NERA
ECONOMIC CONSULTING

Cost of Equity for HAL at H7

Prepared for Heathrow Airport

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Executive Summary

Heathrow Airport Ltd (HAL) commissioned NERA Economic Consulting (NERA) to review the Civil Aviation Authority (CAA)'s and its advisers' analysis of HAL's cost of equity for the H7 price control. We structure our review around the key CAPM parameters: asset beta, debt beta and total market return.

CAA's advisors underestimate HAL's asset beta due to errors in estimating betas for comparator airports

In its December 2018 report for the CAA, Europe Economics (EE) estimates an asset beta of 0.55 for AdP and 0.48 for Fraport. EE calculates the airport betas based on the average of 2-year betas estimated against a domestic index and a European index. EE uses the large-cap French index CAC40 and the large-cap German index (DAX) as the respective domestic indices for AdP and Fraport and the Stoxx Europe 600 index as the European index for both.

In its February 2019 report,[1] PwC estimates betas for AdP and Fraport, using both local and European indices as benchmarks and 2-year and 5-year estimation windows. It takes the average of these values to derive an asset beta of 0.43 for Fraport and 0.51 for AdP.[2] PwC concludes that maintaining an asset beta range for HAL of between 0.42 and 0.52 for H7, in line with the range used in the Q6 price control, is consistent with the betas for AdP and Fraport and given no material change in systematic risk for HAL in H7.[3]

We find that the CAA' advisors EE and PwC calculations of betas are based on flawed assumptions which lead to an understatement of asset betas for comparator airports AdP and Fraport and therefore HAL for H7 including:

- Estimating betas for airport comparators against local indices instead of a European wide benchmark;
- Relying on net debt for Fraport reported by third party data providers (Capital IQ) which is substantially higher compared to "net financial debt" directly reported in Fraport's annual accounts, understating asset betas for Fraport; and
- An incorrect assessment of relative risk of HAL relative to AdP and Fraport.

We discuss these issues further below.

The local large-cap indices used by EE and PwC provide an unreliable method to derive asset betas for AdP and Fraport

We conclude that the local large-cap indices used by EE and PwC provide an unreliable method to derive asset betas for Fraport and AdP as a proxy for HAL's asset beta, and instead the Europe Stoxx 600 should be used for the following reasons:

- Our analysis of ADP's and Fraport's shareholder composition suggest that the investor base is highly international with a number of large international investment funds holding stakes, for whom the local indices are not a representative benchmark. Notably, the local

[1] PwC (February 2019), Estimating the Cost of Capital for H7 - A Report Prepared for the Civil Aviation Authority, p.13.

[2] PwC (February 2019), op. cit., p.71, para. 5.222.

[3] PwC (2017), op. cit., Table 5.11, p.52.

indices used by EE and PwC do not include ADP and Fraport assets and therefore these indices cannot represent the investment universe for investors in these assets.

- Since the overall purpose of using comparator airports for beta is to assess the correct beta for HAL, it follows that the stock market that is being used a reference market should be similar in terms of risk profile to the UK stock market. The domestic indices used by EE (CAC40 for France and DAX for Germany) contain only 40 and 30 stocks, respectively, compared to 641 in the FTSE All-Share. Equally, the market capitalisation for the FTSE All Share is more than double that of the CAC40 and DAX. We show that the European regional index is similar to the FTSE All Share index in terms of size and composition, while the local indices are not. The domestic indices used by EE (CAC40 for France and DAX for Germany) contain only 40 and 30 stocks respectively, compared to 641 in the FTSE All-Share. Equally, the market capitalisation for the FTSE All Share is more than double that of the CAC40 and DAX.

PwC's reliance on Capital IQ data overstates net debt for Fraport and understates asset betas

In unlevering estimated equity betas for Fraport, PwC's relies on net debt amounts for Fraport based on data from Capital IQ.

We have compared the net debt figures provided by Capital IQ and those directly reported in Fraport's annual and quarterly accounts as "net financial debt" and find that Capital IQ overstates net debt by around €400 million over the relevant period. PwC's use of net debt from Capital IQ therefore understates Fraport's beta compared to using figures directly reported in Fraport's annual and quarterly accounts.

We conclude that the "net financial debt" reported by Fraport in its annual and quarterly accounts reflects the most accurate measure of net debt, since it is calculated and reported directly by the company itself rather than via a third-party data provider. Since Fraport defines its net debt in the annual accounts in this manner, we consider that it is the most relevant measure to use when assessing the company's financial obligations for the calculation of betas.

PwC incorrectly concludes that HAL is of comparable risk to Frankfurt and CDG

In our 2018 report, we demonstrated that HAL is more risky than Frankfurt airport, given Frankfurt benefits from demand risk mitigation and a light-touch regulatory regime; and HAL is at least as risky as CDG and could be reasonably viewed as higher risk, given CDG benefits from demand risk-sharing and re-openers within period, while HAL does not enjoy such protections.[4]

PwC's own description of the regulatory regimes in its February 2019 report supports our conclusions. For example, PwC acknowledges that Fraport has requested tariff increases in response to demand and cost changes which have received regulatory approval, notably during the financial crisis. It also acknowledges that AdP benefits from within period demand mitigating measures.

[4] NERA (February 2018), Cost of Equity for Heathrow in H7, Section 3.2.

However, PwC then goes on to state that the moderately greater variation in passenger numbers and revenues for Frankfurt offset the risk mitigating measures. We show that PwC's conclusions that Frankfurt faces moderately greater volatility is based on small sample sizes. Indeed, the conclusion on revenue volatility would be reversed if it were not for the exclusion of a single year (2009), and PwC's own review of the Fraport regime shows that these risks are passed-through and not borne by investors.

PwC also argues that the Group betas reflect the risk associated with a wider set of airports; however, it presents no break-down of the relative revenues. Our analysis shows that the Groups are dominated (e.g. more than 80 per cent of revenues) by their respective European hub airports and there is no evidence that the beta estimates for secondary airports are lower than the group betas.

For these reasons, we disagree with PwC's conclusion that the three airports face comparable risk. Our relative risk assessment shows that HAL's beta should be higher than that observed for Fraport Group, given that Frankfurt operates essentially under cost-of-service regulation, and at least as high as AdP, given the risk-mitigating features of its regime, in line with the conclusions of our February 2018 report.

Our updated beta estimates for AdP and Fraport support our earlier conclusion of an asset beta of 0.55-0.6 for HAL in H7

We present updated estimates of asset betas for Fraport and AdP, estimated against the Europe-wide index in line with the investment universe of the marginal investor in these stocks and using "net financial debt" as reported in Fraport's annual accounts as the best estimate of Fraport's net debt. This provides asset betas of 0.60 for AdP and 0.59 for Fraport. Both estimates are slightly higher than those from our February 2018 report, but still fall within our range of 0.55-0.60. [5] The updated results therefore reinforce our earlier conclusion that the asset beta for HAL in H7 should lie in the range of 0.55 to 0.60.

Table 1: AdP & Fraport's Asset Betas Continue to Support a Range of 0.55-0.60 for HAL

Comparator Airport	2-Year Asset Beta
AdP	0.60
Fraport	0.59

Note: Estimates use Stoxx 600 Index as the regional market index for Europe. Equity betas are de-levered to obtain asset betas using net debt from AdP and Fraport's annual reports.
Source: NERA analysis of Bloomberg data using 26 March 2019 cut-off date and debt beta of 0.05.

We find no evidence of increase in debt beta from previous reviews, we recommend a debt beta of 0 to 0.1 with a point estimate of 0.05

The CAA proposes to set a debt beta estimated of 0.13 for NERL in RP3, higher than the debt beta of 0.1 used in RP2 and Q6. The CAA's proposal is based on i) EE's debt beta estimate (0.19), ii) PwC's empirical analysis which shows increasing debt betas and iii) regulatory precedent.

[5] NERA (February 2018), Cost of Equity for Heathrow in H7, A Report for Heathrow Airport.

We find that there is little support for CAA's assumption to set a higher debt beta of 0.13 for RP3 (and indeed H7).

We have considered the evidence on empirical beta estimates presented by Professor Ania Zalewska (2019) from the University of Bath. In her separate paper on debt beta, she estimates debt betas using NATS and Heathrow bonds, as well as iBoxx indices, therefore providing empirical estimates that can be compared to those of PwC. Professor Zalewska concludes that there is evidence that the debt beta for NERL (and similarly for HAL and iBoxx in general) is significantly smaller than 0.1 and not statistically different from zero.[6] Other academics have also provided empirical debt estimates, including two papers by Schaefer and Myers, which also show debt betas below 0.1 for comparable rated debt to NERL and HAL (for Heathrow and Gatwick, Schaefer recommended a debt beta of 0.04, while Myers recommended a debt beta of 0 for comparable rated debt).[7]

We also considered the evidence from the "indirect" method proposed by EE, but do not find support for debt beta values of 0.19 as estimated by EE. We find that EE's formula omits a key component of the debt premium – the liquidity premium – which was used by the CMA in its calculation of debt betas in 2007. In addition, we identify several issues with EE's assumed inputs used in the decomposition, including: i) understating the default premium, ii) overstating the debt spread and iii) understating the ERP. Correcting for these issues and applying the CMA formula, we calculate substantially lower debt betas of 0.05 to 0.1 using the indirect method.

We consider that the plausible value of debt beta lies in a range of 0 to 0.1, with a point estimate of 0.05 as per our February 2018 report. A debt beta of 0 is consistent with the empirical analysis of Professor Zalewska, Schaefer and Myers while a debt beta of 0.1 is consistent with the upper end of the indirect method and regulatory precedent (e.g. CAA's assumption in Q6).

The CAA provides no evidence that the TMR has fallen relative to Q6/RP2

The CAA proposes a point estimate of 5.4 per cent (RPI deflated), which implies a substantial reduction in the TMR compared to the RP2 estimate of 6.25 per cent (RPI deflated).

The CAA provides no evidence that the TMR has fallen since the RP2/Q6 decision of 6.25 per cent by 85 bps: indeed, we show that a robust assessment of historical data shows no reduction in realised returns over the recent period in light of falling risk free rates (RFR) across global equity markets. Forward looking evidence from dividend growth models (DGM), including PwC's own evidence, shows no reduction in expected TMR estimates relative to RP2. Similarly, forward-looking survey evidence shows no reduction in expected TMR either. Precedent from US also shows that allowed return on equity remained stable despite falling US treasury yields.

All of this evidence supports the notion of a broadly constant TMR over time and provides no reason for the CAA to reduce its estimate from RP2/Q6, which was already lower than the

[6] Zalewska, A. (April 2019), Estimation of the debt beta of the bond issued by Nats (En-Route) plc.

[7] Schaefer, S. (December 2007), BAA Quinquennial Review: The Cost of Capital for Gatwick and Heathrow, pp.13-15.

latest estimate from the CMA of 6.5 per cent from the NIE 2014 and Bristol water 2015 determinations.

CAA draws on flawed estimates of TMR, including UKRN historical TMR and PwC's forward-looking DGM

The CAA estimates a historical TMR of 5 to 6 per cent real RPI-deflated based on the UKRN report. We show that the UKRN report historical TMR estimates are understated due to the authors:

- drawing on a hybrid RPI/CPI historical inflation series, which they incorrectly interpret to represent CPI inflation, thus understating historical real CPI-deflated returns (given RPI inflation is generally lower than CPI); and
- applying an excessive adjustment for long holding periods and alleged predictability of returns, compared to established methods in financial literature as used by the CMA.

Correcting for the above issues, we calculate historical evidence supports a higher TMR range of 6.2 to 6.8 per cent RPI-deflated.

The CAA also presents a forward looking TMR of 4.0 to 6.3 per cent RPI-deflated, drawing largely on PwC's application of the dividend growth models (DGM). We show that PwC's DGM-based TMR estimates are understated due to:

- using UK GDP growth to estimate future dividend growth, which ignores UK FTSE companies' 70 per cent exposure to international markets where expected growth is higher; and
- ignoring analyst forecasts of dividend growth which are substantially higher than forecast GDP growth, and which are used as a basis of estimating DGM in academic literature, by financial institutions including central banks and US regulatory precedent.

In contrast, the Bank of England, whose estimates the CMA relied on it the NIE 2014 and Bristol water 2015 determinations, relies on analyst forecasts for short-term dividend growth and global GDP forecasts for long-term dividend growth, supporting a substantially higher DGM-based TMR of 7 to 8 per cent RPI-deflated compared to the CAA's estimates.

By contrast, we calculate updated TMR of 6.2 to 6.8 drawing on historical evidence

We calculate updated historical returns of 6.2 to 6.8 per cent RPI-deflated, which draw on historical returns deflated using the RPI index and established methods for estimating TMR for long-holding periods used by the CMA in its NIE 2014 and Bristol water 2015 determinations. We adjust the historical data by the difference between the historical and forward-looking RPI-CPI wedge, drawing on available data on CPI and RPI. This adjustment corrects for any structural changes to the RPI index arising from the 2010 ONS change measuring clothing prices and derives an appropriate forward-looking TMR in RPI-deflated terms.

We also present forward-looking evidence from Bank of England DGM model which supports a TMR of 7 to 8 per cent RPI-deflated, which we consider corrects for issues with the PwC / other consultants' application of the DGM.

We conclude on a TMR range for RP3 of 6.2 to 6.8 per cent RPI deflated, drawing on the historical estimates as the primary evidence. We recommend that forward-looking evidence should be considered as a cross-check only, although we note that BoE estimates support even higher TMR compared to historical estimates.

1. Introduction

Heathrow Airport Ltd (HAL) commissioned NERA Economic Consulting (NERA) to review the Civil Aviation Authority (CAA)'s and its advisors' Europe Economics (EE) and PwC analysis for estimating the cost of capital for HAL for the H7 price control, including any implications of the CAA's proposals for NERL's cost of capital for the RP3 regulatory period for HAL in H7.[8] Specifically, we have been asked to respond to the CAA's assessment in relation to the key parameters for setting the cost of equity including the asset beta, the debt beta, and the total market return.

This report is structured as follows:

- Section 2 responds to EE's and PwC's assessment of asset beta for HAL in H7;
- Section 3 responds to the CAA's and PwC's and assessment of debt beta for RP2 and H7;
- Section 4 responds to the CAA's and PwC's assessment of the proposed total market return for RP2 and H7; and
- Appendix A responds to EE's assessment of debt beta for RP2.

[8] CAA (May 2018), Estimating the Cost of Capital: Technical Appendix for the Economic Regulation of Heathrow and Gatwick from April 2014: Notices Granting the Licenses, CAP 1674; PWC (February 2019), Estimating the Cost of Capital for H7 - Response to Stakeholder Views; and Europe Economics (December 2018), Components of the Cost of Capital for NERL.

2. Asset Beta

In this section, we respond to the analysis presented by the CAA's consultants PwC and EE on the asset beta for HAL for the H7 regulatory control period.

In Section 2.1, we first summarise PwC's and EE's analysis of HAL's asset beta. In Section 2.2 we respond to PwC and EE's methodology, explaining why we disagree with EE's and PwC's choice to rely on a local index as the reference market index and PwC's choice measure of net debt and PwC's interpretation of relative risk of HAL versus listed comparators. In Section 2.3, we present our updated estimates of HAL's asset beta based on evidence from comparator airports.

2.1. Summary of CAA and its Consultant's Beta Analysis

At Q6, the CAA adopted a range for HAL's asset beta of between 0.42 and 0.52, with a point estimate of 0.5.[9] This was the same asset beta range used for HAL in Q5, which was derived from BAA stock market data that had been decomposed by airport (including Gatwick and Stansted).[10] The continued use of this asset beta range was justified by the CAA with reference to international comparator airport betas (using AdP and Fraport as the most relevant comparators) and an analysis of changes to HAL's relative risk.

In its February 2019 report,[11] PwC argues for maintaining an asset beta range for HAL of between 0.42 and 0.52 for H7, in line with the range used in the Q6 price control. PwC finds that the asset betas for AdP and Fraport, the two closest comparators to HAL in terms of size, geography and hub status, are within this proposed beta range. PwC concludes that there has been no material change in systematic risk for HAL for H7, from either demand risk, cost structure or regulatory mechanisms.[12] PwC estimates betas for AdP and Fraport, using both local and European indices as benchmarks. It takes an average of these values over 2-year and 5-year estimation periods to derive an asset beta of 0.43 for Fraport and 0.51 for AdP.[13]

In its December 2018 report for CAA, EE estimates an asset beta of 0.55 for AdP and 0.48 for Fraport. EE calculates the airport betas based on the average of 2-year betas estimated against a domestic index and a European index. EE uses the large-cap French index CAC40 and the large-cap German index (DAX) as the respective domestic indices for AdP and Fraport and the Stoxx Europe 600 index as the European index for both.[14]

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9 Civil Aviation Authority (2014), Estimating the Cost of Capital: Technical Appendix for the Economic Regulation of Heathrow and Gatwick from April 2014: Notices Granting the Licenses, Figure 7.1, p.44.

10 PwC (2017), Estimating the Cost of Capital for H7 - A Report Prepared for the Civil Aviation Authority, p.13, para. 1.16.

11 PwC (February 2019), op. cit., p.13.

12 PwC (2017), Estimating the Cost of Capital for H7 - A Report Prepared for the Civil Aviation Authority, Table 5.11, p.52.

13 PwC (February 2019), op. cit., p.71, para. 5.222.

14 Europe Economics (December 2018), Components of the Cost of Capital for NERL, Appendix 8: Analysis of HAL's Beta, pp.81-82.

Table 2.1 compares our asset beta estimates for AdP and Fraport against PwC's and EE's estimates, using the same cut-off date as in the EE's December 2018 report for the NERA estimates.

Table 2.1: 2-Year Asset Beta Estimates - NERA vs. PWC and EE

Comparator Airport		European Index
AdP	PwC	0.55
	Europe Economics	0.56
	NERA	0.56
Fraport	PwC	0.42
	Europe Economics	0.52
	NERA	0.53

Note: NERA's Equity betas are de-levered to obtain asset betas using net debt from AdP and Fraport's annual reports; estimates use daily data.
Source: NERA analysis of Bloomberg data using 7 August 2018 cut-off date and debt beta of 0.05; Europe Economics (December 2018), Components of the Cost of Capital for NERL, Appendix 8: Analysis of HAL's Beta, Table 16.1; PwC (February 2019), op. cit., Table 30, p.71.

2.2. Our Response

In this section, we discuss the key issues with EE's and PwC's estimates of asset betas for airport comparators. These are:

- PwC and EE's reliance on asset betas for AdP and Fraport calculated against domestic large-cap indices;
- PwC's approach to net debt in determining leverage; and
- PwC's assessment of relative risk of HAL vs Fraport and AdP.

2.2.1. Reference market indices for estimating beta

In this section, we explain the issues with using domestic equity indices as the market portfolio when estimating beta and set out the rationale for using a European-wide regional equity index.

In its December 2018 report, EE estimates asset betas for AdP and Fraport calculated against: i) domestic large-cap equity indices; and ii) European regional market index.[15] EE calculates the average between the results obtained using domestic and European indices to obtain its central asset beta estimates of 0.55 for AdP and 0.48 for Fraport.

In its February 2019 report, PwC also bases its estimates of AdP and Fraport's asset betas on estimates from both local and European indices.[16]

Table 2.2 below shows that AdP's and Fraport's 2-year asset betas are very sensitive to the choice of the reference market index. As set out, AdP's and Fraport's asset betas estimated

[15] Europe Economics (December 2018), Components of the Cost of Capital for NERL, Appendix 8: Analysis of HAL's Beta, p.81.

[16] PwC (February 2019), op. cit., Table 30, p.71.

against the domestic large-cap indices used by EE and PwC are around 0.1 to 0.2 lower compared to estimates using the regional index (Stoxx Europe 600). The reason for the difference in the asset beta estimates is that Fraport and AdP are major international hub airports, hence have less exposure to fluctuations in domestic economic activities relative to wider stock market indices.

Table 2.2: AdP and Fraport 2-Year Asset Betas by Market Index

	Large-Cap Domestic Index	Stoxx Europe 600
AdP	0.51	0.60
Fraport	0.47	0.59

Note: Estimates use daily data. For AdP the domestic large-cap domestic index is the CAC40. For Fraport, the domestic large-cap domestic index is the DAX. Equity betas are de-levered to obtain asset betas using net debt from AdP and Fraport's annual reports. Differences in NERA estimates from Table 2.1 reflect differences in cut-off date.
Source: NERA analysis of Bloomberg data using 26 March 2019 cut-off date and debt beta of 0.05.

There are three main issues with estimating beta for AdP and Fraport based on a domestic index:

- Using domestic stock indices does not accurately reflect the investment universe of the marginal investor in AdP and Fraport;
- The domestic large-cap stock indices used by EE do not include Fraport and AdP, which means that these indices cannot represent the investor universe for AdP and Fraport investors by definition; and,
- There are major differences in the industry composition of the FTSE All Share, DAX index (Germany), CAC40 index (France) and Stoxx Europe 600, and the domestic indices are not sufficiently representative of the investor universe.

We explain each issue in detail in the following sections.

2.2.1.1. Local stock market indices do not reflect the investment universe of the marginal investor in AdP and Fraport

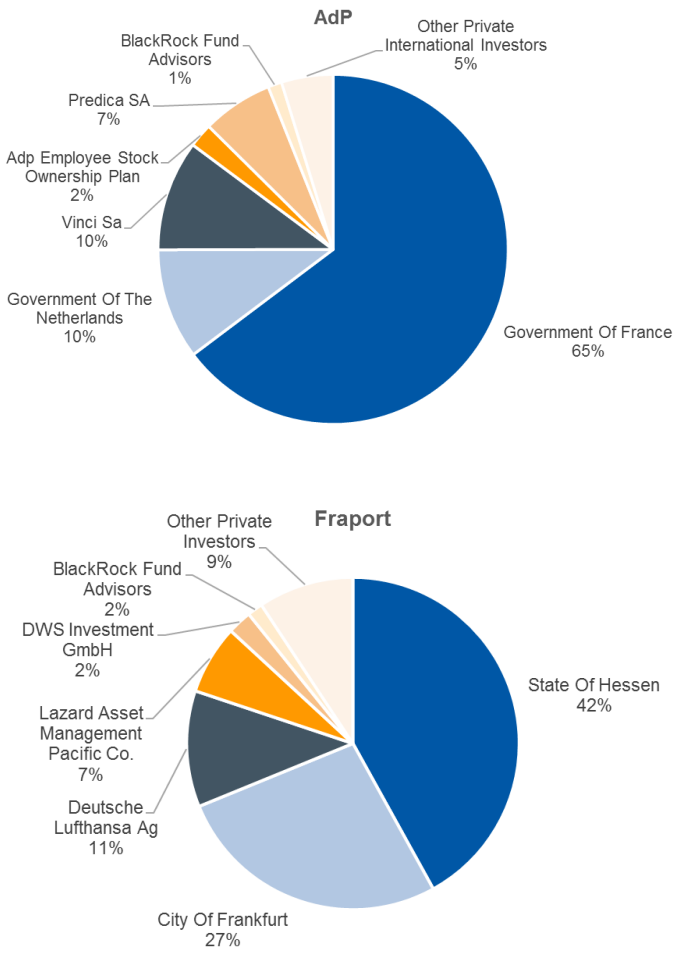
The asset beta parameter is a measure of the systematic (i.e. non-diversifiable) risk of an asset relative to the risk of the market portfolio, proxied by the stock market index. A company's asset beta captures only its systematic risk, which is the risk that an investor cannot diversify away by holding the market index.

The asset beta should be calculated using the investment universe of the marginal investor in the company. The marginal investor is defined as the investor who is most likely to buy/sell the asset, and hence whose behaviour affects the share price (and, as a result, the beta of the asset). Once the marginal investor in the company is identified, the stock market index should represent the investment universe available to the marginal investor to diversify its portfolio of assets.

Figure 2.1 shows the equity investor bases for AdP and Fraport. Whilst the government is the major shareholder for AdP and Fraport, the investor breakdown suggests that the marginal investor in the three companies is likely to be an international institutional investor holding a geographically diversified portfolio of assets. The appropriate investment universe for this

type of investor is wider than just the country in which this specific asset is located. For this reason, local stock market indices are not representative of the investment universe of the marginal investors in the two companies.

Figure 2.1: AdP and Fraport Investor Base Comparison



Note: International investment funds (i.e. marginal investors) shown in shades of orange/beige.
Source: NERA Analysis, Bloomberg.

2.2.1.2. Fraport and AdP are not constituents of the large-cap local indices used by EE

The French and German domestic market indices used by EE to estimate AdP's and Fraport's beta capture the performance of the largest and most traded companies in each stock exchange. However, neither AdP nor Fraport are constituents of their respective domestic large-cap local indices, i.e. the CAC40 and DAX indices.[17]

AdP and Fraport should be included in the investment universe of the airports' respective marginal investors. Therefore, EE's use of the domestic large-cap indices for calculating asset betas by construction leads to unreliable beta estimates for Fraport and AdP. The

[17] They are instead both included in their respective "Mid-Cap", as well as the domestic wider "All Share" indices.

conceptually correct market portfolio index should include the entire universe of investable assets, which would be better proxied by the Europe Stoxx 600 index.

2.2.1.3. The sectoral composition of the FTSE All Share differs from DAX (Germany), CAC40 (France) and is similar Stoxx Europe 600

Since the purpose of using comparator airport betas is to assess the correct beta for HAL, it follows that the stock market that is being used as a reference market should be similar in terms of risk profile to the UK stock market.

As shown in Table 2.3, the domestic indices used by EE to calculate asset betas are different according to various key indicators, such as the total number of stocks, market capitalisation and the sectoral and geographical breakdown of the market. For example, the FTSE All Share contains 641 stocks, compared to only 40 and 30 in the CAC40 and DAX, respectively. Equally, the market capitalisation for the FTSE All Share is more than double that of the CAC40 and DAX.

Table 2.3: Comparison of Local and European Stock Market Indices

Country	Index	Number of stocks	Sectoral breakdown	Geographical breakdown	Mkt Cap (€bn)
UK	FTSE All Share	641	- Finance: 26% - Consumer: 26% - Energy: 14% - Industrials: 11% - Utilities: 1%	UK: 30% Overseas: 70%	2,551
Europe	Stoxx Europe 600	600	- Finance: 21% - Consumer: 22% - Energy: 8% - Industrials: 11% - Utilities: 4%	- US: 19% - UK: 10% - Germany: 7% - France: 7% - China: 5% - Italy: 4%	8,168
France	CAC40	40	- Finance: 12% - Consumer: 36% - Energy: 9% - Industrials: 16% - Utilities: 2%	France: 18% Overseas: 82%	1,200
Germany	DAX	30	- Finance: 19% - Consumer: 18% - Energy: 3% - Industrials: 12% - Utilities: 3%	Germany: 19% Overseas: 81%	1,342

Note: AdP and Fraport are not included in the local indices presented above.
Source: Nera Analysis, Factset, Bloomberg.

In estimating AdP and Fraport's asset beta as a proxy for HAL's beta, the correct reference market index should be as similar as possible to the UK index in terms of relative risk and stock composition. As shown in Table 2.3, the stock market indices used by EE differ

considerably from the FTSE All Share, whereas European regional index is similar to the FTSE All Share index under our criteria. To ensure that AdP and Fraport beta estimates are relevant to the beta risk faced by HAL investors, it is imperative to use the wider Stoxx Europe 600 index.

2.2.1.4. The Home Bias argument does not apply to EU countries

The choice of the market index should reflect the investment portfolio of the marginal investor of our comparators. In principle, we consider that an investor in European assets is likely to diversify his or her portfolio across the European market, given the common currency in major countries and free capital movement.

We note that despite economic integration at the global level, some academic literatures observe "home bias", which shows that some equity investors have preferences for investing in domestic stocks despite the wider benefits of diversification. However, the extent of the "home bias" would depend, amongst other, on the explicit or implicit barriers to trade such as informational asymmetries. While it is likely that distinct geographical regions, such as Australia and New Zealand, will experience stronger explicit and implicit barriers to trade with the rest of the world, we do not consider such investment constraints would apply to the major countries in the European Union, such as France and Germany. On the contrary, the use of a domestic market index for a country may not offer the required level of diversification for an investor, since a domestic index implicitly restricts the investor's investment universe to stocks in that country only.

In summary, we conclude that the wider European market index, rather than the domestic stock indices, represents the appropriate market portfolio for estimating betas for AdP and/or Fraport.

2.2.2. Calculating gearing based on net debt

In our October 2018 report, we explained that that the use of net debt values directly reported in company accounts and Bloomberg produces broadly the same estimates for AdP, but Fraport's beta is 0.02 higher sourcing data from published annual and quarterly reports directly.

In its February 2019 report, PwC sources AdP and Fraport's net debt values from Capital IQ.

PwC calculates net debt using the 'total cash and short-term investments' measure provided by Capital IQ.[18] As we show in Table 2.4 below, this source gives materially higher values for Fraport's net debt in comparison to values of "net financial debt" as directly reported in Fraport's annual and quarterly reports.

[18] This measure includes cash and short-term equivalents, as well as short-term investments and trading asset securities. PwC (February 2019), op. cit., p.62, para. 5.171.

Table 2.4: NERA vs. PwC Fraport Net Debt Measures (£ millions)

Source	2017 Q2	2017 Q3	2017 Q4	2018 Q1	2018 Q2	2018 Q3	2018 Q4
PwC – Capital IQ	3996.8	4011.5	3910.4	3967	4069.8	3954.9	3871.2
NERA – Fraport Annual Reports	3533.5	3556.9	3512.4	3586.2	3697.8	3570.7	3545.4
Difference between Capital IQ and Annual Report	463.3	454.6	398	380.8	372	384.2	325.8

Note: We calculate Fraport's net debt according to PwC's approach by subtracting 'total cash and short-term investments' from 'total debt', as reported in Capital IQ's quarterly financial balance sheet for Fraport.
Source: NERA Analysis, Capital IQ, Fraport Annual Reports & Interim Financial Releases.

The measure of "net financial debt" taken from Fraport's annual and quarterly reports that we use in our calculations is defined by Fraport as the sum of non-current and current financial liabilities minus liquidity.[19] This includes the value of Fraport's trade accounts payable, derivatives, share options, and liabilities from financial leases.[20] Liquidity is defined as cash and cash equivalents (as at the statement of financial position) and short-term realisable items in 'other financial assets' and 'other receivables and financial assets'.

We conclude that the "net financial debt" reported by Fraport in its annual and quarterly accounts reflects the most accurate measure of net debt, since it is calculated and reported directly by the company itself rather than via a third-party data provider. Since Fraport defines its net debt in the annual accounts in this manner, we consider that it is the most relevant measure to use when assessing the company's financial obligations for the calculation of betas. We therefore continue to rely on the "net financial debt" as reported in Fraport's annual and quarterly accounts to estimate Fraport's asset beta.

2.2.3. PwC's interpretation of relative risk of HAL vs Fraport and AdP

In our February 2018 report for HAL[21], we explained that the most relevant comparators for estimating the asset beta for Heathrow at H7 are Fraport and AdP, which in turn represent reasonable approximations of the betas for Frankfurt airport and CDG. We showed that Heathrow is riskier than Frankfurt airport and at least as risky as CDG. We concluded the asset beta for H7 should therefore be higher than the beta for Fraport and at least as high as the beta for AdP.

In our February 2018 report, we also responded to PwC's November 2017 report which argued that Heathrow is lower risk than Frankfurt and CDG airports based on its analysis of demand volatility at the three airports. We explained that PwC's analysis is based on selective evidence and crucially ignores the impact of the regulatory regime on mitigating demand risk at Frankfurt and CDG. Considering both demand volatility and the regulatory

[19] Fraport (2018), Annual Report 2018, p.245.

[20] Fraport (2018), Annual Report 2018, p.198.

[21] NERA (February 2018), Cost of Equity for Heathrow in H7, A Report for Heathrow Airport.

regime together, we concluded that Heathrow is riskier than Frankfurt airport and at least as risky as CDG.[22]

In its February 2019 report, PwC concludes that HAL is of comparable risk to CDG and Frankfurt, the latter facing lower regulatory risk but offset by greater passenger and revenue volatility, according to PwC.

In the remainder of this section, we comment on PwC's updated assessment of relative risk.

2.2.3.1. Fraport's and CDG's regulatory framework presents lower risk than HAL's

In its February 2019 report, PwC reviews Fraport's regulatory regime to evaluate its risk relative to HAL. PwC acknowledges that over the last decade, Fraport has requested tariff increases in response to demand and cost changes which have received regulatory approval. PwC states that:

> *"The timing and nature of these proposals is consistent with an objective of offsetting declines in PAX by raising tariff charges to maintain revenue stability. This is illustrated by the action taken by Frankfurt airport between December 2009 and February 2010, when PAX numbers fell to lower levels in the wake of the financial crisis. During these months, Frankfurt was able to agree with HMWEVL (the regulator) a series of tariff rises that would cover the 2010-2015 period."* [23]

As PwC notes, Fraport has requested five tariff reviews in less than 8 years and these have largely been successful. Given PwC's description of the regime, and Fraport's success in securing changes to tariffs to offset revenue and cost changes, it is surprising that it also notes that the framework *"does not necessarily reduce its investors' risk exposure […] because investors face considerable uncertainty about the timing of Frankfurt's tariff applications and the regulator's verdict […]."*[24] It is clear from PwC's own description that Frankfurt's regime is akin to a cost-of-service regime, where revenues are re-set to closely track costs, and there is a substantive body of empirical evidence to show that beta risk is lower for such regimes.[25]

In regard to CDG airport, PwC acknowledges that risk sharing agreements are in place such that demand risk is shared 50 per cent on the upside and 20 per cent on the downside outside of a pre-determined buffer zone, for the latter years of any given price control period.[26] PwC conclude that *"in many important respects – such as the regular five-year intervals between determinations and the adjusted till regulatory system – the CDG regime is similar to that of HAL."*[27] While we agree with PwC that the regimes are comparable in many aspects such as the length of the regulatory period, the demand risk re-openers in CDG's regulatory regime

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22 PwC (February 2019), op. cit., pp.7-8.

23 PwC (February 2019), op. cit., p.65, para. 5.193.

24 PwC (February 2019), op. cit., p.65, para. 5.193.

25 For example, studies that we have undertaken for National Grid show that empirical beta estimates for US regulated networks operating under cost of service regimes are around 0.2 to 0.3, substantively below betas for UK energy networks operating under incentive based regime of around 0.4, NERA (April 2018) RIIO-T2 Beta and Risk assessment

26 PwC (February 2019), op. cit., p.66, para. 5.199.

27 PwC (February 2019), op. cit., p.67, para. 5.204

dampen volatility in revenues from CDG's demand variation. No such demand mitigation arrangements are available to HAL, which implies that CDG faces lower risk than HAL.

2.2.3.2. Fraport has higher PAX volatility, but this is offset by the regulatory framework

PwC examines historical passenger volatility of CDG and Frankfurt Airport from 2008-2013 to show that Frankfurt airport experienced the largest changes in peak-to-trough passenger flows. PwC use this as evidence to suggest that the moderating influence of Frankfurt's regulatory regime on its outturn revenues may be offset by higher underlying volatility in its passenger numbers.[28]

We agree that there is some greater variation in Frankfurt's traffic over the two sample periods assessed by PwC, although the difference in variation is relatively small: with Fraport experiencing a peak-to-trough passenger variation of 12.7 per cent, with a corresponding figure for HAL of 10 per cent, and CDG 8 per cent according to PwC's estimates.[29] However, Fraport has been largely successful in securing tariffs revisions in response to passenger declines during these periods. For example, as PwC itself shows, Fraport received a variation in revenues in both 2009 and 2010 in response to passenger traffic declines following the financial crisis.[30]

PwC also claims that HAL experiences very similar revenue volatility to CDG and yet lower revenue volatility than Frankfurt. In this instance, we observe that PwC's comparison is based on only 6 years of observations and is entirely dependent on the exclusion of year 2009, where there was a correction to HAL revenues, which halves the volatility metric for HAL. The inclusion of 2009 would otherwise imply HAL faces greatest volatility.[31]

2.2.3.3. AdP and Fraport Groups Are Dominated by European hubs

Finally, PwC explains that AdP and Fraport groups not only operate the CDG and Frankfurt airports respectively – their main European hubs – but also operate a range of other secondary international airports. The beta estimates for AdP and Fraport therefore do not necessarily reflect the systematic risk faced only by CDG and Frankfurt airports but also reflect the risk of these secondary international airports. PwC argue that the betas for CDG and Frankfurt airports alone would be lower than that of the secondary international airports, since capacity constrained hub-airports in mature markets are likely to be lower risk than unconstrained international airports.[32]

In our February 2018 report, we showed that the overall share of Frankfurt airport in the Fraport beta is around 80 per cent when measured by share of revenues, EBITDA and group assets. For AdP group, we find that the overall share of Paris, Schiphol and Ataturk airports

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28 PwC (February 2019), op. cit., p.67, Table 27.

29 PwC (February 2019), op. cit., p.67, Table 27.

30 PwC (February 2019), op. cit., p.65, Table 26.

31 PwC shows that HAL's revenue variability is 7 per cent, compared to 5.4 per cent and 6.3 per cent for CDG and Frankfurt respectively (Source: PwC (February 2019), op. cit., p.69, Table 28). We also noted the importance of excluding/including the year 2009 and other sensitivities to the sample size in our earlier report (Source: NERA (February 2018) Cost of Equity for Heathrow in H7, p. 35).

32 PwC (February 2019), op. cit., p.70, para. 5.216.

(large European hub airports included in AdP group which are relevant comparators for Heathrow) is around 82 per cent when measured in passenger numbers. Therefore, it is clear the Group betas are largely reflective of the risks associated with European hub airports.[33]

In addition, we also decomposed AdP and Fraport's group betas into beta estimates for the groups' respective stakes in secondary international airports. Notwithstanding the low share of secondary airports' revenues and passengers in the wider group,[34] we showed that for both the AdP and Fraport groups the asset beta estimates for secondary airports are lower than those of the entire group, i.e. those including all airports operated by the group. This implies that CDG and Frankfurt airport's betas are at least as high as the respective group estimates.[35]

2.2.3.4. Conclusion: PwC underplays the importance of regulatory regime in mitigating risk

In our February 2018 report, we demonstrated that HAL is riskier than Frankfurt airport, given Frankfurt benefits from demand risk mitigation and a light-touch regulatory regime; and HAL is at least as risky as CDG and could be reasonably considered as higher risk, given CDG benefits from demand risk-sharing and re-openers within period while HAL does not enjoy such protections.[36]

PwC's own description of the regulatory regimes supports our conclusions. However, it then goes on to state that the moderately greater variation in passenger numbers and revenues for Frankfurt offset the risk mitigating measures. We show that PwC's conclusions that Frankfurt faces (moderately) greater volatility is based on small sample sizes, the conclusion for revenue volatility would be reversed if it were not for the exclusion of a single year (2009), and PwC's own review of the Fraport regime shows that these risks are passed-through.

PwC also argues that the Group betas reflect the risk associated with a wider set of airport operations, although our analysis shows that the Groups are dominated (e.g. more than 80 per cent of revenues) by their respective European hub airports and there is no evidence that the beta estimates for secondary airports are lower than the group betas.

For these reasons, we disagree with PwC's conclusion that HAL, Fraport and AdP face comparable risk. As set out in our February 2018 report, our relative risk assessment shows that HAL's beta should be higher than that observed beta for Fraport Group, given that Frankfurt operates essentially under cost-of-service regulation, and at least as high as AdP, given the risk-mitigating features of its regime which are unavailable to HAL.

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33 NERA (February 2018), Cost of Equity for Heathrow in H7, Section 3.3.

34 We also find that the remainder of the airports in the Fraport and AdP groups includes airports in South America (Peru and Chile) as well as Turkey (Source: NERA (February 2018), Cost of Equity for Heathrow in H7, Section 3.3).

35 NERA (February 2018), Cost of Equity for Heathrow in H7, Section 3.3.

36 NERA (February 2018), Cost of Equity for Heathrow in H7, Section 3.2.

2.3. Updated Asset Betas of International Airports Continue to Support HAL Asset Beta Between 0.55-0.60 for H7

In this section, we present updated evidence on empirical betas for listed airport comparators, using the same comparator set as considered by the CAA and PwC in Q6, and as per our February 2018 report.[37]

Table 2.5 presents our estimates for the full sample of international comparator airports over 1-, 2- and 5-year estimation windows and Figure 2.2 shows the 2-year rolling asset betas for the listed airport comparators, using a cut-off date of the 26th March 2019.

HAL's closest comparators AdP and Fraport have estimated asset betas of 0.60 and 0.59 using a 2-year estimation window. Both airports asset betas have increased slightly since our February 2018 report but remain within our estimated range for HAL of 0.55-0.60. The average asset beta of all comparator airports over our preferred 2-year estimation window is 0.58.

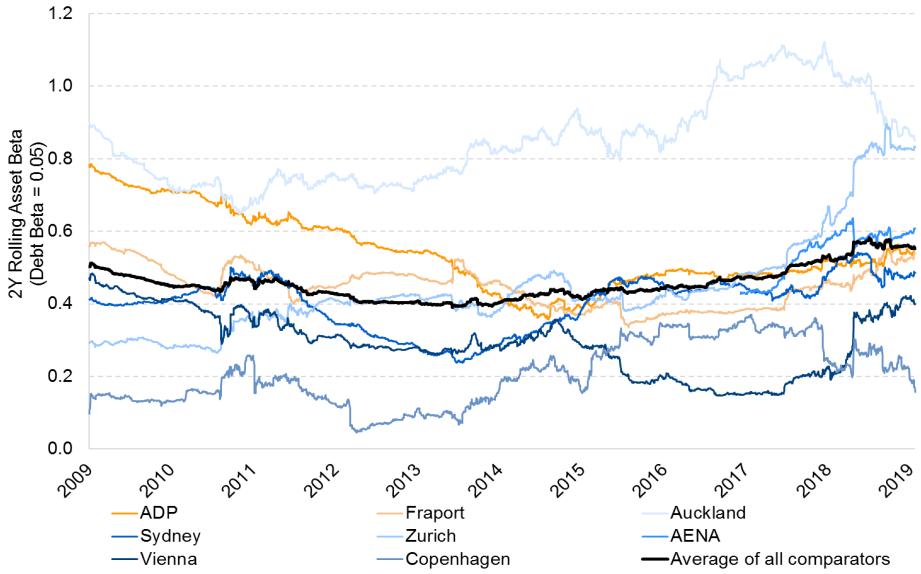
Table 2.5: International Comparator Airports Asset Betas

	Estimation Window		
	1-Year	2-Year	5-Year
ADP (Paris)	0.51	0.60	0.54
Frankfurt	0.55	0.59	0.47
Zurich	0.80	0.89	0.57
Vienna	0.31	0.41	0.22
Copenhagen	0.16	0.16	0.29
Sydney	0.41	0.50	0.46
Auckland	0.91	0.85	0.94
AENA	0.54	0.62	Na.
Average	**0.52**	**0.58**	**0.50**

Note: Calculations use daily data and regional stock indices (STOXX 600 index for EU, ASX200 index for Australia, NZX 200 Index for New Zealand). Asset beta estimates unlevered using net debt, for ADP and Fraport estimates based on net debt derived from the annual reports for others net debt is based on Bloomberg.
Source: NERA analysis of Bloomberg data using 26 March 2019 cut-off date and debt beta of 0.05.

[37] We exclude Rome and Florence airports which were de-listed in 2013 and 2015 respectively. We include AENA, a European airport operator which manages airports in Spain and overseas, which was listed in February 2015.

Figure 2.2: Updated Estimates of Airport Comparators 2-Year Rolling Asset Betas



Source: NERA analysis of Bloomberg data using 26 March 2019 cut-off date and debt beta of 0.05.

We have estimated the betas for the wider set of comparators using the technical estimation techniques as per our February 2018 report, including sensitivities of beta estimates for AdP and Fraport, the two principal comparators, to key methodological assumptions as follows:

- ***Data frequency***: We estimate comparator betas using daily data. In estimating betas, there is a trade-off between data of higher frequency (e.g. daily), which provide greater number of observations and lead to statistically more robust beta estimates, and data with lower frequency, which may be more appropriate if the relevant stock is illiquid where the use of higher frequency data may result in understating the co-movement of the stock and the market due to asynchronous trading. As our comparator set includes major listed airports with bid-ask spreads below 1 per cent, we do not expect illiquidity to be an issue and therefore rely on daily data which produces more statistically robust beta estimates.
- ***Estimation window***: We present betas 2-year estimation windows, but also consider 1 and 5-year estimation windows for AdP and Fraport, CAA's principal comparators. The choice of the estimation window should be sufficiently long to produce robust statistical estimates and should also consider the impact of wider market conditions on beta estimates (e.g. the impact of the Financial Crisis) and to what extent these factors are expected to prevail over the next regulatory period.
- ***Gearing and debt beta***: To convert the estimated equity beta into an asset beta, we assume a debt beta of 0.05, in line with the mid-point of our proposed debt beta range as discussed in Section 3. We use net debt as reported by Bloomberg. For Fraport and AdP, our two main comparators, we show the results using net debt as directly reported in the companies' annual reports, which reflects additional cash-holdings not considered by Bloomberg (which as we explain above, is particularly relevant for Fraport).
- ***Market index***: We present beta estimates using local or regional indices. For the European airports, we use a Europe-wide index (Stoxx Europe 600), for the reasons explained above, namely that a European investor is likely to diversify his portfolio

across the European market given common currency in major countries and free capital movements, while for the other international airports we use a local index. However, we also show the sensitivities for AdP and Fraport betas with respect to the world index for which we use the FTSE All World and a sensitivity using local indices CAC40 and DAX.

Table 2.6 below shows the sensitivity of the asset beta estimates for AdP and Fraport in relation to the estimation window, reference market index and choice of annual reports vs. Bloomberg net debt. For Fraport, we find that beta estimates are higher using net debt as reported directly in Fraport's annual reports, rather than the net debt provided by Bloomberg. For AdP, using net debt sourced from annual reports provides the same results as the Bloomberg source for AdP. As shown in blue highlight, our preferred estimate is 0.6 for AdP and 0.59 for Fraport, based on a 2-year asset beta estimate against a European index and net debt as directly reported in the annual and quarterly accounts.

Table 2.6: AdP & Fraport Asset Beta Sensitivity Analysis

	Local Index			Europe Index			World Index		
	1-Year	2-Year	5-Year	1-Year	2-Year	5-Year	1-Year	2-Year	5-Year
Bloomberg Net Debt									
AdP	0.44	0.51	0.48	0.51	0.60	0.54	0.42	0.51	0.59
Fraport	0.46	0.46	0.37	0.54	0.57	0.44	0.55	0.62	0.58
Annual Report Net Debt									
AdP	0.44	0.51	0.48	0.51	0.60	0.54	0.42	0.51	0.59
Fraport	0.47	0.47	0.39	0.55	0.59	0.47	0.57	0.65	0.61

Note: Estimates use daily data. Local Index is CAC40 for AdP and DAX for Fraport. Regional (Europe) Index is Stoxx Europe 600. World Index is FTSE All World.
Source: NERA analysis of Bloomberg data using 26 March 2019 cut-off date and debt beta of 0.05.

2.4. Conclusions on Asset Beta

We present updated beta estimates for HAL for H7, drawing on updated asset beta estimates of 0.60 for AdP and 0.59 for Fraport. The updated results support the conclusions from our February 2018 report that the asset beta for HAL in H7 should lie in the range of 0.55 to 0.60.

We conclude that local large-cap indices used by EE and PwC provide an unreliable method to derive asset betas for Fraport and AdP as a proxy for HAL's beta, and instead the Stoxx Europe 600 should be used for the following reasons:

- ADP's and Fraport's shareholder bases suggest that their marginal investor is likely to be a large international investment fund holding a geographically diversified portfolio of assets, for which the local index is not representative of their investment universe. Notably, the indices used by EE do not include ADP and Fraport assets and therefore cannot represent the investment universe for investors in these assets.
- The domestic indices used by EE (CAC40 for France and DAX for Germany) contain only 40 and 30 stocks, respectively, compared to 641 in the FTSE All-Share, the reference market for HAL investors. Equally, the market capitalisation for the FTSE All Share is more than double that of the CAC40 and DAX. Since the overall purpose of using comparator airports for beta is to assess the correct beta for HAL, it follows that the stock market that is being used as a reference market should be similar in terms of risk profile to the UK stock market. We show that the EU stock market is more similar to the UK stock market than the CAC40 or DAX.

As well as EE's use of domestic indices, we also have concerns with PwC's calculation of net debt for Fraport, which draws on estimates reported by Capital IQ as opposed to Fraport's stated "net financial debt" calculated by Fraport and reported in Fraport's annual and quarterly accounts. We consider the latter represents a more reliable measure to use when assessing the company's financial obligations for the calculation of betas.

We also respond to PwC's statements regarding relative risk of HAL compared to Fraport and AdP comparators, confirming the conclusions from our previous reports that HAL is riskier than Frankfurt airport, given Frankfurt benefits from demand risk mitigation and a light-touch regulatory regime; and HAL is at least as risky as CDG and reasonably higher risk, given CDG benefits from demand risk-sharing and re-openers within period while HAL does not enjoy such protections.

3. Debt Beta

In this section we review PwC's debt beta evidence, as cited by the CAA in its recent paper on the implications of the NERL cost of capital paper for HAL.[38]

In Section 3.1, we summarise PwC's analysis of debt beta. In Section 3.2, we present alternative empirical debt beta estimates which support lower debt betas compared to PwC and also provide no evidence of a debt beta increase as argued by PwC. In Section 3.3, we conclude that a plausible estimate of the debt beta lies in a range of 0 to 0.1, with a point estimate of 0.05 in line with our February 2018 report.

3.1. Summary of PwC's Debt Beta Analysis

In its February 2019 report, PwC reviews evidence to analyse whether its debt beta recommendation of 0.05 from its December 2017 report remains appropriate.[39]

PwC starts by reviewing recent regulatory precedent, which assumes debt betas ranging from 0 to 0.15.[40]

PwC also presents its own empirical debt beta estimates. Specifically, PwC estimates debt betas by regressing returns on bond indices (iBoxx) against an equity market index (UK MSCI index), providing debt beta estimates ranging from -0.09 to 0.26, with higher values estimated for the most recent period.[41] PwC also regresses the returns on HAL bonds against the same equity market index, estimating debt betas ranging from -0.06 to 0.18, with higher values estimated for the most recent period.[42]

Based on this evidence, PwC concludes that there is evidence supporting an increase in the debt beta estimate and recommends increasing the debt beta from 0.05 used in its earlier December 2017 report to 0.1.[43]

3.2. Empirical Estimates and Regulatory Precedent Support Lower Debt Betas

PwC's conclusion that debt betas have increased in the most recent period appear principally driven by PwC's empirical analysis of debt betas for HAL's bonds and the iBoxx index.

However, empirical estimates of debt betas are not as straightforward as empirical estimates of equity betas and estimates can vary considerably depending on the methodology and specifications chosen.

In response to PwC's recommendations on debt beta, we have considered the evidence presented by Professor Ania Zalewska (2019) from the University of Bath in her separate

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38 CAA (February 2019), Working paper on the cost of capital: the implications of the RP3 draft performance plan for Heathrow Airport Limited (HAL), para 2.6 and 3.9.

39 PwC (February 2019), op. cit., pp.71-72.

40 PwC (February 2019), op. cit., p.72.

41 PwC (February 2019), op. cit., pp.72-73.

42 PwC (February 2019), op. cit., pp.73-74.

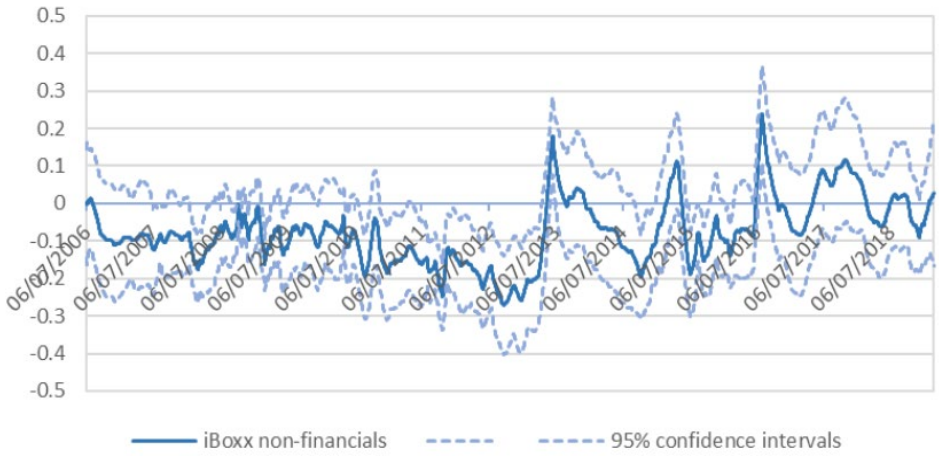
43 PwC (February 2019), op. cit., p.74.

paper on debt beta, which presents empirical evidence on debt betas using NATS and Heathrow bonds, as well as iBoxx indices, thus providing empirical estimates that can be compared to those of PwC.

Professor Zalewska derives debt betas using a variety of methods (OLS, ML, GARCH, Kalman-Filter) and also considered the sensitivity of the results to alternative definitions of the market portfolio, the period of assessment and data frequency.

Professor Zalewska starts by regressing the excess returns on the iBoxx indices against an equity market index (FTSE All Share), which results in negative debt beta estimates over several estimation periods, although relatively closer to zero in the most recent period, as shown in Figure 3.1.[44]

Figure 3.1: The Kalman Filter Estimates of the Daily Betas of Selected iBoxx Non-Financial Index Against the FTSE All Share Index

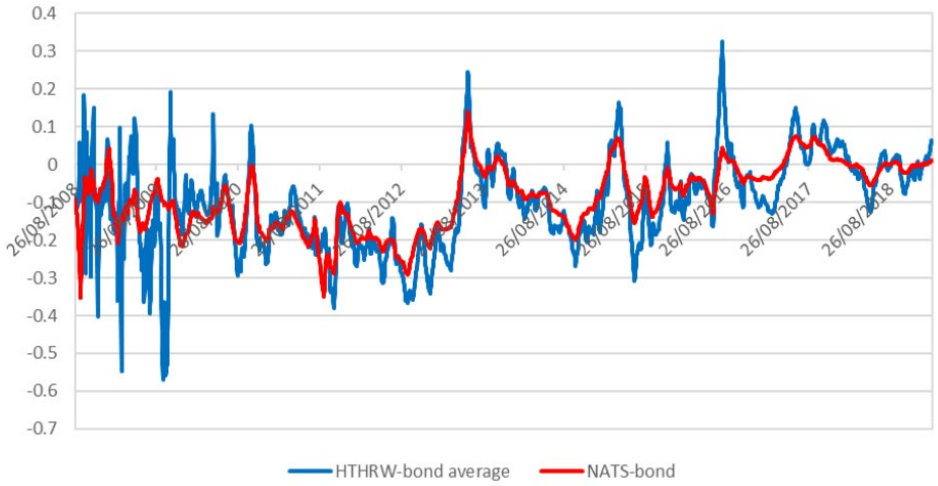


Source: Zalewska, A. (April 2019), Estimation of the debt beta of the bond issued by Nats (En-Route) plc., Figure 5, p.12

Professor Zalewska obtains similar results when regressing excess returns on individual Heathrow bonds and NATS bond against the equity market index (FTSE All Share), i.e. negative debt betas but relatively closer to zero recently.

[44] Zalewska, A. (April 2019), Estimation of the debt beta of the bond issued by Nats (En-Route) plc.

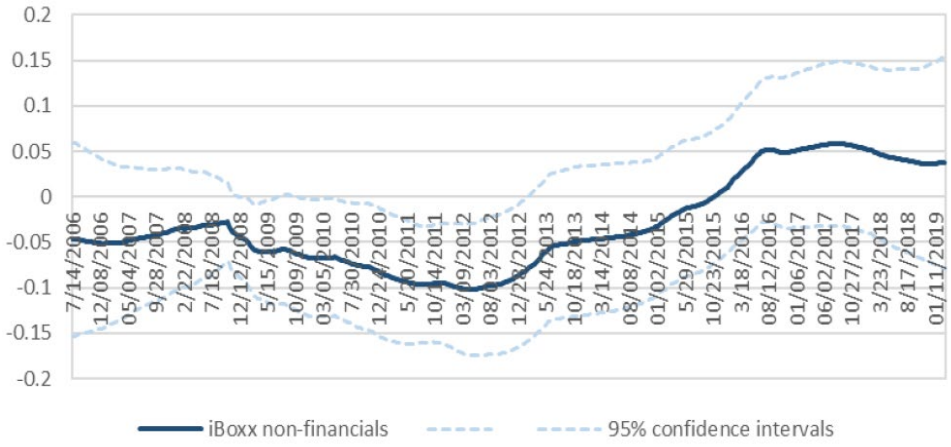
Figure 3.2: The Average of the Kalman Filter Debt Beta Estimates for the Heathrow Bonds and the Kalman Filter Debt Beta Estimate for the NATS-bond



Source: Zalewska, A. (April 2019), Estimation of the debt beta of the bond issued by Nats (En-Route) plc., Figure 9, p.18.

Professor Zalewska also considers debt beta estimates using lower frequency weekly data. Her results are consistent with her calculations based on daily data (as shown above), i.e. she finds evidence of negative debt betas, but closer to zero in the most recent period.

Figure 3: The Kalman Filter Estimates of the Weekly Betas of Selected iBoxx Non-Financial Index with the FTSE All Share Index Used as the Proxy for the Market Portfolio



Source: Zalewska, A. (April 2019), Estimation of the debt beta of the bond issued by Nats (En-Route) plc., Figure 14, p.21.

Drawing on the above analysis, Professor Zalewska concludes that there is evidence that the debt beta from the NATS-bond (and by extension also HAL bonds) is significantly smaller than 0.1 and indeed not statistically different from zero.[45]

[45] Zalewska, A. (April 2019), Estimation of the debt beta of the bond issued by Nats (En-Route) plc.

Regarding recent trends in debt betas, while PwC's debt beta estimates show an increasing trend in the asset beta estimates, Professor Zalewska beta estimates based on advanced econometric models show declining trends over the recent period for several model specifications.[46] This further supports that a wide range of empirical evidence should be reviewed before concluding on a debt beta for H7.

Other academics have also provided empirical debt estimates similar to those from Professor Zalewska. For example, during the Q5 review, BAA submitted two papers by Schaefer and Myers which provided empirical estimates for debt betas.

- Schaefer estimates debt betas by regressing excess bond returns against the corresponding excess equity return for the company issuing the bond for a large sample of US non-financial companies. Using this methodology, Schaefer estimates debt betas ranging from 0 for AAA-rated bonds to 0.15 for B-rated bonds, with an average of 0.04. For Heathrow and Gatwick, Schaefer recommended a debt beta of 0.04.[47]
- Myers estimates debt betas by regressing the returns of a bond portfolio composed of BAA bonds against an equity market index (the FTSE All Share), concluding that these were not significantly different from 0. Myers also estimates debt betas of three UK bond indices (government and corporate indices) against the FTSE All Share, finding support for a debt beta of zero. Finally, Myers also presents beta estimates for US government and corporate bonds against the S&P500, finding that estimates had fallen below zero in recent years.[48]

Given that empirical estimates produce a range of possible debt betas, with many of them supporting debt betas close to zero, we conclude that PwC's debt beta estimate of 0.1 should be considered at most as an upper bound of the plausible range starting at zero.

3.3. Conclusion on Debt Beta

We conclude that the plausible value for the debt beta lies in a range of 0 to 0.1, with a point estimate of 0.05 as per our February 2018 report.

A zero debt beta of is consistent with the empirical analysis of Professor Zalewska, Schaefer and Myers while a debt beta of 0.1 is consistent with PwC's own debt beta analysis and regulatory precedent (e.g. CAA in RP2/Q6). Our conclusion is consistent with the evidence using the alternative "indirect" method of estimating debt betas by decomposing the debt premium, as discussed in Appendix A.

[46] Zalewska, A. (April 2019), Estimation of the debt beta of the bond issued by Nats (En-Route) plc.

[47] Schaefer, S. (December 2007), BAA Quinquennial Review: The Cost of Capital for Gatwick and Heathrow, pp.13-15.

[48] Myers, S. (January 2008), CAA price control proposals Heathrow and Gatwick Airports, Appendix B.

4. Total Market Return

In this section, we comment on the Total Market Return (TMR) proposed by the CAA for the RP3 period for NERL. The CAA's assessment of market-wide parameters for NERL's cost of capital for RP3, such as the TMR, builds on the CAA's and its consultant PwC's earlier analysis for HAL for H7 including an updated report prepared by PwC on HAL's cost of capital for H7. The TMR proposals for NERL are therefore relevant for HAL's costs of capital for H7.

In Section 4.1 we start by summarising the CAA's TMR proposals for RP3, which suggest a substantial reduction in the TMR relative to Q6/RP2. In Section 4.2, we explain that there is no evidence that expected TMR has fallen since RP2, drawing on historical realised returns as well as forward-looking evidence. In Section 4.3, we explain the historical returns evidence the CAA relies is downward biased due to flawed assumptions regarding historical inflation and adjustments for alleged predictability of returns, while correcting for these issues supports TMR values at least as high as the CAA's Q6/RP2 decision. In Section 4.4, we explain that the forward-looking estimates evidence the CAA relies is downward biased, due to PwC's flawed application of the DGM which relies on UK GDP growth forecasts as a proxy for FTSE dividends, while the Bank of England DGM model provides substantially higher estimates drawing on analyst forecasts and global GDP growth. In Section 4.5, we explain that the recent consultations by other UK regulators cited by the CAA are also affected by the same biases as the CAA's own estimates. In Section 4.6, we conclude on a TMR range of 6.2 to 6.8 per cent (real, RPI deflated), drawing on historical data appropriately adjusted for inflation and long holding periods, consistent with the latest CMA determination for BIE (2014) and Bristol water (2015) of 6.5 per cent (real RPI deflated).

4.1. Summary of the CAA's TMR Proposals for RP3

In its proposals for RP3, the CAA proposes to use a "TMR approach" of directly estimating the TMR and risk-free rate (RFR), with the equity risk premium (ERP) calculated as the residual. The CAA considers that the TMR for RP3 should be estimated drawing on a range of evidence, including evidence on: historical realised returns, forward looking estimates based on dividend growth models (DGM) as well as regulatory precedent.

In relation to historical returns, the CAA presents estimates from Wright et al. from their 2018 report for the UKRN ("UKRN report") of 6-7 per cent real CPI-deflated, which the CAA converts to 5-6 per cent real on an RPI-deflated basis using its forward-looking estimate of the RPI-CPI wedge of 100bps.[49]

The CAA also comments on two issues related to the UKRN TMR estimates: i) the appropriate inflation index to use to deflate historical returns into real terms and ii) the appropriate holding period and adjustment for serial correlation.

- In relation to the appropriate inflation index, the CAA notes the use of Bank of England's CPI index is appropriate, given the CPI series is consistent over time while RPI is not due

[49] CAA (February 2019), Appendices to Draft UK Reference Period 3 – Performance Plan Proposals, Consultation, para D19.

to changes in 2010 to the ONS' measure of clothing prices, which implies historical RPI-deflated returns may not be an accurate indicator of forward-looking RPI returns.[50]

- In relation to the second issue, the CAA notes that the UKRN report estimates a TMR as the sum of a geometric mean and 1-2 per cent volatility adjustment, where the top end is consistent with an arithmetic mean (assuming returns are less predictable) while the bottom end includes some degree of predictability, as supported by PwC's analysis for holding periods of around 10 years. [51]

The CAA concludes the UKRN historical returns estimate of 5-6 per cent real RPI-deflated is consistent with other evidence, including recent consultations by UK regulators (Ofgem and Ofcom) and their advisors (Europe Economics, PwC and CEPA).[52]

In relation to forward-looking evidence, the CAA presents a range of TMR estimates derived using the dividend growth model (DGM), including estimates from Ofwat, Ofcom and Ofgem prepared by their advisors Europe Economics, CEPA and PwC, which according to the CAA show a DGM-based TMR of 4.0 to 6.3 per cent real RPI-deflated. The CAA also presents updated estimates from PwC of 5.3 to 6.2 per cent real RPI-deflated.[53]

The CAA also comments on the alternative DGM-based TMR from the Bank of England (BoE) highlighted in our February 2018 report and by Oxera, stating that PwC concludes that the BoE estimates are focussed on movements of analyst equity return expectations rather than levels and are therefore unsuitable for informing the view of a forward-looking TMR.[54]

The CAA concludes that forward-looking evidence presents a relevant piece of evidence on the TMR and that the evidence presents some overlap with the historical returns evidence, supporting a range of 5-6 per cent RPI-deflated. [55]

Finally, the CAA presents evidence from recent consultations by UK regulators including Ofwat, Ofcom and Ofgem, which all support an RPI-deflated return below 6 per cent. The CAA also comments on international precedent, including: international TMR estimates collected by Europe Economics for Ofwat in the range of 5.3 to 6.8 per cent in RPI-deflated terms and PwC's estimate of the TMR for Charles de Gaulle airport of 6.3 per cent real RPI-deflated.[56]

Drawing on the above evidence, the CAA concludes on a TMR range of 5 to 6.25 per cent real RPI-deflated, with the bottom end consistent with evidence on historical returns (UKRN report), forward looking returns (PwC's DGM estimate for HAL and other advisors to UK regulators) and UK precedent (Ofwat, Ofcom and Ofgem) and the top end consistent with the CAA's Q6/RP2 estimates. The CAA notes that the top end reflects its Q6/RP2 estimate,

50 CAA (February 2019), op. cit., para D20-D24.

51 CAA (February 2019), op. cit., para D25-D29.

52 CAA (February 2019), op. cit., para D30-D33.

53 CAA (February 2019), op. cit., para D34-D36.

54 CAA (February 2019), op. cit., para D37.

55 CAA (February 2019), op. cit., para D38.

56 CAA (February 2019), op. cit., para D39-D42.

consistent with the finding that expected returns have fallen since previous reviews and that most sources suggest a TMR of no more than 6 per cent.[57]

The CAA selects a point estimate of 5.4 per cent real RPI-deflated, toward the low end of its overall range, but near the mid-point of the historical evidence (UKRN report), other UK regulators' proposals (Ofgem for RIIO-2 and Ofwat for PR19) and PwC's TMR range for H7.[58]

We consider the CAA's proposed TMR range and point estimate for RP3 (and by extension H7) are downward biased, as many of the TMR estimates the CAA relies on are based on flawed assumptions. We have raised a number of these issues with the CAA's (and its advisor PwC's) estimates in our previous submissions and we refer to these submissions in the rest of this section, where these issues have not been addressed by the CAA.

In particular, we find that the CAA has provided no support for its implicit assertion that the TMR has fallen by 85 bps since the Q6/RP2 reviews from 6.25 to 5.4 per cent real RPI-deflated. We discuss this fundamental point in the following section, while we discuss the detailed issues with the CAA's historic evidence, forward looking evidence and precedent in the subsequent sections.

4.2. There Is No Evidence that Expected Returns Have Fallen Since the Last Review

The CAA presents a point estimate for the TMR of 5.4 per cent, which is 85 bps lower than the point estimate of 6.25 per cent used at the previous Q6/RP2 reviews, consistent with the CAA's assertion that *"expected returns have fallen since previous price reviews"*.[59] Similar assertions have also been made by other UK regulators and their advisors, justifying a reduction in allowed cost of equity in recent UK regulatory consultations.[60]

In this section, we show that these assertions are incorrect and there is no evidence that expected returns have fallen since previous reviews and indeed recent market evidence is consistent with a broadly constant TMR over time.

Realised returns from major equity markets do not support a trend decline in expected returns

Some UK regulators and their advisors argued that UK *realised* returns have fallen in the recent past due to the low interest rate environment, which is indicative that the *expected* returns have fallen as well.[61]

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57 CAA (February 2019), op. cit., para D46-D47.

58 CAA (February 2019), op. cit., para D49.

59 CAA (February 2019), op. cit., para D47.

60 Ofwat states that "evidence points to a materially lower cost of equity for the 2020-2025 period than set for PR14" (Source: Ofwat (December 2017), Delivering Water 2020: Our methodology for the 2019 price review, Appendix 12: Aligning risk and return, p.26).

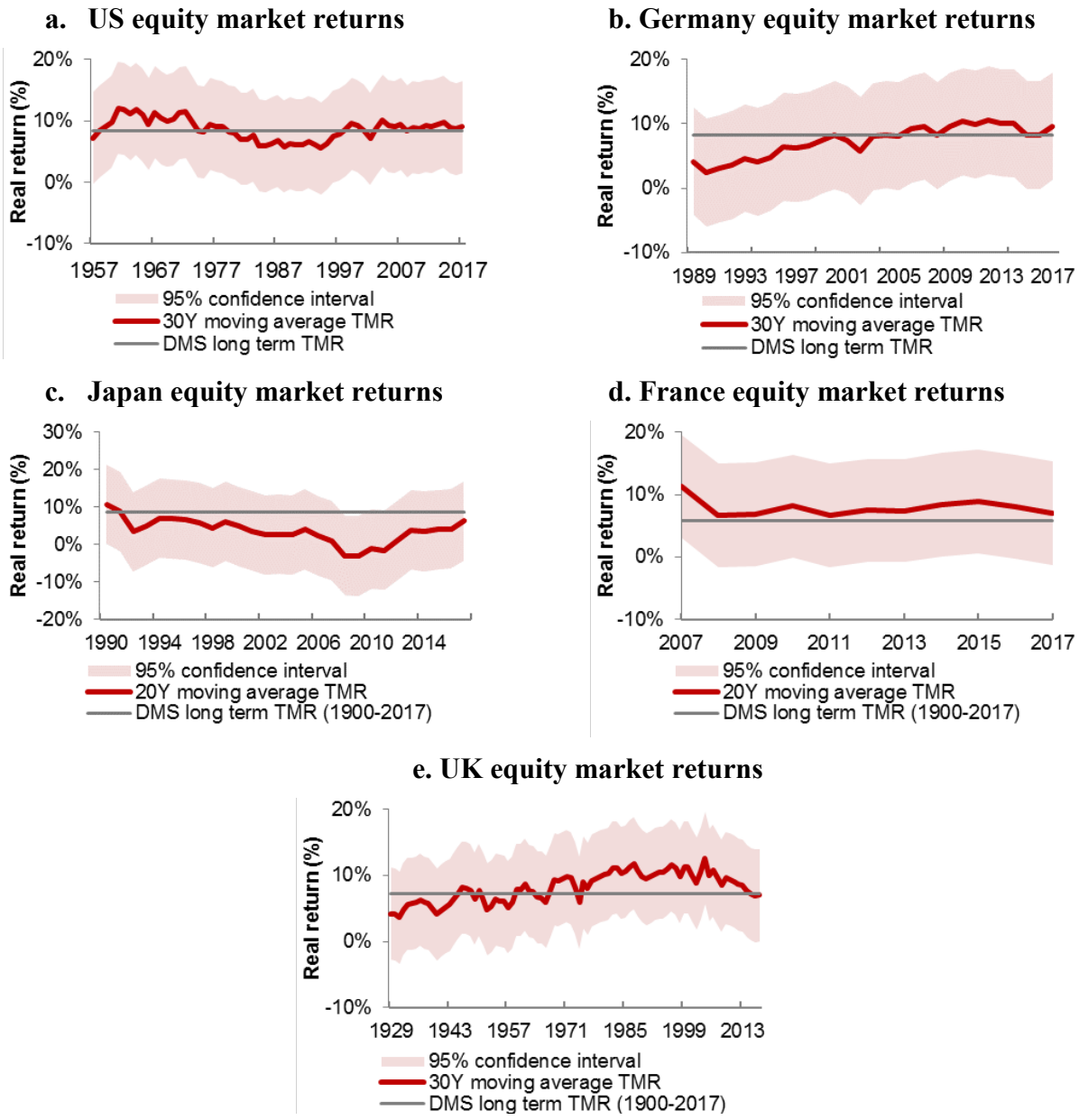
61 See for example Ofwat (December 2017), Delivering Water 2020: Our methodology for the 2019 price review, Appendix 12: Aligning risk and return, Section 5.4.1 and PwC (November 2017), Estimating the cost of capital for H7, pp.35-38.

If this thesis was correct, we would expect to see a decline in equity returns across global equity markets. However, our analysis of recent historical *realised* returns for the five largest global equity markets reveals that there is an upward trend in returns in three of the five largest markets, US, Germany and Japan, while realised returns in France and in the UK do not display any discernible trend, as shown in Figure 4.1 below.[62]

Moreover, in all countries the realised return over the recent period is not statistically different from the long-run average, supporting the conclusion that there is no evidence for the alleged reduction in realised returns. Realised returns data therefore does not support the CAA's assumed decline in the TMR since RP2/Q6.

[62] We calculate real realised returns as a rolling 20-year and 30-year average noting that we can only make inferences around expected returns from market data over relatively long-time period (i.e. minimum 20 to 30-year period). We have calculated 30-year moving average returns for US, Germany, and the UK, while for France and Japan we use 20-year moving average returns, given the shorter available historical series. We note our conclusions are unchanged if we were to use a shorter 10-year trailing average.

Figure 4.1: Major Global Equity Markets Show No Discernible Decline in Realised Returns Over the Recent Period

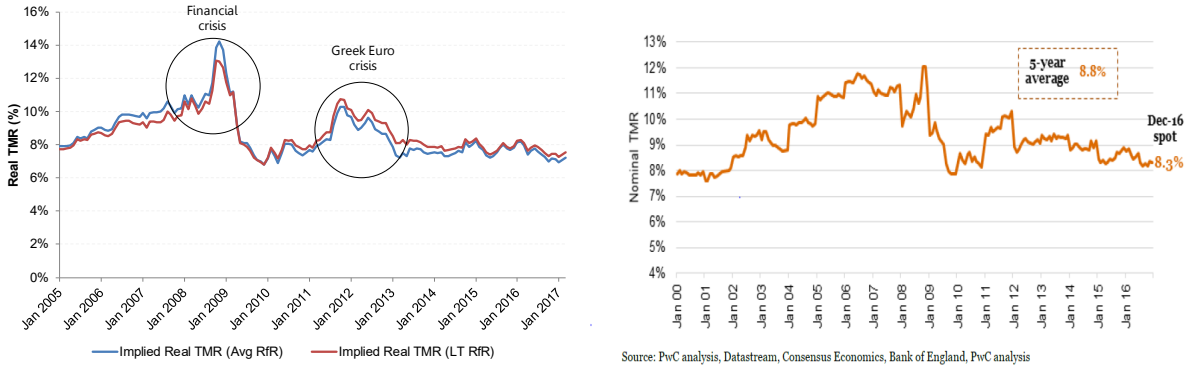


Source: NERA analysis based on data from Bloomberg, OECD, US Bureau of Labour Statistics and DMS (February 2018), Credit Suisse Global Investment Returns Yearbook 2018.

Forward-looking DGM evidence from BoE and PwC does shows TMR relatively stable in recent period

Similarly, evidence from forward looking DGM models, including from the Bank of England and PwC, shows no discernible trend in the TMR estimates over the recent past, as shown in Figure 4.2.

Figure 4.2: DGM Estimates from BoE and PwC Do Not Show a Decline in TMR Over Recent Period



Source: NERA analysis based on data from Bloomberg, OECD, US Bureau of Labour Statistics and DMS (February 2018), Credit Suisse Global Investment Returns Yearbook 2018.

Although we have concerns with the use of DGM to inform the absolute value of TMR given the sensitivity of the results to the dividend growth assumption, as we discuss further in Section 4.4, we can draw on the trend in DGM estimates to assess the CAA's assertion that market evidence supports a decline in market returns. We find that neither the BoE's nor PwC's DGM models shows a trend decline in TMR since RP2/Q6. [63]

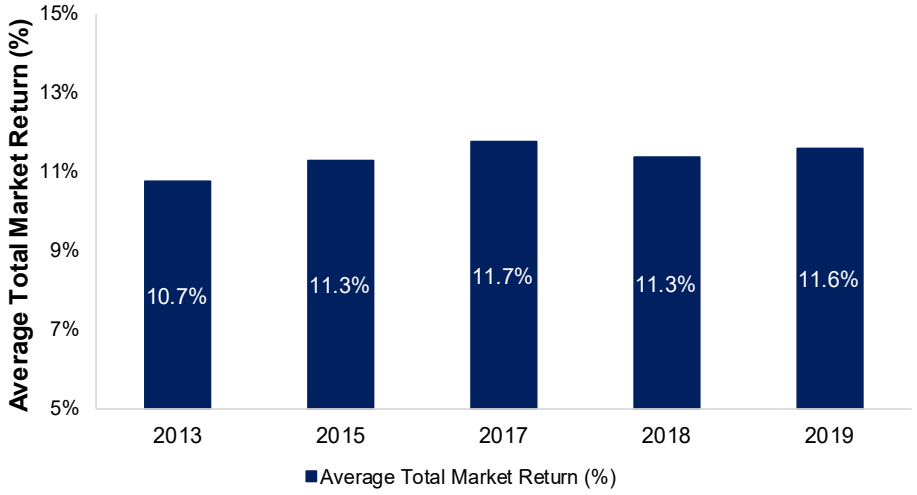
Forward-looking survey evidence also does not show any reduction in TMR in recent period

Forward-looking survey evidence on the TMR from over 40 countries from Fernandez et al., as quoted by PwC in its recent report for Ofwat,[64] shows no systematic decline in the required returns over the wide sample of countries, as shown in Figure 4.3. Indeed, our analysis of Fernandez data shows that the average TMR has increased from 10.7 per cent in 2013 to 11.6 per cent in 2019 on average for the 39 countries included in the survey during 2013 to 2019.

63 For example, PwC's latest DGM spot estimate from February 2019 of 9.4 per cent nominal appears no lower than the value for 2014 in Figure 4.2, which does not support a decline in the TMR for RP3/H7 relative to RP2/Q6.

64 PwC (December 2017), Updated analysis on cost of equity for PR19, p.4.

Figure 4.3: Survey Evidence from Fernandez Does Not Show a Trend Decline in TMR

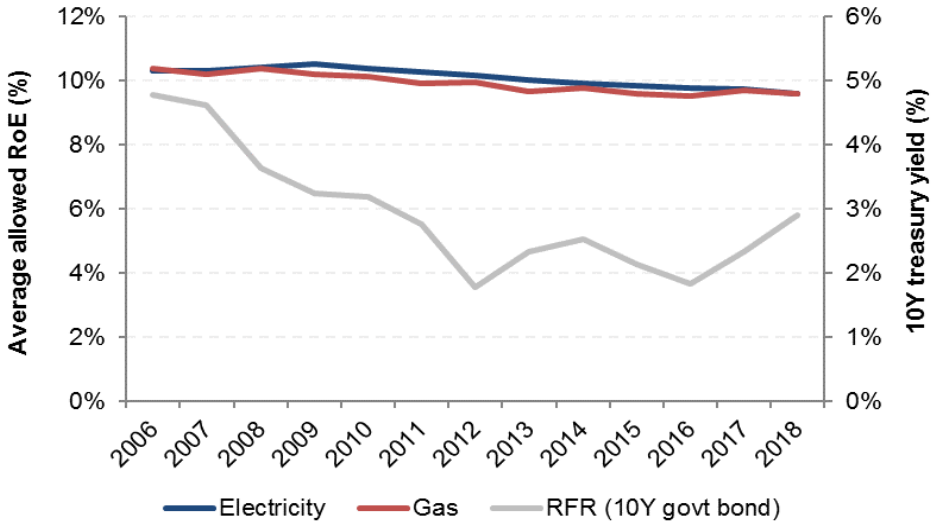


Source: NERA analysis of Fernandez data.

Precedent from North America shows stable equity returns despite falling interest rates

As shown in Figure 4.4, regulatory precedent from the US shows that allowed return on equity for US utilities have remained stable in the most recent period, despite substantive reduction in yields on US government bonds.[65]

Figure 4.4: US Regulators Kept Stable Cost of Equity Allowances Despite Falling Treasury Yields



Note: We show overall RoE as information on individual parameters is not available, given the US regulators' reliance on DGM as a primary model, which produces a RoE directly.
Source: S&P Global Market Intelligence (January 2019), RRA Regulatory Focus – Major Rate Case Decisions – January – December 2018.

[65] As explained in our February 2018 report for HAL, the average gearing has been stable over time, suggesting that the observed trend in RoE was not driven by changes in capital structure assumptions. Source: NERA (February 2018), International precedent on cost of equity, pp.4-5.

In summary, we show that there is no market evidence to support a decline in either realised or expected returns relative to Q6/RP2. Moreover, the CAA's TMR estimate of 6.25 per cent from Q6/RP2 is lower than existing UK determinations including the CMA's latest determination of 6.5 per cent for NIE in 2014 and Bristol water in 2015 and the CAA does not provide evidence that the TMR would have fallen even further since 2014.

In the following sections, we discuss the detailed issues with some of the evidence the CAA relies on in estimating its TMR range for RP3/H7, which leads to a downward biased TMR estimate.

4.3. CAA Estimate of CPI Historical Returns is Downward Biased Due to Reliance on BoE Hybrid RPI/CPI Data and Excessive Adjustment for Long Holding Periods

The CAA relies on the estimate of historical realised returns presented in the 2018 UKRN report of 5 to 6 per cent real RPI-deflated, calculated based on the UKRN recommended TMR range of 6 to 7 per cent real CPI-deflated minus the CAA's estimate of the forward looking RPI-CPI wedge of 100 bps.[66]

As explained in our June 2018 report for HAL,[67] there are a number of issues with the UKRN report estimate of historical realised returns, namely in relation to the use of the Bank of England hybrid CPI/RPI index for deriving historical CPI-deflated returns and the downward adjustment to historical data for alleged predictability of returns at long horizons which forms the basis of the UKRN's lower bound estimate. The CAA failed to address these issues in its proposed TMR for RP3, as we explain below.

4.3.1. Use of BoE hybrid CPI/RPI historical index understates historical CPI deflated returns

As we explained in our June 2018 report for HAL, the key issue with the data labelled as "CPI" by the Bank of England is that it does not represent a CPI index going back to 1900. Instead, it is a mix of an actual and back-casted CPI index for the period 1950-2016 and the RPI index for the earlier period 1915-1949 (as well as another cost of living index for the period 1900-1914). In other words, the alleged "CPI" index from the BoE does not represent measure historical CPI but instead is a hybrid CPI/RPI index.[68]

In its RP2 proposals the CAA argues that using the "CPI" index form the Bank of England is appropriate because the BoE CPI data is calibrated to exclude the RPI "formula effect" and other differences and should be consistent over time, while the structural change to RPI in 2010 implies caution should be exercised in using historical RPI series as an indicator of future RPI-deflated returns.[69]

The CAA fails to address the fundamental point that the BoE "CPI" data does not represent a historical series of CPI inflation but is in fact a hybrid series which combines historical CPI and RPI inflation data (as well as a third cost of living index for part of the period). This

66 CAA (February 2019), op. cit., para D18.

67 NERA (June 2018), Review of UKRN report recommendations on the real TMR.

68 NERA (June 2018), Review of UKRN recommendation son the real TMR, section 3.

69 CAA (February 2019), op. cit., para D23.

hybrid BoE CPI/RPI series therefore cannot be labelled by the CAA as a consistent CPI historical series and indeed no such series which would measure historical CPI inflation going back to 1900 exists for the UK.[70]

The RPI inflation series is therefore the only historical series available as a measure of UK inflation going back to 1900. This conclusion is consistent with the view presented in the ONS paper by O'Donoghue et. al. (2004), which concludes that RPI data presented in Feinstein (1972) for the period before 1947 and the official RPI data post-1947, i.e. the same as the BoE RPI data, represent the appropriate data to be used for making *"long-run comparisons […] of consumer price inflation"*.[71] Similarly, the ONS recently published a *Long term indicator of prices of consumer goods and services* also uses the same RPI data as the Bank of England.[72]

If indeed the CAA wanted to derive a historical real CPI-deflated return, we consider that instead of relying on a hybrid CPI/RPI series form the Bank of England, it should first estimate historical returns using the historical RPI index and then adjust the result for the estimate of the historical RPI-CPI wedge. The historical RPI-CPI wedge in turn should be estimated from available data on the historical difference between RPI and CPI inflation.

- The most reliable evidence on the historical RPI-CPI wedge is available from the period 1989 onwards, when both the RPI and CPI data exists as official indices published by the ONS. Using evidence from this period shows a historical RPI-CPI wedge of 72bps.[73]
- We also have *some* evidence on the historical RPI-CPI wedge over the period 1950 to 1988, drawing on the official RPI index and the back-casted CPI index from the ONS, although the value of the CPI index over this period is less certain given the ONS series reflects a back-cast estimate based on available RPI data rather than a bottom-up derived CPI series from the underlying data. Using evidence from this period shows a historical RPI-CPI wedge of 28bps. [74]
- We have no evidence on the value of CPI inflation (actual or back-casted) prior to 1950 and therefore no evidence on the RPI-CPI wedge.

Based on the above evidence, we consider a historical estimate of the RPI-CPI wedge would lie between 47 bps (calculated over the full historical period since 1950 when *some* CPI data is available) and 72 bps (calculated over the most recent period since 1988 when official CPI data is available).

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70 The CAA also appears to argue that the RPI data used by the BoE for the period prior to 1949 (based on Feinstein (1972) appears to have a different coverage than RPI. As explained in our June 2018 report, according to the ONS paper by O'Donoghue (2004) which compiled the historical RPI data from different sources and that the BoE uses as a source for its RPI, the Feinstein (1972) data was "*put together in a form which was as nearly as possible consistent in concept and definition with the then Central Statistical Office's (post-1947) official estimates of the National Accounts* [i.e. RPI]*"* and hence reflects the best estimate of historical RPI available. (Source: O'Donoghue, Goulding, Allen (March 2004), Consumer price inflation since 1750, p.38-46.)

71 O'Donoghue, Goulding, Allen (March 2004), Consumer price inflation since 1750, p.39.

72 Available at ONS website: https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/cdko/mm23

73 NERA calculations based on ONS data.

74 NERA calculations based on Bank of England (2017), A millennium of macroeconomic data for the UK, tab A47. Wages and prices.

Applying the above historical RPI-CPI wedge of 47 to 72 bps to historical returns deflated using the historical RPI index would then provide an estimate of historical CPI-deflated returns. The CAA could then adjust the above historical figure by its forward-looking RPI-CPI wedge of 100bps[75] to calculate a forward-looking return in RPI-deflated terms. This approach would also address the CAA concern around structural changes to the RPI in 2010, which is corrected for by effectively adjusting the historical real RPI returns by the difference between the historical and the forward-looking RPI-CPI wedge, thus correcting for any structural change in RPI data over time.

4.3.2. Evidence on predictability is contentious and a lower adjustment for long holding periods should be applied based on established methods

As we explained in our June 2018 report for HAL,[76] we consider that the UKRN report 100bps downward adjustment to the arithmetic return for alleged predictability at long-horizons is excessive.

We explained that predictability of returns at long horizons is a contentious issue and there is no consensus in financial literature which provides clear-cut evidence to support the notion of predictability. This was also the conclusion of the earlier 2003 MMW report and the updated analysis from 2013 by Wright and Smithers for Ofgem and the UKRN 2018 report provides no new evidence which would strengthen the case for predictability.[77] The CAA appears to accept the point that returns predictability is a contentious issue, although it argues that PwC's econometric analysis supports the notion of predictability at longer horizons (10 years).

Even if we were to accept the existence of returns predictability at long horizons, which we do not based our review of the evidence in financial literature,[78] we consider the 1 per cent downward adjustment to the arithmetic mean applied by the UKRN report is excessive.

As explained in out July 2018 report for HAL, the UKRN report derives its 1 per cent adjustment from its analysis of decline in variances over long horizons, which ignores the more established methods developed by Blume or JKM for estimating unbiased estimators of the TMR for long investment horizons which also consider serial dependence. These estimators were also used by the CMA in its NIE 2014 and Bristol water 2015 determinations.[79] As we show in Table 4.1, these established estimators provide a more modest downward adjustment relative to the 1 per cent adjustment applied in the UKRN report, below. For example, assuming a 10-year holding period implies a downward adjustment of only 10 to 40bps, which is substantially below the UKRN report assumed 1 per cent adjustment for a 10-year holding period.

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75 CAA (February 2019), op. cit., para D19.

76 NERA (June 2018), Review of UKRN recommendation son the real TMR, section 4.

77 NERA (June 2018), Review of UKRN recommendation son the real TMR, section 4.2 and 4.3.

78 See NERA (June 2018), Review of UKRN recommendation son the real TMR, section 4.2 and 4.3.

79 CMA (March 2014), Northern Ireland Electricity Limited price determination, p.13-27, Table 13.7. In its 2015 Bristol Water determination, the CMA states that the "NIE (2014) represented an appropriate comparison for estimating the equity market return" and adopted the same 6.5 per cent TMR as in NIE (2014) (Source: CMA (October 2015), Bristol Water plc, A reference under section 12(3)(a) of the Water Industry Act 1991, p.332.

The CAA does not address the issue of the appropriate method to adjust for long investment horizons in its RP3 consultation.

4.3.3. NERA updated estimates of historical TMR supports a range of 6.2 to 6.8 per cent (RPI-deflated)

In this section, we present our updated estimate of the TMR derived from historical realised returns, which:

- uses the historical RPI index and RPI-CPI wedge to calculate historical CPI-deflated returns and converts them to a forward-looking RPI-deflated return by applying the forward-looking RPI-CPI wedge; and
- applies the established methods such as Blume and JKM to estimating returns for long investment horizons /holding periods, in line with the CMA approach for NIE in 2014 and Bristol in 2015, which address any potential issues of serial correlation/predictability.

Table 4.1 shows historical realised returns in RPI-deflated using the different methods which account for long-holding periods (such as Blume and JKM discussed above).

Table 4.1: Long-run DMS TMR Estimates (real, RPI-deflated)

	Simple	Overlapping	Blume	JKM
1Y holding	7.1	7.1	7.1	7.1
2Y holding	6.6	7.0	7.1	7.1
5Y holding	6.7	6.8	7.0	7.0
10Y holding	6.8	6.7	7.0	6.7
20Y holding	7.1	6.8	6.8	6.2

Source: NERA calculations using DMS (February 2018), Credit Suisse Global Investment Returns Yearbook 2018 (DMS data since 1988 converted to real RPI-deflated figures for consistency with earlier data).[80].

As explained in our February 2018 report, we consider that evidence supports relatively short holding periods of 1 to 5 years,[81]. This is less than the 10 years advocated by the UKRN report and PwC who argues that many market investors (e.g. pension funds and retail investors) typically have longer-term investment horizons.[82] We find that the average holding periods for the alleged long-term investors mentioned by PwC are typically less than 5 years:

[80] DMS (February 2018), Credit Suisse Global Investment Returns Yearbook 2018, p.214-217. We note that the 2018 DMS publication includes real returns for the UK market since 1988 which have been calculated using CPI as opposed to RPI inflation. (See DMS (February 2018), Credit Suisse Global Investment Returns Yearbook 2018, p.210.) As a result, the DMS reported historical real return for the UK market of 7.3 per cent over the period 1900-2017 should not be interpreted as a real RPI-deflated measure. To ensure consistent treatment of inflation, we have re-calculated the real UK historical returns to be based on an RPI deflated basis. This provides an estimate of historical real returns of 7.1 per cent for the UK market over the period 1900-2017.

[81] NERA (February 2018), Cost of equity for Heathrow in H7, Section 2.2.1.

[82] PwC (February 2019), op. cit., para 5.68.

- A 2018 survey of asset management firms by the Investment Association found that UK retail investors typically held a particular fund for around 3 years;[83]
- A 2016 survey by Schroders found that individual investors typically hold their investments for around 3 years, while pension fund investors have an average holding period of 4.7 years (4.4 years if we consider only the UK and Europe).[84]

We therefore conclude that a holding period assumption of 1 to 5 years remains appropriate for estimating historical TMR. This supports a historical range of 6.8 to 7.1 per cent (RPI-deflated).

As shown in Table 4.2 below, we convert the historical RPI-deflated range to a CPI equivalent using the estimate of RPI-CPI wedge of 47 to 72 bps to calculate a historical CPI-deflated return of between 7.3 and 7.9 per cent. This is higher than the equivalent range from the UKRN report of 6 to 7 per cent, due to i) UKRN report understating the historical CPI returns by relying on a BoE hybrid CPI/RPU series and ii) UKRN report applying an excessive adjustment for long holding periods compared to established methods used by the CMA.

Finally, given the CAA is setting returns under an RPI indexation methodology, we convert the CPI return into an RPI forward-looking return using an estimate of the forward looking RPI-CPI wedge of 100bps (in line with the CAA). This provides a forward-looking RPI-deflated return of 6.2 to 6.8 per cent.

Table 4.2: RPI-deflated TMR Ranges Based on NERA's CPI-deflated TMR

Historical wedge:	1989 Onwards Historical Wedge		1950 Onwards Historical Wedge	
	Low	High	Low	High
Historical RPI TMR	6.80%	7.10%	6.80%	7.10%
RPI-CPI historical wedge	0.72%	0.72%	0.47%	0.47%
Historical CPI TMR	7.57%	7.87%	7.30%	7.60%
RPI-CPI forward-looking wedge	1%	1%	1%	1%
Adjusted RPI TMR range	**6.50%**	**6.80%**	**6.24%**	**6.54%**

Note: Inflation adjustments calculated using the Fisher equation
Source: NERA analysis based on DMS (February 2018) and BoE (2017).

We note our updated real RPI-deflated TMR estimate of 6.2 to 6.8 per cent is lower than the range of 6.5 to 7.1 presented in our February 2018 report for HAL. This reflects an update for the new evidence on different inflation indices raised in the UKRN 2018 report. The

[83] The Investment Association (September 2018), Asset Management in the UK 2017-2018, The Investment Association Annual Survey, p.71; available at https://www.theinvestmentassociation.org/assets/files/research/2018/20180913-fullsummary.pdf.pdf

[84] Schroders (2016), Global Investor Study 2016 – Plan Sponsors, pp.4-5; available at: https://www.schroders.com/en/sysglobalassets/digital/insights/2016/pdfs/global-investors-study-pension-funds.pdf

bottom end of our update range of 6.2 per cent is also consistent with the evidence presented by PwC from Jorda (2017), which supports a real RPI return of 6.2 per cent.[85]

4.4. CAA DGM-based Forward-looking TMR Evidence is Based on Erroneous Assumptions and Downward Biased

The CAA also presents evidence on forward looking TMR calculated using DGM models, including updated estimates from PwC of 5.3 to 6.2 per cent as well as estimates from other UK regulators and their consultants which lies in a range of 4.0 to 6.3 per cent.[86]

As explained in our February 2018 report for HAL, we consider evidence from forward-looking DGM models should be treated with caution, given the relative sensitivity of the results e.g. to the long-term dividend growth assumption, for which there are no equity analyst forecasts available. We therefore recommend relying on historical evidence as the primary source given it is more objective, with forward-looking evidence only as a cross-check. Our recommendation is consistent with the recommendations of the UKRN report as well as Ofgem's consultation for RIIO-2.[87]

Notwithstanding the above general point, the CAA's evidence from forward-looking DGM models (from PwC and other UK regulators' consultants CEPA and EE) is based on erroneous assumptions regarding dividend growth which lead to a substantial downward bias in the TMR estimates, as we summarise below. Instead, we explain that the Bank of England (BoE) DGM estimates, which correct for the biases in the CAA's and its consultants' assumptions and which the CMA relied on it its recent determinations provide the most reliable forward-looking estimates of the TMR.

4.4.1. UK GDP growth cannot be used to proxy FTSE dividends given 70 per cent of FTSE earnings comes from overseas

In our February 2018 report for HAL,[88] we reiterated our earlier criticism that PwC's DGM-TMR estimate is flawed, given it relies on UK GDP growth as a proxy of dividend growth of the FTSE UK all share index. We explained that this assumption is flawed given 70 per cent of earnings of FTSE companies come from overseas and hence the prospects of future dividends depends not only on expected growth for the UK (which is currently somewhat depressed due to Brexit) but also on expected growth from overseas where 70 per cent of the earnings and therefore dividends comes from, which is higher than for the UK. Using a lower UK GDP growth assumption would lead to understating future FTSE dividends and therefore the implied TMR (discount rate) for a given level of the FTSE index.

In its response, PwC acknowledged that FTSE companies derive earnings from overseas but argued that estimates of cost of capital for UK companies require UK specific inputs. PwC

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85 PwC (February 2019), op. cit., p.48.

86 CAA (February 2019), op. cit., para D35-D36.

87 Ofgem states that "we propose to maintain our approach of placing most weight on the average of long run returns, as the most objective measure of investor expectations" (Source: Ofgem (18 December 2018), RIIO-2 Sector Specific Methodology Annex: Finance, p.30). The UKRN report authors recommend that "regulators should continue to base their estimates of the EMR on long-run historic averages" (Source: Wright, S, Burns, P, Mason, R, and Pickford, D (2018), Estimating the cost of capital for implementation of price controls by UK Regulators, An update of Mason, Miles and Wright (2003), p.48.

88 NERA (February 2018), Cost of equity for Heathrow in H7, section 2.4.1.

further notes that if it were to use a global GDP growth assumption, this would produce cost of equity for UK listed firms with global exposure, which would further need to be deconstructed into a UK figure and a non-UK figure. This is, according to PwC, unnecessary and a better estimate for the cost of equity of UK companies can be obtained using UK GDP growth assumptions. PwC also notes that if a global GDP assumption was used, this would also require a global approach to estimating betas, which for utilities would provide lower beta estimates, and the resulting cost of equity may not provide a definitive answer.[89]

PwC's argument in defense of its UK GDP growth assumption for estimating a DGM for the FTSE is illogical. PwC is using a DGM model to estimate a TMR for the UK FTSE index as a whole. The FTSE index reflects all listed UK companies, not just companies with UK activities, and these companies on average derive 70 per cent of their earnings from overseas and hence the forecast dividends have to reflect their international exposure. PwC is correct to say that the use of global GDP growth would result in a cost of equity for UK firms with global activities. But this is precisely the definition of the FTSE index: an index of UK firms with global activities deriving 70 per cent of their earnings from overseas. Hence use of global GDP leads to the correct estimate of the TMR for the FTSE index, which is what PwC is trying to estimate and no further "decomposition" into UK and non-UK activities is necessary.[90] We therefore also disagree with PwC that the use of global GDP growth to proxy dividend growth for the local FTSE index requires a global approach to beta, although we note that for airports the use of a global index would generally produce higher betas than the use of local indices, as shown in our February 2018 report for HAL and in Table 2.6.[91]

The above criticism of relying on UK GDP growth as a proxy applies to the DGM estimates prepared by other UK regulators' consultants CEPA and EE who also erroneously use this assumption, leading to an understatement of the TMR for the FTSE.[92]

4.4.2. Analyst forecast should be used to proxy short term dividend growth

In our February 2018 report for HAL,[93] we also argued that the use of GDP growth as a proxy of short-run dividend growth is problematic, given there is no evidence that short run GDP growth provides a good proxy of investors' expectations of dividend growth.

PwC argues that the use of analyst forecasts for estimating DGM-based TMR for regulatory purposes is problematic, given analyst forecasts are biased and inefficient.

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89 PwC (February 2019), op. cit., p.52, para 5.122-5.123.

90 Indeed, Heathrow itself is an international hub airport serving a global customer base and hence will also be exposed to global growth rather than UK-only growth base (e.g. around 30 per cent of HAL's passengers are transfer passengers). (Source: https://www.heathrow.com/company/company-news-and-information/company-information/facts-and-figures). However, this would only be a relevant consideration if the DGM were to be applied to estimate a cost of equity for Heathrow directly.

91 NERA (February 2018), Cost of equity for Heathrow in H7, Table 3.1.

92 Europe Economics (December 2017), PR19 – Initial Assessment of the Cost of Capital, Section 5; CEPA (February 2018), Review of cost of capital ranges for Ofgem's RIIO-2 for onshore networks, Section 5.1.2 and Annex E.

93 NERA (February 2018), Cost of equity for Heathrow in H7, section 2.4.1.

Our review of recent literature reveals that any evidence of historical optimism bias is not relevant today:

- Much of the historical literature on optimism bias focussed on US companies prior to institutional reforms in 2003, when leading investment banks agreeing to reform analyst pay structures and to rely more on external analyst input in order to mitigate bias in analyst forecasts.[94]
- As a result of the reforms, post-2003 US literature suggests that any bias has been substantively addressed: for example, Ashton et al. (2011) find that the bias in the long-run dividend growth rate due to analyst optimism is insignificant when a US dataset running up to 2006 is used.[95]
- Academic literature based on non-US market data also questions the existence of optimism bias. For example, for the UK, Ryan and Taffler (2006) find that the ratio of sell and buy recommendations is less distorted than in the US.[96] Galanti and Vaubourg (2017) find that optimism bias significantly reduced after the implementation of Commission Sharing Agreements (CSA), which unbundle brokerage and investment research fees, drawing on evidence from France.[97]

Based on our survey of these more recent studies, we conclude there is no evidence that optimism bias in the UK is as prevalent as it may have been in the US in the past.

The use of analysts' forecasts as inputs in to the DGM has a long history in US rate of return testimony and US court decisions consider it the most reliable way of applying a DGM. For example, in 2014, the Federal Energy Regulatory Commission (FERC) relied on security analyst forecasts published by the Institutional Brokers Estimate Systems, when estimating short-term growth rates in the first step of the model.[98]

The use of analyst forecasts also reflects the general approach in academic literature, for example:

- Chin, M. and Polk, C. (2015) use I/B/E/S survey data for calculating short-term dividend growth rates in a DDM model used for estimating expected UK returns;[99]

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94 Sudarsanam, S. (2011), Cost of Equity for Regulated Companies: An International Comparison of Regulatory Practices, p.11.

95 Ashton, D.; Gregory, A. & Wang, P. (2011): Analysts' Optimism in Earnings Forecasts and Biases in Estimates of Implied Cost of Equity Capital and Long-run Growth Rate, University of Bristol Working Paper.

96 Ryan, P. and Taffler, R. (2006), Do Brokerage houses add value? The market impact of UK sell-side analyst recommendation changes, British Accounting Review, vol.38, no.4, pp.371-386.

97 Galanti, S., and Vaubourgm A.G. (May 2017), Optimism bias in financial analysts' earnings forecasts: Do commission sharing agreement rules reduce conflicts of interest?

98 Federal Energy Regulatory Commission, Docket No. EL11-66-001, Opinion No. 531 – Order on Initial Decision, Issued: June 19 2014, p.10, para 17.

99 Chin, M. and Polk, C. (January 2015), Bank of England Working Paper No 520, A forecast evaluation of expected equity return measures, pp.6-7

- Li et al (2013) also use I/B/E/S analyst forecasts as the basis for estimating growth rates that are then used for solving a DDM.[100]
- Patterson, C. (1995) states that "*in valuation tests …. offered strong evidence that investors place the greatest weight on forecasts from Institutional Brokers of Analysts*"[101]

The use of analyst forecasts in the DGM model is also consistent with approaches by central banks including the BoE as well as the European Central Bank (ECB). While the ECB notes that the use of analyst forecasts may be problematic, it also points that:

> *"a better gauge for earnings and dividend expectations than analysts' expectations is hard to come by. (…) In fact,* ***these data constitute the most widely used source of forward-looking earnings expectations for practitioners****"*[102]

We therefore conclude that analyst forecasts should be used as best available evidence on the expected dividends in the short term, in line with approaches by academic literature, financial institutions including central banks and US regulatory precedent.

4.4.3. NERA forward-looking evidence supports TMR higher than historical evidence

As explained in the previous sections, the PwC (and other UK regulators' consultants CEPA and EE) DGM estimates are downward biased due to relying on UK GDP growth as a proxy of dividends for the FTSE which ignores the FTSE companies' exposure to global markets where expected growth is higher compared to UK GDP and disregards higher analyst forecasts in estimating short term dividend growth.

We conclude the correct method to estimate DGM for the UK FTSE index is to use analyst forecasts as a basis of short-term assumptions and GDP growth from countries from which FTSE companies derive their earnings (30 per cent UK and 70 per cent overseas), in line with the approach taken by academics and central banks including the Bank of England.

As shown in our February 2018 report for HAL, evidence from the BoE revised DGM model, which relies on the above assumptions, provides a forward-looking TMR estimates of between 7.2 and 8.1 per cent RPI-deflated. [103] Moreover, the BoE states that its revised model should provide more accurate ERP estimates. [104] Given that the CMA relied on the BoE's DGM based TMR estimates in its 2014 NIE and 2015 Bristol water determinations, [105] i.e. prior to this revision, the fact that the BoE model now provides more accurate ERP estimates would further support its use.

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100 Li, Y., Ng, D. and Swaminathan, B. (2013), Predicting market returns using aggregate implied cost of capital, Journal of financial economics Volume 110 Issue 2, pp.419-436.

101 Patterson, C. (1995), "The Cost of Capital", p.95

102 ECB (2018), Measuring and interpreting the cost of equity in the euro area – Published as part of the ECB Economic Bulletin Issue 4/2018, Section 3. Available at: https://www.ecb.europa.eu/pub/economic-bulletin/articles/2018/html/ecb.ebart201804_02.en.html#toc1

103 NERA (February 2018), Cost of equity for Heathrow in H7, section 2.2.2.

104 Bank of England (2017), Quarterly Bulletin 2017 Q2 – An improved model for understanding equity prices, p.93.

105 CMA (March 2014), Northern Ireland Electricity Limited price determination, pp.13-30 and 13-31; For the 2015 Bristol Water determination, the CMA relied on the same TMR estimate as in the 2014 NIE determination (Source: CMA (October 2015), Bristol Water plc, A reference under section 12(3)(a) of the Water Industry Act 1991, p.332).

Indeed, alternative evidence from Bloomberg DGM which also relies on analyst forecast supports even higher forward-looking TMR values of 8 per cent (spot estimate) to 9.7 per cent (2-year average) real, RPI-deflated.[106]

We therefore conclude that the forward-looking evidence shows higher estimates compared to the historical evidence of 6.2 to 6.8 per cent RPI-deflated.

4.5. CAA Draws on Recent UK Consultations Which Are Affected by Same Issues as CAA's Own Analysis

The CAA also supports its proposed TMR for RP3 of 5.4 per cent RPI-deflated by pointing to recent consultations by other UK regulators including Ofwat, Ofgem and Ofcom.[107]

However, these proposals do not yet represent final decisions and are influenced by the very same issues we point out above with the CAA's own estimates (i.e. understatement of historical returns in UKRN report, errors in consultants' reports in estimating DGM-based TMR).

The most recent precedent from the CMA from its 2014 NIE and 2015 Bristol water determinations, which were made after the CAA's RP2/Q6 decision supports TMR estimate of 6.5% RPI-deflated. Our update of the different approaches the CMA considered in determining the TMR at the 2014 NIE and 2015 Bristol water determinations shows a slight increase in the estimates using updated data compared to the evidence presented by the CMA in 2014 and 2015, which does not support a reduction in TMR.[108]

4.6. Conclusion on a TMR Range

We conclude the CAA proposed TMR range of 5 to 6.25 per cent and especially its point estimate of 5.4 per cent proposed for RP3 is downward biased.

The CAA provides no evidence that the TMR has fallen since the RP2/Q6 decision of 6.25 per cent by 85 bps: indeed, historical data shows no reduction in realised returns over the recent period across global equity markets, forward looking DGM data shows no reduction in expected TMR and forward-looking survey evidence shows no reduction in expected TMR. All this evidence supports the notion of a broadly constant TMR over time and provides no reason for the CAA to reduce its estimate from RP2/Q6, which was already lower than the latest estimate from the CMA of 6.5 per cent from the NIE 2014 and Bristol water 2015 determinations.

The CAA's assessment of the TMR for RP3 relies on selective evidence. In forming its proposed range, the CAA appears to mainly rely on the evidence in the UKRN report and advice from PwC, both of which support unprecedentedly low TMR figures. The CAA

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106 Bloomberg estimates the TMR based on a multi-stage DGM which takes into account short-run growth rates (as provided by equity analysts) as well as long-term sustainable growth rates. From the nominal TMR estimates, we calculate the real TMR by subtracting long-run inflation as published by HM Treasury in its quarterly forecast publications. Estimates as of 6 March 2019.

107 CAA (February 2019), op. cit., para D39.

108 NERA (October 2017), A review of PwC's approach to setting cost of equity in a "lower for longer" era, section 4 and most recently updated in our report for SEW in August 2018 (Source: South East Water (September 2018), Pure know $h_2$ow, Financial, PR19 Supporting Appendix 14, Annex A).

places no weight on the alternative evidence presented by others, including a range of academic papers and evidence from institutions such as the Bank of England, which would lead to higher values for the TMR.

In addition to considering only evidence which supports low TMR figures, the CAA also selects a point estimate of 5.4 per cent, towards the bottom of their estimated range, thus further exacerbating the downward bias in its TMR estimate. This is not the usual approach taken by regulators: given the potential issues resulting from setting a cost of capital that is below the efficient level, regulators have typically erred on the side of caution and consider either the midpoint or the top end of the range. For example, the CMA in its 2014 NIE determination stated that it wished to avoid the cost of capital being too low and selected a point estimate at the top of its range. [109]

The CAA's proposal that the TMR should be substantially reduced at RP3 is driven by a number of issues with the evidence the CAA relies on, which lead to a downward biased TMR range proposed for RP3:

- The historical returns of 5 to 6 per cent real RPI-deflated, which draw on UKRN report estimates, are understated due to: i) UKRN understating CPI-deflated historical returns by relying on a hybrid CPI/RPI inflation series and ii) UKRN excessive adjustment for long-holding periods and alleged predictability of returns.
- The forward-looking DGM-based TMR estimates drawing on PwC's as well as other UK regulators' consultants' calculations are understated due to PwC and other consultants: i) using UK GDP growth to proxy long-term FTSE dividends when FTSE companies derive 70 per cent of earnings from overseas where expected growth is higher and ii) using UK GDP growth to proxy short term dividend growth, which is substantially lower than analyst forecast which we consider represents the best available evidence of short term dividend forecasts.

We calculate updated historical returns of 6.2 to 6.8 per cent RPI-deflated, which draw on historical returns deflated using the RPI index and established methods for estimating TMR for long-holding periods used by the CMA in its NIE 2014 and Bristol water 2015 determinations. We adjust the historical data by the difference between the historical and forward-looking RPI-CPI wedge, drawing on available data on CPI and RPI. This adjustment corrects for any structural changes to the RPI index arising from the 2010 ONS change measuring clothing prices and derives an appropriate forward-looking TMR in RPI-deflated terms.

We also present forward-looking evidence from Bank of England DGM models which supports a TMR of 7 to 8 per cent RPI-deflated, which corrects for issues with the PwC / other consultants' application of the DGM.

We conclude on a TMR range for RP3 of 6.2 to 6.8 per cent RPI deflated, drawing on the historical estimates as the primary evidence. We recommend that forward-looking evidence should be considered as a cross-check only, although we note that BoE estimates support even higher TMR compared to historical estimates.

[109] CMA (March 2014) Northern Ireland Electricity Limited price determination, final determination, p.13-39.

Appendix A. Debt Beta Estimates Using Indirect Estimation Method

In its December 2018 report for the CAA, EE proposes the use of a debt beta formula for calculating the debt beta for NERL at RP3. While the CAA does not mention EE's report in its working paper on the implication of the RP3 consultation for HAL, the CAA does mention that it will review different sources of evidence,[110] which could potentially include EE's evidence. We therefore respond to EE's analysis in the context of the CAA's application of this evidence in the NERL consultation.

A.1. Summary of EE's Debt Beta Approach

EE recommends adopting a debt beta range of 0.1 to 0.19 for NERL at RP3. The lower bound is set in line with the Competition Commission's 2007 decision and Ofcom's 2017 determination, while the upper bound is the result of a formula developed by EE.[111]

EE derives a debt beta formula assuming that the CAPM can be applied to debt and setting an expected return on debt as the weighted average of the promised cost of debt and the loss given default. Its debt beta (β_D) formula relies on the following three equations:

(1) $Expected\ return\ on\ debt\ =\ Prob(default) * \%\ Loss\ given\ default\ +\ (1 - Prob(default)) * Promised\ cost\ of\ debt$

(2) $Debt\ premium\ =\ Promised\ cost\ of\ debt\ -\ Risk\text{–}free\ rate$

(3) $Expected\ return\ on\ debt\ =\ Risk\text{–}free\ rate\ +\ \beta_D * Equity\ risk\ premium$

Relying on these equations, EE then presents the following formula for estimating debt beta:[112]

(4) $\beta_D = \frac{(1 - P_d) * DP - P_d * (RFR + LGD)}{ERP}$

where P_d = probability of default, DP = debt premium, RFR = risk-free rate, LGD = % loss given default and ERP = equity risk premium

To estimate the 0.19 debt beta, Europe Economics uses the following estimates for the individual parameters:[113]

- Nominal risk-free rate of 1.6 per cent based on PwC's midpoint estimate;
- Probability of default = 0.2 per cent, based on an S&P's 2015 study;
- Debt premium = 1.65 per cent, based on the formula debt premium = promised cost of debt − RFR, where the promised cost of debt is 3.32 per cent (Europe

[110] CAA (February 2019), Working paper on the cost of capital: the implications of the RP3 draft performance plan for Heathrow Airport Limited (HAL), para 3.3.

[111] Europe Economics (December 2018), Components of the Cost of Capital for NERL, p.44.

[112] Europe Economics (December 2018), Components of the Cost of Capital for NERL, p.38.

[113] Europe Economics (December 2018), Components of the Cost of Capital for NERL, p.38.

Economics own recommendation) minus 7bps for transaction costs and the risk-free rate is 1.6% based on PwC's midpoint estimate;

- % Loss given default = 20 per cent, a "typical estimate of *costs of bankruptcy* across many sectors" according to Europe Economics;
- ERP of 8.3 per cent, based on the midpoint of PwC's nominal TMR estimate.

In the next section we address several issues with Europe Economics' debt beta estimate based on its application of the indirect estimation method

A.2. EE Formula Differs From the CC's Formula Omitting the Effect of Liquidity Premia on Debt Spreads

As set out by the CMA (then CC) in its 2007 BAA Ltd determination, there are generally two approaches to estimating debt betas:[114]

- Direct method: Estimate debt betas empirically by regressing bond returns against a market portfolio;
- Indirect method: Decompose the observed cost of debt into several smaller components and back out an estimate of the premium for systematic risk.

While EE and the CMA rely on the indirect method, academics such as Schaefer and Myers have estimated debt betas using the direct method. We present evidence on debt betas estimated using the direct method in Section 3.2.

A.2.1. EE makes mistakes in calculating debt beta based on its own formula

Our review of EE's calculations reveals that EE's application of its debt beta formula assumes an incorrect ERP estimate.

EE states that it uses an ERP estimate of 8.3 per cent and that this is based on the midpoint of PwC's range. However, 8.3 per cent is the mid-point of PwC's TMR range not the ERP range. Subtracting PwC's midpoint risk-free rate estimate (1.6 per cent) from the mid-point of its TMR estimate (8.3 per cent) would result in an ERP of 6.7 per cent, which is the figure EE should have used in its calculations.

Correcting EE's calculation to use an ERP of 6.7 per cent in line with the mid-point of PwC's range, we calculate a debt beta of 0.24 under EE's own methodology. This reflects a considerable increase from EE's debt beta of 0.19, and is also out of line with other debt beta estimates. For example, as discussed in Section 3.2, empirical debt beta estimates by academics including Zalewska, Schaefer and Myers support values relatively closer to 0 as well as PwC's recent empirical estimates, which support a debt beta of closer to 0.1.[115]

[114] Competition Commission (28 September 2007), BAA Ltd, A report on the economic regulation of the London airport companies (Heathrow Airport Ltd and Gatwick Airport Ltd), Appendix F, p.F-24.

[115] PwC (February 2019), op. cit., pp.72-74.

A.2.2. EE's formula fails to take into account the liquidity premium considered by the CMA when estimating debt betas

EE's debt beta formula omits the effect of liquidity premium considered by the CMA when estimating debt betas.

In the 2007 BAA Ltd determination, the CMA (then CC) applied the indirect method of estimating debt betas using the following formula:[116]

$$(5)\ \beta_D = \frac{DP - LP - P_d * (RFR + LGD + DP)}{ERP}$$

where LP = liquidity premium, P_d = probability of default, DP = debt premium, RFR = risk-free rate, LGD = % loss given default and ERP = equity risk premium.

If we combine the debt premium terms in equation (5), we can rewrite it as:

$$(6)\ \beta_D = \frac{(1 - P_d) * DP - LP - P_d * (RFR + LGD)}{ERP}$$

Comparing EE's debt beta formula (equation (4)) with the CMA's debt beta formula (equation (6)), we find that EE's formula fails to take into account the effect of the liquidity premium.

The CMA's formula decomposes the debt-premium into three constituent elements: 1) compensation for holding illiquid assets; 2) compensation to cover the expected costs of default and 3) the residual which reflects investors' compensation for systematic risk exposure. In contrast, EE's formula omits the first element and instead assumes that the debt premium only compensates investors for the expected costs of default, with the remainder assumed to compensate for systematic risk. As a result, EE overstates the systematic risk component of the debt premium and therefore the debt beta. [117] The CMA estimated that the liquidity premium explains between 27 and 37 per cent of the total debt premium,[118] suggesting EE's omission leads to a material overstatement of the debt beta.

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116 Competition Commission (28 September 2007), BAA Ltd, A report on the economic regulation of the London airport companies (Heathrow Airport Ltd and Gatwick Airport Ltd), Appendix F, p.F-24.

117 In its December 2018 report, EE includes a footnote in which it states: "*We note that the Competition Commission 2008 disaggregation of the debt premium into the debt beta included an allowance for transaction costs, referred to there as "liquidity cost"*." (Source: Europe Economics (December 2018), Components of the Cost of Capital for NERL, p.38 fn 38.) It is unclear whether EE's footnote argues that its approach of subtracting 7bps from its cost of debt estimate for NERL, which it previously added to derive the cost of debt from information on traded yields in the first place, is supposed to address the issue of a liquidity premium. If this is EE's argument, then it is flawed, given the liquidity premium reflects the element of the observed debt spreads calculated from traded yields which compensate investors for holding illiquid assets like bonds. This premium is unrelated to EE's estimate that costs of issuing and maintaining a debt portfolio, such as underwriting costs or rating agency fees, add an additional 7bps to the cost of debt estimated from traded yields which should be recognised in the calculation of WACC for regulated companies like NERL.

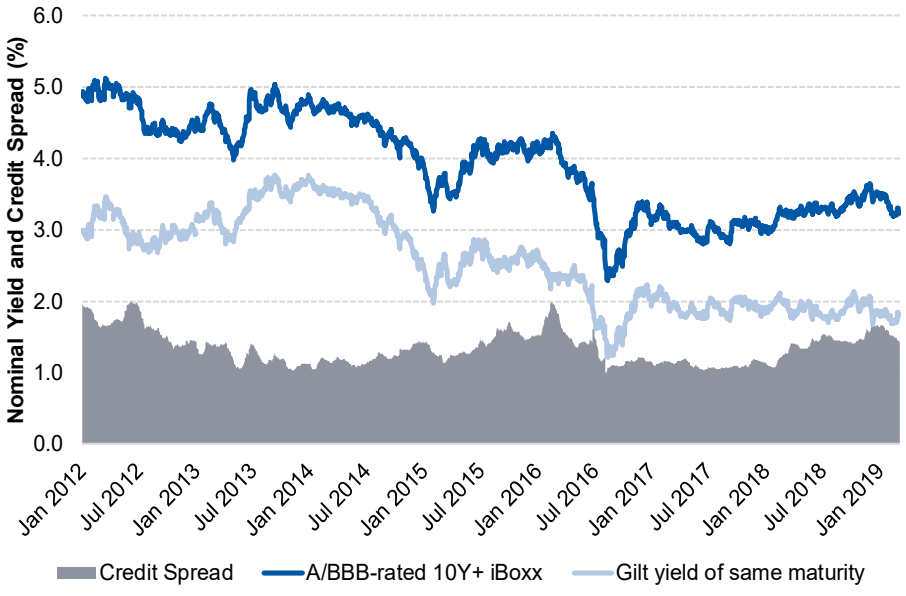
118 In its 2007 determination, the CC calculated the liquidity premium as a percentage of the debt premium between 27 and 37 per cent. Source: Competition Commission (28 September 2007), BAA Ltd, A report on the economic regulation of the London airport companies (Heathrow Airport Ltd and Gatwick Airport Ltd), Appendix F, pp.F-25 para 100.

A.2.3. Correcting for EE's unjustified assumptions used to decompose debt premia support substantially lower debt betas in line with empirical estimates

Moreover, we consider several inputs used by EE in the debt beta calculation are incorrect:

- First, EE's estimate for the default premium is understated compared to the assumption used by CMA's in its 2007 determination. In 2007, the CMA estimated the default premium to be 12.4 to 34.7 per cent of the debt premium, based on estimates from academic literature and corroborated with expected default probabilities and a 45 per cent recovery rate assumptions from Moody's.[119] In contrast, EE estimates the default premium to represent only around 3 per cent of the overall debt premium, substantially below the CMA's estimate. The difference from the CMA's default rate estimate appears driven by two factors: i) EE assumes a probability of default of 0.2 per cent, which appears to be an annual default rate rather than a cumulative default rate over the entire duration of the bond, which understates the expected default probability as cumulative default rates increase with the time horizon; ii) EE assumes a much lower loss given default of 20 per cent compared to the CMA, without providing any reference. [120]
- Second, EE's assumed debt premium of 1.65 per cent is overstated. We have calculated debt spreads for the A/BBB rated iBoxx GBP corporate non-financial index with 10+ years maturity over the risk-free rate with the same maturity, as shown in Figure A.1. Evidence from iBoxx indices supports a debt spread of around 1.29 per cent on average over the last two years for A/BBB investment grade rated debt.

Figure A.1: Debt Premium Implied From iBoxx A/BBB-rated 10Y+ Index Yields



Source: NERA analysis of iBoxx data and Bank of England yield curves

[119] Competition Commission (28 September 2007), BAA Ltd, A report on the economic regulation of the London airport companies (Heathrow Airport Ltd and Gatwick Airport Ltd), Appendix F, p.F-26

[120] Source: Europe Economics (December 2018), Components of the Cost of Capital for NERL, p.38, footnote 39.

- Third, we consider PwC's proposed TMR (and therefore ERP) is understated as explained in Section 4 We calculate a higher TMR of 6.2 to 6.8 per cent (real RPI-deflated). Using the mid-point of our TMR range of 6.5 per cent (real, RPI-deflated) and the mid-point of PwC's estimate of the real risk-free rate of -1.25 per cent (real, RPI-deflated),[121] we calculate an ERP of 7.75 per cent.

If we use our estimate of the debt spread for A/BBB rated bonds, the CMA's estimate of the default premium and liquidity premium, and our estimate of the ERP together with the CMA's debt beta formula, we calculate a debt beta of 0.05 to 0.1, broadly consistent with the empirical estimates discussed in Section 3.

A.2.4. Conclusion: EE debt beta analysis does not provide a reasonable estimate of debt beta for the upcoming price controls

Based on the evidence above, we conclude that the debt beta formula proposed by EE does not provide a reasonable estimate for the debt beta for upcoming price controls.

We find that EE incorrectly estimated the debt beta resulting from its own formula and, correcting for these issues results in higher values of 0.24, substantially above empirical estimates and regulatory precedent, which appears implausibly high, casting doubt on the reliability of EE's proposed debt beta estimation method.

Moreover, we find that EE's formula omits a key component of the debt premium – liquidity premium – as considered by the CMA in its calculation of debt betas in 2007. In addition, we identify several issues with EE's assumed inputs used in the decomposition, including: i) understating the default premium, ii) overstating the debt spread and iii) understating the ERP. Correcting for these issues and applying the CMA formula, we calculate substantially lower debt betas of 0.05 to 0.1.

[121] PwC (February 2019), op. cit., p.14

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