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Dublin Airport Cost of Capital for 2019 Determination

Final Report

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A report for the Commission for Aviation Regulation

30 September 2019

ISSN 2235-1868

Title:	Dublin Airport Cost of Capital for 2019 Determination
Status:	Final Report
Date:	30.09.2019
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Executive Summary

Swiss Economics conducted a study on Dublin Airport's efficient cost of capital for the Commission for Aviation Regulation (CAR) in connection with the 2019 Determination on the maximum level of airport charges. Based on this assessment, we advise CAR to set a real pre-tax rate on the cost of capital of 4.25 percent for the next regulatory period from 2020.

Our advice is based on the sum of our estimate of Dublin Airport's efficient cost of capital, 3.75 percent, and an uplift of 50 basis points to mitigate asymmetric risks between overestimating and underestimating the true cost of capital.

Our analysis of market evidence and regulatory precedent suggests that Dublin Airport's cost of capital ranges from 2.94 percent to 4.52 percent with a point estimate of 3.75 percent. We use a weighted average cost of capital (WACC) framework which takes into account the difference in cost levels for equity and debt. The weighting is based on a notional capital structure that minimises overall capital costs.

The cost of equity ranges from 5.33 percent to 6.46 percent with a point estimate of 5.96 percent. This is the result of a capital asset pricing model (CAPM) approach, which relates Dublin Airport's systematic risk (measured by its Equity Beta) to the current equity risk premium (ERP) and returns on risk-free assets.

The real risk-free rate (RFR) ranges between -1.12 percent to -0.10 percent with a point estimate of -0.61 percent. This range is indicated by current yields on Irish and German government bonds taking into account market expectations on future government bond yields.

The Equity Beta ranges from 0.91 to 0.95 with a point estimate of 0.94. This is the result of our analysis of Dublin Airport's Asset Beta based on 12 comparator airports. We estimate Asset Betas for 9 exchange-listed airports using regression analysis of stock market data with varying time horizons and data frequencies. In addition, we look at Asset Betas set by other regulators for 3 non-listed comparator airports. Comparator airports' Asset Betas are weighted according to their relevance for Dublin Airport in terms of similarity of regulatory environments, demand structure, and business structure. We converted our estimate of Dublin Airport's Asset Beta to an Equity Beta estimate using Dublin Airport's notional gearing and the effective Irish corporate tax rate.

The ERP ranges between 6.57 percent and 7.41 percent with a point estimate of 6.99 percent. This range is based on the delta between total market returns (TMR) and the RFR. We combine backward-looking evidence from long-term averages of equity market returns with forward-looking estimates from a dividend discount model to estimate the TMR.

The cost of debt ranges from 0.37 percent to 1.02 percent with a point estimate of 0.69 percent. We distinguish between cost of embedded debt and cost of new debt. Our estimate of cost of embedded debt is based on Dublin Airport's current interest payments and the expected level of interest payments on existing debt facilities during the next regulatory period. The cost of new debt is based on an index for yields of investment-grade corporate bonds and adjusted by market forward rates. We weight rates for embedded and new debt according to the debt structure expected over the next regulatory period.

Table 1 summarises our advice and reports the findings of our analyses on the individual WACC components.

Table 1: Overview of advice for individual WACC components

	Lower bound	Upper bound	Point estimate
Gearing	45%	55%	50%
Tax Rate			12.50%
RFR	-1.12%	-0.10%	-0.61%
TMR	5.96%	6.80%	6.38%
ERP	6.57%	7.41%	6.99%
Asset Beta	0.48	0.51	0.50
Equity Beta	0.91	0.95	0.94
Cost of equity (post-tax)	5.33%	6.46%	5.96%
Cost of debt (pre-tax)	0.37%	1.02%	0.69%
Estimate of pre-tax WACC	**2.94%**	**4.52%**	**3.75%**
Aiming up			0.50%
Advice on regulatory pre-tax WACC			**4.25%**

Note: All rates are reported in real terms.

Source: Swiss Economics.

Our final estimate of Dublin Airport's WACC has increased by 26 basis points compared to a draft version of this report that was published alongside CAR's Draft Determination in May 2019. The adjustment of the level of the WACC was indicated by updated evidence on current market conditions and by specific amendments to the methodology of estimating certain WACC elements, which resulted from extensive stakeholder consultation.

Our estimate of the pre-tax WACC decreases by 3 basis points if the notional credit rating underlying the determination of Dublin Airport's cost of debt is increased by a notch from BBB to BBB+. Thus, if a BBB+ credit rating is considered a more appropriate notional credit rating, our advice would be to set the regulatory pre-tax WACC at 4.22 percent.

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Abbreviations

AEEGSI	Italian Regulatory Authority for Electricity and Water
bn	billion
bps	basis points
CAA	Civil Aviation Authority
Capex	capital expenditure
CAPM	Capital asset pricing model
CAR	Commission for Aviation Regulation
CER	Commission for Energy Regulation
CIP 2020+	Capital Investment Plan 2020+
Comreg	Commission for Communications Regulation
daa	Dublin Airport Authority
DDM	Dividend Discount Model
DMS	Dimson, Marsh, and Staunton
e.g.	for example
ECB	European Central Bank
EDF	Electricité de France
EIB	European Investment Bank
ENAC	Ente Nazionale per l'Aviazione Civile
ERP	Equity Risk Premium
ESBN	Electricity Supply Board Networks
GARCH	Generalized autoregressive conditional heteroskedasticity
GDP	Gross Domestic Product
GER	Germany
GLS	Generalized Least Squares
GNI	Gas Networks Ireland
IATA	International Air Transport Association
i.e.	in other words
IRE	Ireland
ISIN	International Securities Identification Number
m	million
mppa	million passenger per annum
Ofgem	Office of Gas and Electricity Markets
OLS	Ordinary Least Squares
Opex	operating expenditure
Q	quarter

QE	Quantitative Easing
RAB	Regulatory Asset Base
RFR	Risk-free Rate
S&P	Standard & Poor
SE	Swiss Economics
TMR	Total Market Return
Totex	Total Expenditure
UK	United Kingdom
UKRN	United Kingdom Regulatory Network
WACC	Weighted Average Cost of Capital

1 Introduction

1.1 Background

1 The Commission for Aviation Regulation (CAR) commissioned Swiss Economics SE AG (Swiss Economics) to conduct a study on Dublin Airport's efficient pre-tax cost of capital in connection with its 2019 Determination on the maximum level of airport charges (2019 Determination). CAR published a draft version of the report along its Draft Determination in May 2019. This Final Report builds on the methodology employed in the Draft Report. We amended specific aspects where recent developments or arguments, which were brought forward by stakeholders, indicated that our methodology could be improved. All changes compared to the Draft Report are described in dedicated subsections within the sections on the various WACC elements. Analyses relying on current evidence were updated with recent financial market data up to August 2019.

2 Dublin Airport is Ireland's busiest airport with passenger numbers in excess of 30 million per annum. It is the country's main gateway for incoming and outgoing travellers. Price regulation ensures that charges to airlines for using the facilities at Dublin Airport are not higher than necessary. Dublin Airport is operated and owned by daa plc (daa).

3 The 2019 Determination will apply from 1 January 2020 for a period of at least four years and will replace the current 2014 Determination. CAR aims to set maximum allowable airport charges per passenger such that Dublin Airport's revenues cover the total efficient economic costs for its operations. These include a rate of return on the Regulatory Asset Base (RAB) that reimburses investors and lenders for accepting risk and foregoing alternative opportunities when providing Dublin Airport with the necessary funds to efficiently operate the regulated entity.

1.2 Methodology

4 In line with Irish regulatory precedent, we determine the appropriate rate of return using the Weighted Average Cost of Capital (WACC) approach. We estimate the WACC on a real, pre-tax basis in order to be consistent with other building blocks of CAR's regulatory scheme.

5 The pre-tax WACC is defined by the following formula:

$$WACC = R_E \times (1 - g) \times \frac{1}{1 - T} + R_D \times g \quad (1)$$

where

- g is the gearing ratio;
- R_E is the real and efficient post-tax cost of equity;
- T is the Irish corporate tax rate (currently at 12.5 percent); and
- R_D is the real and efficient pre-tax cost of debt.

6 We estimate the cost of equity using the capital asset pricing model (CAPM):

$$R_E = RFR + \beta \times (TMR - RFR) \quad (2)$$

where

- RFR is the risk-free rate;
- β measures the sensitivity of Dublin Airport equity returns with reference to changes in returns of the market portfolio; and
- TMR are expected total market returns.

7 We estimate the cost of debt R_D based on weighted estimates for the cost of embedded debt and the cost of new debt.

8 Each component of the WACC is assessed based on quantitative and qualitative evidence, keeping economic theory and regulatory practice in mind. Specifically, we have considered the following sources of evidence:

- relevant theory from financial economics and corporate finance;
- empirical results from academic studies;
- actual market data of government and corporate bond yields, stock returns, and central bank interest rates; and
- regulatory precedent in Ireland and Europe.

9 We had a strong focus on stakeholder engagement during the process and held multiple meetings and calls with daa as well as airlines. Opinions and views from stakeholders that were considered already in the Draft Report include the following:

- various stakeholders' views expressed in responses to CAR's Issues Paper;
- various stakeholders' views expressed during calls and meetings between November to December 2018;
- a report prepared by Nera Economic Consulting (Nera) on Dublin Airport's cost of capital dated December 2018, which was commissioned by daa;
- a note from the International Air Transport Association (IATA) dated 10 January 2019;
- a letter from Ryanair to Swiss Economics dated 16 January 2019; and
- a slide pack from Nera dated 22 January 2019.

10 For the finalisation of the report, we considered the stakeholder responses to the Draft Determination. In particular, we considered comments on the WACC methodology expressed in a variety of manners including:

- written stakeholder responses from ACI Europe, Dublin Airport (including a technical appendix written by Nera), Chambers Ireland, IATA, and Ryanair;
- a workshop between representatives of CAR, Dublin Airport, Nera, and Swiss Economics on 21 August 2019;
- a supplementary submission from Ryanair regarding Dublin Airport's submission dated 21 August 2019; and
- various e-mails of representatives from Dublin Airport to CAR sent in August and September 2019.

11 Appendix B presents our responses to the written stakeholder submissions.

1.3 Structure

12 The remaining parts of the report are structured as follows:

- in Section 2, we analyse Dublin Airport's notional gearing;
- in Section 3, we quantify the appropriate level of the risk-free rate;
- in Section 4, we assess the risk premium for holding equity;
- in Section 5, we estimate Dublin Airport's Beta;
- in Section 6, we determine the cost of debt for Dublin Airport;
- in Section 7, we discuss arguments for aiming up the WACC; and
- Section 8 concludes.

2 Gearing

13 We base our advice regarding the gearing level on the following evidence and considerations:

- conceptual points on the purpose of the appropriate gearing level; and
- regulatory precedent from CAR and other airport regulators.

2.1 Considerations regarding the appropriate gearing level

14 Rather than reflect Dublin Airport's actual gearing, the notional capital structure underlying the regulatory WACC should reflect a hypothetical gearing rate representing the capital structure that an efficient airport operator would choose in order to minimise cost of capital. The notional capital structure optimises the trade-off arising from increasing debt levels between greater tax benefits (as cost of debt is tax deductible) and increased risk (for which equity holders must be reimbursed). Independent of theoretical considerations, the notional gearing ratio should be set so that it can be achieved by Dublin Airport over the next regulatory period so that financial viability is not put at risk.

15 daa's actual gearing level is currently below 50 percent. According to daa's 2017 financial statement, total assets amount to €2.7bn with gross debt of €1.1bn (i.e. 41 percent of total assets). However, daa raises debt on the group level without distinguishing between various business activities. Borrowings used to finance assets for Cork Airport, ARI, daa's airport retailing business, or daa international, daa's management and advisory services, cannot be distinguished from borrowings used to finance Dublin Airport assets.

16 If all of daa's debt was allocated to Dublin Airport assets, the corresponding gearing ratio would be approximately [✂] percent.[1] This value represents the maximum achievable gearing ratio for Dublin Airport in the short term and should not be exceeded substantially by the upper boundary of gearing ratio range.

17 **Table 2** summarises regulatory precedent of European airport regulators regarding the gearing ratio.

Table 2: Recent regulatory precedent on gearing ratios of airports

Regulator	Decision	Point estimate	Based on
HMWEVL (2017)	Fraport 2017 WACC Determination	52%	n/a
ENAC (2016)	Aeroporti di Roma WACC Determination for 2017-2021 Price Control Period	57%	n/a
CAA (2014)	Q6 (2015-2019) Price Control of Heathrow	60%	Gearing as debt to regulatory asset base
CAA (2014)	Q6 (2015-2019) Price Control of Gatwick	55%	Gearing as debt to regulatory asset base
CAR (2014)	Maximum Level of Airport Charges at Dublin Airport 2014 Determination	50%	n/a

Source: Swiss Economics based on regulatory decisions.

18 We note that other airport regulators have typically chosen values for the notional gearing ratio between 50 percent to 60 percent.

[1] This is based on current total debt of [✂] and a regulatory asset base (RAB) of €1.5bn (see Section 6).

19 CAR has used a gearing ratio of 50 percent in past decisions, mimicking a balanced capital structure that takes into account the trade-off between tax benefits and risk described above. There is merit in maintaining the current gearing ratio for the next regulatory period in the absence of a compelling reason to deviate. Regulatory consistency is likely to increase investor and creditor confidence and have a hampering effect on the cost of capital.

20 Also, no stakeholder has raised any concerns in connection with our proposal to keep the gearing rate at a level of 50 percent.

2.2 Methodological changes compared to the Draft Report

21 We have not changed the methodology for assessing Dublin Airport's notional gearing compared to the Draft Report.

2.3 Conclusion

22 There is no compelling reason to deviate from the notional capital structure used in past decisions. In the interest of regulatory consistency, we advise to continue using a gearing rate of 50 percent.

23 **Table 3** summarises our advice.

Table 3: Summary gearing rate

	Range (in %)	Point estimate (in %)
2019 SE advice	45 – 55	50
CAR 2014 Determination	40 – 60	50

Source: Swiss Economics.

3 The risk-free rate

24 The level of the RFR can be assessed using a benchmark security that proxies the characteristics of a risk-free asset. Theoretically, the benchmark security has the following properties:

- no variance, i.e. a guaranteed fixed return absent of any credit default risks;
- no liquidity or reinvestment risks;
- no currency risks; and
- no risks in connection with inflation.

25 We consider the following evidence to estimate the level of the RFR:

- current market evidence from Irish and German government bond yields;
- evidence from forward rates and effects of monetary policy; and
- regulatory precedent.

3.1 Evidence from current government bond yields

3.1.1 Nominal yields of Irish and German government bonds

26 We use long-term Irish and German government bond yields as a benchmark for the RFR. Given their discretion to levy taxes, governments are frequently perceived as the most reliable debtors.

27 The use of Irish government bonds as benchmark is in line with the Thessaloniki Forum of Airport Charges Regulators (Thessaloniki Forum) recommendations, which suggest using bonds from the member state the airport is located in (Thessaloniki Forum Guidelines, 2016, p. 4). Although it is not explicitly mentioned by the Thessaloniki Forum, we consider that for airports in the Euro area, bonds from other Euro countries are relevant as well. This is illustrated by the fact that daa is not limited to raise funds in Ireland. For example, most of its existing debt was raised through the European Investment Bank. This is of relevance because bonds from other countries in the Euro area are perceived to be lower risk than Irish government bonds.

28 Within the Euro area, German government bonds are often considered to be the least risky assets by practitioners (van Riet, 2017). Even though Luxembourg and the Netherlands similarly achieve the highest possible credit ratings, German government bonds trade at higher volumes implying slightly lower liquidity risks.

29 We focus on liquid bonds with a relatively long investment horizon, i.e. 10 years to maturity, reflecting that physical assets at Dublin Airport are of long-term nature. In addition, investors seeking to invest in airport assets with limited business risk, such as pension funds, are likely to have a relatively long investment horizon.

30 The use of Irish and German 10-year government bonds is consistent with Irish regulatory precedent. The Commission for Energy Regulation (CER) and the Commission for Communications Regulation (Comreg) have both relied on consultant reports that considered 10-year government bond yields as evidence for the appropriate RFR. For example, CER's 2016 Decision Paper for the Second Revenue Control 2017 – 2018 for Irish Water cites a report by Europe Economics (2016) which refers, among other evidence, to yields of 10-year Euro area bond markets to inform the level of the RFR. Similarly, Comreg's 2014 decision on the WACC for mobile, fixed line, and broadcasting services in Ireland is based on a consultancy report referring to 10-year government bond yields in the Euro area.

31 Most recent consultation papers from Irish regulators continue to use 10-year government bonds when looking at current market evidence of the RFR. For example, the Commission for Regulation of Utilities (CRU) uses Irish government bond yields in its Consultation Paper 2091 for market evidence on the RFR.

32 **Table 4** recaps the methodologies used by various Irish regulators in past decisions. From the widespread adoption of current government bond yields, we conclude that their relevance as evidence to inform the RFR is uncontroversial.

Table 4: Use of current government bond yields in regulatory precedent

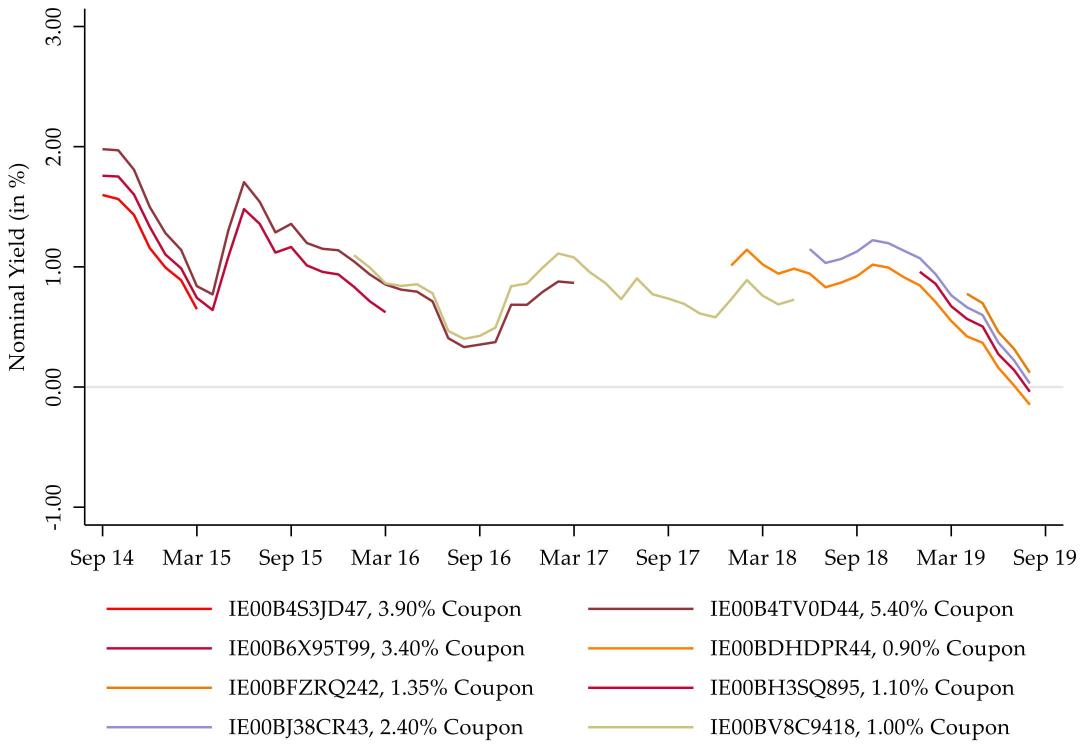
Regulator	Decision	Issuing government	Time horizon	Importance
CRU (2019)	Irish Water Revenue Control Consultation Paper	Ireland	10-year bonds	Irish government bond yields, adjusted with forward-looking evidence
CER (2016)	Second Revenue Control period 2017 – 2018 for Irish Water	Euro area governments	10-year bonds	Pre-2008 yields considered.
CER (2016)	ESBN/EirGrid PR4	Germany	10-year bonds	Yields considered for lower bound of estimate.
Comreg (2014)	2014-Decision on Cost of Capital for mobile, fixed, and broadcasting	Germany	10-year bonds	German government bonds from 2000-October 2014 considered.
CAR (2014)	Airport Charges 2014-Determination	Germany	10-year bonds	Yields considered for lower bound of estimate.

Note: The importance of the CER (2016) ESBN/EirGrid government bonds becomes clear only in the consultant's report prepared for CER by Europe Economics.

Source: Swiss Economics based on regulatory reports.

33 **Figure 1** displays nominal yields of Irish government bonds over time. All bonds pay a fixed annual coupon and are denominated in Euros. We focus on bonds with a remaining duration to maturity of between 8 to 12 years. Spreads between yields are small. They are the result of slightly different weights of short-term and long-term risks between bonds with 8 years to maturity and bonds with 12 years to maturity. Marginal changes in cash-flow profiles, due to differences in coupon payments, may play a role as well.

Figure 1: Nominal yields of Irish government bonds



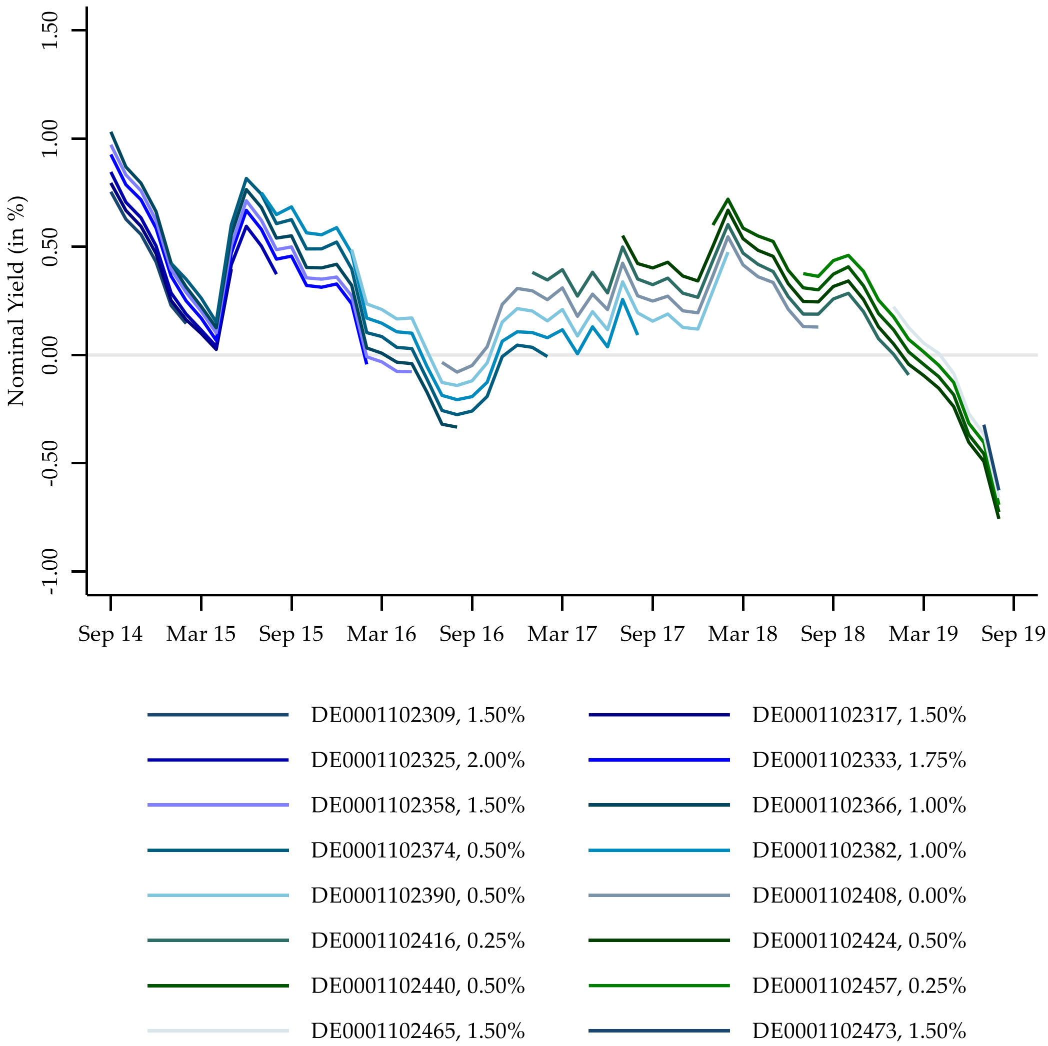
Note: Illustrated are nominal yields of Irish government bonds with a remaining time to maturity between 8 to 12 years. Only Euro-denominated fixed coupon bonds are considered.

Source: Swiss Economics based on Infront data.

34 After the European debt crisis rescinded, nominal yields of Irish government bonds dropped significantly in 2014. Since 2015, yields remained on a level at around 1.00 percent. Recently, Irish government bond yields have dropped to a new low. In August 2019, nominal yields of bonds with approximately 10 years remaining to maturity were negative.

35 A similar picture is revealed for German government bonds. German bonds have always been traded at slightly higher prices (i.e. lower nominal yields) compared to Irish bonds. The substantial decrease in yields in 2014 could be observed for German government bonds as well. **Figure 2** displays nominal yields of Euro denominated German government bonds with 8 to 12 years remaining to maturity.

Figure 2: Nominal yields of German government bonds

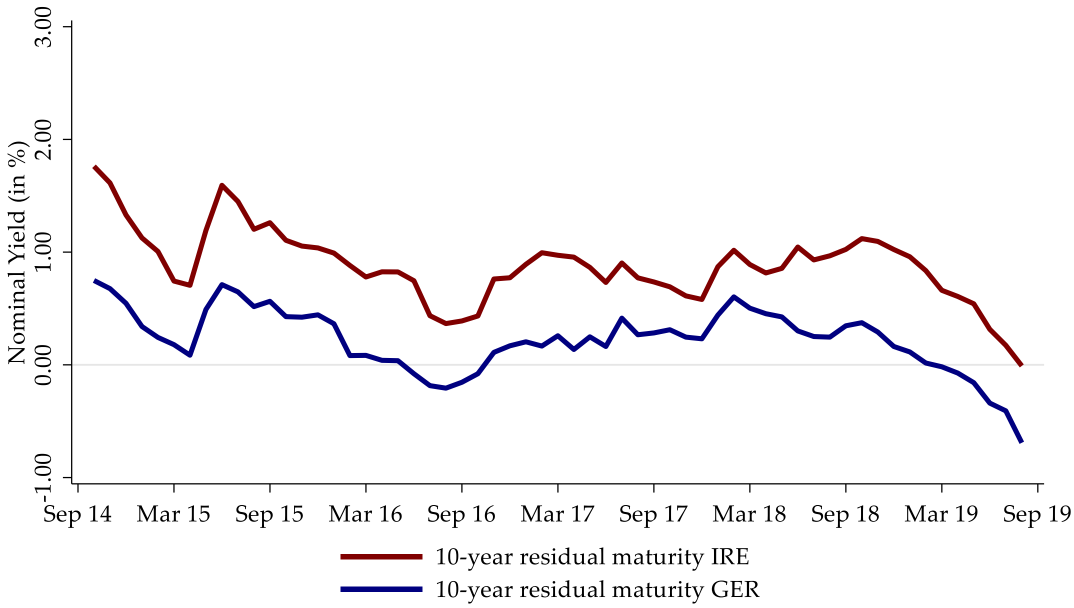


Note: Illustrated are nominal yields of German government bonds with a remaining time to maturity between 8 to 12 years. Only Euro-denominated fixed coupon bonds are considered.

Source: Swiss Economics based on Infront data.

36 **Figure 3** shows average series of Irish and German government bond yields using the data presented in **Figure 1** and **Figure 2**. The series indicate the range of the RFR in nominal terms based on current market data.

Figure 3: Average nominal yields of Irish and German government bonds



Note: The series reflect arithmetic averages of the yields for all issued Irish and German government bonds with a residual time to maturity between 8 to 12 years.

Source: Swiss Economics based on Infront data.

3.1.2 Conversion from nominal to real yields

37 To be consistent with other building blocks, we express the level of the RFR and all other WACC components in real terms.

38 Nominal government bond yields are converted to real yields using the Fisher equation (Fisher, 1930):

$$1 + i_t = (1 + n_t)/(1 + \pi_t^e) \tag{3}$$

where

- i_t is the real yield at time t;
- n_t is the nominal yield at time t; and
- π_t^e is the long-term expected inflation at time t.

39 The rate of expected inflation cannot be observed directly in the market. It must be approximated using proxy variables. We use two different sources to estimate long-term inflation expectations.

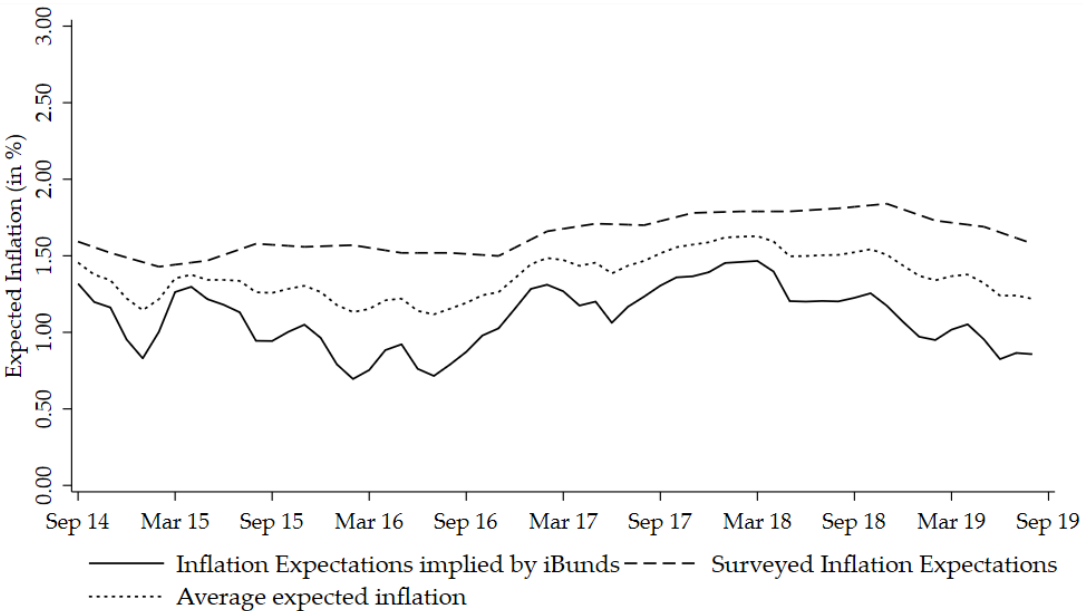
- Firstly, we use survey data maintained by the European Central Bank (ECB). The ECB regularly surveys professional forecasters on their expectations of inflation rates in the Euro area at various time horizons and publishes the results quarterly.[2] Survey participants are expert economists who work at financial or non-financial institutions, such as banks or independent economic research institutes. **Figure 4** shows that surveyed inflation expectations have remained relatively stable over the past 5 years, ranging from 1.5 percent to 1.8 percent. In Q3 of 2019, expected average inflation over the next 10 years is close to 1.5 percent. One potential problem with this source is that expectations of surveyed experts do not necessarily coincide with true market expectations.

[2] See https://www.ecb.europa.eu/stats/ecb_surveys/survey_of_professional_forecasters/html/index.en.html.

- Secondly, we use yield data on inflation-linked German government bonds, which directly incorporate the market's inflation expectations. Inflation-linked bonds have frequently been suggested as a proxy of the real RFR (see for example UKRN, 2018). In addition to strong creditor risk profiles, inflation-linked government bonds eliminate risks related to changes in general price levels, which, in theory, brings them closer to the concept of a risk-free asset. However, in practice, inflation-linked bonds often have issues of reduced liquidity, which offset the inflation risk advantage compared to nominal bonds (see for example Auckenthaler et. al, 2015).

40 **Figure 4** illustrates the rate of expected long-term inflation derived from the two sources. We use an average of the two series to convert nominal to real rates.

Figure 4: Expected annual inflation over the next 10 years

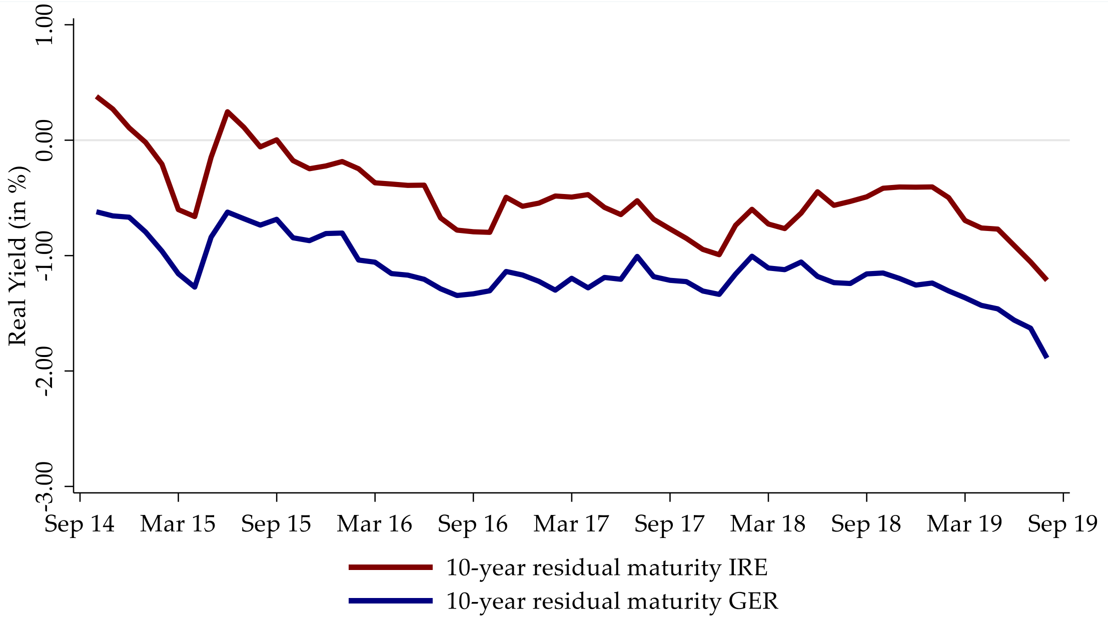


Note: The expected rate of inflation based on the ECB survey of professional forecasters was calculated using the geometric mean of expected annual inflation over the next 10 years. Monthly values were interpolated from quarterly observations. Inflation expectations implied by German government bonds were derived from the spread between nominal German government bonds and inflation-linked German government bonds using the Fisher transformation. We used monthly averages of the nominal yield series displayed in Figure 2 and a series of average yields from German inflation-linked bonds with a remaining 8 to 12 years to maturity (DE0001030542, DE0001030526, DE0001030559, DE0001030567, DE0001030575). We limit ourselves to German inflation-linked government bonds because of data availability for the few existing Irish linkers.

Source: Swiss Economics based on ECB's Survey of Professional Forecasters and Infront data.

41 The resulting time series of real yields for German and Irish government bonds are presented in **Figure 5**.

Figure 5: Real government bond yields



Source: Swiss Economics based on Infront data.

42 We use averages over various time periods ranging from 1 to 5 years to estimate the current real RFR.

43 Spot rates or short averaging periods risk picking up random fluctuations or temporary market sentiments that do not bear any meaningful information about the true RFR. Long averaging periods, on the other hand, risk including yields that do no longer reflect relevant market conditions.

Table 5: Average real yields

Bond	1-year average	2-year average	5-year average
Irish Government Bonds	-0.67%	-0.69%	-0.47%
German Government Bonds	-1.39%	-1.28%	-1.12%

Note: 1-year averages are calculated over the period from September 2018 to August 2019, 2-year averages are calculated over the period from September 2017 to August 2019, and 5-year averages are calculated over the period from September 2014 to August 2019. Only Euro denominated bonds with 8 to 12 years remaining to maturity were considered. Conversion from nominal to real terms based on inflation expectations derived from ECB survey and spread between nominal and inflation-linked German government bonds.

Source: Swiss Economics based on Infront data.

3.2 Forward rates

44 Forward rates reflect market expectations about future yields. They are not directly observable in the market, but they can be backed out from spreads between spot rates of bonds with various maturities.

45 Formally, the relationship between spot rates and forward rates is given by the following formula:

$$i_{t_y t_x}^{FOR} = \left[\frac{(1+i_x)^x}{(1+i_y)^y}\right]^{\frac{1}{x-y}} - 1 \quad (4)$$

where

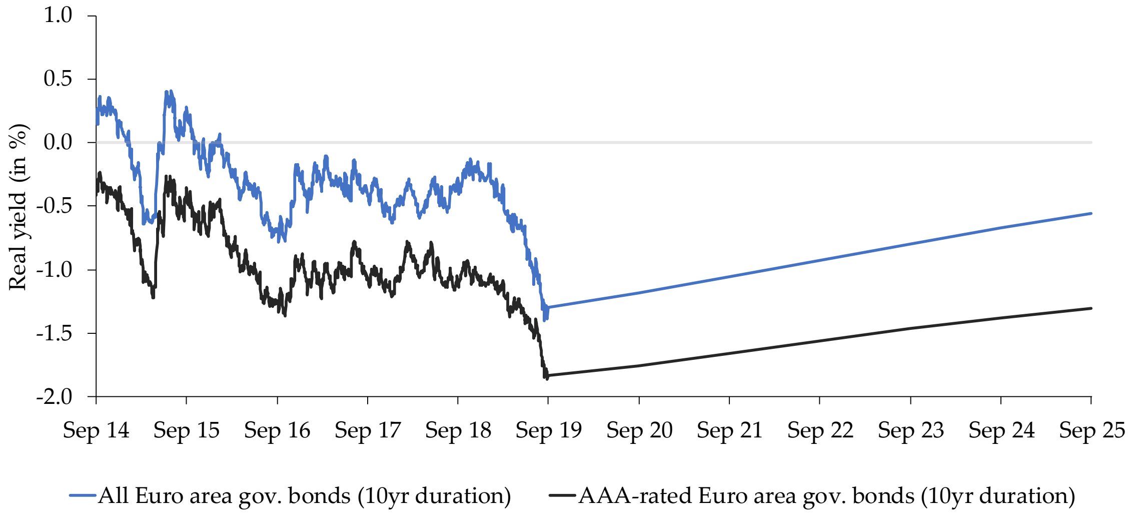
- $i_{t_y t_x}^{FOR}$: implicit forward rate for a bond from t_y to t_x;
- i_x: spot rate at time t_x; and

- i_y: spot rate at time t_y (where t_y is closer to the present than t_x).

46 We use ECB data rather than country-specific German or Irish data for reasons of data availability. The calculation of reliable forward rates requires a wide range of maturities, which is not readily available for Ireland and only to a limited extent for Germany.[3]

47 **Figure 6** depicts implied real forward yields of Euro area government bonds with a remaining duration to maturity of 10 years from January 2019 onwards. Data points before 2019 are actual real yields.

Figure 6: Forward rates implied by government bond spot rates



Note: Spot rates at 31 December 2018 were used as the basis for the calculation of forward rates.

Source: Swiss Economics based on ECB data.

48 The upwards trend in forward rates suggests that the market expects an increase in government bond yields over the next few years. This holds for all Euro area government bonds as well as for AAA-rated bonds, although the expected increase for the latter is slightly less pronounced.

49 **Table 6** summarises market expectations about the increase in yields during the upcoming regulatory period.

[3] In addition, the ECB data also contains government bond yields series for AAA-rated Euro area government bonds as shown in Figure 6. These represent valid proxies for German bond yields since, next to Germany, Luxembourg and the Netherlands are the only AAA-rated countries in the Eurozone. However, their government bond markets are much smaller than the German market and their influence on the AAA-rated Euro area government bonds yields series is limited.

Table 6: Expected real future yields during the upcoming regulatory period

Forward rate	All Euro area bonds	Delta to Aug 19	AAA-rated Euro area bonds	Delta to Aug 19
2020	-1.18%	12 bps	-1.76%	8 bps
2021	-1.06%	24 bps	-1.66%	17 bps
2022	-0.93%	37 bps	-1.56%	27 bps
2023	-0.80%	50 bps	-1.46%	37 bps
2024	-0.67%	62 bps	-1.38%	46 bps
2020 – 2024	**-0.93%**	**37 bps**	**-1.56%**	**27 bps**

Note: Last row shows arithmetic means across all years. Delta to August 2019 values represent the difference in yields to 30 August 2019.

Source: Swiss Economics.

50 The markets expect an average increase in real yields for the period from 2020 to 2024 of 37 basis points for all Euro area bonds and 27 basis points for AAA-rated Euro area bonds. We believe it is appropriate to adjust the current level of the RFR for the market's expectations of future developments over the next regulatory period.

3.3 The impact of Quantitative Easing

51 Over the past years, several regulators have considered the effects of central banks' Quantitative Easing policy when setting the allowed rates of return on capital. Their reasoning has typically been that large-scale asset purchase programs have the potential to temporarily increase demand for government bonds leading to inflated prices and hampered yields.

52 Ofgem, the energy regulator in the UK, adjusted its estimate of the RFR based on market evidence by 100 basis points in order to compensate for the Bank of England's £375bn purchase of gilts in 2014 (Ofgem, 2014).

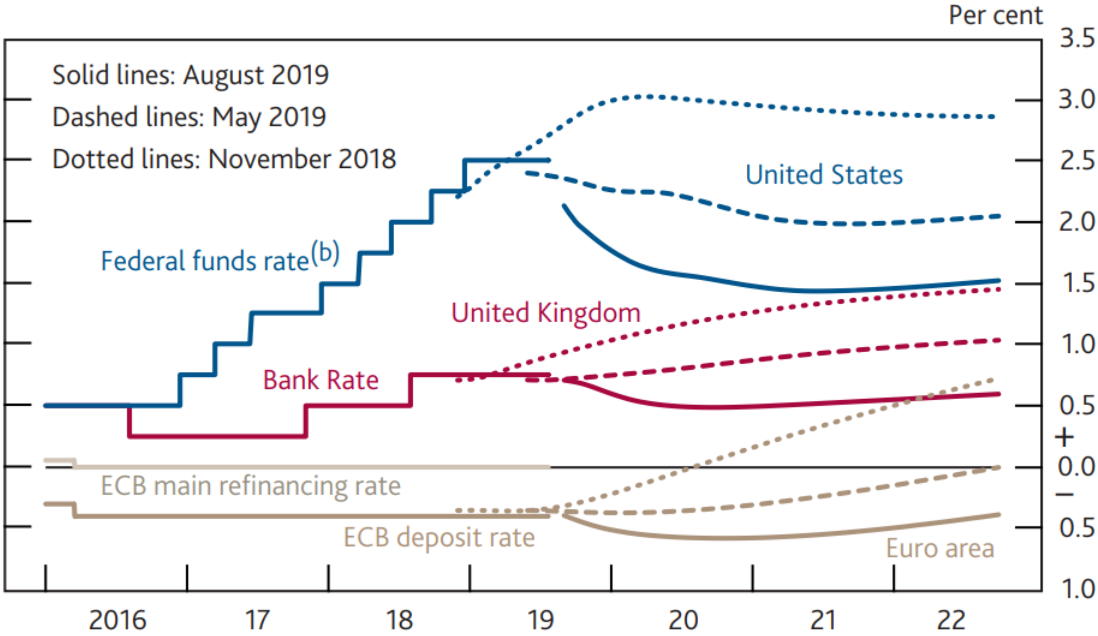
53 For the same reason, the Italian regulator for gas and water AEEGSI added a premium to its estimate of the RFR of around 50 basis points in 2015 (AEEGSI, 2015).

54 In December 2018, the ECB ended its net purchases of European bonds implying a departure of the Quantitative Easing (QE) policy of the past three years.[4] However, besides a short-lived spike, government bond yields have not increased systematically in 2019. On the contrary, recently the fear of an imminent recession has captured financial markets and decreased bond yields again. The ECB is planning to take up quantitative easing again and an increase in bond yields due to more restrictive monetary policy is unlikely in the near future (Financial Times 2019).

55 Recent research from the Bank of England confirms that markets expect central banks to decrease interest rates in the short term again. Over the next couple of years, markets expect ECB interest rates at least to rebound to current levels. **Figure 7** presents central bank base rates and their implied market forward rates as calculated by the Bank of England (2019).

[4] See https://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html.

Figure 7: International central bank base rates expectations by the Bank of England



Note: Forward rates are estimated using instantaneous forward overnight index swap rates in the 15 working days prior to 24 July 2019, 24 April 2019, and 24 October 2018, respectively.

Source: Bank of England August 2019 Inflation Report.

56 In conclusion, we currently do not see any convincing reasons for making adjustments to the current RFR in addition to a moderate uptick that is suggested by forward rates for 10-year government bonds.

3.4 Regulatory consistency and long-term evidence of the RFR

57 During our meetings with stakeholders, we have been asked to reflect Irish precedent with reference to the RFR in our report and to consider the importance of consistency across regulatory periods and across regulated sectors.

3.4.1 Regulatory consistency

58 Indeed, we find that many regulatory decisions in the past referred to previous regulatory decisions as a source of evidence to find the RFR going forward.

59 For example, in their most recent decision from 2017, the Commission for Energy Regulation (CER) set a RFR in line with previous decisions in order to support Irish regulatory stability. The regulator set a RFR close to 2 percent, which was significantly above current rates of real government bond yields at the time. CER noted that there was no conclusive evidence on whether the current state of low government bond yields was of temporary nature or due to longer-term macroeconomic changes. CER stated that, on the one hand, factors such as demographic changes and expectations of weak future growth speak for a long-term change in the RFR; on the other hand, factors such as increased risk aversion and market distortions resulting from monetary policy following the financial crisis point to current rates being short-lived (CER, 2017).

60 Recent Consultation Papers from CRU and the Safety Regulation Division (NSA) of the Irish Aviation Authority continue to lay a heavy emphasis on regulatory precedent.

61 **Table 7** summarises other recent Irish precedent regarding the RFR.

Table 7: Recent Irish precedent on the RFR

Regulator	Decision	Range	Point estimate	Based on
CRU (2019)	Consultation Paper on Irish Water Revenue Control	-0.14% - -0.05%	-0.09% (real)	Regulatory precedent, acknowledging that market evidence points to a range between -0.14% to -0.05%
NSA (2019)	Consultation Paper on Irish RP3 Performance Plan	0.00% – 2.00% (real)		Recent Irish regulatory precedent
CER (2017)	Decision on October 2017 to September 2022 Transmission Revenue for Gas Networks Ireland	n/a	1.90% (real)	Upper end of recent UK regulatory determinations and recent CER determinations
CER (2016)	Second Revenue Control period 2017 – 2018 for Irish Water	1.80% – 2.00%	2.00% (real)	Combination of pre-2008 sovereign bond yields, recent regulatory precedent, changes in output growth rate for the Eurozone
CER (2016)	ESBN/EirGrid PR4	1.75% – 2.10%	1.90% (real)	Upper bound in line with recent Irish regulatory precedent, lower bound in line with 2000-2014 average yield of German 10-year bonds
Comreg (2014)	2014-Decision on Cost of Capital for mobile, fixed, and broadcasting	Ranges only given in preliminary report	2.10% (real)	Yields on 10-year German government bonds from 2000-October 2014, risk-free rates from recent Irish regulatory precedent
CAR (2014)	Maximum Level of Airport Charges at Dublin Airport 2014 Determination	0.00% – 2.00%	1.50% (real)	Yields on AAA-rated 10-year government bonds from 2009 to 2014, risk-free rates from previous Irish regulatory precedent

Note: Information regarding calculation of CER (2016) ESBN/EirGrid risk-free rate found in Europe Economics report prepared for CER. The AAA-rated government bonds used in CAR (2014) determination are Finnish and German government bonds.

Source: Swiss Economics based on Irish regulatory decisions.

62 However, we believe that our focus on current market evidence is not inconsistent with past decisions. For its 2014 Determination, CAR set the lower bound of the RFR range with reference to current German government bond yields at the time. We follow the same approach, the difference being that financial markets have evolved and German government bond yields dropped significantly compared to 2013. Thus, a decrease in the level of the RFR compared to the 2014 Determination is not inconsistent with regulatory precedent.

63 UK based regulators have adopted a similar view in their current thinking for a range of upcoming regulatory decisions. For example, the CAA recently published a working paper that confirms the authority's plan to reflect current negative government bond yields in Heathrow Airport's regulatory control period H7 (CAA, 2019). Based on a consultancy report, the CAA plans to set a RFR within the range of -1.50 percent to -1.00 percent. The underlying analysis recognises that a RFR in this range is significantly below other recent regulatory decisions, but argues that consistency in the way various WACC components are calculated (i.e. broadly in line with current market observations) is more important than consistency with precedent (PwC, 2017).

3.4.2 Long-term averages of the RFR

64 We are sceptical whether long-term averages (i.e. more than 10 years) can accurately reflect an appropriate RFR for the 2019 Determination. We believe that current yields combined with forward-looking evidence represent a more accurate forecast of the RFR over the 2020-24 period.

65 Even Dimson, Marsh, and Staunton (2018), who are often cited for their preference to use long-term averages, acknowledge that bond yields have undergone systematic changes in the past and that "many alleged distortions are likely to be permanent". For example, they refer to the period of permanently low prices over the 1981-2008 period as the golden age of bonds (DMS, 2018).

66 We accept that from a historical point of view, bond yields are currently at a low level. However, we do not believe that the current state is the result of momentary market distortions and only very short lived.

67 Periods of negative bond returns are relatively rare in recent history, but they were quite normal for the most part during the 20th century. In fact, DMS (2018) reveal that European bonds have yielded negative real rates on average between 1900 to 1980. The difference to today's situation is the rate of inflation. Considerably higher rates of inflation during most of the 20th century resulted in positive nominal rates despite real rates being negative.

68 Real German government bonds have yielded negative rates since early 2014 and there are no signs that they will increase to levels of the past (close to 2 percent) in the near future. Even if government bonds recover in the longer term, we have not seen any compelling evidence that suggests that this would happen within the next 5 years.

3.5 Methodological changes compared to the Draft Report

69 We have not changed the methodology for assessing the level of the RFR compared to the Draft Report. Changes in the level of the RFR are exclusively due to updated market evidence. Specifically, current real yields of Irish and German government bonds have decreased compared to the Draft Report. Also, financial markets expect less of an increase in government bond yields over the coming years as is indicated by a decreased slope of forward rates.

3.6 Conclusion

70 We believe the true RFR to be used for the 2019 Determination ranges **from -1.12 percent to -0.10 percent**. This conclusion is based on the following observations:

71 Historic averages of government bond yields suggest a range from approximately -1.39 percent to -0.47 percent. Forward rates reveal market expectations of an increase in government bond yields over the 2020-2024 period from 27 basis points to 37 basis points.

72 Table 8 summarises our findings on the RFR.

Table 8: Evidence on the RFR

		SE lower bound	SE upper bound	SE point estimate
	Evidence from current yields	-1.39%	-0.47%	
+	Evidence from forward rates and monetary policy	27 bps	37 bps	
=	**RFR**	**-1.12%**	**-0.10%**	**-0.61%**

Source: Swiss Economics.

73 Our advice for the 2019 Determination implies a significant decrease in the RFR compared to CAR's 2014 Determination consistent with recent developments on international bond markets. **Table 9** compares our advice to the values used in the 2014 Determination.

Table 9: Summary real RFR

	Range (in %)	Point estimate (in %)
2019 SE advice	-1.12 – -0.10	-0.61
CAR 2014 Determination	0.00 – 2.00	1.50

Source: Swiss Economics.

4 The equity risk premium

74 The WACC-CAPM framework predicts that investors will require a premium for holding risky equity instead of a risk-free asset such as government bonds. The equity risk premium (ERP) is typically expressed as the difference between expected returns of the market portfolio (TMR) and the RFR.

75 We base our estimate of the ERP on the following evidence:

- a review of academic literature and empirical evidence of systematic changes in the level of the ERP, indicating that a so called CAPM-TMR approach is to be preferred;
- backward-looking evidence of the TMR using long-term averages of market returns; and
- forward-looking evidence of the TMR based on a dividend discount model.

4.1 Traditional approach may neglect changes in the ERP over time

76 Irish regulators have mostly employed a so called CAPM-ERP approach when setting the regulatory cost of equity in past decisions.

77 The CAPM-ERP approach looks at the ERP as an isolated and stable component of financial markets. Typically, the ERP is estimated based on a long-run average of the difference between market returns and government bond yields. The underlying assumption is that a long-run average adequately reflects future values of the ERP. In practice, regulators have often referred to the annual Credit Suisse Global Investment Returns Yearbook by Dimson, Marsh, and Staunton (e.g. DMS, 2018).

78 However, theoretical and empirical research suggests that the ERP is counter-cyclical. In times of increased market uncertainty, investors demand higher premiums. Even Dimson, Marsh, and Staunton (2018), who are often cited as proponents for assuming a stable ERP, admit that in times of higher stock market volatility the ERP is likely to increase as well.

> *The risk premium […] should be higher at times when the equity market is riskier and/or when investors are more risk averse.*
>
> DMS (2018), page 37.

79 Dimson, Marsh, and Staunton (2018) argue that market volatility usually reverts to the mean quickly, which implies that changes in the ERP are rather short-lived. However, during a relatively short regulatory period between 4 to 5 years, deviations from the long-term average of the ERP may have a substantial impact on the estimated WACC and should be investigated carefully.

4.2 Evidence of systematic negative co-movements between ERP and RFR

80 We find a relatively broad consensus that the ERP and the RFR systematically move in opposite directions, implying that total market returns (the sum of the RFR and the ERP) are more stable over time than either of the individual components. This raises the question whether a CAPM-TMR approach, which assumes stable total market returns (TMR) over time, is better suited to inform the appropriate level of the equity risk premium than a CAPM-ERP approach.

4.2.1 Academic literature

81 The CAPM was developed in the 1960s based on Markowitz' (1952) portfolio theory. The early literature was of theoretical nature and focused on the conceptual relation between returns of an efficient market portfolio and the RFR. The fact that neither expected market returns, market premia, nor risk-free returns could be directly observed in the market was not of primary concern.

82 With an increasing number of empirical studies, numerous inconsistencies between market data patterns and theoretical predictions became apparent. One of these puzzles was that empirical estimates of the ERP were consistently higher and empirical estimations of the risk-free rate were consistently lower than predicted by financial theory (see, for example, Mehra and Prescott, 1985).

83 Scholars in financial economics have attempted to explain this puzzle through the existence of frequent extreme outliers (referred to as fat tails in statistics). The most influential studies in this respect are articles by Rietz (1988) and Barro (2006), who attempt to explain observations of inflated ERP through microeconomic consumption theory.

84 Their argument builds on a simple theorem that in equilibrium, the price of an investment is determined by the sum of expected future discounted cashflows. A discount factor reflects how much investors prefer sooner cashflows over later ones. This factor is dependent on preferences of consumption today versus consumption in the future and, additionally for risk averse investors, on the relative differences in risk associated with the cashflows. Investors prefer assets which generate cashflows also in times when they most need them: in times of "economic disasters". The utility of financial returns from an asset is much higher in times when there are few alternative sources of income, than in times of prosperity when income can be generated from a multitude of other sources. The idea that identical returns can result in different levels of utility dependent on the economy's condition is described in Cochrane (2005) as follows:

> *Given that an asset must do well sometimes and do badly at other times, investors would rather it did well when they are otherwise desperate for a little bit of extra wealth, and that it did badly when they do not particularly value extra wealth.*
>
> Cochrane (2005), Page 2.

85 In times of increased market volatility, the probability of "economic disaster" increases. Investors' willingness to pay for low-risk assets that generate similar cashflows, regardless of the economic situation, increases as well and results in a reduction of government bond yields and simultaneously in an increase in the premium for holding equity. Rietz (1988) describes this connection as follows:

> *[By considering] a low-probability, depression-like […] state, I can explain both high equity risk premia and low risk-free returns […]. Risk-averse equity owners demand a high return to compensate for the extreme losses they may incur during an unlikely, but severe, market crash. To the extent that equity returns have been high with no crashes, equity owners have been compensated for the crashes that happened not to occur. High risk premia should not be puzzling in such a world.*
>
> Rietz (1988), Page 117-118.

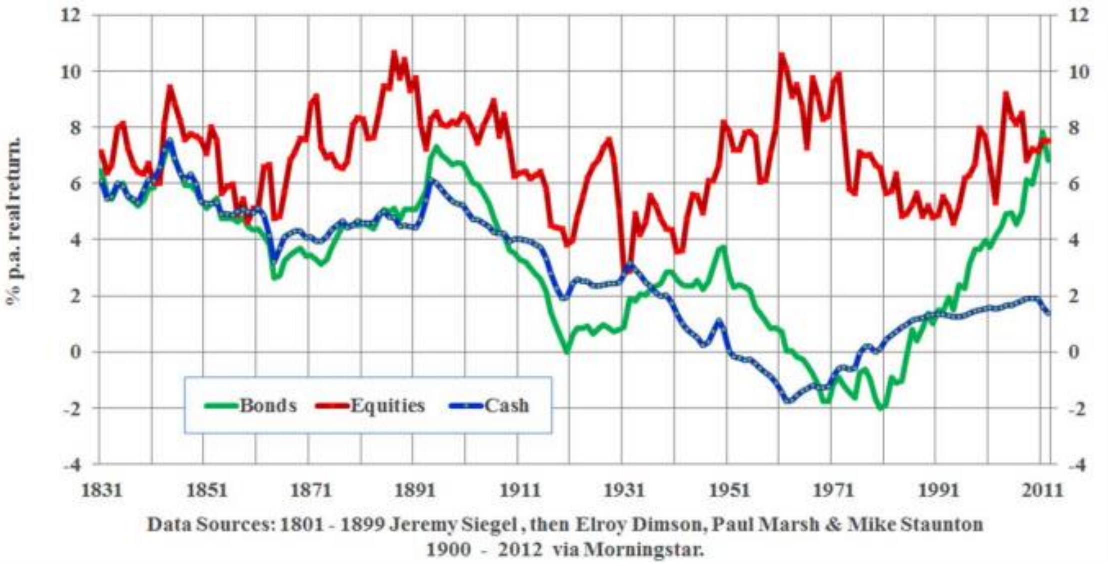
86 As an example of an economic disaster, Barro (2006) refers to real GDP growth rates during the Second World War in countries like Germany and Greece. He estimates, that a disaster event of this magnitude reduces the risk-free rate by 5.9 percentage points and increases the ERP by 3.7 percentage points.

4.2.2 Empirical evidence

87 Various empirical studies confirm the existence of a negative correlation between the RFR and the ERP.

88 The UK electricity regulator Ofgem commissioned studies from Mason, Miles and Wright (2003) and Wright and Smithers (2014) that analyse historical returns of different investment classes to investigate whether ERP or TMR is more stable over time.

Figure 8: **US Data on Changes in Yields of Different Investment Classes (30 Year Moving Average)**



Source: Wrights and Smithers (2014).

89 The results of the studies are illustrated in **Figure 8**. Historical equity yields are much more stable over time than historical bond yields. Wright and Smithers comment:

> *A glance at [Figure 8] demonstrates very clearly, on the basis of US data, that real stock returns have shown a remarkable degree of stability over more than two centuries. This is consistent […] with the average* ***expected*** *return having been stable. In marked contrast, there is no such stability evident in either the bond return or the risk-free return.*

Wright and Smithers (2014), Page 14.

90 The authors go further and exclude the possibility that the ERP remains constant over time:

> *[T]here is no evidence of stability of the [ERP]. Without such evidence, there is no empirical basis for the assumption that falls in risk-free rates should translate to falls in expected market returns.*

Wright and Smithers (2014), Page 15.

91 They come to the clear conclusion that ERP and RFR are negatively correlated:

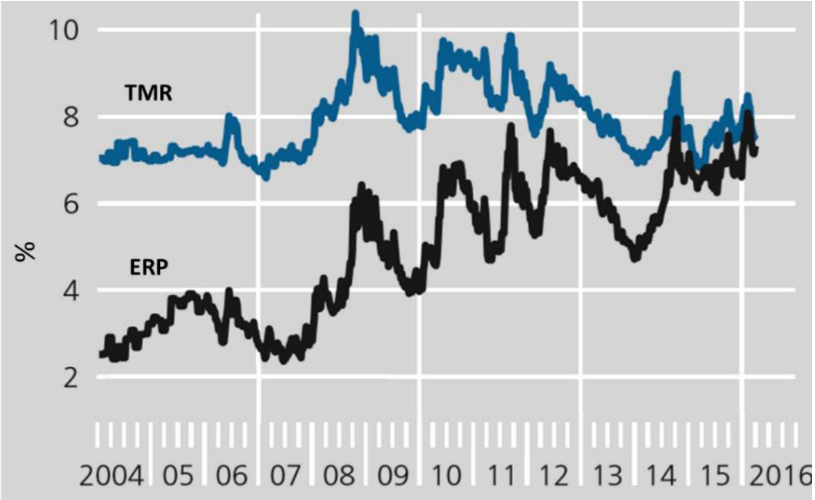
> *It is therefore an application of simple arithmetic to conclude that, applying our methodology, the (assumed) [ERP] and the risk-free rate must move in opposite directions, i.e. must be perfectly negatively correlated.*

Wright and Smithers (2014), Page 16.

92 A different approach to analyse movements in ERP and RFR is chosen by the German Bundesbank (2016). They use data on stock prices and analyst surveys on expected profits and dividends to back out implicit values for the ERP and TMR.

93 The time series predicted by their Dividend Discount Model is displayed in **Figure 9**.

Figure 9: TMR and ERP estimates from German Bundesbank analysis



Source: German Bundesbank (2016), page 24, adopted and translated by Swiss Economics.

94 Their estimate of the level of the ERP has been increasing since the beginning of the financial crisis in 2007 whereas their estimate of the level of the TMR has remained relatively stable over time. In late 2014, the ERP reached a level that is comparable to the long-term level of the TMR. The ERP has stayed on this level since.

95 The German Bundesbank concludes that the ERP does not remain constant over time, but it is rather correlated negatively with the RFR. In its August 2018 report, the Bundesbank writes:

> *The risk premium continued to be significantly above the long-run average. From this it can be drawn that the risk-free rate and the risk premium consistently evolve in opposite directions and therefore cancel each other out in their effect on the cost of equity.*

German Bundesbank (2018), page 46, translated by Swiss Economics.

4.2.3 Implications on the methodology for estimating the ERP

96 Based on the theoretical and empirical evidence of the existence of a negative covariation between the RFR and the ERP above, we choose a CAPM-TMR approach for estimating the cost of equity. Rather than estimating the ERP directly, we first determine the TMR and subsequently subtract our estimate of the RFR from Section 3.

97 The reason behind this choice is that the TMR is more stable over time and thus more predictable than the ERP. We are less likely to neglect systematic changes in the ERP when using evidence from long-term averages or dividend discount models, which both assume true population means to remain constant over time.

4.3 Quantification of the TMR

98 In a first step, we estimate the appropriate level of the TMR. We employ a backward-looking method based on long-term historic averages and a forward-looking method based on a Dividend Discount Model.

4.3.1 Backward-looking estimate

99 We use long-term averages of actual total market returns as primary evidence regarding the appropriate level of the TMR. The assumption behind this approach is that historical outturn market returns fluctuated around stable expected TMR. With increasing sample size, a long-run average of

actual returns will converge to the true TMR even if annual returns have great volatility and deviate substantially from their mean.

100 We use DMS (2018) to estimate long-term averages. The yearbook contains data on Irish and European real equity returns from 1900 to 2017. **Table 10** reports mean equity returns for Ireland and Europe using arithmetic, geometric, and Blume's averaging methods.

Table 10: Average equity returns over the 1900-2017 period

Equity returns	Arithmetic mean	Geometric mean	Blume's method
Irish equity returns	7.00	4.40	6.80
European equity returns	6.20	4.30	6.05

Note: Blume's method (BM) gives a weighted estimate of the arithmetic (AM) and geometric means (GM) based on the time period over which the mean was calculated (N) and on the time period over which returns are to be forecasted (T). The method is based on the following formula:
$BM=(T-1)/(N-1)\times GM+(N-T)/(N-1)\times AM,$ with T = 10 years holding period and N = 116 observations of historic returns
Source: Swiss Economics based on DMS (2018).

101 Blume's method accounts for the fact that the geometric mean and arithmetic mean are both likely to be biased due to measurement errors (see Blume 1974).

- The arithmetic mean is an unbiased estimate of the return over a holding period of one year, but likely overestimates the annual returns over a multi-year holding period.
- The geometric mean is an unbiased estimate of the annual returns over a holding period of 116 years, but likely underestimates annual returns over shorter holding periods, as movements between the first and last period are cancelled out.

102 Blume's method weights the geometric and arithmetic means depending on the length of the underlying estimation and holding periods. Consistent with the assumptions underlying our estimate of the RFR, we assess the appropriate return for a notional investor with investment horizon of 10 years (i.e. we use a 10-year-holding period).

103 One stakeholder asked us to use an unweighted average of arithmetic and geometric means as a point estimate for the TMR. However, this approach would not adequately address the issue underlying the biased estimator. Cooper (1996) shows that the geometric mean is always more biased than the arithmetic mean. The skewed weighting applied through Blume's method leads to an approximately unbiased estimate of the average annual return over the holding period and as such is to be preferred to an unweighted average.

104 Another stakeholder asked us to consider historic equity returns of the United Kingdom in addition to Irish and European equity returns. The underlying argument was that the UK equity market was closely intertwined with the Irish equity market during most of the last century and has only recently become less relevant than the European equity market since Ireland joined the Euro area in 1999. We accept that UK markets may have been slightly more relevant for Irish investors than the broader European equity markets for most of the time span covered in the DMS time series. However, in order to maintain consistency across the various WACC components, we refrain from introducing the UK as another benchmark market.

4.3.2 Forward-looking estimate

105 We use evidence from a forward-looking dividend discount model (DDM) as a second source of evidence for the level of the TMR.

106 DDMs are based on the idea that stock prices should reflect the sum of expected future dividend payments, discounted back to their present value. The discount rate accounts for investors' preference of current payments over future payments and compensates them for the risks of holding equity rather than a risk-free asset. The discount rate hence conceptually corresponds to a TMR.

107 Our model is based on a standard representation of the DDM, as, for example, presented by the Bank of England in its report on modelling equity prices (2017):

$$P_t = \sum_{k=1}^{\infty} \frac{E_t(D_{t+k})}{(1 + TMR_t)^k}, \tag{5}$$

where

- P_t is the stock's price at time t; and
- $E_t(D_{t+k})$ is the expected dividend at time t for time $t + k$.

108 Following the classic model of Gordon (1962) which assumes a constant dividend growth rate, and using a formula for simplifying geometric series, we get the following expression:

$$P_t = \sum_{k=1}^{\infty} \frac{D_t(1+g)^k}{(1 + TMR_t)^k} = \frac{D_t(1+g)}{TMR_t - g}, \tag{6}$$

where g denotes the constant dividend growth rate.

109 Solving for TMR we get:

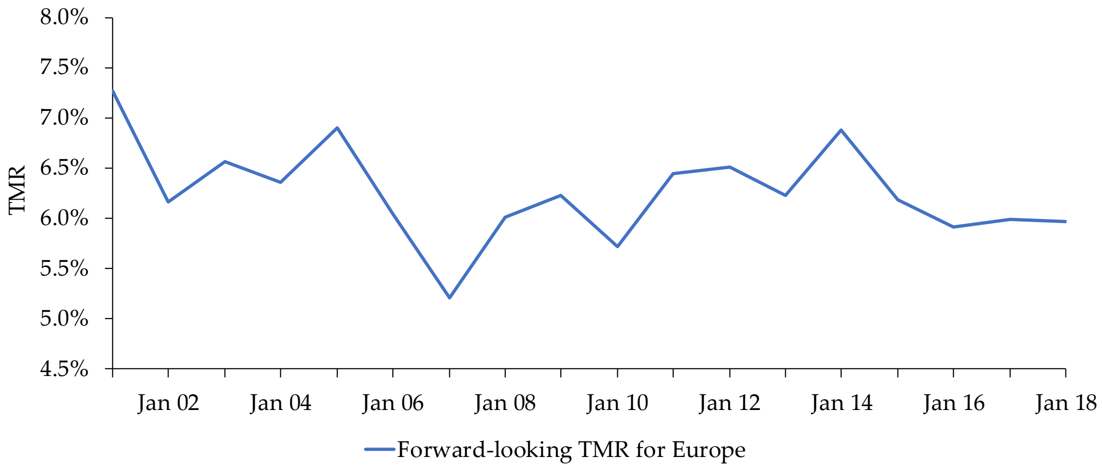
$$TMR_t = \frac{D_t(1+g)}{P_t} + g. \tag{7}$$

110 A key issue of dividend discount modelling is the estimation of future dividends. In general, the ideal DDM would separately model each future period up to infinity. However, such a model needs perfect foresight in terms of future dividend payments. It is very difficult to obtain high-quality dividend forecasts and they usually suffer from substantial noise. Hence, the benefits from more flexible multi-stage DDM can be overshadowed by additional errors in the inputs (Damodaran, 2002). There exists empirical evidence which finds that the Gordon growth model – assuming a constant dividend growth rate – performs nearly as well at explaining prices as more complex DDM models (e.g. Foerster & Sapp, 2005).

111 For this reason, we assume a constant dividend growth rate. We use the average of the OECD's one-year-ahead real GDP forecasts as a proxy value for dividend growth[5]. Using data from the STOXX Europe 50 price index, which represents the 50 largest stock-traded companies in Europe, we compiled a dataset containing dividends and prices of all index constituents from 2001 to 2018. Using this information and using yearly average market prices of the index constituents, we obtain relatively constant TMR values over time with a long-term average of 6.3 percent. **Figure 10** displays the TMR estimates from our DDM.

5 An alternative methodology to measure dividend growth would be to use analysts' predictions of future dividend growth. However, analyst forecasts are prone to large swings (e.g. at turning points in the economic cycle) and add volatility to the DDM.

Figure 10: Forward-looking TMR for Europe (assuming constant dividend growth)



Note: The analysis spans the time period of 2001 to 2018. Yearly price and dividend data were summed over all constituents of the STOXX Europe 50 price index. A constant dividend growth rate was assumed. The constant dividend growth rate was calculated by taking an arithmetic average of the yearly OECD real GDP forecast.

Source: Swiss Economics based on Infront data.

112 **Table 11** below (and Figure 10) confirm the long-term stability of the TMR. In addition, our forward-looking estimates are comparable in magnitude to DMS' long-term backward-looking estimates.

Table 11: Average forward-looking TMR estimates over the recent past

	1-year average	2-year average	5-year average
TMR	5.96%	5.98%	6.19%

Source: Swiss Economics.

4.4 Regulatory precedent on the TMR

113 The majority of past Irish WACC determinations is based on a CAPM-ERP approach and rarely reports an explicit value for the TMR.

114 One exception is CER's determination of the WACC for Gas Networks Ireland (GNI) from October 2017. To our knowledge, CER's (2017) was the first Irish decision using a TMR-Approach. CER referred to regulatory practice in the UK (particularly Ofgem) to justify its choice.

115 **Table 12** gives an overview over recent Irish regulatory decisions in respect of the level of TMR. For decisions that are based on a CAPM-ERP approach, we present the implied TMR, given by the sum of RFR and ERP.

Table 12: Irish regulatory precedent on TMR

Regulator	Decision	Range	Point estimate	Approach	Based on
CRU (2019)	Irish Water Revenue Control	5.90% – 6.95%	6.30%	CAPM-ERP	Irish regulatory precedent, DMS data
NSA (2019)	Irish RP3 Performance Plan Consultation Document	6.50% – 7.00%	n/a	CAPM-TMR	Irish regulatory precedent
CER (2017)	Decision on October 2017 to September 2022 Transmission Revenue for Gas Networks Ireland	6.50% – 6.75%	6.65%	CAPM-TMR	UK and Irish regulatory precedent, DMS data
CER (2016)	Second Revenue Control period 2017 – 2018 for Irish Water	6.30% – 6.75%	6.75%	CAPM-ERP	UK and Irish regulatory precedent, DMS data
CER (2016)	ESBN/EirGrid PR4	6.35% – 7.10%	6.65%	CAPM-ERP	Irish regulatory precedent, DMS data
Comreg (2014)	2014-Decision on Cost of Capital for mobile, fixed, and broadcasting	6.35% – 7.75%	7.30%	CAPM-ERP	Irish regulatory precedent, DMS data
CAR (2014)	Maximum Level of Airport Charges at Dublin Airport 2014 Determination	4.50% – 7.00%	6.50%	CAPM-ERP	Recent regulatory precedent, DMS data

Note: The listed TMR are calculated as the sum of the RFR and ERP. CER (2016) Irish Water TMR calculated as 2.00% (RFR) + 4.75% (ERP). CER (2016) ESBN/EirGrid TMR calculated as 1.90% (RFR) + 4.75% (ERP). Comreg (2014) TMR calculated as 2.30% (RFR) + 5.00% (ERP). CAR (2014) Irish Water TMR calculated as 1.50% (RFR) + 5.00% (ERP).

Source: Swiss Economics.

116 We note that our estimates of the TMR, which were obtained using empirical methods, are in line with the values used in Irish precedent.

4.5 Methodological changes compared to the Draft Report

117 Changes in the methodology for estimating TMR and ERP are limited to the way we calibrate the DDM.

118 In the Final Report, we use average values of OECD one-year-ahead real GDP forecasts for the years between 2001 and 2018 as a proxy for dividend growth taking into account daa's critique. Using GDP forecasts rather than average historic dividend growth as a proxy for dividend growth has the advantage of adding stability to the estimation since GDP forecasts are less volatile than dividend growth rates.

4.6 Conclusion

119 We believe the appropriate value for the ERP ranges from 6.57 percent to 7.41 percent. This range is based on the following evidence:

120 Academic research shows that the TMR is more stable over time than the ERP, implying that a CAPM-TMR approach is the preferred choice for estimating the cost of equity.

- backward-looking evidence based on DMS data suggests TMR between 6.05 percent to 6.80 percent; and

- forward-looking evidence from our Dividend Discount Model suggests a TMR between 5.96 percent and 6.19 percent.

121 Thus, we estimate a range for the TMR between 5.96 percent and 6.80 percent with a point estimate at 6.38 percent. **Table 13** summarises our findings regarding the level of the TMR.

Table 13: Evidence on the TMR

		SE lower bound	SE upper bound	SE point estimate
	Evidence from backward-looking evidence	6.05%	6.80%	
	Evidence from forward-looking evidence	5.96%	6.19%	
Min./Max.	TMR	5.96%	6.80%	6.38%

Source: Swiss Economics.

122 **Table 14** summarises our advice regarding the level of the TMR and compares our advice with the values set by CAR in the 2014 Determination.

Table 14: TMR summary

	Range (in %)	Point estimate (in %)
2019 SE advice	5.96 – 6.80	6.38
CAR 2014 Determination	6.00 – 6.50	6.50

Note: CAR have not explicitly determined a value for TMR in their 2014 Decision. The reported values represent the sum of the RFR point estimate and the boundaries of the ERP range used in 2014.

Source: Swiss Economics.

123 The range for the ERP was derived by subtracting our point estimate of the RFR of -0.61 percent from the TMR range. **Table 15** summarises our advice regarding the level of the ERP.

Table 15: ERP summary

	Range (in %)	Point estimate (in %)
2019 SE advice	6.57 – 7.41	6.99
CAR 2014 Determination	4.50 – 5.00	5.00

Source: Swiss Economics.

124 Our advice for the 2019 Determination implies an increase in the ERP of 199 basis points compared to CAR's 2014 Determination. This is caused by the change from a CAPM-ERP to CAPM-TMR approach, which captures systematic negative co-movements between the ERP and the RFR.

5 Beta

125 The Beta coefficient captures the extent of systematic or undiversifiable risk related to holding Dublin Airport equity. It measures the degree of correlation between returns of Dublin Airport equity and returns of a market portfolio.

126 We use the following evidence to determine Dublin Airport's Asset Beta:

- Asset Beta estimates from regression analysis of exchange-listed comparator airports' stock price movements based on 1 year / daily, 2 years / daily, and 5 years / weekly data;
- comparator Betas from international regulatory precedent; and
- information on comparator airports' regulatory environment, demand structure, and business structure to understand and weight their relevance as a benchmark for Dublin Airport's risk exposure.

127 We employ several sensitivity analyses and robustness checks to understand the uncertainty around our estimates:

- rolling values of historical Asset Betas;
- sensitivity analyses in connection with weighting schemes (see Section 5.3);
- sensitivity analyses regarding the effect of changes in data frequencies, time horizons, and market indices (see Appendix A.2.1, A.2.2, and A.2.3);
- sensitivity analyses regarding the effect of two different formulas to de- and re-lever Betas (see Appendix A.3);
- GARCH models (see Appendix A.2.4); and
- Beta adjustments according to Blume and Vasicek (see Appendix A.4).

5.1 Comparator Asset Betas

5.1.1 Empirically estimated Asset Betas

128 We analyse airport stock returns to empirically estimate Dublin Airport's Asset Beta. Rather than focusing on isolated comparator airports, we aim for a large sample size of comparable airports in order to reduce the risk of skewed estimates due to outliers. However, the number of airports that can be used to estimate comparator betas empirically is limited, since a majority of airports is not listed on any stock exchange. After excluding recently listed or unlisted stocks, with limited data availability, our sample consists of 9 exchange-listed airports.[6]

129 We regress European airport stock returns on a European-area stock index (STOXX Europe 600) and non-European airport stock returns on their respective national stock price indices to get raw beta estimates. The use of a European-area stock index for European airports is consistent with our choice of including evidence from multiple European countries in other WACC components, such as the RFR. Furthermore, European markets are likely to reflect the investment universe of a typical

[6] Due to limited data availability, we decided to exclude SAVE (Venice and Treviso) and Toscana Aeroporti (Florence and Pisa). SAVE was acquired by private equity investors in August 2017 and was unlisted in October 2017. Toscana Aeroporti was only listed in June 2015.

marginal investor in airports – e.g. an internationally diversified investment funds – more accurately than local indices[7].

130 **Table 16** lists the data of comparator airports and market indices underlying our regression analysis.

Table 16: Exchange-listed comparator airports

Airport	Market index
Aena (Spain), AENA	STOXX Europe 600
Aeroports de Paris, ADP	STOXX Europe 600
Auckland Airport, AIA	MSCI New Zealand
Copenhagen Airport, KBHL	STOXX Europe 600
Fraport (Frankfurt), FRA	STOXX Europe 600
Sydney Airport, SYD	S&P/ASX Australian 200 Index
TAV (Turkey), TAVHL	MSCI Turkey
Vienna Airport, FLU	STOXX Europe 600
Zurich Airport, FHZN	STOXX Europe 600

Note: Aena is the operator of 47 Spanish airports, including, amongst others, Madrid-Barajas Adolfo Suarez Airport, Barcelona-El Prat Airport, and Palma de Mallorca Airport. TAV operates 15 airports in Turkey, Tunisia, Macedonia, Saudi Arabia, and Croatia. Aeroports de Paris is the operator of Charles de Gaulle Airport, Orly Airport, and Le Bourget Airport. All other comparator airports are operated by stand-alone companies. We use price rather than performance indices.

Source: Swiss Economics based on Infront data.

131 We use three different datasets with varying time horizons and data frequencies. Shorter time horizons reduce the sample size, making it more likely that random noise in the data is interpreted as meaningful variation. Longer time horizons risk including observations from time periods that are no longer relevant for current and future Beta values (e.g. Wright et al., 2018).

132 Similarly, there is a trade-off underlying the choice of data frequency. Lower data frequency reduces the sample size and leads to less accurate Beta estimates. Higher data frequency may put too much emphasis on correlations caused by events that dissipate over longer periods (e.g. Brotherson et al., 2013).[8]

133 Specifically, we use the following dataset parameters:

- Daily stock returns over the 1-year-period from September 2018 to August 2019
- Daily stock returns over the 2-year-period from September 2017 to August 2019
- Weekly stock returns over the 5-year-period from September 2014 to August 2019

[7] The impact of using national market indices for all airports is small. We present a corresponding sensitivity analysis in Appendix A.2.3.

[8] Further analysis regarding the behaviour of Asset Beta estimates with respect to data frequency, time horizon, and the choice of market indices are presented in Appendix A.2.

134 We use a simple OLS estimator to generate empirical Equity Beta estimates for the airports in the comparator sample.[9][10]

135 To adjust the estimated Equity Betas for differences in financial leverage across airports, we follow the Thessaloniki Forum's (2016) recommendations. Hence, we convert Equity Betas to Asset Betas using the Hamada-formula including net debt to equity ratios[11] and effective tax rates.[12] The Hamada-formula assumes that the level of debt is fixed but allows for fluctuations in the debt to equity ratio.

136 **Table 17** reports the resulting Asset Betas based on the various datasets.[13]

Table 17: Asset Betas of exchange-listed comparator airports

Airport	1 year / daily data	2 years / daily data	5 years / weekly data
Aena (Spain), AENA	0.57	0.59	0.54
Aeroports de Paris, ADP	0.54	0.52	0.47
Auckland Airport, AIA	0.61	0.66	0.81
Copenhagen Airport, KBHL	0.13	0.12	0.44
Fraport (Frankfurt), FRA	0.56	0.55	0.45
Sydney Airport, SYD	0.50	0.54	0.33
TAV (Turkey), TAVHL	0.34	0.33	0.37
Vienna Airport, FLU	0.20	0.32	0.24
Zurich Airport, FHZN	0.67	0.77	0.48

Note: Based on OLS regressions of stock market data from airports and a European price index (national price indices were used for TAV, Auckland, and Sydney). Estimated Betas were de-levered using the Hamada-formula based on net debt/equity ratios and effective tax rates. All datasets cover data until 31 August 2019.

Source: Swiss Economics based on Infront data.

137 **Figure 11** shows 2-year rolling Asset Betas of the exchange-listed comparator airports. The black line displays the mean value across all comparator airports. A slight upwards trend can be observed from 2014 to the beginning of 2018. Recently, this trend seems to have reverted and Betas tend to decrease again.

9 We abstain from using Blume's adjustment (1971, 1975) or Vasicek's (1973) adjustment for correcting the Beta values for reversion to the mean. We are concerned that Blume's adjustment is too mechanistic. The decision against a Vasicek adjustment is due to estimation issues (see Appendix A.4 for a detailed discussion and sensitivity analyses of Blume's and Vasicek's adjustments).

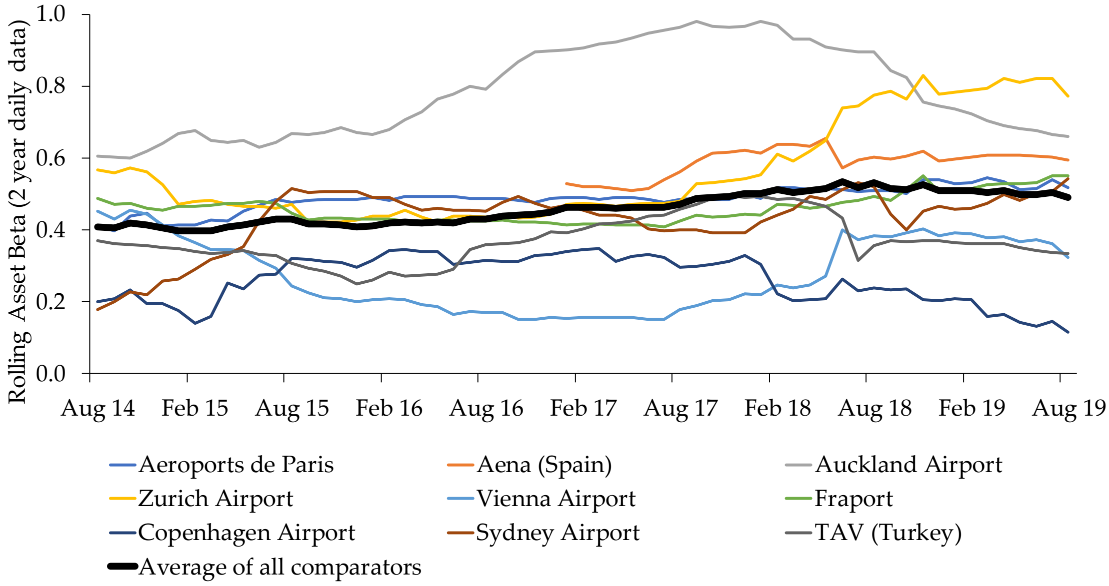
10 We also refrain from using evidence from GARCH models to estimate Asset Betas (see Appendix A.2.4 for an analysis using the GARCH method). GARCH has been primarily of academic interest and has, to the best of our knowledge, only been adopted as additional cross-checks in a regulatory context to date. Also, as shown in Appendices A.2.4 and A.4, GARCH models tend to decrease Beta values whereas Blume's and Vasicek's adjustments tend to increase Beta values, offsetting their respective effects to some degree.

11 We use market values of equity and book values of net debt.

12 We describe the Hamada-formula in more detail in Appendix A.3. In Appendix A.3 we also present a sensitivity analysis using the Harris-Pringle-formula (also known as the Miller-formula).

13 The parameters in Table 17 are estimated by Ordinary Least Squares (OLS). A sensitivity analysis using the GARCH methodology can be found in Appendix A.2.4.

Figure 11: 2-year rolling Asset Betas for comparator airports

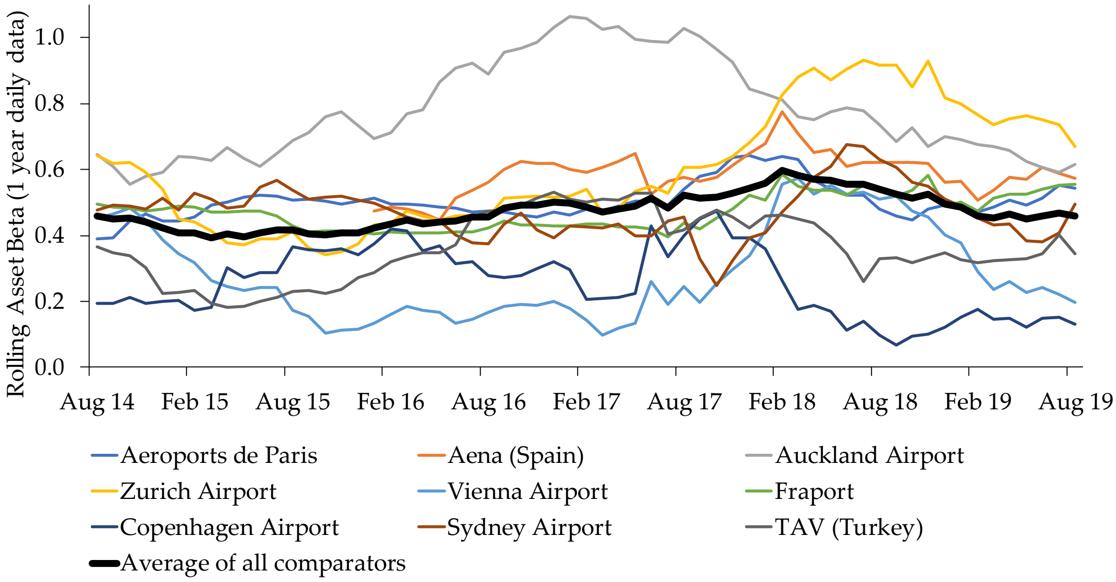


Notes: Estimates based on daily return data and a time horizon of two years. Betas were de-levered using the Hamada-formula and most recent data on net debt, equity and effective tax rates. No data is available for Aena (Spain) before February 2015.

Source: Swiss Economics based on Infront data.

138 **Figure 12** displays rolling 1-year Asset Betas. With the reduced averaging period, volatility of beta values over time beta increases. Nevertheless, the trend across all comparator airports, evidenced through the arithmetic average series, is comparable to Figure 11.

Figure 12: 1-year rolling Asset Betas for comparator airports



Notes: Estimates are based on daily return data and a time horizon of one year i.e. for each month, Betas were estimated using daily data of the last 365 days (up until 31 August 2019). Betas were de-levered using the Hamada-formula and most recent data on net debt, equity and effective taxes. No data is available for Aena (Spain) before February 2015.

Source: Swiss Economics based on Infront data.

5.1.2 Asset Betas from regulatory precedent

139 We complement the list of empirically estimated comparator Asset Betas with values from relevant regulatory precedent.

140 Of particular relevance for Dublin Airport's Beta is precedent from London Heathrow Airport due to the high comparability of the regulatory regime to CAR's approach. Also included are Asset Betas for London Gatwick Airport and Aeroporti di Roma. We are not aware of any other public regulatory decisions regarding the level of the Asset Beta for unlisted European airports.

141 **Table 18** summarises the evidence on Asset Betas determined by European regulators for comparator airports that are not exchange-listed.

Table 18: Asset Betas from regulatory precedent

Airport	Decision and Regulatory Period	Asset Beta
Aeroporti di Roma	ENAC (2016), 2017-2021	0.57
London Gatwick Airport	CAA (2014), Q6	0.52
London Heathrow Airport	CAA (2014), Q6	0.47

Note: Aeroporti di Roma is the operator of Rome airports Fiumicino and Ciampino. We use range midpoints from regulatory decisions rather than point estimates, consistent with our approach across all WACC components for determining final values.

Source: CAA (2014), ENAC (2016).

5.2 Weighting of comparator airports

142 We consider differences between regulatory environments, demand structure, and business structure by weighting comparator airports according to their relevance as adequate benchmarks for Dublin Airport. The variables we use to assess comparability reflect the real-world parameters that determine the level of undiversifiable risk (i.e. the degree of correlation between returns on airport equity and total market returns) and coincide with the risk affecting factors named by the Thessaloniki Forum (2016).

143 We use a point-based system for our weightings. Some of the variables that determine comparability of airports' risk profiles are of a qualitative nature and are difficult to quantify. For the purpose of upmost transparency, we outline the reasoning behind all choices below.

5.2.1 Differences in regulatory environment

144 Central to the systematic risk profile of an airport is the regulatory scheme under which it is operated. The regulatory scheme determines to what extent the airport is exposed to risk associated with fluctuating passenger volumes and flight numbers. These are heavily driven by economic activity (as is evidenced by strong correlations between economic growth and passenger numbers observed at Dublin Airport).

145 In particular, the following dimensions of the regulatory scheme are central to the extent of volume risk an airport is subject to:

- **Length of the regulatory period**: Short regulatory periods (e.g. annual reviews) reduce the risks of changes in volume compared to longer regulatory periods. Changes in passenger numbers typically evolve slowly over time and can be predicted to some extent via flight schedules, which are usually determined well in advance. Regulators can anticipate and react to changing traffic volumes when regulatory periods are short, e.g. annual review periods. Regulatory periods of 4 to 5 years, as in the case of Dublin Airport, create incentives to become more efficient over time, but they transfer significant risks to airport operators. Comparator airports were awarded a point if the length of the regulatory period is long enough to create substantial volume risk for the airport.

- **Involvement of regulator**: The type of involvement of a regulator can have an impact on the extent of systematic risk an airport is exposed to. For example, the risk profile of an airport may differ to Dublin Airport if the regulator, unlike CAR, only approves tariffs or only intervenes in the tariff setting process if stakeholders do not find an agreement. In this case, the comparator airport may react to changes in passenger volumes, which is likely to lower the extent of systematic risk. Comparator airports were awarded a point if tariffs are *set* by an independent regulator.
- **Till system:** The choice of a single till, dual till, or hybrid till regulation regime has an impact on an airport's non-diversifiable risk. Specifically, a single till regime considers commercial revenues in addition to aeronautical revenues to determine the appropriate level of airport charges. A single till system is likely to increase the regulated entity's systematic risk as increased diversification in cashflows supposedly leads to a higher degree of correlation between returns on its equity and the development of the overall economy. Comparator airports were awarded a point if their regulatory regime is single till.
- **Price or revenue control:** The level of systematic risk depends on whether the regulator sets a cap on total revenues or on tariffs per passenger. For example, a per passenger cap, as employed by CAR, limits an airport's manoeuvring space for increasing prices in the case of unexpectedly low passenger volumes.[14] This is due to a typical airport's cost structure with a relatively high share of total costs being fixed. Thus, the choice between price or revenue control poses a source of systematic risk for an airport, making it more or less affected by volatility in traffic volumes (which in turn is known for its high correlation with economic growth). Comparator airports were awarded a point if the regulatory regime caps tariffs per passenger.
- **Within period adjustments**: Some regulators have implemented rules to adjust airport tariffs within the regulatory period depending on passenger number outturn. These rules mitigate the volume risk to which an airport is exposed to. CAR has set Capex triggers in the past to eliminate the risk of underinvestment in the case of faster growth than expected. However, the 2014 Determination did not include any rules for adjusting tariffs if passenger volumes fall below a certain threshold. Within period adjustments lower the degree of undiversifiable risk for an airport as macroeconomic shocks on the overall economy are cushioned. Comparator airports were awarded a point if tariff adjustments within the regulatory period are not foreseen or foreseen only to a limited extent.

146 **Table 19** reports our assessment of the comparability of regulatory environments between airports.

[14] However, the airport may also profit from an unexpected increase in passenger numbers.

Table 19: Regulatory environment of comparator airports

Airport	Length of regulatory period	Involvement of regulator	Till approach	Price or revenue control	Within period adjustments for volume risk	Comparability with Dublin
Aena (Spain)	5 years	Approval of charges	Dual till	Price cap	No within-period adjustments	★★★☆☆
Aeroports de Paris	5 years	Approval of charges	Hybrid till	Price cap	Adjustment factors linked to traffic, investments, operating costs etc.	★★☆☆☆
Aeroporti di Roma	5 years	Approval of charges	Dual till	Price cap	Annual tariff reviews resulting from verified progress on capex plans	★★★☆☆
Auckland Airport	5 years	Monitoring	Dual till	Price cap	Adjustments when operating or capital expenditure resulting from airline-requested or unforeseen regulatory requirements	★★☆☆☆
Copenhagen Airport	Negotiated; max. 6 years	Regulator sets charges If no agreement b/w airport and airlines	Hybrid till	Revenue cap (if regulated)	Adjustments upon request if significant changes occur	☆☆☆☆☆
Fraport (Frankfurt)	Operator discretion	Approval of charges	Operator discretion Dual till in the past	Price cap	Operator can initiate consultation on new charges at own discretion	★☆☆☆☆
London Gatwick Airport	7 years	Monitoring	Single till	Price cap	n/a	★★★☆☆
London Heathrow Airport	5 years	Regulator sets charges	Single till	Price cap	Adjustments only for increases in security costs	★★★★★
Sydney Airport	Annual	Monitoring	Dual till	Price cap	n/a	★☆☆☆☆
TAV (Turkey)	Annual	Regulator sets charges	n/a	Price cap	n/a	★★☆☆☆
Vienna Airport	Annual	Regulator sets charges	Dual till	Price cap	Adjustments possible but should not result in additional revenues	★★☆☆☆
Zurich Airport	Negotiated; max. 4 years	If no agreement b/w airport and airlines; regulator sets charges	Hybrid till	Price cap	Adjustments under exceptional circumstances affecting costs	★☆☆☆☆

Note: At Copenhagen and Zurich airports, regulators only step in if bilateral agreements between the airport and airlines fail.

Source: Swiss Economics based on annual reports, regulatory reports, and legal texts.

5.2.2 Differences in demand structure

147 Demand structure is another variable that determines the extent of systematic risk an airport is faced with. We consider the following dimensions to be relevant:

- **Number of passengers**: The number of passengers is a proxy for airport size. Airports of different sizes are likely perceived to have different risk profiles. This is demonstrated by the small firm stock premium, which has been consistently observed in empirical studies (e.g. Fama & French (2012)).
- **Number of flights**: The number of flights is an alternative proxy for airport size. The ranges regarding the number of flights and passengers in our comparator airport dataset is large. For this reason, we set a large range around Dublin airport's number of passengers and flights to award comparison points. We awarded comparator airports a point if the number of passengers *and* the number of flights are within a range of between half and double the levels of Dublin Airport. Last year, Dublin airport had 31.5 million annual passengers and 233.2 thousand flights, which translates to a range of comparable airports with between 15.8 million and 63 million passengers per annum and between 116.6 thousand and 466.4 thousand annual flights.
- **Aeronautical revenue share**: Greater shares of commercial revenues are the result of income diversification and may imply a closer correlation between airport returns and the market portfolio. The dispersion of aeronautical revenue shares across comparator airports is small, ranging from 44 to 84 percent, with Dublin's share amounting to 51 percent. We use 60 percent as the threshold, up to which airports are still comparable to Dublin Airport.

148 **Table 20** reports our assessment of the demand structure comparability of Dublin Airport and its comparators.

Table 20: Demand structure comparability with Dublin airport

Airport	Annual passengers (in millions)	Annual flights (in thousands)	Aeronautical revenue share	Comparability with Dublin
Aena (Spain)	249.2	2174.3	66.8%	☆☆
Aeroports de Paris	101.5	704.7	50.0%	★☆
Aeroporti di Roma	46.9	351.7	73.0%	★☆
Auckland Airport	20.5	174.3	44.0%	★★
Copenhagen Airport	29.2	259.2	60.1%	★☆
Fraport (Frankfurt)	64.5	475.5	54.4%	★☆
London Gatwick Airport	45.7	280.8	51.9%	★★
London Heathrow Airport	78.0	474.2	60.7%	☆☆
Sydney Airport	43.3	348.5	48.4%	★★
TAV (Turkey)	115.0	836.0	46.1%	★☆
Vienna Airport	30.9	273.9	84.0%	★☆
Zurich Airport	29.4	270.5	60.2%	★☆

Note: Aeronautical Revenue includes Ground Handling Services. The annual number of passengers and flights was treated as one criterion (maximum one star was awarded) because both characteristics are highly correlated.

Source: Swiss Economics.

5.2.3 Differences in business structure

149 Finally, the comparability between Asset Betas depends on the corporate structure of the airport operator. This includes whether the airport is listed and thus, the Beta was estimated using actual market data or whether it was determined during the regulatory process. In particular, the following criteria can influence an airport's risk profile:

- **Geographical diversification:** An internationally diversified airport operator differs in systematic risk from an airport operator that is active exclusively in one country. An internationally diversified airport operator is likely to face less undiversifiable risk because of effects from national economic shocks are dampened (see Appendix A.2.3 for a discussion of the Beta sensitivities with respect to different market indices). Comparator airports were awarded a point if the holding company is active only in one country.
- **Stock-market listed**: We believe the most accurate methodology for estimating airport Betas is based on regression analysis of current stock market data. Weights for Beta estimates set by regulators should reflect that they may be inaccurate (e.g. due to lobbying work during the regulatory process or outdated market conditions). Comparator airports with Asset Betas from our regression analysis were awarded a point.

150 **Table 21** reports our assessment of how comparable the business structure is between Dublin Airport and the comparator airports we estimated Asset Betas for.

Table 21: Business structure comparability

Airport	Geographical diversification	Stock-market listed	Comparability with Dublin
Aena (Spain)	Yes; Participation in managing airports in 5 countries	Yes	★☆
Aeroports de Paris	Yes; Stakes in airports in 14 countries	Yes	★☆
Aeroporti di Roma	No	No (2016 regulatory decision)	★☆
Auckland Airport	No	Yes	★★
Copenhagen Airport	No	Yes	★★
Fraport (Frankfurt)	Yes; Stakes in airports in 3 countries	Yes	★☆
London Gatwick Airport	No	No (2014 regulatory decision)	★☆
London Heathrow Airport	No	No (2014 regulatory decision)	★☆
Sydney Airport	No	Yes	★★
TAV (Turkey)	Yes; Airports under management in 7 countries	Yes	★☆
Vienna Airport	Yes, Airports under management in 3 countries	Yes	★☆
Zurich Airport	Yes; Stakes in airports in 5 countries	Yes	★☆

Source: Swiss Economics.

5.2.4 Summary of weights

151 Finally, **Table 22** presents an overview of awarded points and the resulting weights for all airports across all criteria. The maximally obtainable points for regulatory environment characteristics equal five, whereas the maximum points for the other comparability characteristics equal two. Hence, regulatory characteristics have a higher weighting than demand and business structure characteristics, which is in line with the notion that the regulatory environment is a principal risk factor.

Table 22: Overview of comparability

Airport	Regulatory environment	Demand structure	Business structure	Total	Resulting weight
Aena (Spain)	★★★☆☆	☆☆	★☆	★★★★☆☆☆☆	7.5%
Aeroports de Paris	★★☆☆☆	★☆	★☆	★★★★☆☆☆☆	7.5%
Aeroporti di Roma	★★★☆☆	★☆	★☆	★★★★★☆☆☆	9.4%
Auckland Airport	★★☆☆☆	★★	★★	★★★★★★☆☆	11.3%
Copenhagen Airport	☆☆☆☆☆	★☆	★★	★★★☆☆☆☆☆	5.7%
Fraport (Frankfurt)	★☆☆☆☆	★☆	★☆	★★★☆☆☆☆☆	5.7%
London Gatwick Airport	★★★☆☆	★★	★☆	★★★★★★☆☆	11.3%
London Heathrow Airport	★★★★★	☆☆	★☆	★★★★★★☆☆	11.3%
Sydney Airport	★☆☆☆☆	★★	★★	★★★★★☆☆☆	9.4%
TAV (Turkey)	★★☆☆☆	★☆	★☆	★★★★☆☆☆☆	7.5%
Vienna Airport	★★☆☆☆	★☆	★☆	★★★★☆☆☆☆	7.5%
Zurich Airport	★☆☆☆☆	★☆	★☆	★★★☆☆☆☆☆	5.7%

Note: The total points represent the sum of points awarded to regulatory, demand, and business structure comparability. The weights for each airport were then calculated by dividing each airport's number of points by the total number of points awarded to all airports.

Source: Swiss Economics.

152 Auckland Airport, London Gatwick, and London Heathrow Airport achieve the highest weights (11.3 percent). The lowest weight is assigned to Copenhagen Airport, Fraport (Frankfurt), and Zurich Airport (5.7 percent). However, the difference from lowest to highest weight as well as the variability between the weights is limited. The reason for this is that, in general, airports with a high comparability in terms of the regulatory environment tend to be less comparable with respect to the demand and business structure, and vice versa.

153 The results of a sensitivity analysis using different weighting decisions are reported in **Appendix A.5**.

5.3 Weighted Asset and Equity Betas

154 Estimates of Dublin Airport's Asset Betas based on weighted comparator airport betas are reported in **Table 23**.

Table 23: Asset Betas of comparator airports and their weights

Airport	1 year / daily data	2 years / daily data	5 years / weekly data	Weight
Aena (Spain)	0.57	0.59	0.54	7.5%
Aeroports de Paris	0.54	0.52	0.47	7.5%
Aeroporti di Roma	0.57	0.57	0.57	9.4%
Auckland Airport	0.61	0.66	0.81	11.3%
Copenhagen Airport	0.13	0.12	0.44	5.7%
Fraport (Frankfurt)	0.56	0.55	0.45	5.7%
London Gatwick Airport	0.52	0.52	0.52	11.3%
London Heathrow Airport	0.47	0.47	0.47	11.3%
Sydney Airport	0.50	0.54	0.33	9.4%
TAV (Turkey)	0.34	0.33	0.37	7.5%
Vienna Airport	0.20	0.32	0.24	7.5%
Zurich Airport	0.67	0.77	0.48	5.7%
Weighted Asset Beta	**0.48**	**0.51**	**0.49**	

Note: Airport Asset Betas only vary for empirically estimated estimates. Airport Asset Betas from regulatory decisions (i.e. Aeroporti di Roma, London Gatwick Airport, and London Heathrow Airport) remain constant across the various methodologies.

Source: Swiss Economics.

155 We re-levered Asset Betas to Equity Betas using the Hamada-Formula (see Appendix A.3), using Dublin Airport's notional gearing level and tax rate. We use Dublin Airport's effective tax rate of 12.5 percent and assume a notional gearing of 50 percent (see Section 2 for a discussion).

Table 24: Dublin Airport Asset and Equity Beta

Airport	1 year / daily data	2 years / daily data	5 years / weekly data
Asset Beta	0.48	0.51	0.49
Equity Beta	0.91	0.95	0.92

Source: Swiss Economics.

156 **Table 24** reveals a range for the Equity Beta from 0.91 to 0.95, depending on the time horizon and the data frequency that is used in the estimation.

5.4 Methodological changes compared to the Draft Report

157 We have made several smaller amendments to the methodology for estimating Dublin Airport's Equity Beta.

158 First, following Dublin Airport's suggestion, we moved from using local stock market indices as a proxy for the market returns to a regional stock market index (i.e. the STOXX Europe 600 index) for most airports.[15] European market indices are likely to reflect the investment universe of a notional investor better than local indices. The amendment makes the methodology for estimating Beta values more consistent with our assessment of other WACC components. For example, we also consider wider European evidence for the RFR (see Section 3), the TMR (see Section 4), and the cost of

[15] Airports Sydney, Auckland, and Istanbul are still regressed on local indices due to a lack of appropriate regional indices.

debt (see Section 6). A sensitivity analysis comparing estimates with regional and local indices can be found in Appendix A.2.3.

159 Secondly, in the final report, we de- and re-lever Betas using market instead of book values for equity. The use of market equity values is more in line with industry practice and is recommended by the finance literature (e.g. Brealey et al., 2011, or Damodaran, 2002).

5.5 Conclusion

160 Dublin Airport's Asset Beta ranges from 0.48 to 0.51. This finding is based on the following evidence:

- empirical estimates of exchange-listed comparator airport Asset Betas;
- regulatory precedent of Asset Betas at comparator airports that are not listed; and
- an assessment of comparability between airports.

161 Asset Betas were re-levered to Equity Betas using the notional gearing rate and effective tax rate. **Table 25** summarizes the resulting Equity Betas.

Table 25: Evidence on the Beta estimation

		SE lower bound	SE upper bound	SE point estimate
	Evidence from weighted average Asset Betas	0.48	0.51	0.5
x	Re-levering multiplicator	1.88	1.88	1.88
=	**Equity Beta**	**0.91**	**0.95**	**0.94**

Note: The re-levering multiplicator is defined by the following formula [1 + debt / equity x (1 - tax rate)]. We used a gearing ratio of 50 percent for all values.

Source: Swiss Economics.

162 We advise to set a point estimate for Dublin Airport's Asset Beta of 0.5 and a corresponding point estimate of Dublin Airport's Equity Beta of 0.94.

163 This is consistent with the Thessaloniki Forum's recommendations, which states that airport Betas should be lower than 1 (Thessaloniki Forum Guidelines, 2016, p. 5) due to low commercial and traffic risk and low level of competition among airports. We note that our Asset Beta point estimate of 0.5 is higher than the midpoint of the CAA's range for Heathrow's Asset Beta from 0.42 to 0.52 in its last determination (Q6).

164 **Table 26** summarises our advice on the range of the Equity Beta and compares it to CAR's 2014-Determination.

Table 26: Equity Beta summary

	Range	Point estimate
2019 SE advice	0.91 – 0.95	0.94
CAR 2014 Determination	1.00 – 1.50	1.20

Source: Swiss Economics.

165 The decrease in the Equity Beta compared to CAR's 2014 Determination is primarily driven by our point estimate for Dublin Airport's Asset Beta of 0.5 being lower than CAR's point estimate of 0.6 in 2014. However, our point estimate for the Asset Beta is within the range from 0.5 to 0.6 that was set during the 2014 Determination.

166 There may exist many good reasons for why systematic risk for Dublin Airport has decreased over the last five years. For example, the number of airlines flying to Dublin Airport has increased

significantly and now includes a solid share of foreign airlines. Also, the number of routes increased. New intercontinental routes were introduced, including to North America, Africa and the Middle East. This increased diversification has likely dampened Dublin Airport's income volatility and risk exposure.

167 However, the difference in Asset Betas is primarily driven by differences in the underlying methodology. Firstly, we lay a stronger emphasis on empirical evidence than CAR in the 2014 Determination. CAR noted in its 2014 Draft Determination that the available evidence points towards a lower Asset Beta than 0.6. Out of ten comparator airports, only two Asset Beta ranges included values as high as 0.6 (AdP and Fraport). Even though CAR noted that there was an arguable case for an Asset Beta of 0.5, a point estimate at the top of the range was chosen.

168 One reason for choosing the top of the range was due to the decision's general approach of how to deal with uncertainty around the true WACC parameters. The 2014 Determination used point estimates towards the upper end of the range for all WACC elements, implicitly aiming up the regulatory WACC compared to a WACC based on the midpoints of the ranges for each component. We deal with uncertainty explicitly, by aiming up our estimate of the WACC (Section 7).

6 Cost of debt

169 The rate of cost of debt should reflect the efficient level of Dublin Airport's expected debt interest payments over the next regulatory period. Debt interest payments are due for borrowings raised before 2020 (i.e. embedded debt) and new debt raised over the 2020-24 period.[16]

170 We estimate the cost of embedded debt based on the following evidence:

- daa's current cost of existing debt; and
- our estimate of Dublin Airport's debt payments for embedded debt over the 2020-24 period.

171 To estimate the rate on new debt, we use reference indices for EUR-denominated investment grade corporate bonds.

172 We use daa's actual debt plans for the 2020-24 period to determine the shares of embedded and new debt and their relative cost weights.

6.1 Cost of embedded debt

6.1.1 Current cost of embedded debt

173 We use data on daa's current level of interest payments on existing debt to estimate the cost of embedded debt. In July 2019, daa had a total of [✂] in debt outstanding. About half of the existing debt was raised through European Investment Bank (EIB) loans with weighted interest obligations of [✂] percent in nominal terms. With long-term inflation expectations at 1.22 percent as of July 2019, this translates into a real interest rate of [✂] percent.[17] The residual outstanding debt stems from daa's 2028 bond with nominal coupon payments of [✂] percent or [✂] percent expressed in real terms. Combined, weighted nominal interest payments on existing debt amount to [✂] percent or [✂] percent expressed in real terms.

174 **Table 27** lists all currently outstanding daa borrowings and the related interest payment obligations.

Table 27: daa debt structure July 2019

Debt category	Current Loan Amount (€m), July 2019	Weight	Nominal interest rate	Real interest rate
Existing EIB loans	[✂]	[✂]	[✂]	[✂]
Bond 2028	[✂]	[✂]	[✂]	[✂]
Total	**781.5**	**100%**	**2.19%**	**0.96%**

Note: Reported are interest rates and loan amounts as of July 2019. Nominal interest rates are converted to real interest rates using a rate of 1.22% for expected inflation as of July 2019.

Source: Swiss Economics based on daa data.

[16] In past decisions, CAR has focused on the cost of new debt exclusively, emphasising that actual cost of embedded debt may contain inefficiencies that should not be considered. We accept that embedded debt may have been raised at inefficient rates. However, the regulatory rate for cost of debt should imply an efficiency target that is achievable within the next regulatory period. Without the possibility of refinancing inefficiently raised debt, the scope for achieving efficiencies for existing debt is limited.

[17] see Section 3.1.2 for a discussion on expected inflation

6.1.2 Forecast of the cost of embedded debt over the 2020-24 period

175 The cost of embedded debt, which is incurred over the next regulatory period, is likely to deviate from the current rate on embedded debt. This is due to the following factors affecting the level of existing debt costs:

- **Expiring debt**: A substantial share of daa's existing debt will expire over the next years and alter the weighted interest rate across all borrowings. Specifically, the EIB € [✂] loan, which was issued in 2002, and the various tranches of the EIB € [✂] loan, which were issued between 2004 and 2006, are expiring at various points in time during the next regulatory period.
- **Varying amortisation rates**: Whereas all currently drawn EIB loans are amortising over time, the daa bond principal is non-amortising and will remain at € [✂], increasing the relative importance of the coupon payments.
- **Drawdown of currently undrawn debt agreements**: As of August 2019, daa has signed an agreement with the EIB for an additional € [✂] loan, which has not yet been drawn. Interest payments are either fixed based on a nominal rate of [✂] basis points above the 11-years swap rate or floating based on a rate of [✂] basis points above the 6-months EURIBOR.
- **Changes in the rate of inflation**: All currently drawn borrowings come with a fixed nominal interest rate independent of inflation. As such, the real future cost of debt depends on the level of inflation.

176 A likely scenario of the development of borrowings from existing debt agreements according to daa is depicted in **Table 28.**

Table 28: Debt structure forecast over 2020-24 period

Debt category	Amortising	2020 (in €m)	2021 (in €m)	2022 (in €m)	2023 (in €m)	2024 (in €m)
Existing EIB loans	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Bond 2028	[✂	[✂]	[✂]	[✂]	[✂]	[✂]
Drawdown of EIB agreement	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Total		[✂]	[✂]	[✂]	[✂]	[✂]

Note: Reported are forecasted loan amounts as of July 2019. Nominal interest rates are converted to real interest rates using a rate of 1.22% for expected inflation as of July 2019.

Source: Swiss Economics based on daa data.

177 Real interest rates are fixed over the next regulatory period for the 2028 bond. For the existing EIB loans, the average nominal interest rate will decrease due to older and more expensive debt expiring. The interest rate on the planned drawdown from the € [✂] EIB agreement is likely to be floating with [✂] basis points above the 6-months EURIBOR and as such is forecasted to slightly increase over the regulatory period (as indicated by government bonds forward rates).

178 **Table 29** reports the development of real interest rates over the next regulatory period for the various debt categories.

Table 29: Forecast of real interest rates per embedded debt class over the 2020-24 period

Debt category	Amortising	2020 (in €m)	2021 (in €m)	2022 (in €m)	2023 (in €m)	2024 (in €m)	Average 2020-24 (in €m)
Existing EIB loans	Fixed	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Bond 2028	Fixed	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Drawdown of EIB agreement	Floating	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Weighted Average		**0.16%**	**0.15%**	**0.14%**	**0.14%**	**0.13%**	**0.14%**

Note: Nominal rates are converted to real rates using long-term inflation expectations of 1.22 percent in July 2019. We forecast the floating interest rate on the EIB agreement drawdown using the current real rate of EURIBOR adjusted for the market's expectations on future developments as evidenced in forward rates (see Table 6).

Source: Swiss Economics based on daa data.

179 **Table 30** summarises our findings on the cost of embedded debt. The upper bound of the range is based on evidence of the current rate of interest payments on embedded debt. However, the current rate will decrease over the next regulatory period, given that a substantial share of older expensive debt will amortise and expire over the next years and a the € [✂] EIB loan, which is due to be drawn soon, comes with relatively low nominal interest payments. Given the uncertainty around how inflation expectations will develop over the coming years, using a range between forecast and current cost of embedded debt seems reasonable.

Table 30: Summary on cost of embedded debt

	SE lower bound	SE upper bound
Real cost of embedded debt	0.14%	0.96%

Source: Swiss Economics.

6.2 Cost of new debt

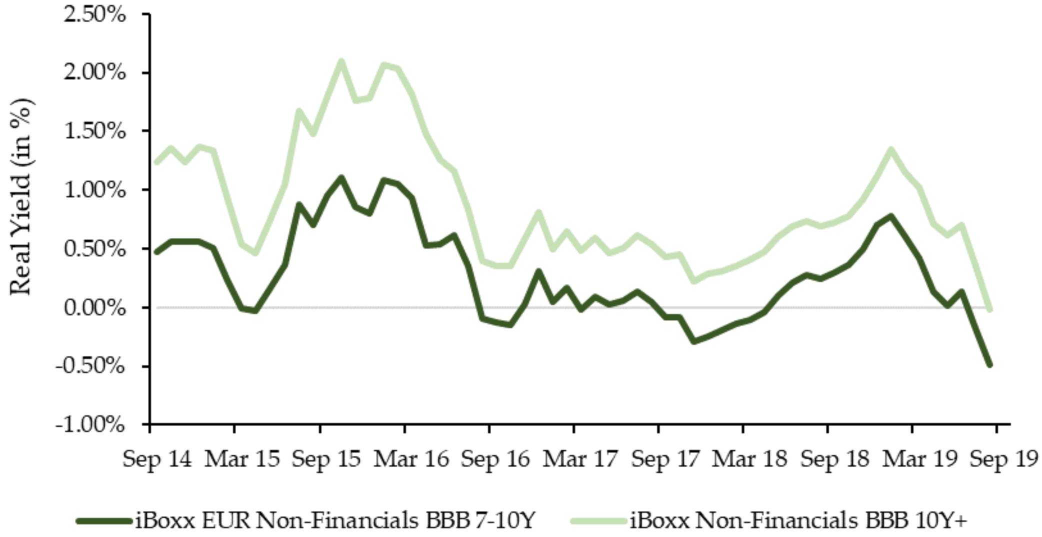
6.2.1 Evidence from comparator indices

180 We use bond indices as a reference to estimate the cost of new debt. The iBoxx EUR BBB Non-Financials indices are designed to reflect the performance of EUR denominated bonds from non-financial corporates with an investment grade credit rating. Two versions of the index are relevant as comparators for Dublin Airport's cost of new debt. The 10 or more years remaining to maturity and the index version capturing bonds with 7-10 years remaining to maturity consistent with a notional investment horizon of 10 years.[18]

181 **Figure 13** depicts real yields of the two relevant iBoxx EUR BBB Non-Financials indices over the last five years.

[18] The 10Y+ index captures bonds with an average remaining time to maturity of 13.1 years over the period from September 2018 to August 2019. The 7-10Y index captures bonds with 8.2 years remaining to maturity.

Figure 13: Real yields of the iBoxx EUR BBB Non-Financials 7-10Y and 10Y+



Source: Swiss Economics based on iBoxx indices.

182 **Table 31** reports 1-year averages, 2-year averages, and 5-year averages of real yields for the relevant iBoxx EUR Non-Financials indices.

Table 31: Average real yields based on iBoxx indices

Index	1-year average	2-year average	5-year average
iBoxx EUR Non-Financials BBB 10+ years remaining to maturity	0.78%	0.63%	0.89%
iBoxx EUR Non-Financials BBB 7-10 years remaining to maturity	0.27%	0.12%	0.29%
Average	**0.53%**	**0.37%**	**0.59%**

Note: Based on arithmetic averages of monthly yields up to August 2019.

Source: Swiss Economics based on Infront data.

183 We suggest adjusting current reference bond yields for market expectations on the development of bond yields over the next regulatory period similar to the adjustment for the RFR. This translates to an uptick ranging between 27 basis points and 37 basis points as indicated by EUR government bond forward rates.

184 In addition, we suggest including an allowance for issuance costs that is incurred when raising new debt. In line with international regulatory practice, we deem an allowance of 10 basis points appropriate.[19]

185 **Table 32** summarises our findings regarding the cost of new debt.

[19] See for example PwC (2017).

Table 32: Evidence on cost of new debt

	Cost of new debt	SE lower bound	SE upper bound
	Current investment grade yields	0.37%	0.59%
+	Forward-looking adjustment of new debt	27 bps	37 bps
+	Issuance costs	10 bps	10 bps
=	**Cost of new debt**	**0.74%**	**1.06%**

Source: Swiss Economics.

6.3 Weighting of embedded and new debt

186 The appropriate weighting of cost for new and embedded debt should consider that Dublin Airport's capex plans are likely to require significant volumes of new debt. In addition, several existing EIB loans will reach maturity during the next regulatory period and will have to be replaced, further increasing the need for new debt.

6.3.1 Planned future debt

187 We use daa's plan for future debt to estimate the appropriate weighting between cost of embedded debt and cost of new debt.

188 **Table 33** reports planned debt levels across the different debt categories over the next regulatory period.

Table 33: Dublin Airport future debt forecast

Debt Category	2020 (in €m)	2021 (in €m)	2022 (in €m)	2023 (in €m)	2024 (in €m)
Existing debt	[✂]	[✂]	[✂]	[✂]	[✂]
Drawdown from undrawn debt agreements	[✂]	[✂]	[✂]	[✂]	[✂]
New debt	[✂]	[✂]	[✂]	[✂]	[✂]
Total Debt	[✂]	[✂]	[✂]	[✂]	[✂]

Source: Swiss Economics based on daa data.

189 We express the share of new debt as a fraction of total debt across the entire next regulatory period. Depending on whether undrawn debt is considered as new or embedded, the weighted share of new debt over the full 2020-24 period ranges from 38 to 60 percent. **Table 34** summarises the results of our analysis of the share of new debt.

Table 34: Share of new debt

Cost of new debt	Share of new debt
Share of new debt (treating undrawn debt as embedded)	38%
Share of new debt (treating undrawn debt as new)	60%

Source: Swiss Economics.

6.4 Regulatory precedent

190 Irish regulators have traditionally chosen a debt premium approach to determine the regulatory rate on the cost of debt. Rather than estimating the cost of debt directly, this approach estimates the spread relative to the RFR creditors expect for borrowings to the regulated entity. The sum of RFR and debt premium represents the total cost of debt.

191 **Table 35** summarises regulatory precedent for cost of debt set. The sum of RFR and debt premium ranges from 2.50 percent to 5.08 percent in recent Irish decisions.

Table 35: Cost of debt based on Irish precedent

Regulator	Decision	Range	Point Estimate	Based on
CRU (2019)	Consultation Paper Irish Water Revenue Control	1.00% – 2.60%	2.00% (nominal)	Sum of debt premium and risk-free rate. Debt premium approach with focus on new debt. Debt premium based on benchmark bonds with the same credit rating.
NSA (2019)	Consultation Document Irish RP3 Performance Plan	n/a	2.50% (real)	Costs of credit facilities in the past, adjusted for the fall in EURIBOR.
CER (2017)	Decision on October 2017 to September 2022 Transmission Revenue for Gas Networks Ireland	n/a	2.50% (real)	Sum of debt premium and reference bond yield. Cost of new debt approach to calculate the debt premium.
CER (2016)	Second Revenue Control period 2017 – 2018 for Irish Water	2.65% – 3.10%	3.00% (real)	Sum of debt premium and risk-free rate. Debt premium approach with focus on new debt. Debt premium based on benchmark bonds with the same credit rating.
CER (2016)	ESBN/EirGrid PR4	2.50% – 3.25%	2.90% (nominal)	Sum of debt premium and risk-free rate. Debt premium approach with focus on new debt. Debt premium based on benchmark bonds with the same credit rating.
Comreg (2014)	2014-Decision on Cost of Capital for mobile, fixed, and broadcasting	n/a	5.08% (nominal)	Sum of debt premium and risk-free rate. Debt premium approach with focus on new debt. Debt premium based on benchmark bonds with the same credit rating.
CAR (2014)	Maximum Level of Airport Charges at Dublin Airport 2014 Determination	2.50% – 3.00%	3.00% (nominal)	Sum of debt premium and risk-free rate. Debt premium approach with focus on new debt. Debt premium based on benchmark bonds with the same credit rating.

Source: Swiss Economics based on Irish regulatory decisions.

192 In recent decisions, all Irish regulators have used a debt premium approach to estimate the cost of debt. In contrast to our approach of estimating the cost of debt directly, a debt premium approach typically assesses the spread creditors require to lend to the regulated entity rather than investing in a risk-free asset with a guaranteed return on the level of the RFR. The cost of debt is the sum of RFR and debt premium.

193 Given that the RFR fluctuates significantly over time, as evidenced by current yields on government bonds, it is useful to include a comparison of the various rates of cost of debt set in recent precedent that adjusts for differences in the RFR. **Table 36** presents the values for the RFR and the debt premium set in recent decisions separately and shows an adjusted level for the cost of debt that would have resulted if the regulator had used our point estimate of the RFR of -0.61 percent instead.

Table 36: Cost of debt from regulatory precedent adjusted for changes in RFR

Regulator	Decision	RFR (in %)	Debt Premium (in %)	Regulatory cost of debt (in %)	Adjusted cost of debt (in %)
CER (2017)	Decision on October 2017 to September 2022 Transmission Revenue for Gas Networks Ireland	1.50*	1.00	2.50	0.39
CER (2016)	Second Revenue Control period 2017 – 2018 for Irish Water	2.00	1.00	3.00	0.39
CER (2016)	ESBN/EirGrid PR4	1.90	1.00	2.90	0.39
Comreg (2014)	2014-Decision on Cost of Capital for mobile, fixed, and broadcasting	2.10	1.45	5.08**	0.84
CAR (2014)	Maximum Level of Airport Charges at Dublin Airport 2014 Determination	1.50	1.50	3.00	0.89

Note: Reported adjusted cost of debt values are based on our estimate of the RFR of -0.61 percent instead of the value that was actually used by the regulator during the decision.
* CER uses a reference bond yield of 1.50% to determine the cost of debt. CER's point estimate for the RFR lies at 1.90%.
** For Comreg (2014), the sum of RFR and Debt Premium does not equal the regulatory cost of debt. This is because the RFR and Debt Premium are reported in real terms, whilst the regulatory cost of debt is reported in nominal terms.
Source: Swiss Economics.

194 When adjusting for differences in the level of the RFR to our point estimate of -0.61 percent, regulatory precedent of the cost of debt indicates a range between 0.39 percent to 0.89 percent.

6.5 Methodological changes compared to the Draft Report

195 We have made changes to the methodologies underlying both our estimates for cost of embedded debt as well as cost of new debt.

196 The assessment of the level of cost of embedded in the Draft Report relied exclusively on the current structure and cost of existing debt. In the Final Report, we have added an additional perspective that looks at how Dublin Airport's debt structure and the associated debt payments are likely to evolve during the next regulatory period. For this purpose, we have considered new information about an EIB loan, which was agreed in July 2019, after the Draft Report was published. Also, based on the study of several loan agreements, which were provided to us after the Draft Report was published, we concluded that an uptick for a notional investment grade credit rating was not required for embedded debt. Finally, a forward rate adjustment on embedded debt is no longer required, as all current embedded debt now have a fixed interest rate.

197 The assessment of the level of cost of new debt in the Draft Report was based on estimates for three independent building blocks cost of comparator airport bonds, an Irish country risk premium, and an uptick for the notional investment grade credit rating. Following stakeholder feedback (see Appendix B), we change the methodology to directly estimate the cost of new debt in a single step. We use iBoxx EUR non-financials BBB indices as a benchmark for Dublin Airport's cost of new debt under a notional investment grade credit rating.

198 Also, we changed our approach for assessing transaction costs. In the Draft Report, we included a general uptick for bank margins. After stakeholder feedback and further research on Dublin Airport's loan agreements and contractual obligations with several lenders, we came to the conclusion that it is more appropriate to treat bank margins as an integral part of interest payments. The change in methodology does not have any impact on the level of cost of embedded debt, but it decreases

the overall allowance for cost of new debt. Rather than an exhausting allowance for bank margins, the methodology in the Final Report only considers costs at issuance.

6.6 Conclusion

199 We believe the real cost of debt for Dublin Airport ranges from 0.37 percent to 1.02 percent. The range is based on weighted cost of embedded debt and new debt and is summarised in **Table 37**.

Table 37: Weighted cost of debt

Debt category	Share (lower bound)	Lower bound	Share (upper bound)	Upper bound
Cost of embedded debt	62%	0.14%	40%	0.96%
Cost of new debt	38%	0.74%	60%	1.06%
Weighted cost of debt		**0.37%**		**1.02%**

Source: Swiss Economics.

200 **Table 38** summarises our findings on the range of the cost of debt and compares it to the range set in the 2014 Determination.

Table 38: Summary cost of debt

	Range (in %)	Point estimate (in %)
2019 SE advice for cost of debt	0.37 – 1.02	0.69
Sum of CAR 2014 debt premium and 2019 SE advice on RFR	0.39 – 0.89	0.89

Note: CAR estimated a debt premium rather than total cost of debt in the 2014 Determination. We report the range that is implicitly given by the sum of CAR's estimate of the debt premium for Dublin Airport of 1 percent to 1.5 percent and our point estimate of the RFR of -0.61 percent.

Source: Swiss Economics.

201 While our range for the cost of debt spans the full range from the 2014 Determination, our point estimate is slightly below the point estimate from the 2014 Determination. CAR's point estimate coincided with the upper boundary of their range, implying a conservative approach for choosing the point estimate. We choose the midpoint of the range as point estimate, aiming for the most likely estimate of the true cost of debt. We deal with the risks of underestimating the true cost of debt in the next section.

202 In general, our cost of debt estimate is in line with recent regulatory precedent if estimates of debt premia are combined with our estimate of the RFR.

7 Aiming Up

7.1 Asymmetric risks from estimation errors

203 Following UKRN recommendations, we assess whether the regulatory WACC should be uplifted compared to the point estimate, or most likely value of the true WACC. Aiming-up the point estimate is appropriate if the consequences of under-estimating the true WACC are more severe than the consequences of over-estimating the true WACC.

204 Asymmetric consequences may be due to decreased investment activities of Dublin Airport as a result of under-estimating the true WACC. If the level of investment falls below the optimal level, the negative consequences for airport users from missing infrastructure may exceed the positive effects of lower airport charges. The UK Competition Commission (2007) described the risks associated with under- and overestimating the true WACC as follows:

> *If the WACC is set too high then the airports' shareholders will be over-rewarded and customers will pay more than they should. However, we consider it a necessary cost to airport users of ensuring that there are sufficient incentives for [the airport operator] to invest, because if the WACC is set too low, there may be underinvestment from [the airport operator] or potentially costly financial distress […] Most importantly, we note that it is difficult for a regulator to reduce the risks of underinvestment within a regulatory period.*

Competition Commission (2007).

205 In economic terms, under-investments are likely to have dynamic effects on welfare. In the context of airports, dynamic effects are likely to include a worsening of user experience compared to an optimal level of investment. For example, waiting times for departing passengers during security checks may increase due to a lack of infrastructure or flight delays may increase due to missing capacity. In the longer run, travellers, especially transfer passengers, may try to avoid or bypass Dublin Airport, which comes with negative consequences on the Irish air transport industry and tourism and economic activity in general.

206 Over-estimating the true WACC leads to excessive airport charges, which harm consumers directly. However, there likely exist fewer indirect dynamic effects on welfare than in the case of underinvestment since fewer long-run negative effects on economic development are to be expected.

207 The argument for aiming-up is particularly strong when new investments must be incentivised. The UKRN argues that the WACC on new investments should be set above the 90th percentile of the range depending on their importance. For sunk investments, the UKRN argues that the point estimate of the true WACC is enough (UKRN, 2018).

208 Dublin Airport's plans for investments over the next years are in excess of €2bn higher than its current RAB. The CIP 2020+ comprises capacity projects that will enable growth in passenger numbers from currently 31mppa to 40mppa.

209 Given the level and importance of planned investments, we believe aiming up the WACC is prudent and necessary.

7.2 Regulatory precedent on aiming up

210 Aiming up has been part of most Irish regulatory decisions on the WACC of the recent past.

211 Recent CER decisions for water and electricity sectors include small upticks between 15 basis points to 22 basis points. Comreg added an average of 53 basis points to mobile, fixed, and broadband WACC estimates.

212 CAR did not explicitly aim up the WACC in its 2014 Determination. However, CAR chose point estimates towards the higher end of the range for most of the WACC components, which suggests that risk asymmetry was considered implicitly.

213 **Table 39** summarises the regulatory precedent.

Table 39: Aiming up based on Irish precedent

Regulator	Decision	Aiming-Up Adjustment	Based on
CER (2017)	Decision on October 2017 to September 2022 Transmission Revenue for Gas Networks Ireland	Do not consider aiming up to be necessary	Estimated WACC already appropriately conservative; scale and direction of future impact of risks like Brexit unclear.
CER (2016)	Second Revenue Control period 2017 – 2018 for Irish Water	Aim up to the 80th percentile. Translates into an increase of 15 bps in WACC.	The longer-term consequences of underestimating the WACC outweigh those of overestimating the WACC. Aiming up percentile determined as one standard deviation above the mean.
CER (2016)	ESBN/EirGrid PR4	Aiming up allowance of 22 bps	Prefer to add aiming up allowance in determination, rather than adjust the WACC in the annual adjustment to address new economic circumstances. Aiming up percentile determined as one standard deviation above the mean.
Comreg (2014)	2014-Decision on Cost of Capital for mobile, fixed, and broadcasting	Aim up to the 66th percentile on certain parameters used in the WACC calculation. This translates to an average increase of 53 bps	Aiming up reflects that the negative consequences of setting the cost of capital too low greatly outweigh the negative consequences of setting the WACC too high. Aiming up percentile determined as one standard deviation above the mean.
CAR (2014)	Maximum Level of Airport Charges at Dublin Airport 2014 Determination	No explicit aiming up mentioned, but point estimates are at the higher end of ranges for most WACC components	

Note: The calculation of the aiming up percentile in both CER (2016) Irish Water and ESBN/EirGrid determinations were in the respective Europe Economics report.
The aiming up methodology in Comreg (2014) was applied to the nominal risk-free rate, the asset beta and the debt premium. Tax rate and notional gearing were not aimed up, as there is little uncertainty concerning these parameters. The basis point change in the Comreg WACC is calculated as the average change to mobile telecommunications (49 basis points), fixed line telecommunications (51 basis points), and broadcasting (58 basis points), resulting from aiming up.

Source: Swiss Economics based on regulatory decisions.

7.3 Methodological changes compared to the Draft Report

214 We have not changed our view regarding the level of an appropriate aiming up component compared to the Draft Report.

7.4 Conclusion

215 We advise to uplift the estimate of the WACC by 50 basis points in order to mitigate risks associated with measurement errors. This value is at the higher end of regulatory precedent in Ireland. However, we believe this value is justified because of the following reasons:

- Dublin Airport's CIP 2020+, combined with other ongoing capital projects (e.g. North Runway), will result in investments in excess of €2bn;
- regulatory precedent in Ireland is likely to have relied on implicit aiming up in the past, in contrast to the numbers estimated in this report which are best estimates; and
- the dynamic effects of air transport due to the industry's strong effects on trade, tourism, and economic growth are expected to be larger compared with other utilities (e.g. water)[20].

216 **Table 40** summarises our advice on aiming up.

Table 40: Summary aiming up

	Range	Point estimate
2019 SE advice	n/a	50 bps
CAR 2014 Determination	n/a	n/a

Source: Swiss Economics.

217 CAR has not explicitly aimed up the WACC in its 2014 Determination, but the chosen point estimates indicate that similar considerations were made.

[20] See e.g. Sellner & Nagl (2010) for an estimate on the economic effects of airport capacity expansions.

8 Conclusion

218 We estimate the efficient level of real cost of capital for Dublin Airport over the 2020-24 period to be between 2.94 percent and 4.52 percent. This range reflects the evidence from actual market data, academic literature, and regulatory precedent on each of the individual WACC components we presented in this report. We believe the most likely value of the WACC is 3.75 percent.

219 **Table 41** summarises our findings for each WACC component.

Table 41: Ranges and point estimates for all individual WACC components

	Lower bound	Upper bound	Point estimate
Gearing	45%	55%	50%
Tax rate			12.50%
RFR	-1.12%	-0.10%	-0.61%
TMR	5.96%	6.80%	6.38%
ERP	6.57%	7.41%	6.99%
Asset Beta	0.48	0.51	0.50
Equity Beta	0.91	0.95	0.94
Cost of equity (post-tax)	5.33%	6.46%	5.96%
Cost of debt (pre-tax)	0.37%	1.02%	0.69%
Estimate of pre-tax WACC	**2.94%**	**4.52%**	**3.75%**

Note: All values are reported in real terms. Point estimates reflect our estimates of the most likely values.

Source: Swiss Economics.

220 The point estimate of the WACC does not coincide with our advice to CAR on the rate that should be used in the 2019 Determination. This is because we accept that thebre is uncertainty regarding the true value of each individual component and the level of the WACC in general. However, the consequences from underestimating the WACC are likely to be more severe than the consequences of overestimating the WACC. An uptick of 50 basis points seems appropriate to us given ambitious plans at Dublin Airport over the next regulatory period. Thus, our advice to CAR is to set a regulatory WACC above the point estimate at 4.25 percent, reflecting the asymmetric risks of overestimating and underestimating the WACC.

221 **Table 42** summarises our advice regarding the efficient level of the pre-tax real WACC of Dublin Airport for the 2019 Determination.

Table 42: SE regulatory WACC advice and comparison with 2014 Determination

	CAR 2014	SE Advice 2019	Difference
Gearing	50%	50%	-
Tax rate	12.50%	12.50%	-
RFR	1.50%	-0.61%	211bps ▼
ERP	5.00%	6.99%	199bps ▲
Asset Beta	0.60	0.50	0.10 ▼
Equity Beta	1.20	0.94	0.26 ▼
Cost of equity (post-tax)	7.53%	5.96%	156bps ▼
Cost of debt (pre-tax)	3.00%	0.69%	231bps ▼
Aiming up	n/a	0.50%	n/a
Advice on regulatory pre-tax WACC	**5.80%**	**4.25%**	**155bps ▼**

Note: All values are reported in real terms.

Source: Swiss Economics.

222 Our advice implies a decrease in the regulatory WACC of 155 basis points compared to the 2014 Determination. This decrease is mainly due to reductions in the cost of debt, the RFR, and the Equity Beta. Given the trends in prices of Euro government bonds and corporate bonds over the last 5 years, we believe a decrease of this magnitude is legitimate.

223 Finally, CAR asked us to estimate the effect of an increase in the notional credit rating underlying the determination of the cost of debt. Based on an analysis of the spread between credit notches outlined in Appendix C, we concluded that the pre-tax WACC decreases by 3 basis points following an upgrade in credit ratings by a notch from BBB to BBB+. Thus, if a BBB+ credit rating is considered a more appropriate notional credit rating, our advice would be to set the regulatory pre-tax WACC at 4.22 percent.

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A Appendix A: Source data and sensitivity analyses

A.1 Bonds

Table 43: Government bonds

ISIN	Country	Credit rating	Type	Issue date	Coupon	Maturity date
DE0001030526	Germany	AAA+	Inflation Linked	10.06.2009	1.75%	15.04.2020
DE0001030542	Germany	AAA+	Inflation Linked	21.03.2012	0.10%	15.04.2023
DE0001030559	Germany	AAA+	Inflation Linked	08.04.2014	0.50%	15.04.2030
DE0001030567	Germany	AAA+	Inflation Linked	10.03.2015	0.10%	15.04.2026
DE0001030575	Germany	AAA+	Inflation Linked	09.06.2015	0.10%	15.04.2046
DE0001102309	Germany	AAA+	Nominal	16.01.2013	1.50%	15.02.2023
DE0001102317	Germany	AAA+	Nominal	22.05.2013	1.50%	15.05.2023
DE0001102325	Germany	AAA+	Nominal	11.09.2013	2.00%	15.08.2023
DE0001102333	Germany	AAA+	Nominal	29.01.2014	1.75%	15.02.2024
DE0001102358	Germany	AAA+	Nominal	21.05.2014	1.50%	15.05.2024
DE0001102366	Germany	AAA+	Nominal	10.09.2014	1.00%	15.08.2024
DE0001102374	Germany	AAA+	Nominal	14.01.2015	0.50%	15.02.2025
DE0001102382	Germany	AAA+	Nominal	15.07.2015	1.00%	15.08.2025
DE0001102390	Germany	AAA+	Nominal	13.01.2016	0.50%	15.02.2026
DE0001102408	Germany	AAA+	Nominal	13.07.2016	0.00%	15.08.2026
DE0001102416	Germany	AAA+	Nominal	11.01.2017	0.25%	15.02.2027
DE0001102424	Germany	AAA+	Nominal	12.07.2017	0.50%	15.08.2027
DE0001102440	Germany	AAA+	Nominal	10.01.2018	0.50%	15.02.2028
DE0001102457	Germany	AAA+	Nominal	11.07.2018	0.25%	15.08.2028
DE0001135374	Germany	AAA+	Nominal	12.11.2008	3.75%	04.01.2019
DE0001135382	Germany	AAA+	Nominal	20.05.2009	3.50%	04.07.2019
DE0001135390	Germany	AAA+	Nominal	11.11.2009	3.25%	04.01.2020
DE0001135408	Germany	AAA+	Nominal	28.04.2010	3.00%	04.07.2020
DE0001135416	Germany	AAA+	Nominal	18.08.2010	2.25%	04.09.2020
DE0001135424	Germany	AAA+	Nominal	24.11.2010	2.50%	04.01.2021
DE0001135440	Germany	AAA+	Nominal	27.04.2011	3.25%	04.07.2021
DE0001135457	Germany	AAA+	Nominal	24.08.2011	2.25%	04.09.2021
DE0001135465	Germany	AAA+	Nominal	23.11.2011	2.00%	04.01.2022
DE0001135473	Germany	AAA+	Nominal	11.04.2012	1.75%	04.07.2022
DE0001135499	Germany	AAA+	Nominal	05.09.2012	1.50%	04.09.2022
DE0001141687	Germany	AAA+	Nominal	15.01.2014	1.00%	22.02.2019
DE0001141695	Germany	AAA+	Nominal	07.05.2014	0.50%	12.04.2019
DE0001141703	Germany	AAA+	Nominal	03.09.2014	0.25%	11.10.2019
DE0001141711	Germany	AAA+	Nominal	21.01.2015	0.00%	17.04.2020
DE0001141729	Germany	AAA+	Nominal	01.07.2015	0.25%	16.10.2020
DE0001141737	Germany	AAA+	Nominal	03.02.2016	0.00%	09.04.2021
DE0001141745	Germany	AAA+	Nominal	20.07.2016	0.00%	08.10.2021
DE0001141752	Germany	AAA+	Nominal	01.02.2017	0.00%	08.04.2022

DE0001141760	Germany	AAA+	Nominal	05.07.2017	0.00%	07.10.2022
DE0001141778	Germany	AAA+	Nominal	31.01.2018	0.00%	14.04.2023
DE0001141786	Germany	AAA+	Nominal	25.07.2018	0.00%	13.10.2023
DE0001141794	Germany	AAA+	Nominal	25.01.2019	0.00%	05.04.2024
DE0001141802	Germany	AAA+	Nominal	05.07.2019	0.00%	18.02.2024
IE00B4S3JD47	Ireland	A+	Nominal	15.03.2013	3.90%	20.03.2023
IE00B4TV0D44	Ireland	A+	Nominal	18.10.2009	5.40%	13.03.2025
IE00B6089D15	Ireland	A+	Nominal	24.06.2009	5.90%	18.10.2019
IE00B60Z6194	Ireland	A+	Nominal	15.01.2010	5.00%	18.10.2020
IE00B6X95T99	Ireland	A+	Nominal	07.01.2014	3.40%	18.03.2024
IE00BDHDPQ37	Ireland	A+	Nominal	14.10.2017	0.00%	18.10.2022
IE00BDHDPR44	Ireland	A+	Nominal	13.01.2018	0.90%	15.05.2028
IE00BV8C9418	Ireland	A+	Nominal	17.01.2016	1.00%	15.05.2026
IE00BH3SQ895	Ireland	A+	Nominal	11.01.2019	1.35%	15.05.2029
IE00BJ38CR43	Ireland	A+	Nominal	11.11.2014	2.40%	15.05.2030
IE00BFZRQ242	Ireland	A+	Nominal	15.10.2018	1.10%	18.03.2031

Source: Swiss Economics based on Infront data.

A.2 Beta Sensitivity analyses

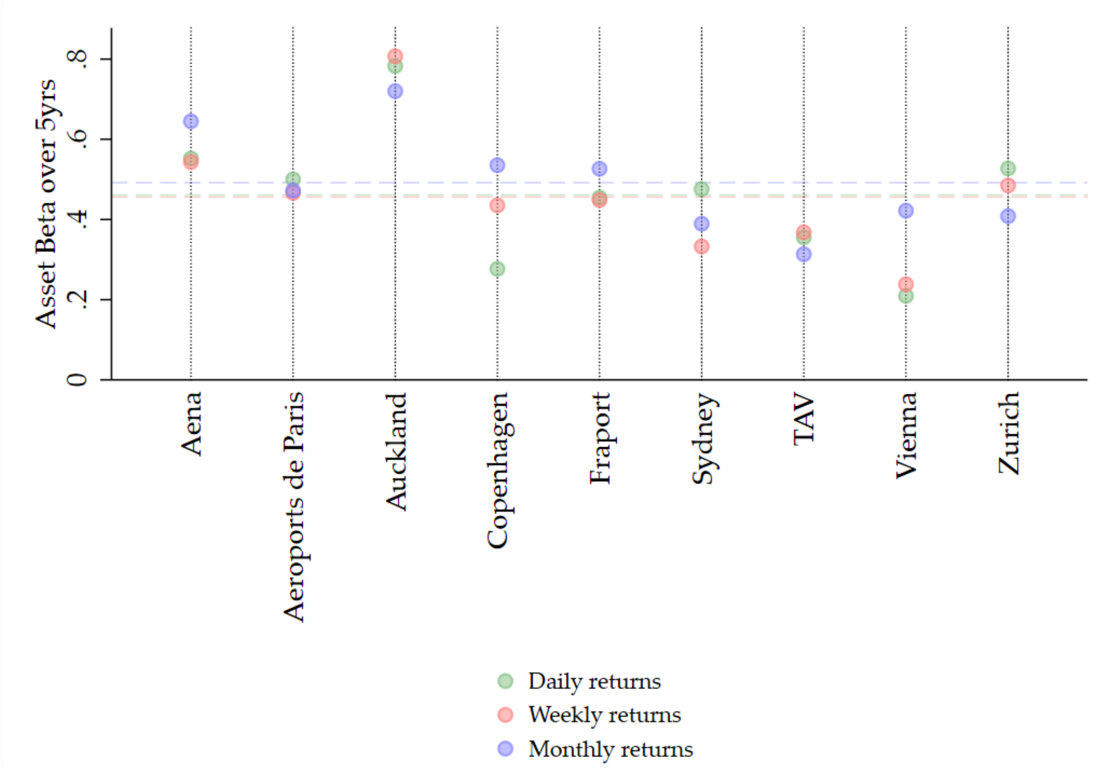
224 This section presents various sensitivity analyses of Betas. Appendix A.2.1 introduces a sensitivity analysis of the Beta estimates with respect to the frequency of the underlying return data. Appendix A.2.2 shows a similar analysis with respect to the choice of different time horizons. Differences in Betas estimated on national or supranational market indices are presented in Appendix A.2.3. Finally, Appendix A.2.4 contrast Betas estimated by OLS with Betas estimated by GARCH.

A.2.1 Data frequency

225 An important decision in the estimation of Asset Betas is the choice of the data frequency. Betas are estimated on daily, weekly, monthly, or sometimes even quarterly return data. In general, there is a trade-off between the sample size and accuracy of the Beta estimates. Whereas shorter frequencies increase the sample size and therefore the statistical reliability, they may yield observations that are not normally distributed and may introduce unwanted noise.

226 **Figure 14** shows the sensitivity of the estimated Asset Betas with respect to the data frequency chosen, i.e. whether the Asset Betas are estimated on daily, weekly, or monthly returns. All estimates in Figure 14 result from a time horizon of 5 years. The dashed lines represent the average Asset Beta values for daily (0.46), weekly (0.46), and monthly (0.49) estimates. In general, the sensitivity of the estimates to changes in the data frequency is limited, as the small differences in the average values show. The estimates for monthly data frequencies are highest, whereas the estimates for daily and weekly frequencies are slightly lower. A potential explanation is provided by the literature on overshooting, which suggests some negative serial correlation in returns between short frequencies. In other words, periods of exceptionally high or low returns tend to be followed by some reversal in succeeding days (e.g. Wright et al., 2018).

Figure 14: Sensitivity with respect to data frequency



Note: Based on OLS regressions with a European index (national price indices were used for Auckland, Sydney, and Istanbul). De-levering using Hamada-formula based on net debt/equity ratios and effective tax rates. Data until 31 August 2019 was used.

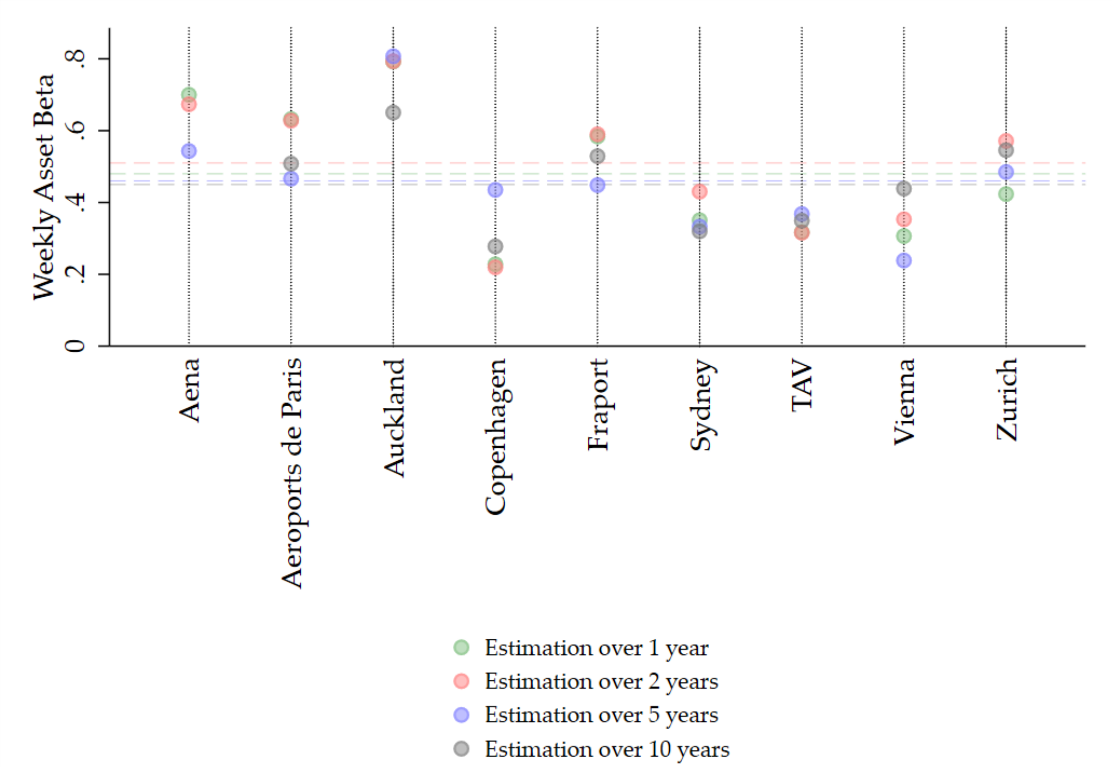
Source: Swiss Economics based on Infront data.

A.2.2 Time horizon

227 Another crucial decision in estimating Asset Betas is the choice of an appropriate time horizon. Time horizons of 1 year, 2 years, 5 years, and 10 years or longer are common. Again, a trade-off is involved. The drawback of shorter time horizons is a smaller sample size, which makes it more likely that random noise is interpreted as meaningful variation in the data. Longer time horizons increase the number of observations and reduce the impact of noise in the data. However, they risk representing data variation which is no longer relevant and, at the same, diluting the impact of recent risks which are relevant.

228 **Figure 15** reports weekly Asset Betas estimated over different time horizons. As in the case of different data frequencies, the sensitivity of the Asset Betas with respect to different time horizons is very low. The averages Asset Beta values correspond to 0.48, 0.51, 0.46, and 0.45 for time horizons of 1, 2, 5, and 10 years, respectively.

Figure 15: Sensitivity with respect to the time horizon



Note: Based on OLS regressions with a European price index (national price indices were used for Auckland, Sydney, and Istanbul). De-levering using Hamada-formula based on net debt/equity ratios and effective tax rates. There is no estimation data over 10 years for the case of Aena (Spain), since data is available only from February 2015. Data until 31 August 2019 was used.

Source: Swiss Economics based on Infront data.

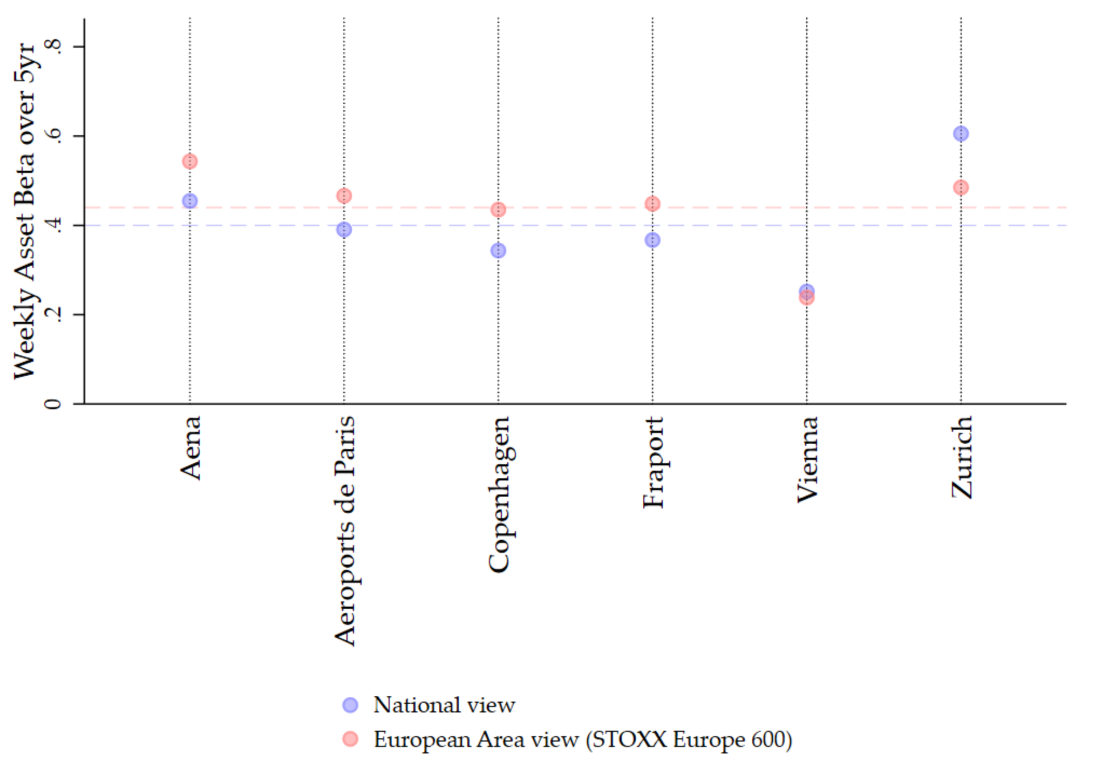
A.2.3 Market indices

229 The estimation of Asset Betas necessitates the choice of an appropriate market index. This is primarily a choice between national indices and indices that represent a larger economic entity. The rationale for national indices originates from the assumption that idiosyncratic national risks exist which have a common impact on all national companies.

230 **Figure 16** shows the sensitivity of weekly Asset Betas with respect to the choice of market indices. All Asset Betas in Figure 16 are estimated over 5 years. Betas based on national indices are slightly lower (average of 0.40) than Betas estimated on a European Area index[21] (average of 0.44). The slightly higher Asset Betas which result from estimations using European indices may reflect common impacts of European risks. Nevertheless, the differences between Asset Betas regressed on national and European indices are small. Wright et al. (2018) suggest that the dominance of large multinational corporations in many national stock markets render the differences between national and broader indices less relevant.

[21] STOXX Europe 600 price index.

Figure 16: Sensitivity with respect to the choice of market indices



Note: Based on OLS regressions using price indices. De-levering using Hamada-formula based on net debt/equity ratios and effective tax rates. Data until 31 August 2018 was used. European Area view indicates that airport returns were regressed on the STOXX Europe 600 price index.

Source: Swiss Economics based on Infront data.

A.2.4 Estimation method

231 The most common methodology to estimate Beta coefficients is Ordinary least squares (OLS). OLS models usually assume homoskedasticity, which is frequently violated in practice. Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models depart from the assumption of homoskedasticity by treating heteroskedasticity as a variance to be modelled. GARCH-based approaches to estimate Beta coefficients have been primarily of academic interest and, to the best of our knowledge, not been adopted in a regulatory context to date. However, given the possibility of GARCH models to explicitly model heteroskedasticity, and given the widespread occurrence of heteroskedasticity in financial data (e.g. volatility clustering), we conducted sensitivity analyses using GARCH models. The GARCH models estimated here correspond to the most commonly employed GARCH(1,1) specification, in which the variance is specified as a function of the previous period's squared error and the previous period's variance.

232 **Table 44** represents the results of the sensitivity analysis. In general, GARCH estimates are slightly lower than OLS estimates.

Table 44: Asset Betas estimated by OLS, GLS and GARCH

Estimation period / frequency	OLS (unweighted Asset Beta averages)	GARCH (unweighted Asset Beta averages)	Deviation vs. OLS
1 year / daily data	0.47	0.45	-4.7%
2 year / daily data	0.50	0.49	-1.4%
5 year / weekly data	0.47	0.46	-3.6%

Note: Average values are based on nine comparator airports (excluding Aeroporti di Roma, London Heathrow and London Gatwick). Betas are adjusted for differences in leverage and converted to Asset Betas using the Hamada-formula based on net debt/equity ratios and effective tax rates.

Source: Swiss Economics based on Infront data.

A.3 Levering and de-levering

233 The de-levered Betas (Asset Betas) only reflect each airport's business risk and can be compared with each other. The following formula is used in order to derive Asset Betas (Hamada (1972) and Modigliani and Miller (1963)):

$$\beta_{Asset} = \frac{\beta_{Equity}}{1 + \frac{D}{E} * (1 - t)} \tag{8}$$

where

- β_{Asset} is the Asset Beta;
- β_{Equity} is the Equity Beta;
- D is the net debt (debt minus cash and cash equivalents);
- E is the equity; and
- t is the effective tax rate.

234 The formula by Hamada is identified as regulatory best-practice by the Thessaloniki Forum's (2016) recommendation.

235 An alternative de- and re-levering method is the Harris-Pringle formula (1985), which is also known as the Miller-formula:

$$\beta_{Asset} = \frac{\beta_{Equity}}{1 + \frac{D}{E}} \tag{9}$$

236 The Harris-Pringle formula assumes a constant capital structure, i.e. a fixed ratio of debt to equity. In other words, companies are assumed to rebalance their capital structures in order to keep the ratio of debt to equity constant. The Hamada formula in contrast is based on the assumption that the level of debt is fixed. However, no rebalancing assumption is needed.

237 The assumptions underlying both formulas are unlikely to be met in practice. In the longer-run, debt levels may change and there is little reason to assume a fixed level of debt. On the other hand, a typical firm does not engage in constant rebalancing and the ratio of debt to equity typically fluctuates over time.

238 **Table 45** shows a comparison of Beta values using the different de- and re-levering formulas. The table shows that the differences in Beta values which result from using the Hamada or Miller formula are very small. The average weighted Asset Beta when de- and re-levered by Hamada's formula equals 0.49, while the average weighted Asset Beta based on Miller's formula is 0.47. The differences in the case of Equity Betas when rounded to two digits after the decimal point reduce to 0.01.

Table 45: Hamada/Harris-Pringle (Miller) de- and re-levering

Airport	Hamada Average of 1yr/daily, 2yr/daily, and 5yr/weekly	Harris-Pringle (Miller) Average of 1yr/daily, 2yr/daily, and 5yr/weekly	Delta
Aena (Spain)	0.57	0.53	0.04
Aeroports de Paris	0.51	0.43	0.08
Aeroporti di Roma	0.57	0.57	-
Auckland Airport	0.69	0.66	0.04
Copenhagen Airport	0.23	0.22	0.01
Fraport (Frankfurt)	0.52	0.45	0.07
London Gatwick Airport	0.52	0.52	-
London Heathrow Airport	0.47	0.47	-
Sydney Airport	0.46	0.40	0.05
TAV (Turkey)	0.35	0.31	0.04
Vienna Airport	0.25	0.24	0.01
Zurich Airport	0.64	0.62	0.03
Asset Beta - unweighted average	**0.48**	**0.45**	**0.03**
Asset Beta - weighted average	**0.49**	**0.47**	**0.03**
Equity Beta - unweighted average	**0.90**	**0.90**	**0.00**
Equity Beta - weighted average	**0.92**	**0.93**	**-0.01**

Note: Based on OLS regressions of stock market data from airports and a European price index (national price indices were used for TAV, Auckland, and Sydney). Estimated Betas were de- and re-levered by the same formula (Hamada or Harris-Pringle) based on net debt/equity ratios and – if applicable – effective tax rates. All datasets cover data until 31 August 2019.

Source: Swiss Economics based on Infront data.

A.4 Beta adjustments

239 One reason for possible distortions in the estimation of Betas is caused by the fact that Betas vary over time. Marshall E. Blume has shown (1971, 1975) that the variation of Betas over time is often associated with "reversion to the mean". Reversion to the mean means that a portfolio with a high or low Beta is likely to have a less extreme Beta in the following period, i.e. that Betas tend to approximate the average of all Betas which is 1. This may be an issue for the setting of Betas for multiannual regulatory periods, since the estimated Betas for future years may be too low (for a Beta below 1) or too high (for Betas above 1). The occurrence of reversion to the mean has been taken into account by Blume and others through the following formula:

$$\beta_{Blume\ adjusted} = \frac{2}{3} * \beta_{raw} + \frac{1}{3} * \beta_{market} \tag{10}$$

where

- β_{raw} is the estimated Beta; and
- β_{market} is the market Beta, by definition equal to 1.

240 An alternative adjustment of Beta parameters based on the idea of reversion to the mean is provided by Oldrich Vasicek (1973). In contrast to the Blume's adjustment, the Vasicek's adjustment assumes that Beta values with a high estimation error tend to move more strongly towards the market average than Betas which are estimated more precisely. There are many versions of Vasicek's adjustment and a common formula is the following (e.g. Hollstein et al., 2017):

$$\beta_{Vasicek\ adjusted} = \frac{\sigma^2[\beta_{raw}]}{\sigma^2[\beta_{market}] + \sigma^2[\beta_{raw}]} * \beta_{market} + \frac{\sigma^2[\beta_{market}]}{\sigma^2[\beta_{market}] + \sigma^2[\beta_{raw}]} * \beta_{raw} \quad (11)$$

where

- β_{raw} is the estimated Beta;
- β_{market} is the market Beta, by definition equal to 1;
- $\sigma^2[\beta_{raw}]$ is the variance of the estimated Beta; and
- $\sigma^2[\beta_{market}]$ is the variance of the market Beta.

241 Klemkosky and Martin (1975) compared the Vasicek's adjustment with the Blume's adjustment and concluded that Vasicek led to somewhat better results. Other studies have concluded otherwise (Eubank & Zumwalt 1979). A study from a purely theoretical point of view finds that Vasicek's adjustment is at least theoretically superior to the Blume's adjustment (Lally, 1998). Nevertheless, contemporary empirical research advises against the use of Beta adjustments (e.g. Echterling & Eierle, 2015).

242 **Table 46** shows the effect of the Blume's and Vasicek's adjustment on our Asset Beta values.

Table 46: Blume/Vasicek's adjustment of Asset Betas

Airport	Unadjusted (2yr / daily data)	Blume's adjustment (2yr / daily data)	Vasicek's adjustment (2yr / daily data)
Aena (Spain)	0.59	0.66	0.71
Aeroports de Paris	0.52	0.59	0.62
Aeroporti di Roma	0.57	0.67	0.72
Auckland Airport	0.66	0.73	0.78
Copenhagen Airport	0.12	0.36	0.52
Fraport (Frankfurt)	0.55	0.57	0.57
London Gatwick Airport	0.52	0.61	0.65
London Heathrow Airport	0.47	0.55	0.59
Sydney Airport	0.54	0.59	0.59
TAV (Turkey)	0.33	0.39	0.40
Vienna Airport	0.32	0.49	0.55
Zurich Airport	0.77	0.79	0.81
Average increase relative to unadjusted Betas		**+17%**	**+26%**

Notes: Blume's and Vasicek's adjustment for Aeroporti di Roma, London Heathrow, and London Gatwick were calculated based on the average increase of Blume's and Vasicek's Asset Betas relative to the unadjusted Asset Betas of the nine estimated comparator airports. Blume's and Vasicek's adjustments were applied on the "raw" Betas before delevering. We use the cross-sectional variance of the estimated Betas within the comparator group as a proxy for the variance of the market Beta in the case of Vasicek's adjustment.

Source: Swiss Economics.

243 As shown in Table 46 for the case of Asset Betas estimated on daily data over a period of 2 years, both, the Blume's and the Vasicek's adjustment exert a considerable impact on the values obtained. On average, the Blume's adjustment increases Asset Betas by 17 percent, whereas the Vasicek's adjustment increases the same values by 26 percent.

244 We oppose the use of Blume's or Vasicek's adjustment since both suffer from serious shortcomings. The main issue in the case of Blume's adjustment is that it mechanically moves all Betas towards a value of 1 by attaching a weight of only two-thirds to the estimated Betas and a weight of one-third to 1. Vasicek's adjustment is less mechanical, as it more strongly moves Betas that are statistically

imprecise, i.e. that have large variances, to 1 than Betas based on more precise estimations. Nevertheless, its issues are related to estimation feasibility. Theoretically, a calculation of the market Beta variance would involve calculating the cross-sectional variance of all Betas in the market portfolio. This is a very data-intensive calculation, which is the reason why the usual procedure is to use the cross-sectional variance of the estimated Betas within the comparator group as a proxy for the variance of the market Beta. Such an approach, however, reduces the validity of the Vasicek's adjustment and negatively affects the transparency and understanding of the adjustment.

A.5 Sensitivity of the Asset Beta in connection to different weighting schemes

245 **Table 47** reports the effects of different, alternative weighting schemes on the average weighted Asset Beta (i.e. the Betas averaged over the estimates based on 1 year and daily data, 2 years and daily data, and 5 years and weekly data).

Table 47: Effect of different weighting schemes

Airport	Actual weights (Table 23)	Only listed airports	Only European airports	Equal weights (all airports)	Only regulatory factors (all airports)	Only demand and structural factors (all airports)
Aena (Spain)	7.5%	11.1%	10.5%	8.3%	12.0%	3.6%
Aeroports de Paris	7.5%	11.1%	10.5%	8.3%	8.0%	7.1%
Aeroporti di Roma	9.4%	-	13.2%	8.3%	12.0%	7.1%
Auckland Airport	11.3%	16.7%	-	8.3%	8.0%	14.3%
Copenhagen Airport	5.7%	8.3%	7.9%	8.3%	0.0%	10.7%
Fraport (Frankfurt)	5.7%	8.3%	7.9%	8.3%	4.0%	7.1%
London Gatwick Airport	11.3%	-	15.8%	8.3%	12.0%	10.7%
London Heathrow Airport	11.3%	-	15.8%	8.3%	20.0%	3.6%
Sydney Airport	9.4%	13.9%	-	8.3%	4.0%	14.3%
TAV (Turkey)	7.5%	11.1%	-	8.3%	8.0%	7.1%
Vienna Airport	7.5%	11.1%	10.5%	8.3%	8.0%	7.1%
Zurich Airport	5.7%	8.3%	7.9%	8.3%	4.0%	7.1%
Average Weighted Asset Beta	**0.49**	**0.48**	**0.48**	**0.48**	**0.50**	**0.48**

Note: We report arithmetic averages of weighted 5-year weekly, 2-year daily, and 1-year daily Asset Beta estimates.
Source: Swiss Economics.

246 Table 47 shows a weighting scheme with equal weights, a scheme which considers exclusively the regulatory factors (see Table 19), and a scheme based on demand and structural comparability only (see Table 20 and Table 21). In addition, weighting schemes excluding non-listed airports and excluding non-European airports are presented. The last row in Table 47 shows the corresponding weighted Asset Beta for all methodologies. The variation in the weighted Asset Betas with respect to different weighting schemes is very small, ranging from 0.48 to 0.50.

B Appendix B: Stakeholder responses to the Draft Report

247 Finalising this report, we considered the responses to the Draft Determination from several stakeholders. Appendix B summarises our assessment of the following stakeholder submissions:

- ACI Europe;
- Dublin Airport (including a technical appendix written by Nera);
- Chambers Ireland;
- IATA; and
- Ryanair.

B.1 RFR

B.1.1 Long-term evidence of the RFR – Dublin Airport

248 Dublin Airport argued that the Draft Report relies too heavily on short-term evidence to assess the level of the RFR. Dublin Airport suggested to take a wider set of evidence into account, including historical evidence and regulatory precedent of the level of the RFR. Dublin Airport argued that an appropriate level for the RFR could be as high as 2 percent.

249 We disagree with Dublin Airport's suggestion for two main reasons:

- First, using long-term evidence for the RFR contradicts the rationale behind the CAPM-TMR approach. The CAPM-TMR approach relies on the explicit assumption that RFR and ERP change over time as a result of how investors perceive market risk. Long-term evidence of the RFR is likely to be skewed towards a historic mean of the RFR, which particularly in times of nervous financial markets probably does not coincide with the recent RFR. Thus, a RFR based on long-term evidence contradicts the logic of a CAPM-TMR approach. Also, recent developments on financial markets indicate that yields on government bonds are not going to increase soon. For example, on 14 August 2019, longer-term US treasury bond yields fell below shorter-term yields, indicating that investors are still afraid of an economic downturn and continue to demand safe assets.
- Second, using long-term evidence for the RFR contradicts the evidence we found regarding the level of other WACC components. For example, a RFR of 2 percent would be higher than any assessment of the cost of new debt that we have seen so far (including Dublin Airport's own assessment). As such, an RFR based on long-term evidence leads to values of the RFR that are inconsistent with basic finance principles, as the costs of an airport bond with a certain risk of default cannot sensibly be lower than the cost for a risk-free asset.

B.1.2 Market expectations reflected in forward rates – Ryanair

250 Ryanair argued that forward rates only reflect market expectations on future interest rates, neglecting other factors, such as macroeconomic conditions, sovereign credit ratings, daa's prospect and, Central Banks' base rates. Ryanair is concerned that this may result in inflated estimates of future interest rates.

251 Forward rates are calculated from yields currently observed in the market on bonds with differing remaining time spans to maturity. As such, forward rates reflect how markets asses how market conditions are likely going to change in the future and how this will affect bond prices. Hence, also markets' expectations on how macroeconomic conditions, sovereign credit ratings, or Central

Banks' base rates (i.e the factors named by Ryanair) should be appropriately reflected in forward rates.

252 Even if market expectations, as reflected in forward rates, are imprecise, it is unclear whether the resulting estimation error would increase or decrease the level of the true RFR compared to our estimate. In general, there are no signs that forward rates are systematically higher or lower than the actual interest rate development (see for example Kloster, 2000).

B.2 ERP

B.2.1 Holding period – Dublin Airport

253 Dublin Airport argued that the Draft Report's assumption of a holding period, which serves as an input to calculate the annual returns from holding the market portfolio, of 10 years is too long. Rather than 10 years, Dublin Airport argues that investor surveys and other research suggest investors' average holding period is only about 1 to 5 years.

254 We disagree with Dublin Airport's suggestion to shorten the length of the holding period from 10 to 5 (or even fewer) years for the following reasons:

- The choice of a 10-year investment horizon is consistent with UKRN recommendations (UKRN, 2018). The UKRN recommends using a relatively long investment horizon, explicitly referring to 10 years as an example, because the notional investor would typically invest through a pension fund. The problem with using a short investment horizon is that this would introduce a clear disconnect between the horizon of the (notional) investor and the expected life of the assets employed (UKRN, 2018).
- A 10-year holding period allows for consistency across WACC elements, as we use a similar investment horizon also for estimating the RFR and the cost of debt. Dublin Airport's suggestion to reduce the investment horizon to calculate the ERP contrasts with its suggestion to increase the investment horizon underlying the cost of new debt assessment and introduces unnecessary complexity to the methodology. In line with the UKRN recommendations (see recommendation 2), we prefer to estimate all WACC elements using methodologies consistent with a single investment horizon. We assess the level of the RFR and cost of debt using bond yields with a remaining time to maturity of ten years and we calculate the annual returns from holding the market portfolio assuming a 10-year holding period (UKRN, 2018, page 29).

B.2.2 The choice of the market portfolio – Dublin Airport

255 Dublin Airport argued that a worldwide equity portfolio approximates a notional investor's investment universe better than a European portfolio. The reason for this is that the sample underlying DMS' European portfolio is sensitive to the inclusion of additional countries. For example, the inclusion of Austria and Russia in 2013 led to a material change in average historic returns.

256 We continue to believe that a European equity portfolio is likely to represent an Irish investors' investment universe better than a world equity portfolio. We believe a worldwide portfolio contains too much equity from countries with only negligible relevance to Irish investors. It is likely the countries from the Euro area that are in the focus of an Irish investor. Naturally, these countries are better represented in a European portfolio.

257 In some developing countries, equity returns have exceeded European levels by far. However, given risks related to currency exchange rates, political and institutional stability, as well as economic development it seems unlikely that these countries represented more than a marginal share in Irish

investors' portfolios. In fact, the sensitive reaction of historic returns from the DMS European portfolio with regard to the inclusion of Russia underlines our argument for why we believe that the appropriate market portfolio is the European portfolio. We do not believe that Russian equity has significant weight in a notional Irish investor's investment portfolio.

B.2.3 Consistency of time frame for estimating TMR and ERP – Ryanair

258 Ryanair argued that the assessment of the ERP in the Draft Report used inconsistent time frames for the RFR and TMR. Whereas short-term evidence was used to inform the level of the RFR, long-term evidence was used to inform the level of TMR. According to Ryanair, this inconsistency led to an inflated estimate of the ERP.

259 We disagree with Ryanair's argument. Underlying our CAPM-TMR approach is the assumption that TMR (i.e. expected rather than actual market returns) are constant (or at least more constant than the ERP) over time. On the other hand, the approach assumes that that there are significant negative co-movements between the RFR and the ERP. We have summarised the relevant academic literature and empirical evidence in Section 4.2. Given the recent decrease in the level of the RFR, a related increase in the ERP is in line with the CAPM-TMR's logic and is not an unwanted result of inconsistent time frames.

B.2.4 Averaging method for annual returns – IATA

260 IATA argued that Blume's averaging method, which was used in the Draft Report to determine a weighted average between arithmetic and geometric means of historic equity returns, results in inflated estimates of TMR.

261 We use Blume's estimator as a weighting method because it is a simple, but theoretically well-founded way to correct the likely upward bias form using empirical estimates of the annual return in a multi-year investment horizon. Despite the arithmetic mean being an unbiased estimator for the return of holding a portfolio for a single year, the arithmetic mean is upward biased as an estimator for the annual return of holding period spanning several years. The upward bias results from the error term implicit in any empirical assessment of annual returns and can be demonstrated using Jensen's inequality (Blume, 1974).

262 We have not seen any compelling reason for why a simple mean between of arithmetic and geometric averages, as seems to be preferred by IATA, leads to a more accurate estimate of the one-year return of holding the market portfolio for several years than the Blume estimator.

B.2.5 Characteristics of the dividend discount model – Dublin Airport

263 Dublin Airport suggested to use a multi-stage DDM based on forecasted dividend growth rates provided by equity analysts rather than the single-stage DDM based on historic dividends employed in the Draft Report. Dublin Airport also suggested considering a broader market stock index (STOXX Europe 600 index) instead of the used STOXX Europe 50.

264 Estimating future dividends is a key challenge in dividend discount modelling. Ideally, a DDM could rely on precise estimates of dividend growth from this year to infinity i.e. a DDM that considers all stages. However, most dividend forecasts suffer from substantial noise and estimation error. Hence, the benefits from more stages in a DDM can be repealed by additional errors in the inputs (Damodaran, 2002). Empirical evidence exists which finds that the Gordon growth model, which assumes a constant dividend growth rate and is employed in the Draft Report, performs nearly as well at explaining prices as more complex DDM models (e.g. Foerster & Sapp, 2005).

265 However, we agree with Dublin Airport that the use of historic dividend growth rates as a proxy for future growth rates may be improved. Though, we disagree with Dublin Airport that analyst forecasts is a better source. Analyst forecasts are prone to large swings (e.g. at turning points in the economic cycle). An alternative methodology providing more stability in the estimation of the DDM is to use GDP forecasts as proxy values for dividend growth.

266 Therefore, we adjust our model in the final report by using real average GDP forecasts as measures for dividend growth (in line with PWC's approach for H7 (2017)). GDP forecasts are obtained from the OECD based on a one-year-ahead assessment of the economic climate in individual countries and the world economy, using a combination of model-based analyses and expert judgement.

267 We continue using the STOXX Europe 50 for reasons of easier tractability compared with Dublin Airport's suggested STOXX Europe 600 index comprising 600 companies. However, the indices are highly correlated, which renders a substantial difference in the resulting level for the TMR due to the choice of the index unlikely.

B.3 Beta

B.3.1 Evidence for the reduction in Beta values – Dublin Airport

268 Dublin Airport argued that there is no evidence that would indicate a reduction in Dublin Airport's Asset Beta.

269 The decrease of Dublin Airport's Asset Beta compared to the last determination is primarily driven by differences in the underlying methodology. Firstly, we rely more on empirical evidence than CAR did in the 2014 Determination. CAR noted in its 2014 Draft Determination that the available evidence pointed towards an Asset Beta lower than 0.6. Out of ten comparator airports, only the ranges for AdP and Fraport included values as high as 0.6. Despite market evidence pointing to an Asset Beta at the lower end of the range, a point estimate at the top of the range was chosen.

270 One reason for choosing the top of the range was due to the decision's general approach of how to deal with uncertainty around the true WACC parameters. The 2014 Determination used point estimates towards the upper end of the range for all WACC elements, implicitly aiming up the regulatory WACC. This contrasts our approach of adding an explicit aiming up component to the best estimate of the WACC (see Section 7).

271 In addition to methodological differences in choosing a point estimate, there also exist good reasons for why Dublin Airport's systematic risk may have decreased over the past five years. For example, the number of airlines flying to Dublin Airport has increased significantly and now includes a solid share of foreign airlines. Also, the number of routes increased. New intercontinental routes were introduced, including to North America, Africa and the Middle East, which have likely dampened Dublin Airport's income volatility and risk exposure.

B.3.2 Lower traffic volatility and business risks calls for lower Beta – Ryanair

272 Ryanair claimed that Dublin Airport's business risk is lower than for other airports as evidenced by stronger correlation of GDP growth and traffic growth, stable improvement in EBITDA per pax, and a decreasing Herfindahl-Hirschman Index (HHI) at Dublin Airport. Thus, Dublin Airport's Asset Beta should be lower than other airports' Asset Betas.

273 We are not fully convinced that all the evidence submitted by Ryanair really points to a decreased risk exposure of Dublin Airport compared to other airports. For example, high correlation of GDP growth and traffic growth may point towards an increased Beta rather than a decreased Beta, since

Dublin Airport's profits would show a stronger link with the Irish stock market, translating into greater undiversifiable risk.

274 Finally, Ryanair presents evidence for an increase in the diversification of the airline market at Dublin Airport and an increase in the geographic market coverage in recent years. While we agree that these effects are likely to reduce Dublin Airport's systematic risk, we believe that the extent of the reduction is unlikely to exceed the reduction in Asset Betas compared to the 2014 Determination that is implied by the Final Report.

B.3.3 Including Asset Betas based on regulatory decisions – Ryanair

275 Ryanair criticises the inclusion of Heathrow Airport, Gatwick Airport, and Aeroporti di Roma in the set of comparator airports for the following reasons:

- Some of the Asset Beta values for these airports were determined in reference to the listed airports in the set of comparator airports, potentially double counting certain airports.
- The time frame used to derive the Asset Betas of the unlisted airports is not consistent with the time frame used to estimate the Asset Betas of exchange-listed airports.

276 We weigh comparator Asset Betas from regulatory decisions less than empirically estimated Asset Betas of exchange-listed airports. As such, we acknowledge that the process, which led to the regulatory Asset Betas for these airports, may not be equally suitable as evidence from recent market data to inform Dublin Airport's Asset Beta.

277 Nevertheless, we include Heathrow Airport, Gatwick Airport, and Aeroporti di Roma because of their high comparability to Dublin Airport with respect to other characteristics. For example, Gatwick Airport is, together with Auckland Airport and Sydney Airport, the most comparable airport to Dublin Airport in our dataset in terms of demand structure (annual passengers, annual flights, and aeronautical revenue share) and Heathrow Airport is the most comparable airport to Dublin Airport in terms of the regulatory environment.

278 Finally, a sensitivity analysis, which only considers listed airports, shows that the estimate of the Asset Beta is not sensitive to whether regulatory Asset Betas are included in the assessment or not (see Appendix A.5).

B.3.4 Adjusting for Dublin Airport's increased Capex/RAB ratio over the 2020-24 period – Dublin Airport

279 Dublin Airport argued that the methodology from the Draft Report does not take into account that Dublin Airport's Asset Beta is likely to increase over the next regulatory period due to an increased Capex/RAB ratio following the investments from the CIP 2020+.

280 In our view, the Draft Report methodology for assessing Dublin Airport's Asset Beta does not require any adoptions to reflect an increase in the airport's Capex/RAB ratio. The methodology relies on a weighted sample of comparator airports that reflect Dublin Airport's risk profile over the next regulatory period the most and is independent of Dublin Airport's past risk profile.

281 Many of the comparator airports with relatively strong weights have a capex/RAB ratio that is comparable to Dublin Airport's ratio over the next regulatory period. For example, Heathrow Airport is forecasted to have an average Capex/RAB ratio of 16.8 percent over the 2020-24 period (PwC, 2017). The equivalent measure for Dublin Airport over the 2020-24 period is likely to be in a comparable range. **Table 48** illustrates this using Dublin Airport's RAB and depreciation forecast from CAR's Draft Determination 2019 (see page 8).

Table 48: Dublin Airport Capex/RAB ratio over the 2020-24 regulatory period

Year	Opening RAB (€m), I	Regulatory Depreciation (€m), II	CAPEX (€m), III: IV – (I-II)	Closing RAB (€m), IV	CAPEX / RAB Ratio, V: III/IV
2020	1,756.2	92.1	410.9	2,075.0	20%
2021	2,075.0	103.9	410.9	2,382.0	17%
2022	2,382.0	116.5	410.7	2,676.2	15%
2023	2,676.2	131.1	411.1	2,956.2	14%
2024	2,956.2	146.2	411.0	3,221.0	13%

Source: Swiss Economics based on CAR Draft Determination 2019.

282 We suggested in the Draft Report as well as in the Final Report to allow for an aiming up component of 50 basis points that specifically addresses the negative consequences of underestimating the true WACC on Dublin Airport's incentives to invest. This approach is in line with how the CAA plan to deal with any impact of a third runway on Heathrow Airport's risk. Rather than allowing for an adjustment of the Asset Beta, the CAA plan to add an uplift between 25 to 100 basis points to account for increased risk from the construction of the third runway (PwC, 2017).

283 Thus, we do not see any compelling reason to add an adjustment to Dublin Airport's Asset Beta in connection to the CIP 2020+ in addition to the aiming up component that is added to the overall WACC.

B.3.5 Choice of stock market indices – Dublin Airport

284 Dublin Airport claimed that a Europe-wide stock index should be used as a benchmark for estimating Betas of European comparators – specifically, Dublin Airport suggested using the STOXX Europe 600 index.

285 We follow Dublin Airport's suggestion in the Final Report and estimate Beta values based on the STOXX Europe 600 index. We keep regressing returns for Sydney Airport, Auckland Airport, and Istanbul Airport on local indices due to a lack of appropriate regional indices.

286 The main rationale for using a regional index such as the STOXX Europe 600 is consistency with other WACC components that rely on evidence from several European countries. Furthermore, European markets are likely to reflect the investment universe of a typical diversified airport investor more so than local indices.

287 A sensitivity analysis on Beta estimates based on national and regional indices can be found in Appendix A.2.3.

B.3.6 De- and re-levering formulae – Dublin Airport

288 Dublin Airport claims that the Miller formula (also known as the Harris/Pringle formula) is more appropriate to de- and re-lever Beta values than the Hamada formula, which is used in the Draft Report.

289 The Miller formula suggested by Dublin Airport assumes a constant capital structure, i.e. a fixed ratio of debt to equity. In other words, companies are assumed to rebalance their capital structures in order to keep the ratio of debt to equity constant. The Hamada formula is based on the assumption that the level of debt is fixed.

290 The assumptions underlying both formulas are unlikely to be met in practice. In the longer-run, debt levels may change and there may be reasons to assume that the level of debt is not fixed. However, most firms do not constantly rebalance their debt to equity ratio.

291 We have conducted a sensitivity analysis comparing the two approaches for de- and re-levering Betas in Appendix A.3. The effects on final estimates of Equity Betas are negligible.

292 Given the minor impact of changing de- and re-levering formulae and the fact that the Thessaloniki Forum recommends using the Hamada formula, we continue using Draft Report's approach.

B.3.7 Choice of comparator airports and weighting scheme – Dublin Airport

293 Dublin Airport claimed that the weighting scheme from the Draft Report for comparator airports is flawed, leading to an unduly reliance on airports with significantly lower risk, resulting in an understatement of Dublin Airports' Beta. Dublin Airport also claimed that no theoretical basis for the choice of comparability factors is provided and that a large set of comparator airports makes the sample noisy. Furthermore, Dublin Airport deemed that the Draft Report's approach is mechanical and rigid.

294 Our choice of comparability measures is based on a qualified assessment of the real-world parameters that determine an airport's level of undiversifiable risk. Rather than an isolated focus on few comparator airports, we aim for a large sample in order to reduce the risk of outliers distorting the estimate. This is important given the strong volatility across airports' Asset Betas.

295 Furthermore, instead of relying on a more qualitative and subjective weighting scheme, we implement a methodology that is as transparent as possible. The reasoning behind all choices and decisions in relation to the weighting of different airport characteristics is outlined in Section 5.2.

296 Finally, an extensive sensitivity analysis regarding different weighting schemes is presented in Appendix A.5 (Table 47). We assess the impact on the Asset Beta if the following weighting schemes are applied:

- only listed airports;
- only European airports;
- all comparison factors weighted equally;
- only regulatory factors considered; and
- only demand and business structural factors considered.

297 The sensitivity analysis reveals that the effect from different weighting scheme on the Asset Beta is negligible. Based on this analysis and the conceptual arguments outlined above, we choose to continue the weighting scheme from the Draft Report without any amendments.

B.3.8 Excluding Auckland and Sydney as comparator airports – IATA & Ryanair

298 Ryanair claimed that Auckland Airport and Sydney Airport should be excluded from the set of comparator airports as they operate in different geographies and have a connectivity mix that is not the same as Dublin Airport's. IATA advises to follow the Thessaloniki forum recommendations and focus on airports within the region.

299 We include Auckland Airport and Sydney Airport for several reasons. First of all, our Beta estimation is based on identifying a sufficiently large set of comparison entities in order to reduce the risk of skewed estimates due to outliers. Although the Thessaloniki Forum recommends to use a peer group from the European Economic Area and Switzerland, the guidelines also recommend to extend the peer group to countries with a comparable general economy in case of a too limited number of comparable peers.

300 Second, Auckland Airport and Sydney Airport are, together with London Gatwick Airport, the most comparable airports to Dublin Airport with respect to demand structure comparability. Both,

the number of passenger and the number of flights are comparable to Dublin Airport. In addition, the aeronautical revenue share of Auckland Airport and Sydney Airport are 44 percent and 48 percent, respectively, which is comparable to Dublin Airport's share of 51 percent.

301 Ryanair also claimed that Auckland Airport and Sydney Airport have a different connectivity mix to Dublin Airport. However, data on connectivity from Auckland Airport's annual reports shows that the 2018 share of transfer and transit passengers of 5.5 percent (Auckland Airport annual information disclosure 2018) is comparable to Dublin Airport's share of 6.7 percent (daa annual report 2018).

302 Finally, a sensitivity analysis estimating Asset Betas on European airports exclusively shows that the resulting Betas are almost identical to the Asset Betas estimated on the whole comparison set (see Appendix A.5).

303 Based on the above, we abstain from excluding Auckland Airport and Sydney Airport from the set of comparator airports in the Final Report.

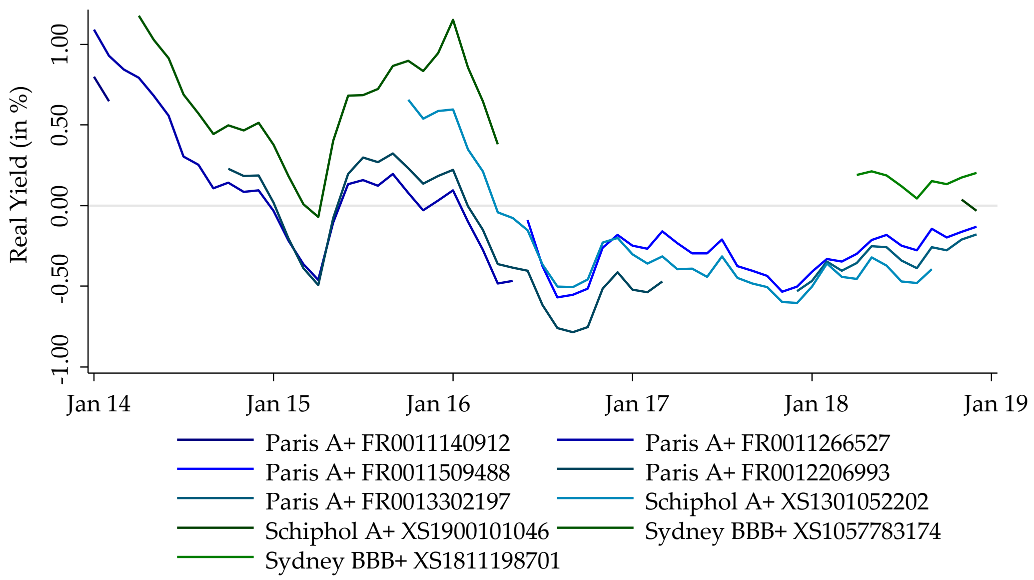
B.4 Cost of debt

B.4.1 Controlling for differences in remaining maturities across comparator bonds – Dublin Airport

304 Dublin Airport argued that the methodology used to estimate the cost of new debt based on bond yields from comparator airports does not correct for changes in maturities of the comparator bonds, leading to a downwards bias.

305 We disagree with Dublin Airport's argument. The rolling averages include all EUR bonds issued from comparator airports with remaining time to maturity between 8 to 12 – also bonds that were issued during the averaging periods. **Figure 17**, which was included in the Draft Report, shows that several bonds have only been included during the averaging period (e.g. Schiphol's A+ XS1900101046).

Figure 17: Chart of comparator airport bonds from Draft Report



Source: Swiss Economics Draft Report.

306 Thus, Dublin Airport's argument is incorrect. The methodology employed in the Draft Report does not systematically understate the true cost of debt due to decreasing remaining maturities. At every point in time, all available EUR bonds from the comparator airports are included in the calculation of averages. Schiphol's A+ XS1900101046 bond reaches maturity in November 2030 and as such entered the calculation of averages only with a remaining time to maturity of approximately 12 years in autumn 2018.

B.4.2 Debt tenor and investment horizon – Dublin Airport

307 Dublin Airport argues that the tenor of new bonds is likely to be higher than 10 years, as evidenced by Dublin Airport's 2028 Bond, which was issued with a tenor of 12 years. The delta to the notional investment horizon of 10 years, which is adopted in the Draft Report, results in a downward bias of the cost of new debt estimate according to Dublin Airport.

308 However, it is not clear what the appropriate tenor for Dublin Airport's new debt is. The 2028 Bond was indeed issued with a tenor of 12 years, however the tenor of new loans from the undrawn €350m EIB facility may be anywhere between 4 to 20 years according to the underlying facility agreement.

309 Without any clear evidence on the tenor length of future debt, we do not see a compelling reason to deviate from the investment horizon of 10 years that we also adopted in other WACC components (e.g. the RFR and the TMR). As such, we are aligned to UKRN recommendations that advise using methodologies for all WACC components that are consistent with a single chosen investment horizon, e.g. 10 years (see UKRN 2018, recommendation 2).

310 Moreover, although we agree that interest payments on debt are likely to increase with the length of tenor at issuance, the effect from two additional years from 10 to 12 years is likely to be small. Other factors, such as industry outlooks and macroeconomic developments are likely to have a much bigger impact on the cost of new debt.

B.4.3 Sample size of comparator bonds – Dublin Airport

311 Dublin Airport argued that the sample of comparator airport bonds on which the Draft Report methodology relied for the assessment of the cost of new debt leads to an unreliable estimate because of the small sample that consists only of three comparator bonds, namely ADP, Amsterdam Airport, and Sydney Airport, making the estimate sensitive to random fluctuations.

312 We agree that the precision of the cost of new debt estimate increases with the number of bonds in the sample. However, the Draft Report methodology set high standards in terms of comparability for the bonds we included in the sample. We only focused on bonds that match the following criteria:

- The bond is issued by an airport
- The issuing airport has a comparable credit rating to daa
- The bond principal and coupon payments are denominated in EUR
- The bond's remaining time to maturity is between 8 to 12 years

313 To our knowledge we included every bond that matches all of the above criteria. Thus, the sample size can only be increased by relaxing any of the above criteria, which means that there is a risk that the estimator becomes biased.

314 However, we agree that the bias from relaxing some of the above criteria may be negligible. Thus, in accordance with Dublin Airport's submission, we amended the methodology for the assessment

of the cost of new debt to not only focus on airport bonds. Instead, we use a broader bond index reflecting EUR denominated non-financial corporate bonds as a new benchmark for cost of new debt in the Final Report.

B.4.4 Country risk premium – Dublin Airport & Ryanair

315 Albeit for different reasons, the approach used in the Draft Report to determine the country risk premium was criticised by Dublin Airport and Ryanair.

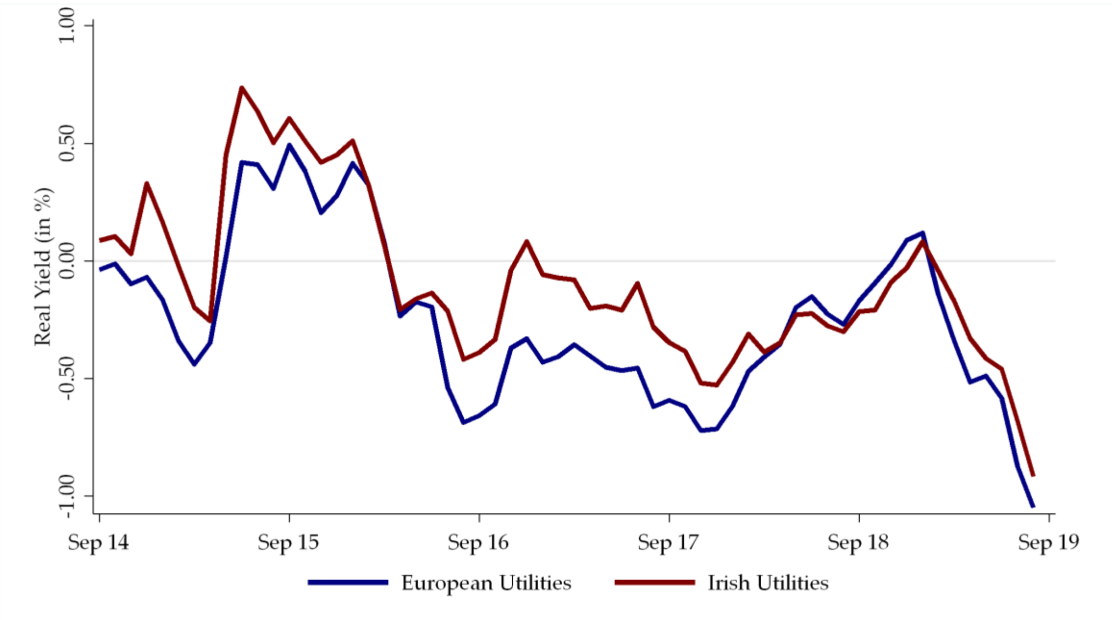
316 Dublin Airport argued that the methodology to assess the country-specific risk premium suffers from the same issues that they raised in connection to the assessment of the cost of new debt (i.e. no control for credit ratings, maturities and other factors that could influence the yield spread as well as a too small sample size). In addition, Dublin Airport argued that the reference point for measuring the country-specific risk premium is ambiguous, since the estimated premium is heavily influenced by the choice of countries and bonds in the comparator sample.

317 Ryanair made an argument regarding country premium and notional investment grade uptick, which can be summarised as follows: The analysis of the country-specific premium does not control for differences in the credit rating between the two comparator samples and the analysis of the credit rating spread does not control for differences in country risk across the two comparator samples, potentially leading to an upward bias of our estimate.

318 We agree with some of the above points, but we doubt that any distortive effects on the cost of new debt estimate is substantial. The arguments brought forward by Dublin Airport and Ryanair are likely to have opposite effects and, as such, are likely to cancel each other out to some extent.

319 Already in the Draft Report we stated that market evidence points towards a decreasing country risk premium. As per August 2019, we constitute that Irish utility bonds are not traded at a significant premium compared to European utility bonds anymore. **Figure 18** depicts average bond yields of European utility bonds and Irish utility bonds over time.

Figure 18: Irish vs European utility bond yields



Note: Irish utilities include ESB and GNI. European utilities include Iberdrola, EDF, Engie, Veolia, Innogy, and Enel.

Source: Swiss Economics Draft Report (Updated to 31 August 2019).

320 The updated market evidence, which suggests that the Irish country risk premium has largely disappeared, led us to amend the methodology and refrain from applying a country risk premium in the Final Report.

B.4.5 Premium for notional investment grade credit rating – Dublin Airport & Ryanair

321 Regarding the premium for the notional investment grade credit rating, we have received submissions from Dublin Airport and Ryanair.

322 Dublin Airport argued that the methodology to assess the premium for the notional credit rating suffers from the same issues that they have raised against the sample of comparator bonds and the methodology to estimate the country risk premium (i.e. no control for credit ratings, maturities and other factors that could influence the yield spread as well as a too small sample size).

323 In addition, Dublin Airport makes the argument that the methodology from the Draft Report leads to a reduced estimate of the uptick, because the "A" sample of comparator bonds is tilted downwards whereas the "BBB" sample of comparator bonds is tilted upwards.

324 Ryanair makes an argument overarching both analyses that can be summarised as follows: The analysis of the country-specific premium does not control for differences in the credit rating between the two comparator samples and the analysis of the credit rating spread does not control for differences in country risk across the two comparator samples, potentially leading to an upward bias of our estimate.

325 We agree with some of the above points, but we doubt that the distortive effect on the estimate of the cost of new is substantial. The arguments brought forward by Dublin Airport and Ryanair are likely to have opposite effects on the level of cost of new debt and, as such, are likely to cancel each other out to some extent.

326 Nevertheless, we have amended the approach regarding the assessment of the notional investment grade credit rating. We move from estimating Dublin Airport's efficient cost of new debt and an uptick for the notional credit rating separately to an approach of estimating the cost of new debt for comparator firms with a BBB credit rating directly. In the Final Report, we use a benchmark iBoxx index reflecting yields of BBB-rated non-financial corporates to capture the cost of new debt at a notional investment grade credit rating. As such, we eliminate the uncertainty around the Draft Report's methodology inherent to a two-step approach.

B.4.6 Transaction costs – Ryanair

327 Ryanair argue that the allowance for transaction costs, which is included in the Draft Report, overestimates efficient transaction costs.

328 Indeed, the estimate of transaction costs in the Draft Report is relatively high compared to regulatory precedent. The In the UK, regulators have typically set transaction costs in the range between 10 to 30 basis points. Uregni (2016), who set notional transaction costs between 40 to 60 basis points comparable to the transaction costs in the Draft Report, must be considered an exception. In their recommendation for the CAA, PwC suggest setting issuance costs of 10 basis points for the upcoming regulatory period H7.

329 However, the approach chosen in the Draft Report is not directly comparable to most regulatory precedent. This is because it considered banking costs as a whole rather than focusing on costs related to the issuance of debt. After further discussion with Dublin Airport and screening of the agreements underlying embedded debt, we conclude that it is more appropriate to treat transaction costs as an integral part of interest payments.

330 On the level of cost of embedded debt, the change in methodology does not have any effect. While transaction costs were added separately to interest payments in the Draft Report, they are now included in the overall interest rate incurred on existing debt.

331 However, the omission of transaction costs does impact the level of cost of new debt. To compensate, we suggest adding an allowance for issuance costs in line with regulatory precedent (e.g. PwC, 2017).

B.5 Aiming Up

B.5.1 Aiming up on new investments only – Ryanair

332 Ryanair argues that the aiming up component should only be applied for new investments consistent with UKRN recommendations. For the existing RAB, Ryanair argue that the best estimate of the WACC should be used.

333 We are aware that UKRN recommends limiting the aiming up of the WACC on new investments. However, regulatory precedent in Ireland was not limited to new investments. In fact, all regulatory decisions listed in Table 39 applied the aiming up to the full RAB. Thus, to be consistent with the explanations that justify the extent of aiming up, we believe it is important to apply the aiming up on the full RAB, including new as well as existing assets.

B.5.2 Double counting with notional investment grade credit rating – IATA

334 IATA argued that any aiming up component is redundant because any uncertainty was already dealt with by the uptick for the notional investment grade credit rating.

335 We disagree with IATA's view. The uptick for the credit rating brings our estimate of the WACC closer to the true notional WACC. The aiming up component serves set the regulatory WACC on a level that is above our best estimate of the notional WACC, in order to avoid a situation in which the regulatory WACC is set below the notional WACC. This could happen because there is a degree of uncertainty around the level of the true value. Thus, the two adjustments serve different purposes.

C Appendix C: Cost of debt at a BBB+ credit rating

336 CAR have commissioned us to determine Dublin Airport's cost of capital for a notional credit rating at BBB+.

337 The main report uses a notional BBB credit rating. A BBB+ credit rating may constitute a signal of reduced risk to investors compared to a BBB credit rating and may result in reduced yields required by lenders and lower cost of debt for Dublin Airport. We use two complementary approaches to estimate the difference between the cost of new debt at BBB and BBB+ credit ratings.

338 First, we use evidence from an undrawn debt facility agreement from [✂] between Dublin Airport and [✂]. The interest rate on loans from the facility agreement is defined by the level of the EURIBOR and a margin, which is dependent on Dublin Airport's credit rating. **Table 49** reports the margins that apply under a BBB+ credit rating and a BBB credit rating. We use the spread of 10 basis points between the two margins as an upper bound of the for the downward adjustment of the cost of new debt from a BBB credit rating to a BBB+ credit rating.

Table 49: Interest rate margins depending on Dublin Airport's credit rating

Credit rating	Margin
BBB+	[✂]
BBB	[✂]
Difference between BBB and BBB+	**0.10%**

Note: Margins are reported in nominal terms in line with the relevant debt facility agreement.

Source: Swiss Economics based on daa data.

339 Second, we use EUR iBoxx indices for yields from A and BBB rated non-financial corporate bonds. The difference in average yields between the two indices is the spread attributed by the markets to an upgrade of a full grade from BBB to A. It seems reasonable to assume the spreads between the individual notches remain constant (i.e. deltas between A to A-, A- to BBB+, and BBB+ to BBB are equidistant), such that the spread from BBB+ to BBB is simply a third of the spread between A and BBB bond yields.

340 **Table 50** reports 1-year averages, 2-year averages, and 5-year averages of deltas between yields of iBoxx EUR indices with A and BBB rated non-financial corporate bonds.

Table 50: Spread between A and BBB rated corporate bonds

Index	1-year average	2-year average	5-year average
iBoxx EUR Non-Financials A	-0.44%	-0.51%	-0.45%
iBoxx EUR Non-Financials BBB	0.30%	0.14%	0.02%
Delta A to BBB	**74 bps**	**65 bps**	**47 bps**
Delta BBB+ to BBB (1/3 x Delta A to BBB)	**25 bps**	**22 bps**	**16 bps**

Note: Based on arithmetic averages of monthly yields up to August 2019.

Source: Swiss Economics based on Infront data.

341 Table 50 reveals considerable fluctuation around the spread between yields of bonds with BBB+ and BBB ratings. The average spread over the past five years is at 16 basis points. However, the spread seems to have widened recently, converging closer to 25 basis points for the past 12 months. Based on this trend, we deem that market evidence supports a value of 20 basis points for the lower bound of the spread between yields of BBB+ and BBB rated corporate bonds.

342 We conclude that an appropriate downwards adjustment for the cost of new debt based on a BBB+ credit rating ranges from 10 basis points to 20 basis points. **Table 51** compares the main report's cost of new debt at a BBB credit rating to the cost of new debt at a BBB+ credit rating.

Table 51: Summary cost of new debt for a BBB+ credit rating

	Lower bound	Upper bound
Cost of new debt at BBB credit rating	0.74%	1.06%
Downward adjustment for notch from BBB+ to BBB	-20 bps	-10 bps
Cost of new debt at BBB+ credit rating	**0.54%**	**0.96%**

Source: Swiss Economics.

343 A weighted cost of debt for Dublin Airport ranging from 0.29 percent to 0.96 percent results after adjusting cost of new debt estimates for a BBB+ credit rating. No adjustment is required for the range of the cost of embedded debt, as the underlying debt agreements do not foresee any changes to the interest rate in the event of downgrades from BBB+ to BBB or upgrades from BBB to BBB+.[22] The updated range for Dublin Airport's weighted cost of debt at a BBB+ credit rating is summarised in **Table 52**.

Table 52: Weighted cost of debt at a BBB+ credit rating

Debt category	Share (lower bound)	Lower bound	Share (upper bound)	Upper bound
Cost of embedded debt	62%	0.14%	40%	0.96%
Cost of new debt at BBB+ credit rating	38%	0.54%	60%	0.96%
Weighted cost of debt		**0.29%**		**0.96%**

Source: Swiss Economics.

344 **Table 53** summarises our findings on the range of the cost of debt at a BBB+ credit rating and compares it to the cost of debt at a BBB credit rating.

Table 53: Summary cost of debt at BBB+ and BBB credit rating

	Range (in %)	Point estimate (in %)
2019 SE advice for BBB+ credit rating	0.29 – 0.96	0.63
2019 SE advice for BBB credit rating	0.37 – 1.02	0.69

Source: Swiss Economics.

345 Finally, **Table 54** reports our estimate of the real pre-tax WACC for Dublin Airport based on a BBB+ credit rating.

[22] The undrawn debt facility, which contains the margins presented in Table 49, was not considered as embedded debt in this report.

Table 54: Ranges and point estimates for all individual WACC components based on BBB+ credit rating

	Lower bound	Upper bound	Point estimate
Gearing	45%	55%	50%
Tax rate			12.50%
RFR	-1.12%	-0.10%	-0.61%
TMR	5.96%	6.80%	6.38%
ERP	6.57%	7.41%	6.99%
Asset Beta	0.48	0.51	0.50
Equity Beta	0.91	0.95	0.94
Cost of equity (post-tax)	5.33%	6.46%	5.96%
Cost of debt (pre-tax)	0.29%	0.96%	0.63%
Estimate of pre-tax WACC	**2.90%**	**4.49%**	**3.72%**

Note: All values are reported in real terms. Point estimates reflect our estimates of the most likely values.

Source: Swiss Economics.

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