periods, the range for A and BBB rated debt is much wider than 3.8-4.4%. Over a 12 month average, the range is 4.1-5.2% and over a 5 year average, the range is 6.3% to 7.0%. PwC does not justify why the starting point for the future cost of debt should be simply the range for A and BBB cost of debt on one particular day.

As we show in Figure 2.1 the PwC approach yields unstable results which differ significantly when estimated at different points in time only a few months apart.

yields. Under the scenario where there is no association between debt spreads and gilts the "beta" for corporate bond yields relative to gilt yields is 1.0 (cf. Figure 2.2)

Figure 2.1
Results using PwC methodology over the last 6 months



Source: NERA analysis of Datastream and Bloomberg data; Note: we do not use the BoA Merill Lynch benchmark index used by PwC, because it is not available to us. We use iBoxx £ NON-GILTS 10-15Y A and BBB indices instead. The iBoxx NON-GILTS index is the closest index we can find to match the PwC index.

PwC bases its range for cost of new debt of 4.4% to 5.0% nominal on data from 28th March 2013. As can be seen from the figure above, using this date produces results which are low relative to historical values, and the results are lower than the most recent values in June 2013 which show a range of 4.8% to 5.4%.

The large volatility of the PwC estimate over a period as short as six months undermines the PwC methodology, since it means the Q6 results are highly dependent on the date (day/week/month) of the consultant's report.

However, there is an even bigger problem with using "current" spot price data to set the cost of debt at the current time. It is widely acknowledged that recent data *in both the gilt markets and the corporate bond markets* is distorted by the effects of QE and other macro-economic policy measures. This effect has been clearly documented in Bank of England reports and recently in a published paper by Breedon, Chadha and Waters (2012):

> *"Starting with the gilt market, it shows that, apart from the 0- to 5-year sector, QE operations seem to have an impact on the average price of bonds (including those not purchased in the QE operation) in the sense that there are significant price different relative to the day of a QE operation on at least one time horizon. This impact seems to carry through to 10-year corporate bonds (both AA and BBB) as well as swaps, where the price impact of these*

> *operations is comparable with the impact on the 10-year sector of the gilt market."* [6]

The above quote shows that current spot yields for the corporate bond market in the UK are likely to be significantly biased with an inevitable expectation of rising yields during times when QE is being stopped and / or unwound.

Since PwC has only considered forward rate evidence up to September 2016, it has not taken account of the market's expectation of future interest rates after this point, when it is widely expected that the macro-economic climate would have recovered and interest rates would be less distorted by the effects of QE and related measures.

2.4. PwC's Analysis of Relationship between Debt Spreads and the Risk Free Rate is Flawed

To calculate the expected future cost of debt, PwC takes the benchmark A and BBB yields on the 28th March 2013 of between 3.8% and 4.4% and then applies a 60 bps uplift to account for the expected increase in yields on benchmark indices in the future.

However, as stated above, the 60bps uplift is based on an assumption that gilt rates will rise by 100bps based on the forward rate curve but PwC then states (p.33) "*when adjusting the cost of corporate debt for trends we in forward rates we dampen this effect noting that there is unlikely to be a one-for-one relation between movement in the risk free rate and the cost of debt*".

PwC then assumes a correlation coefficient of 0.6 between the change in future gilt yields and corporate bond yields to derive the 60pbs uplift. PwC's approach is especially surprising since it provides very little evidence or discussion of the relationship between debt spreads and the risk free rate and the robustness of the correlation coefficient of 0.6, which is crucial for the overall cost of debt calculation. In fact the only evidence we found on this issue was in footnote 30 of its report:

> *"We regress the nominal yield on the average of A and BBB rated 10+ year maturity iboxx indices on the yield on Government bonds of 10 year maturity– based on 2 year daily data. Our analysis suggests current regression coefficients of around 0.55 (rounded to 0.6), with slightly lower one year averages of 0.5. Similar estimates for real yields regressed on index-linked gilts suggests a slightly lower current estimate of around 0.40 (with 1 year average of around 0.2). For the purpose of the current analysis we prefer using nominal yields on corporate and Government bonds as we use spot rates on nominal corporate bonds when estimating the cost of new debt with reference to benchmark indices."*[7]

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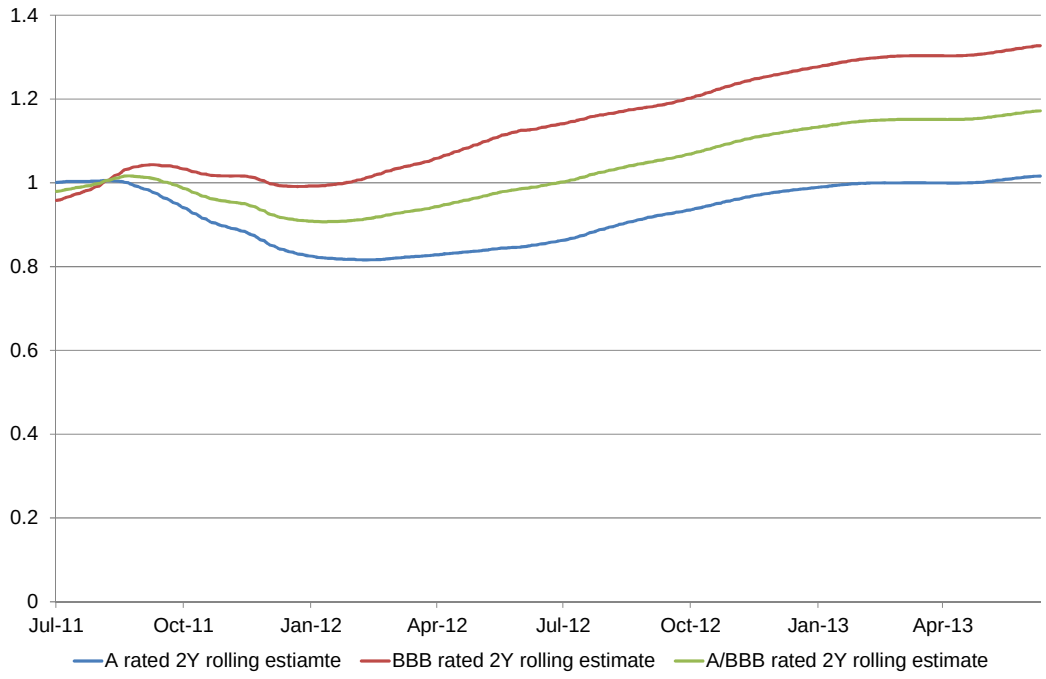
[6] Breedon, F, Chadha, J, Waters A (2012) "The financial market impact of UK quantitative easing" *Oxford Review of Economic Policy*, Oxford University Press, Vol. 28(4), p288-289.

[7] PwC (April, 2013): Estimating the cost of capital in Q6 for Heathrow, Gatwick and Stansted, p. 33.

It is not at all clear why PwC used a two year time horizon to predict this relationship. A static regression using only two years of historical data is far too unreliable to be used as a basis for predicting the relationship between corporate bond yields and government bond yields.

When examined over a longer estimation period of 5 years, using a rolling regression analysis, we find the regression coefficient fluctuates around 1, suggesting that debt spreads over government bonds are on average broadly constant over longer periods of time. The five-year rolling estimate is shown in Figure 2.2 below.[8]

Figure 2.2
Rolling regression using a 5 year estimation window and 20Y gilt index



Source: NERA analysis of Bloomberg and Datastream data

This evidence completely undermines PwC's assumption that there is a correlation coefficient of 0.6. Instead, it clearly shows that, when evaluated over a longer period, and using a range of credit spreads, the correlation coefficient is close to one, meaning that there is little evidence that debt spreads systematically fall when the risk free rate rises and/or vice-versa. Correcting this error would increase PwC's assumed cost of debt range by 0.4% to 4.8% to 5.4%.

[8] We note that PwC uses a 10 year maturity government bond index to establish the relationship between yields on benchmark bonds and gilts. PwC fails to recognise, that the benchmark index it is using (10+ iBoxx) has bonds of 10 years maturity and higher and that in fact the average maturity of bonds in the index is around 20 years (according to information from Markit, the data provider for the iBoxx indices). Our 5 year rolling estimate uses a 20Y government bond index since it correctly matches the maturity of the benchmark bond index.

2.5. PwC's Upper Bound for the Q6 Cost of Debt Estimate is lower than 1 year BBB Averages

Finally, we note that PwC proposes an upper bound for the cost of new debt over Q6 of 5% in nominal terms, derived from the benchmark BBB index. We note that this is 20 basis points *below* the yield of the BBB index over the last 12 months of data (prior to the PwC report), which was 5.2%, as can be seen in Table 2.2 below.[9]

Table 2.2
Comparison of PwC proposed cost of new debt to historical yields

	A rated 10-15Y index	BBB rated 10-15Y index
Spot rate (28th March 2013)	3.8%	4.4%
1 year average	4.1%	5.2%
5 year average	6.3%	7%
PwC proposed cost of debt	***4.4%***	***5%****

Source: PwC (April, 2013): Estimating the cost of capital in Q6 for Heathrow, Gatwick and Stansted, p. 33;
**The 5% nominal, translating to 2.2% real using PwC's RPI forecast of 2.8%, is arbitrarily reduced by 10 basis points for the final allowance. PwC provides no justification for its subjective adjustment.*

By accepting PwC's analysis the CAA's nominal cost of debt allowance of 4.4% to 5% for Q6 is below the average of observed yields on BBB rated bonds over the past 12 months, and over 2% below the average of observed yields on BBB rated bonds over the past five years. Implicitly the CAA appear to be assuming that there is no possibility that yields in the debt markets will return to recent historic levels.

However, this position is entirely inconsistent with wider macro-economic evidence that shows the market expects gilt yields to rise (as PwC's own forward curve projections show) and the economy is expected to recover over the Q6 period, which would be expected to lead to a return to more "normal" levels for the cost of debt. This counter-intuitive result is the consequence of the errors described above where PwC takes spot market data on bond yields and assumes an erroneous relationship between yields on corporate debt and yields on government bonds.

2.6. Cost of New Debt under a "CC Approach"

Recent Competition Commission (Bristol Water, 2010) precedent estimates the future cost of debt as the sum of recent debt spreads and a forward looking measure of the benchmark gilt rate.[10] We examine the results of using this method to derive an estimate of the cost of new debt.

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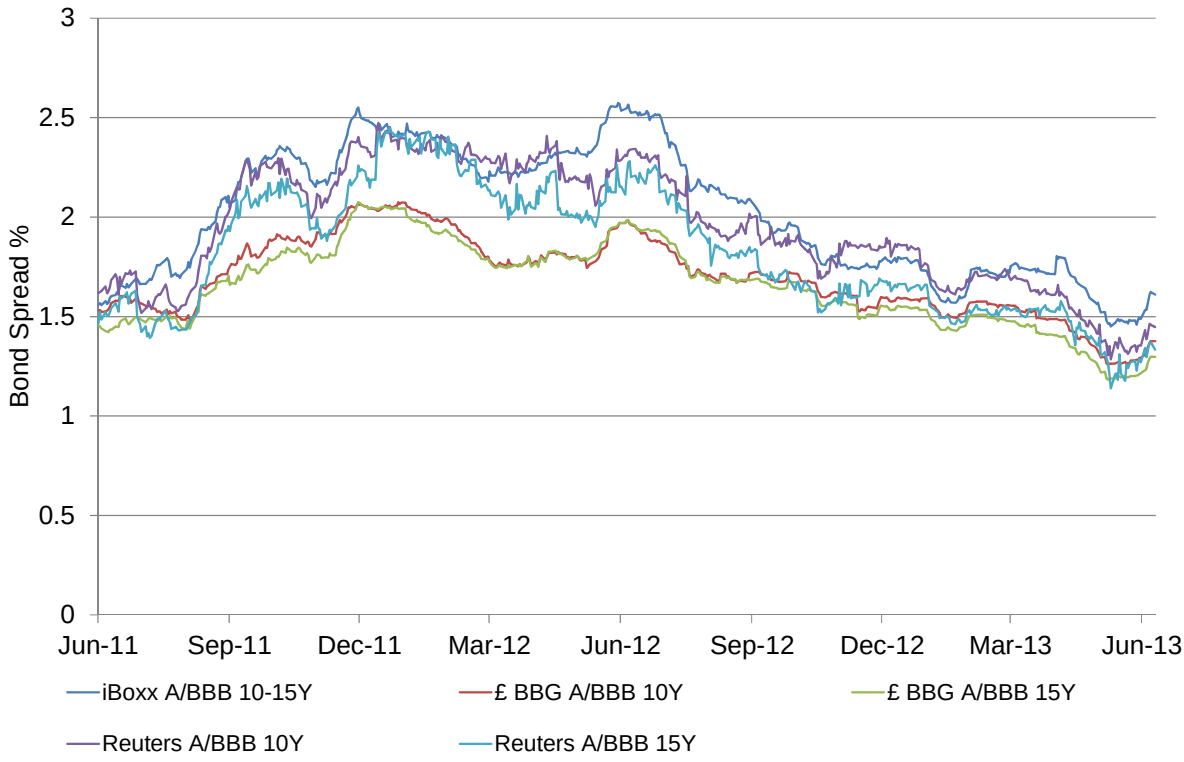
9 For the A index, PwC propose a forward looking figure of 4.4%, which is slightly above the one year average of 4.1% and significantly below the three year average of 5.2%.

10 The CC placed greater emphasis on bond market data from the last year prior to the decision (second half of 2009 and the beginning of 2010) due to those being, in the CC's view, more representative of current market conditions at that time than the period before mid-2009.

Figure 2.3 shows debt spreads for the last two years for UK corporate debt indices. The chart shows there is considerable volatility in debt spreads over this period which immediately undermines the PwC approach of estimating the future cost of new debt based on debt spreads on one day.

Figure 2.3
Debt spreads over the last 2 years for available UK corporate debt indices



Source: NERA analysis of Bloomberg and Datastream data; the spreads are calculated for average of the respective A and BBB indices; Note: iBoxx stands for the UK corporate non-financials iBoxx index provided by Datastream, £ BBG stands for GBP denominated European debt index provided by Bloomberg, Reuters stands for Thomson Reuters UK corporate debt index provided by Datastream

Table 2.3 below shows our calculation of the evolution of debt spreads over the last 2 years for different available UK corporate debt indices. We show the average, minimum and maximum spread achieved for each of the indices presented in Figure 2.3 above.

Table 2.3
Debt spread evolution over the last 2 years

Debt spread (%)	Average over 2y	Average over 1y	Max/Min over 1y
iBoxx A/BBB 10-15Y	2.0	1.9	2.6/1.5
£ BBG A/BBB 10Y	1.7	1.6	2.0/1.3
£ BBG A/BBB 15Y	1.7	1.5	2.0/1.2
Reuters A/BBB 10Y	2.0	1.8	2.3/1.3
Reuters A/BBB 15Y	1.8	1.7	2.3/1.1

Source: NERA analysis of Bloomberg and Datastream

Our analysis of debt spreads shows a wide range from 1.1% to 2.6 % over the last year, reflecting the recent volatility in the debt markets. To smooth out the large day to day volatility in debt spreads, we calculate average spreads achieved over the last year for the different indices. This produces a range from 1.5% to 1.9% based on the different indices considered.[11] We believe that the proposed range for debt spreads needs to be sufficiently wide to allow for uncertainty around the cost of new debt in Q6, including headroom for distortions in the debt markets to unwind.

The proposed debt spread range of 1.5% to 1.9% needs to be combined with a forward looking benchmark gilt rate. In the Bristol Water case, the CC used spot rates on long dated gilts, since at the time of its decision forward rates did not imply an increase in gilt rates in the future. We cannot use the same methodology at present, because upward sloping forward curves indicate market expectations of substantial increases in gilt rates over Q6.[12]

As we show in our section on the risk-free rate in Figure 4.1, forward rates calculated from the yield curve for nominal gilts are very volatile when estimated even over a short period of six months. This suggests that using an average estimate is more appropriate, to smooth out this volatility.

Since we have looked at debt spreads over the last 12 months to smooth for volatility, we use the same approach for estimating forward rates for the benchmark gilt rate. The average forward estimate for the benchmark gilt rate over the last 12 months for the 10 year and 15 year maturity is 3% and 3.5% respectively.[13] Combining this with our range for debt spreads yields a range from 4.5% to 5.4% for the nominal cost of debt. Using PwC's assumption of 2.8% RPI inflation yields a real cost of new debt estimate of 1.7% to 2.6%.

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[11] If we look at average spreads over the last two years, the range increases to 1.8% to 2.0%.

[12] Note that forward curves for UK gilts may not be accurate reflections of the "true risk-free rate" as we show in chapter 4. However, as long as a company can issue debt at downward biased rates it is unlikely to care about whether the underlying rate is affected by institutional factors. Hence we see merit in using the forward curve for estimating financing cost but not for estimating the risk-free rate to be included in the cost of equity.

[13] We provide an estimate of the September 2016 forward rate, consistent with PwC. Methodologically, PwC should have looked at average forward rates over the entire Q6, instead of looking at an estimate for the middle of the period. However, there is little difference in the estimates produced by the two approaches.

Table 2.4
NERA proposed cost of new debt for Q6

%	Low case	High case
Debt spread	1.5	1.9
Benchmark gilt rate	3.0	3.5
Nominal cost of new debt	4.5	5.4
Real cost of new debt	**1.7**	**2.6**

Source: NERA analysis

2.7. Conclusion

PwC's cost of new debt estimate is based on a single day's observation (28th March 2013) for benchmark yields, adjusted by an estimate of association between gilt yields and bond yields, which we show to be highly unstable over time. This approach results in PwC's unreasonable conclusion that the possible range for the cost of new debt over the Q6 period will be lower than the average value observed over the last 12 months.

PwC's approach ignores uncertainty around the future cost of new debt over Q6, as implied by recent debt spread volatility, and is based on a flawed understanding of the relationship between corporate bond yields and the risk free rate.

We see merit in estimating the forward looking cost of debt as a sum of a fixed debt spread and a forward looking benchmark gilt rate, in line with CC precedent given by the Bristol Water Price Determination. This approach provides a real cost of new debt estimate of 1.7% to 2.6% for Q6 (relative to PwC's estimate of 1.6% to 2.1%).

3. Total Market Returns

3.1. High-level Comments

This section describes our assessment of the PwC and CAA methodology to estimating total market returns (TMR).

PwC proposes a range from 6.25% to 6.75% for total market returns (TMR), which was accepted by the CAA. This range is based on a range of evidence including forward looking evidence, as well as regulatory precedent. However, in all cases, PwC appears to have misinterpreted the evidence or made mistakes in methodology that have led to downward biases in its results.

In summary these errors are as follows:

- PwC appears to misinterpret the evidence on regulatory precedent, which leads to the unjustified conclusion that there is a downward trend in these relative to Q5.
- The single period dividend growth model (DGM) PwC uses to estimate forward looking TMR is too simplistic, resulting in a potentially inaccurate estimate of true forward looking total market returns.
- PwC ignores current market evidence based on more sophisticated DGM models provided by the Bank of England and Bloomberg which support a figure of at least 7% for forward looking total market returns and thus also cannot support a downward trend relative to when the CAA last set prices.

Our assessment shows that current evidence on forward looking total market returns based on more sophisticated DGM approaches suggests a figure of at least 7%, implying that the upper bound for expected TMR is underestimated by PwC's range. Our view has been shared by UK regulators who have recently set their allowances for total market returns at or above 7% (for example Ofgem allowed 7.25% for total market returns at its most recent RIIO GD1 and T1 review).

3.2. PwC Wrongly Asserts that Recent Regulatory Precedent Shows a Downward Trend in Total Market Returns

On page 47 of its report PwC states:

"*There has been a downward trend in (TMR) figures used by UK regulators with the exception of the recent Ofgem 2012 price decision for gas distribution.*"

However, this is not true and PwC's own statement is contradicted by PwC's Figure 7.1 which does not show a downward trend in regulatory precedent on estimates of Total Market Returns.

Below we show the change in TMR estimates *for each* regulator and find that apart from Ofcom no regulator has revised downward its estimate of TMR (as shown in the PwC report)

relative to Q5 and that indeed Ofgem, ORR and the CAA itself have revised *upward* their estimates since 2008/09 with a resulting range for TMR from 6.4 to 7.25%.

Table 3.1
UK regulatory views on TMR from 2008/09 to today

	2008/09	2010-13	Difference
CAA	6.6 – 6.8	7.0	+0.2 to + 0.4
CC	N/A	7.0	N/A
Ofcom	7.0	6.4	- 0.6
Ofgem	7.0	7.0 – 7.25	0 to + 0.25
Ofwat	7.4	N/A	N/A
ORR	6.5	6.5 – 6.75	0 to +0.25

Source: NERA analysis of PwC report, Figure 7.1 and ORR

3.3. PwC's Simple Formulation of the DGM Leads to Downward Biases in the Cost of Equity

We note that PwC's DGM is very simplistic and will likely lead to downward biases in the cost of equity. There are a number of reasons for this:

- First, PwC applies a one-stage dividend growth model to the whole FTSE 100 index, as opposed to using individual stocks. Thereby PwC's approach fails to take any account of potentially very different short-term growth rates by immediately applying the same (long run) growth rate to all companies in the index. In the short term, many of the FTSE 100 companies are expected to grow dividends at a higher rate, which is why PwC's approach leads to a downward bias.

- Second, PwC calculates next year's dividend yield by multiplying the current yield by its own assumption of long-run growth rather than actual stock market forecasts of next year's dividend yield, differentiated by company. While it is necessary to make assumptions about long-run growth rates in dividends in the context of the dividend growth model, PwC ignores the fact that medium-term analyst forecasts of dividends for individual stocks in the FTSE 100 are available and that growth prospects for these internationally diversified companies may differ significantly from UK GDP growth for long periods. This warrants the use of a multi-period dividend growth model which can account for available medium-term dividend forecasts.

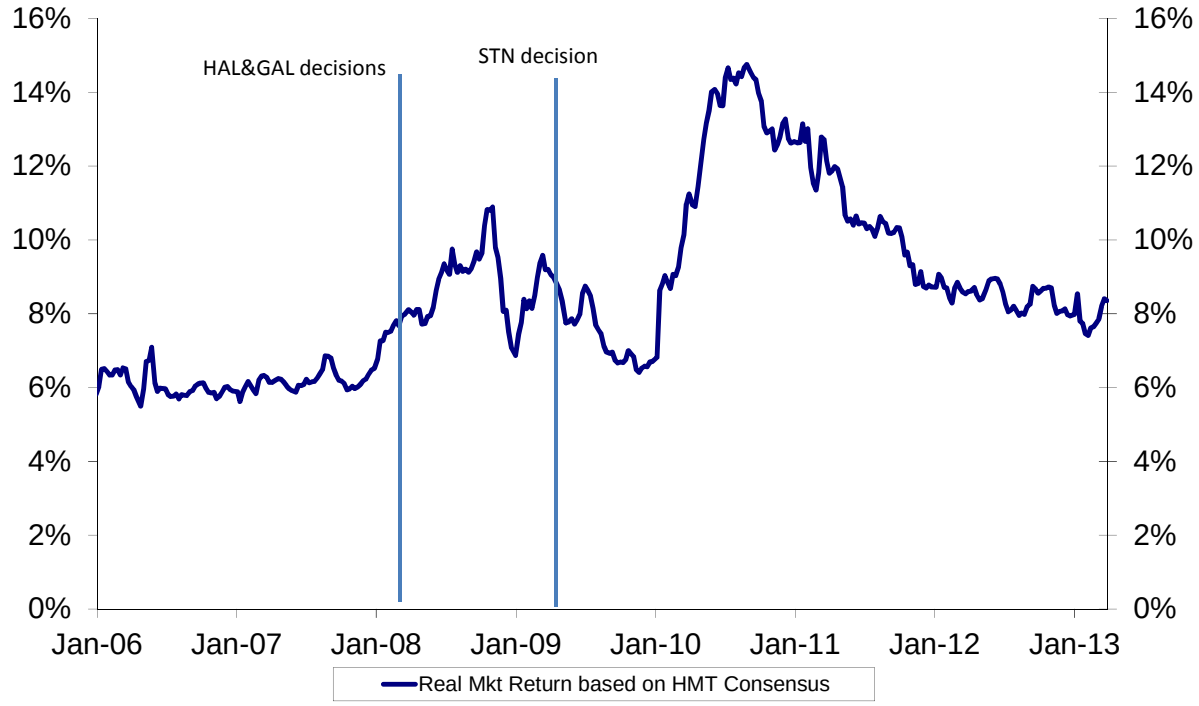
- Thirdly, by applying the DGM to an index rather than the underlying individual stocks PwC cannot account for ex dividend dates. In general the DGM needs to be applied at the ex dividend date in order to avoid capturing stock price appreciation in expectation of the next dividend in the denominator. This error will always lead to a downward bias in results (since the price of the stock falls at ex dividend dates).

In our view, the dividend growth model represents a useful approach to estimating forward looking total market returns. However, a more sophisticated dividend growth model which

addresses the above weaknesses of the PwC model is likely to provide more accurate account of true expected market returns at the current time.

Total market return estimates based on more sophisticated dividend growth models are available (amongst others) from Bloomberg and the Bank of England. Figure 3.1 and Figure 3.2 below show the Bloomberg and Bank of England recent estimates for TMR and ERP respectively.

Figure 3.1
Real Total market return estimates from Bloomberg



Source: Bloomberg and NERA analysis of HMT RPI forecasts

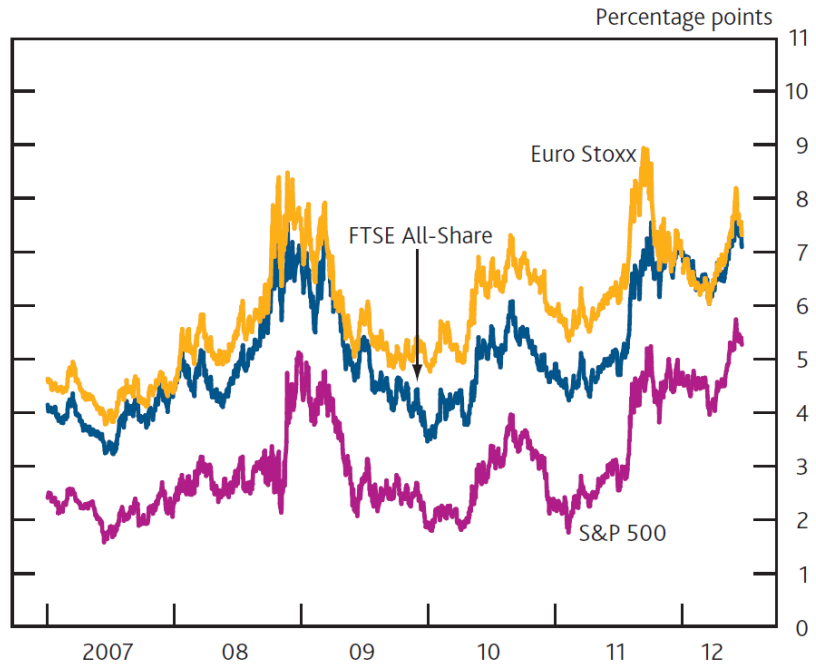
Figure 3.1 for the Bloomberg TMR DGM, which includes a number of the refinements[14] missing from the PwC model, reports a real current TMR estimate of around 8%, in line with the conditions when the CAA last set the WACC for HAL and significantly above the top end of PwC's range.

Figure 3.2 shows the latest estimates of the equity risk premium based on calculations by the Bank of England; another model that addresses some of the shortcomings of the PwC

[14] According to Bloomberg Helpdesk, the Bloomberg MRP is calculated as follows: i) Short run dividend growth is based on analyst forecasts (in line with the 1-stage DGM). Long run expected dividend growth is based on the current required marked return (as per the 1-step DGM) times the payout ratio (this is a proxy adjustment with the idea being that companies with very low current payout ratios are in a fast growth phase and will find it harder to maintain the same levels of growth). Medium run dividend growth is a linear extrapolation between the short- and long run growth rates. The length of the "medium run" varies depending on the availability of analyst forecasts and ends between years 5 and 10.

model.[15] These show an equity risk premium in excess of 7.0% for the FTSE All-Share. The BoE Financial stability report does not include the information on what assumption the BoE has made on the RFR. However, the Bank of England Quarterly Bulletin 2010 Q1 provides some additional detail on risk-free rates used (5Y maturity, 5Y forward). Based on Bank of England data around the cut-off date for the Financial Stability Report we calculate we calculate this rate to have been around zero at the time suggesting TMR that were in line with the ERP estimate of 7.0%

Figure 3.2
Equity risk premium estimates from the bank of England



Source: BoE Financial stability report (June, 2012) p. 10.

As can be seen from the above figures, total market return estimates based on more sophisticated dividend growth models provided by Bloomberg and the Bank of England produce current estimates, which lie above the top of PwC's proposed range.

In summary, the errors that PwC has made in its formulation of the DGM have led to downward biases in its results. Evidence on TMR from more sophisticated multi-period models, correctly formulated using individual stocks at ex dividend dates confirm this.

3.4. Conclusion

There appears to be no empirical basis for PwC's assertion that regulatory precedent has been on a downward trend.

[15] According to the Bank of England Quarterly Bulletin 2010 Q1 the BoE model uses the following assumption: "Dividend growth varies over the first four years, before reverting back to a long-run growth rate. The term structure of the equity risk premium is assumed to be flat."

More importantly, PwC's single period dividend growth model is poorly formulated and will lead to downward biases in results. Total market return estimates based on more sophisticated dividend growth models are available from Bloomberg and the Bank of England. This evidence supports a **forward looking total market return figure of at least 7%.**

4. Risk Free Rate

4.1. High-level Comments

PwC proposes a range for the risk free rate of 0.25% to 0.75% over the Q6 period. We identify the following weaknesses and inconsistencies in the PwC approach:

- The PwC's risk-free estimate for a six-year period is essentially based on a forward curve estimate for a single point in time. This approach fails to capture:
  - The volatility of forward curve estimates over even short periods of time;
  - The biases caused to current yields due to QE and other policy measures designed to stimulate recovery from the GFC.
- In addition PwC includes arbitrary and unjustified adjustments to its initial results and ignores regulatory precedent that has reached different views on the appropriate risk free rate for regulatory purposes.

We believe that it would be more appropriate for the CAA to take a long-run view on both ERP and risk-free rate. Our view has been shared by all other UK regulators who have used more long-run evidence to determine the risk-free rate. E.g. the CC in its Bristol Water Decision (2010) explicitly set its allowance above recent market evidence implied by forward rates for gilts because it considered there were biases in the gilts market affecting both the short and long end of the yield curve.

4.2. Overview of the CAA/PwC Approach

PwC analyses current evidence from both index linked and nominal gilt markets to provide its estimate of the real risk free rate. PwC estimates current rates for index linked gilts for 10Y to 15Y maturities between -1.39% and -0.78% (real). In addition PwC discusses the results of looking at the forward curve for September 2016 where it finds a range for the 10Y to 15Y real risk-free rate from -0.28% to 0% (based on ILGs), which PwC interprets as evidence for an expected increase in real yields between 80 and 110bps. Applying a 100bps uplift PwC concludes on a real risk-free rate range from -0.39% to +0.22% based on ILGs.

PwC also reviews current and forward rates for nominal gilts. It finds current values of 1.9% to 2.7% (before inflation) to which it again applies an uplift of 100bps (based on an observed difference between today's values and the forward curve in September 2016 of 90-120bps). After subtracting inflation of 2.8% PwC concludes on a range for the real (from nominal) risk-free rate from 0.1% to 0.9%.

PwC states it combines the evidence from index linked and nominal gilt yields, while giving slightly more weight to nominal yields. PwC states its analysis suggests a mid-point of 0.5% and proposes a "reasonably tight range" of **0.25% to 0.75%** for its final risk free rate estimate. PwC notes but does not discuss the impact of QE on the robustness of these estimates.

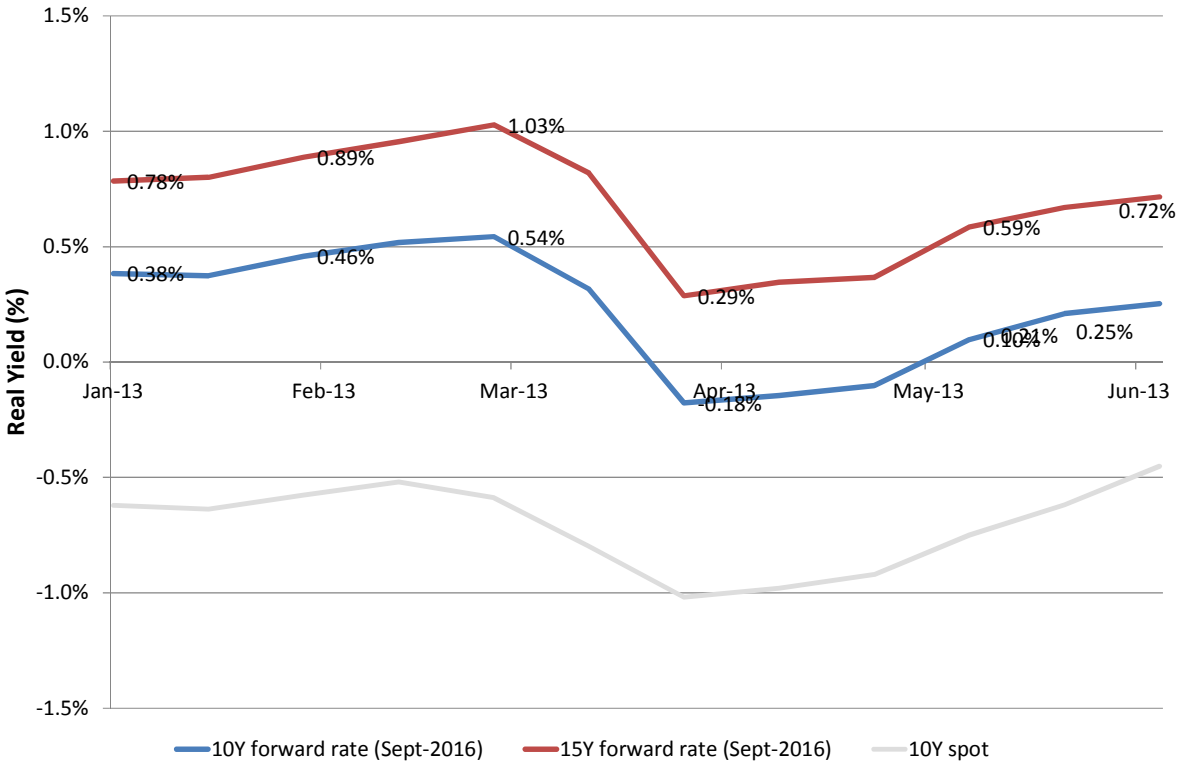
4.3. PwC's Methodology is Unstable and Risks Significantly Misjudging the Future Risk-free Rate

Although PwC presents a range of data (current estimates, forward curves and historical averages) the final estimate is essentially based around the September 2016 forward curve data for 10Y to 15Y nominal gilts (0.1% to 0.9%) with the range narrowed by an arbitrary adjustment that shortens the range at both ends to 0.25% to 0.75%.

In addition to the use of arbitrary adjustments, we see a number of further weaknesses in PwC's methodology. The first weakness of this approach is that it is unstable, since PwC's approach essentially bases the risk free rate for Q6 on data at a single point in time when the forward curve for September 2016 was estimated.[16]

As Figure 4.1 shows there has been significant variation within the implied forward risk-free rate over just the last six months depending on which decision date has been used. Over this relatively short period of time we have observed values both exceeding the top end and undershooting the bottom end of PwC's narrowed down range suggesting the method adopted by the CAA is not robust to even relatively small changes in observation period. We further note the strong upward trend in forward risk free rates observed since May 2013 reflecting recent expectations of a pull back in QE.

Figure 4.1
Variation in Spot and Forward Rates over the last 6 months



Source: NERA analysis of Bank of England and Bloomberg data

[16] PwC does not report the date at which the forward curve for September 2016 was derived.

The volatility of forward curves and their limited predictive power has been documented in the literature for a long time. E.g. Fama and Bliss (1987) and Campbell and Shiller (1991) show that forward rates do not forecast spot rates well, even over a one-year horizon.[17] This poor predictive power may be one reason why the use of forward rates as a predictor of future yields has not been widespread in regulatory practice.

4.4. PwC's Methodology Fails to Account for Bias in the Risk-free Rate Caused by QE

A second fundamental criticism of the use of forward curves relates to potential bias in the forward curve brought about by quantitative easing. PwC discusses that QE has affected yields along the whole yield curve and that this impact may not have been symmetric. PwC interprets widening spreads between 5Y, 10Y and 15Y maturity yields as evidence that the impact of QE has been largest for 5Y to 10Y maturities rather than the longer maturities. However, PwC does not discuss how this is likely to affect the forward curve and whether distortions across the spot yield are also likely to affect forward curves.

The recognition of the need to adjust forward curves for bias arising from supply-demand imbalances goes back to at least 2003 when e.g. Choudhry discussed the bias to forward curves arising from perceived shortages in gilts supply, which mirror a market situation like today where there is artificially created excess demand.[18]

In general the forward curve is likely to produce downward biased results when the long end of the current yield curve that is used to generate the forward curve is biased downward.[19] In considering the 10Y to 15Y forward curve three years from now (as PwC does) the central question is whether 13Y to 18Y maturity gilts are biased downward in a way that is not (fully) offset by the bias to 3Y gilts as these are the two components of the 10Y to 15Y forward rate in three years' time. If this is the case than the forward curve evidence is likely to result in a downward biased estimate of the future 10Y to 15Y risk-free rate.

There is no a priori reason why one end of the yield curve is necessarily more biased than the other. One could expect that yields to maturity for bonds with short tenor are more affected by QE, because QE is expected to be in place over a large portion of their remaining tenor (life). However, the Bank of England was more aggressive in buying medium to long maturities and therefore may have affected their yields more than the yields of bonds with short tenor.

> *"By the end of January 2010, the Bank's purchases of gilts totalled just over £198 billion, representing nearly 30% of the free float. Relative to the free*

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[17] Fama, E. and Bliss,R. (1987): "The Information in Long-Maturity Forward Rates," *American Economic Review* 77, 680-92.
Campbell, J. and Sheller. (1991): "Yield Spreads and Interest Rate Movements: A Bird's Eye View," *Review of Economic Studies* 58, 495-514.

[18] Choudhry, M. (2003): The impact of demand and liquidity on the information content and predictive power of the government bond yield curve: an illustration from the UK gilt market, *Journal of Asset Management*, Volume 4, Number 2, 1 August 2003 , pp. 119-130(12)

[19] Note that in principle it is possible for the forward curve to be unbiased or biased upward even in the presence of downward bias to the long end of the yield curve if the short end is significantly "more biased."

> *float, the Bank bought 40% of the 3 to 10 year maturity segment, about 50% of the 10 to 25 year maturity segment, and 15% of the 25 year and over maturity segment"* [20]

It is not clear a priori which effect prevails, i.e. it is not clear whether the yields on bonds with long or short tenor are further away from their equilibrium value. To assess this question further we review the empirical evidence for the downward impact that QE has had on different parts of the yield curve and thus the likely direction of bias to the forward curve that PwC uses.

The Bank of England's own research suggests that the impact of QE was highest for the 15Y to 20Y range of maturities, which would be consistent with likely downward bias in the forward curve used by PwC.

> *On balance, the gilt yield moves following QE news events suggest an overall reaction of close to 100 basis points on average across medium to long-term maturities, with the bulk of this effect skewed towards longer maturities of 15 and 20 years."* [21]

This finding is corroborated by the findings of Jarrow and Li (2012) who review a number of studies on the impact of QE along the (US) yield curve and also find that the longer maturities have been more affected by QE than the shorter maturities.[22,23]

Table 4.1
Estimates of the Impact of QE on the Yield Curve
Treasury Yield Change (bps)

	1Y	2Y	3Y	5Y	10Y	30Y
Gagnon et al (2011)		-34			-91	
Krishnamurthy & Vissing-Jorgensen (K&VJ, 2011) – QE1	-25		-39	-74	-107	-73
K& VJ (2011) – QE2	-2		-8	-20	-30	-21
Jarrow & Li (2012)	-372	-32		-55	-73	-79

Source: Jarrow & Li (2012), p.40

Based on the above evidence we conclude that the QE program has resulted in downward biases in gilts as true risk free rate measures for all maturities. Using current yields (plus an uplift based on forward rates) or forward rates directly, without any adjustment for the effects

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[20] Bank of England, *QE and the gilt market: a disaggregated analysis* Working Paper No. 466 October 2012 p.7

[21] BoE op.cit. p. 14

[22] Jarrow, R. & Li, H. (2012): The Impact of Quantitative Easing on the U.S. Term Structure of Interest Rates, *Johnson School Research Paper*, Cornell University

[23] The one exception is the finding of the impact on the 1Y maturity in Jarrow & Li's paper, which is very high. However, this impact has no bearing on the 10Y to 15Y maturity, 3Y ahead.

of QE, is likely to introduce a bias into the forward looking risk free rate estimate. In Table 4.2 we illustrate the impact of bias at the long and short end of the yield curve on the implied forward rate.

Table 4.2
Illustration of the Impact of QE on Forward Curves

	Current unadjusted (nominal)	Adjusted (nominal, using K&VJ estimates)	
3Y Maturity	0.61	1.00	Applying K&VJ 3Y uplift
13Y Maturity	2.68	3.75	Applying K&VJ 10Y uplift
10Y maturity, 3Y forward	3.31	4.59	

Source: NERA analysis of Bank of England data (14-Jun 2013) & K&V-J (2011)

We note that given the above data even marginal bias in the long-term yield is sufficient to bias downward the forward estimate.[24] Given the evidence about which parts of the yield curve have been most affected we believe setting a risk free rate above the current forward rates for UK gilts is justified.

4.5. PwC's Approach is without Regulatory Precedent in the UK

Our view has been shared by other UK regulators including the CC, who have put less weight on direct evidence from gilt markets due to the prevailing exceptional conditions resulting from QE and distortions from pension fund demand:

> *At present, shorter-dated index-linked yields are affected by action by the authorities to address the credit crunch and recession and are less relevant to estimating the RFR. Nevertheless, we continue to see merit in the argument that distortions (associated, for example, with pension fund dynamics) continue to affect longer-dated index-linked yields.*[25]

The CC does not discuss at that stage whether distortions of QE have also affected longer dated gilts as we show above but the CC does highlight that the there is no mechanical way of deriving the risk free rate from market data and that it is necessary to make an overall judgement based on a range of evidence, which led the CC to conclude that the appropriate risk-free rate allowance was above current spot and forward rates. As set out in the Bristol 2010 decision:

[24] We calculate that for an unchanged current yield curve and bias to the 3Y maturity of 39bps the minimum bias that results in the forward curve based on current data to lie below the QE-adjusted curve is 9 basis points, i.e. less than 10% of the actual bias calculated by K&V-J (2011).

[25] UK Competition Commission (2010): Bristol Water Price Determination, p.N19.

> *"Our view therefore is that a range of 1 to 2 per cent for the real RFR is reasonable. We note that the lower end of this range is well above current short-term real interest rates (which are negative) and would remain above short-term real interest rates during 2010/11 to 2014/15 even if short-term real interest rates increased above the levels implied by current forward rates."*[26]

Other regulators have also recently set allowances for the risk free rate above the evidence implied by current market (forward) rates. For example, Ofgem in its latest RIIO GD1 and T1 decision (2012) set a risk free rate allowance equal to 2%.

Taking a more long-run view is consistent with the CAA's approach at previous inquiries including the Heathrow & Gatwick Q5 decision where the CAA stated:

> *"An assumption based on the long-run historical evidence is more likely to provide a robust basis for taking regulatory decisions over the longer-term than an assessment based on short-term market fluctuations. This is consistent with the long-term view adopted by the Commission, both at this and previous reviews. (…)*
>
> *However, given the recent volatility in the observed yields, and the long-term focus of the associated ERP assumption, the CAA considers that it would be prudent, and internally consistent, for it to retain the Commission's proposed risk-free rate point estimate"*[27]

On this basis it seems more appropriate for the CAA to take a long-run view on both ERP and risk-free rate, in line with Ofgem, Ofwat and the CC. As we showed above the evidence on long-run and short-run TMR produces relatively comparable results just slightly above the CAA's current range while a long-run view on the risk-free rate would suggest an estimate closer to 2% rather than the 0.5% base case estimate chosen by the CAA as part of the Initial Proposals.

4.6. Conclusion

The CAA's risk-free rate estimate, which is based on PwC's proposed range is not a robust measure of the expected risk-free rate over Q6. It is based on data from a single point in time while our analysis of fluctuations in spot rates shows that there has been wide variety around the estimate used by the CAA over a period as short as six months.

In addition the CAA and its advisors fail to account for the fact that the entire yield curve and consequently forward curves have been heavily affected by QE with the impact not necessarily being equal across the yield curve. A differential impact of QE on the yield curve makes forward curves unreliable as estimators of the future expected risk-free rate, a finding long recognised in the academic literature as well as by other UK regulators who have recently selected risk-free rate estimates above current forward rates.

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[26] UK Competition Commission (2010): Bristol Water Price Determination, p.N20.

[27] CAA (Mar 08): Economic Regulation of Heathrow and Gatwick Airports 2008-2013: CAA decision, p.130-131.

5. Conclusion

We have reviewed the CAA's and its consultants' approach to estimating: the cost of new debt, total market returns and the risk free rate in its Initial Proposals for Heathrow for Q6. We highlight areas which we believe are inconsistent with best practice and/or regulatory precedent as well as provide our own assessment of how the above parameters should be estimated in Q6.

PwC's cost of new debt estimate is based on a single day's observation (28th March 2013) for benchmark yields, adjusted by an estimate of association between gilt yields and bond yields, which we show to be highly unstable over time. This approach results in the implausible conclusion that the cost of new debt is not even likely to return to its 1Y average value over the next six years despite the finding that there is significant volatility over even short periods of time. In addition, PwC make an arbitrary and unjustified 10 basis points downward adjustment to the top of their proposed range.

PwC's approach to the cost of new debt also ignores uncertainty around the future cost of new debt over Q6, as implied by recent debt spread volatility, and is based on a flawed understanding of the relationship between corporate bond yields and the risk free rate.

We see merit in estimating the forward looking cost of debt as a sum of a fixed debt spread and a forward looking benchmark gilt rate, in line with CC precedent given by the Bristol Water Price Determination. This approach provides a real cost of new debt estimate of 1.7% to 2.6% for Q6 (relative to PwC's estimate of 1.6% to 2.1%)

We also review PwC's conclusion that TMR appear to be lower than when the CAA set prices for Q5. Our review shows no justification for this statement for any of the three pieces of evidence analysed by PwC. PwC appears to misinterpret the evidence on forward-looking TMR measures and regulatory precedent. The single period dividend growth model (DGM) PwC uses to estimate forward looking TMR is too simplistic, resulting in an inaccurate estimate of true forward looking TMR. We show that current evidence on forward looking total market returns based on more sophisticated DGM approaches suggests a figure of at least 7%, implying that the upper bound for expected TMR is underestimated by PwC's range.

Finally, we find that PwC's proposed risk-free rate range is not a robust measure of the expected risk-free rate over Q6. It is based on forward rates calculated from data at a single point in time while our analysis of fluctuations in spot rates shows that there has been wide variation around this estimate over a period as short as six months. In addition the CAA and its advisors fail to account for the fact that the entire yield curve and consequently forward curves have been heavily affected by QE, (potentially in a differentiated manner) thus making it impossible to draw exact conclusions from current spot rates. We believe that it would be more appropriate for the CAA to take a long-run view on both ERP and risk-free rate. Our view has been shared by all other UK regulators as well as the CC who have used more long-run evidence to determine the risk-free rate.

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