Appendix 1 – Commission for Aviation Regulation Traffic Forecast Review

Source: Mott MacDonald

MOTT MACDONALD

Commission for Aviation Regulation Traffic Forecast Review

Technical Report

July 2019

Dublin Airport Authority

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Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
Rev01	18/06/2019	BIB/CB	NR	JC	Draft Report
Rev02	26/06/2019	BIB/CB	NR	JC	Final Draft Report
Rev03	01/07/2019	BIB/CB	NR	JC	Final Report

Document reference: 411099 | 03 | AA

Information class: Standard

Executive Summary

Mott MacDonald has been commissioned by the Dublin Airport Authority (daa") to undertake a traffic forecast and a review of the Commission for Aviation Regulation ("CAR") traffic forecast, as part of the draft determination of the maximum level of airport charges at Dublin Airport. Mott MacDonald's approach to this study is to analyse the robustness of CAR's traffic model and to generate independent econometric and constrained forecasts to validate the commission's methodology.

For the purpose of this analysis, Mott MacDonald forecast Dublin Airport traffic volumes until 2024 (the five-year regulatory period for determining the maximum level of airport charges). In addition to a review of the CAR forecast methodology, Mott MacDonald developed its own independent forecast to evaluate the accurateness of the econometric model.

Mott MacDonald can confirm that the CAR's forecast approach is statistically valid, although upon reviewing the CAR's methodology, Mott MacDonald have identified the following concerns:

- **The CAR's econometric analysis considers only a single explanatory variable, Irish GDP**, although other factors are also likely to influence air traffic at DUB such as GNI, oil price and the GDP of source markets (i.e. economies at the other end of a route)
- **The CAR's econometric analysis is based only on aggregate total passenger volumes** and does not considered differential growth rates in demand by market
- **The CAR's forecasts represent unconstrained demand** and do not take account DUB's capacity constraints
- **The CAR's forecasts do not consider downside traffic risks** due to softening economic conditions and the potential impacts of Brexit.

The effect of DUB's capacity constraints and the downside traffic risks due to economic conditions is that the traffic risks are asymmetrically distributed – daa is unlikely to fully benefit from upside traffic opportunities due to capacity limitations, but are fully exposed to the downside traffic risks.

CAR's initial econometric model described in the 2019 Draft Determination produced an elasticity of 1.05 which translated to 37.8 million passenger demand in 2024 and a CAGR of 3.1% over the 2019 to 2024 period. However, **during the time of this writing, CAR have altered their methodology following correspondence with the daa** and have amended the elasticity which was reported in the 2019 Draft Determination. The revised elasticity is now 1.014 which, combined with updated estimates of 2019 traffic and using the latest IMF April 2019 GDP forecasts, translates to 37.7 million passenger demand in 2024 and a CAGR of 3.0% over the 2019 to 2024 period.

Mott MacDonald's analyses validates that the CAR's Revised Forecast regression has been performed correctly, but that the performance of the Irish GDP-based model can be improved through the inclusion of a dummy variable to correct for the variance seen in the 2006 to 2009 period. This best-fit regression produces an Irish GDP elasticity of 1.001, resulting in 37.6 million passenger demand in 2024 and a CAGR of 2.97% over the 2019 to 2024 period.

Mott MacDonald has developed a more detailed market demand forecast, which takes account of differential growth rates by market and GDP contributions from both the Irish economy and economies at the other end of the route. This market demand forecast results

in a lower growth rate, with a CAGR of 2.76% per annum over the 2019 to 2024 period, and 37.3 million passenger demand in 2024.

In addition to reviewing the CAR unconstrained econometric forecasts, Mott MacDonald has analysed and considered the impacts of DUB's runway and stand capacity constraints. Taking these constraints into account, cumulative traffic over the five-year period 2020 to 2024 is 2.4 million passengers lower than the Mott MacDonald Market Forecast unconstrained case (and 3.9 million passengers lower than the CAR Revised forecast based solely on an Irish GDP explanatory variable).

Traffic forecast methodologies that consider both segmented market demand growth projections and the impact of capacity constraints are consistent with the approaches adopted for other regulated airports such as Heathrow, Gatwick and Aeroports de Paris.

The table below summarises the traffic forecasts reviewed and developed for this report. **Mott MacDonald's recommendation is the constrained forecast**, which is based on a detailed market forecast of unconstrained demand modified by an assessment of the impacts of runway and stand capacity constraints during the 2020 to 2023 period.

Summary of Forecasts

	2019	2020	2021	2022	2023	2024	2020-24 Total or 2019-24 CAGR
CAR Draft Determination [1]	32.40	33.59	34.64	35.66	36.71	37.78	178.38
		3.67%	3.14%	2.93%	2.93%	2.93%	3.12%
CAR Revised Forecast [2]	32.50	33.64	34.70	35.71	36.68	37.69	178.42
		3.50%	3.17%	2.91%	2.71%	2.75%	3.01%
MM Market Forecast (unconstrained) [3]	32.50	33.51	34.47	35.40	36.31	37.25	176.94
		3.10%	2.88%	2.69%	2.57%	2.58%	2.76%
MM Constrained Forecast [4]	**32.50**	**33.15**	**33.81**	**34.72**	**35.62**	**37.25**	**174.55**
		2.00%	2.00%	2.69%	2.57%	4.58%	2.76%

Sources:

(1) CAR 2019 Financial Model Draft Determination 2019 publishable version
(2) daa/CAR correspondence, projections based on revised 2019 estimate and IMF April 2019 GDP forecasts
(3) Mott MacDonald analysis, see section 3.2.3
(4) Mott MacDonald analysis, see section 4.2.3

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Glossary

Table 1: Glossary

Acronym	Description
ACI	Airports Council International
CAGR	Compound Average Growth Rate
CAR	Commission for Aviation Regulation
CSO	Central Statistical Office of Ireland
DAA	Dublin Airport Authority
EU	European Union
GDP	Gross Domestic Product
GNI	Gross National Income
GNI*	Modified Gross National Income
HICP	Harmonised Indices of Consumer Prices
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IMF	International Monetary Fund
MIDT	Marketing Information Data Tapes
OECD	Organisation for Economic Co-operation and Development
POS	Point of Sale
RAB	Regulatory Asset Base
SRS	Schedules Reference Service

1 Introduction

This section presents an introduction to the review of the air traffic forecast of the Commission of the Aviation Regulation Draft Determination, the background of this study, the objectives of the Dublin Airport Authority, and the general outline of this report.

1.1 Background

In May 2019, the Commission of Aviation Regulation ("CAR") published its draft determination of the maximum level of airport charges at Dublin Airport. The document presents the maximum level of Airport Charges that Dublin Airport ("DUB") may levy for the period 2020 to 2024. Airport Charges include charges for taking off, landing and parking aircraft, using air bridges, arriving and departing passengers, and the transportation of cargo.

CAR's approach to determining the maximum level of airport charges is to set a maximum average charge per passenger over a five-year regulatory period, using a building blocks approach with a single till and having regard to the regulatory asset base ("RAB")[1].

The calculations require traffic forecasts to set targets for passenger numbers, commercial revenues and operating expenditure. The main driver for commercial revenues is passenger numbers, which in return is a key component in determining the maximum level of airport charges. The CAR passenger traffic forecast methodology follows an approach is based on statistical models relating potential traffic growth at DUB to a macroeconomic indicator, in this instance the Gross Domestic Product ("GDP")[2] of the Republic of Ireland.

1.2 Objectives

daa has appointed Mott MacDonald to undertake a review of the CAR's traffic forecast methodology and results. As the traffic forecasts form a key component in the determination of regulated charges, daa is seeking independent, professional advice to ensure that the forecasts are fair and reasonable, and that they consider the traffic risks.

1.3 Report Outline

This report is organized as following:

- **Section 2** starts by providing a review of the traffic forecast described in the 2019 Draft Determination, including details of the methodology, data sources as well as a review of robustness of the model.
- A description of Mott MacDonald's independent traffic forecast methodology is provided in **Section 3**, with the ensuing traffic forecast and comparison to the CAR.
- A description of the recent trends and the potential risks to the aviation market is given in **Section 4**, including a review of the macroeconomic markets (Brexit, liberalisation and the global softening of demand) as well as analysis of the capacity infrastructure constraints at Dublin Airport.

[1] Maximum Level of Airport Charges at Dublin Airport 2020-2024, Draft Determination, Commission Paper 3/2019, 9 May 2019, p11

[2] Maximum Level of Airport Charges at Dublin Airport 2020-2024, Draft Determination, Commission Paper 3/2019, 9 May 2019, p11

2 Review of the CAR Traffic Forecast Methodology

This section describes and evaluates the traffic forecast methodology adopted by the CAR and described Section 5 in its publication CP3/2019 Draft Determination. The evaluation is intended to test the robustness of the model from a statistical and theoretical viewpoint.

The CAR passenger traffic forecast methodology follows an approach is based on statistical models relating potential traffic growth at DUB to a macroeconomic indicator, in this instance the Gross Domestic Product ("GDP")[3] of the Republic of Ireland. Upon reviewing the CAR's methodology, we have identified the following potential issues with the methodology:

1. The CAR's econometric analysis considers only a single explanatory variable, Irish GDP, although other factors are also likely to influence air traffic at DUB such as GNI, oil price and the GDP of source markets (i.e. economies at the other end of a route).
2. The CAR's forecasts represent unconstrained demand and do not take account DUB's capacity constraints
3. The CAR's forecasts do not consider downside traffic risks due to softening economic conditions and the potential impacts of Brexit.

These downside risks and the impact of DUB's capacity constraints are explored in Section 4.

The effect of DUB's capacity constraints and the downside traffic risks due to economic conditions is that the traffic risks are asymmetrically distributed – daa is unlikely to fully benefit from upside traffic opportunities due to capacity limitations, but are fully exposed to the downside traffic risks.

The CAR has updated their forecast modelling since the CP3/2019 Draft Determination following correspondence with daa, and have amended the derived elasticity compared with the Draft Determination.

The CAR's Draft Determination estimated that DUB will reach 37.8 million passengers by 2024, with an average annual growth of 3.1% per annum over the period 2019 to 2024. This is based on IMF October 2018 GDP forecasts. The CAR estimated a GDP elasticity of 1.05 using econometric modelling. CAR's current econometric model uses Irish GDP as the explanatory variable and the underpinning analysis covers the years 1997 to 2018[4].

The CAR's updated forecast modelling undertaken since the Draft Determination gives a revised GDP elasticity of 1.014 which, when applied to the latest IMF April 2019 GDP forecast, gives an annual average growth rate of 3.0% per annum over the period 2019 to 2024 and an estimated 37.7 million passengers by 2024, marginally lower than in the Draft Determination.

Demand for air travel often grows at a rate higher than the economy, so GDP elasticities greater than 1.0 are often seen. However, the GDP elasticity generally tends to decline over time as the market in question matures, so GDP growth starts to have a smaller impact on air travel growth.

The United States of America (US) is an example of a mature aviation market, one which tends to have relatively low elasticities between economic growth and air travel demand; domestic US

[3] Maximum Level of Airport Charges at Dublin Airport 2020-2024, Draft Determination, Commission Paper 3/2019, 9 May 2019, p11

travel demand is often recognised to have an elasticity ratio to economic growth of 1.0. In contrast, developing economies may have elasticities exceeding 2.0.

The CAR's regression results have previously indicated GDP elasticities for DUB passenger traffic ranging from 1.0 in the 2009 forecast[5], to 1.15 in the 2014 forecast[6], so these elasticities against Irish GDP are indicative of a relatively mature market.

2.1 Explanatory Variables

The CAR uses Irish GDP as its sole driver to estimate passenger growth at Dublin Airport[7]. While using GDP as an explanatory variable to forecast airport passenger traffic is common practice, it is also common to use one or more further variables. Such variables may include, as examples, fuel prices, population projections, employment rates or exchange rates, the rationale being that there is often more than one driver of air passenger growth.

In the case of Ireland, there are additional risks associated with linking airport traffic solely to the national GDP. Ireland has a small, open economy which offers one of the lowest rates of corporate tax in the EU which has led to foreign corporations setting up operations in Ireland, notably large American global companies; Google, Apple and Microsoft are examples of such companies[8]. This means that Ireland is a country where GDP should be interpreted with care as the inward investment and labour generates profits and other revenues, some of which flow back out of Ireland to the country of origin.

Gross national income (GNI) adjusts for flows into and out of a country (mostly wages earned by cross-border workers and repatriated profits and dividends from foreign-owned companies operating in the country). In many cases, a country's inward and outward flows tend to balance out so there is little difference between GDP and GNI, but in Ireland's case the outflows of profit and other revenues from the global companies often exceed the income flows back into the country[9]. Therefore, GDP can overstate the strength of the Irish economy – in 2015, for example, Irish GDP rose by 25%[10], however this was largely attributed to internal restructuring at some of the large global companies[11].

The Central Bank of Ireland therefore created modified GNI (GNI*) in February 2017 which is a measure designed to exclude globalisation effects which distort the true size of the Irish economy, stripping out factors related to Ireland being a favoured foreign investment country. Figure 1 illustrates Irish GDP, GNI and GNI* growth between 2000 and 2017. GNI* presents a less volatile measure of economic growth; if GNI*, as opposed to GDP, is used as a measure of economic growth, Ireland's economy grew by 8.6% in 2015[12]:

[5] Final Determination – Dublin airport charges 2010-14, p44

[6] Maximum Level of Airport Charges at Dublin Airport, 2014 Determination, Commission Paper 2/2014, 7 October 2014, p42

[7] Maximum Level of Airport Charges at Dublin Airport 2020-2024 Draft Determination 9 May 2019, p15

[8] Marketplace.org, June 2018

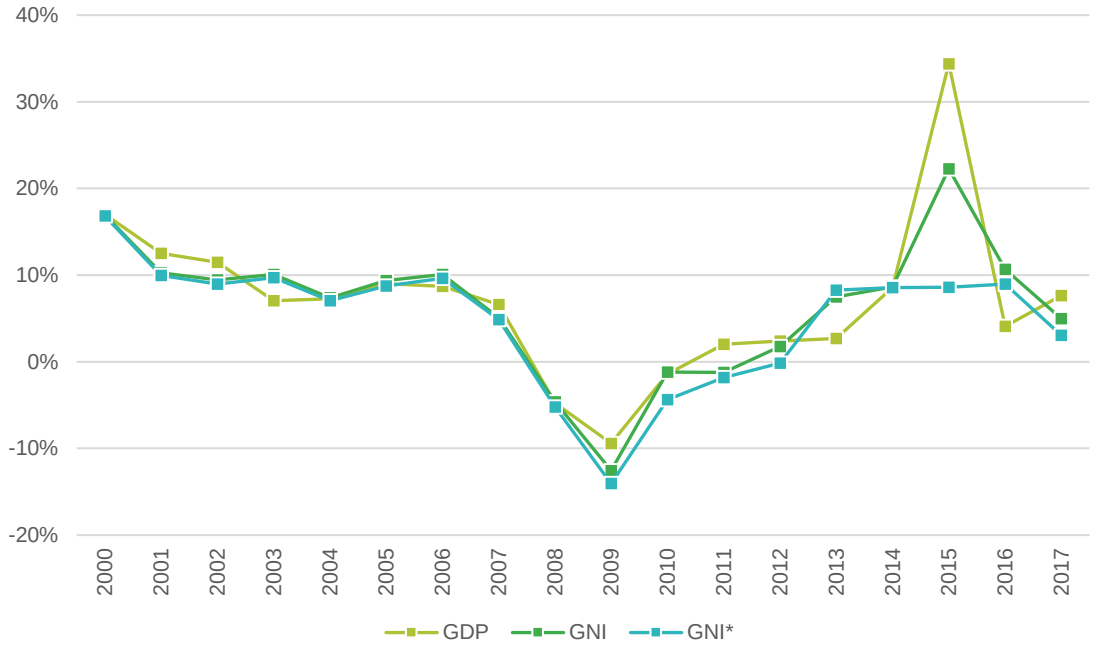
[9] OECD Observer

[10] IMF, World Economic Outlook April 2019

[11] Financial Times, July 2017

[12] Central Statistics Office, National Accounts, extracted June 2019

Figure 1: Irish GDP, GNI and GNI* (current prices) growth 2000-2017

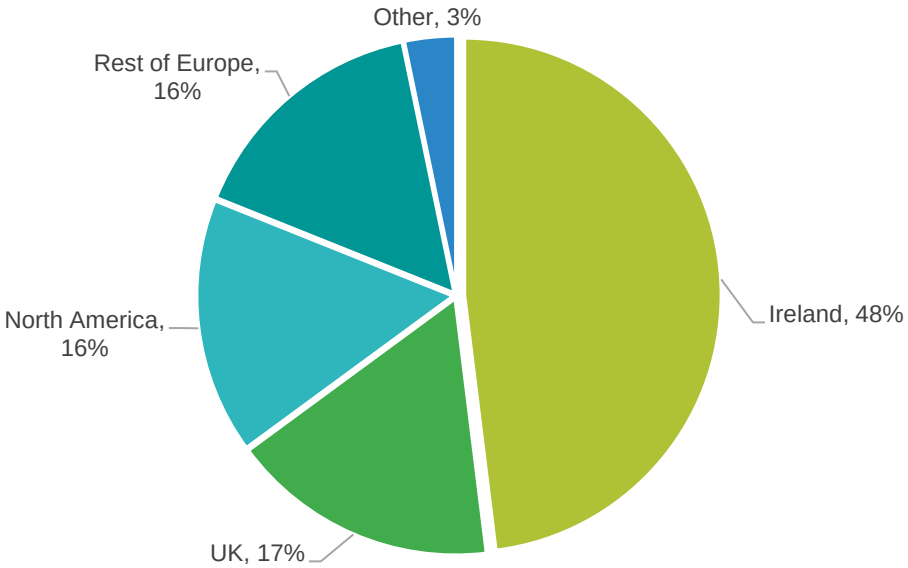


Source: Central Statistics Office, National Accounts, accessed June 2019

The key challenge, however, regarding the use of GNI* as a forecast variable is the lack of available forward-looking GNI* figures. While retrospective GNI* is available and could be used as part of a regression analysis with DUB passenger traffic, the resulting elasticity will need a forward-looking variable to generate a forecast.

GDP forecasts, by contrast, are readily available, yet, as discussed, GDP in econometric forecasting is often used in conjunction with a secondary variable and Irish GDP is subject to greater volatility due to the disproportionate economic contribution of global companies. A potential addition could be to incorporate foreign GDPs, as well as Irish GDP. As illustrated in Figure 2, a little under half of DUB's passengers reside in Ireland, with the UK, North America and Rest of Europe all contributing significant passenger shares:

Figure 2: DUB Passenger Residencies – Q2 2018 to Q1 2019



Source: daa, supplied May 2019

This residency split would suggest that other GDPs that may be worth consideration in building econometric forecasts are the UK, North America (particularly the United States of America) and Rest of Europe (particularly the EU). In this case, the DUB traffic would be split by major markets with each assigned its own Irish and foreign GDP blend.

In selecting the variables to consider in a specific traffic forecast, the primary criterion is that they represent an important influence on demand. Traffic demand is normally affected by many factors, and the variables should be chosen so that together they cover as many factors affecting demand as possible. Two approaches may be taken. The first is an exploratory approach, where the researcher identifies a long list of potentially useful causal variables, while the second approach involves the selection of a small number of the most relevant variables.

The explanatory variables should be chosen from those that are available from reliable sources. They should be measurable, quantifiable, continuous and predictable. Their magnitude should be on record so that their influence on the traffic can be quantified through statistical analysis. A continuous variable is a variable for which data are available over time with no missing periods. A predictable variable is a variable that can be independently predicted, either by a reliable independent source or by the forecaster as an "in-house" or internal prediction. Table 2 describes some macroeconomic factors which could influence air traffic at DUB and therefore could be considered explanatory variables in econometric modelling:

Table 2: Potential Explanatory Variables

Explanatory Variable	Source	Notes
Gross domestic product, constant prices (National currency)	IMF – sourced from National Statistics Office. Central Statistical Office of Ireland (CSO)	April 2019 IMF Publication
Gross domestic product per capita, constant prices (National currency)	IMF – sourced from National Statistics Office. Central Statistical Office of Ireland (CSO)	April 2019 IMF Publication

Explanatory Variable	Source	Notes
Population (Persons)	IMF – sourced from National Statistics Office. Central Statistical Office of Ireland (CSO)	April 2019 IMF Publication
European Union[13] Real GDP per capita	IMF	April 2019 IMF Publication
Price of Crude Oil	IMF - equally weighted average of three crude oil spot prices—West Texas Intermediate ("WTI"), Dated Brent ("Brent"), and Dubai Fateh ("Dubai").	April 2019 IMF Publication
Irish Average Cost of Air Transport	Eurostat	Harmonised Indices of Consumer Prices ("HICP") are designed for international comparisons of consumer price inflation. HICPs are used for the assessment of the inflation convergence criterion as required under Article 121 of the Treaty of Amsterdam and by the ECB for assessing price stability for monetary policy purposes. The ECB defines price stability on the basis of the annual rate of change of the euro area HICP.

Source: Mott MacDonald analysis

The correlogram in Figure 3 depicts the correlation of all the variables that can considered to be drivers for DUB passenger traffic. The variables which have the strongest relationship to the traffic are Irish Real GDP (0.97), Irish Real GDP per capita (0.94), Irish Population (0.89) and European Union (EU) Real GDP per capita (0.95).

The average cost of air transport variable has a relativity weak coefficient of 0.63 and a positive coefficient. From a general economic perspective, an increase in prices will reduce demand, and a decline in economic activity will shift the demand curve to the left rather than to the right. In the context of DUB, although the average cost of air transport has increased, the effect of demand stimulation caused by low-cost carriers ("LCCs"), at DUB notably Ryanair, may not be fully considered. LCCs have attracted many additional air passengers over the last decades; between 40% and 60% of all LCCs passengers have switched from other airlines or other modes of transport, the rest are 'new' passengers[14]. Overall, Figure 3 displays evidence that there are several factors which could influence air traffic at DUB but were not used by CAR in its econometric analysis.

The correlogram also portrays the correlation of the independent variables. For example, we observe that the Irish Real GDP is closely correlated to Irish population and EU Real GDP per capita. It should be noted that if more than one explanatory variable were used in a regression, and if an explanatory variable used is closely correlated with one or more of the other explanatory variables, this can lead to greater bias in the estimated coefficients and reduces the reliability of the estimated coefficients. This situation, referred to as "multicollinearity", is often encountered in econometric estimation. A low "t" statistic or a larger standard error may be a symptom of multicollinearity.

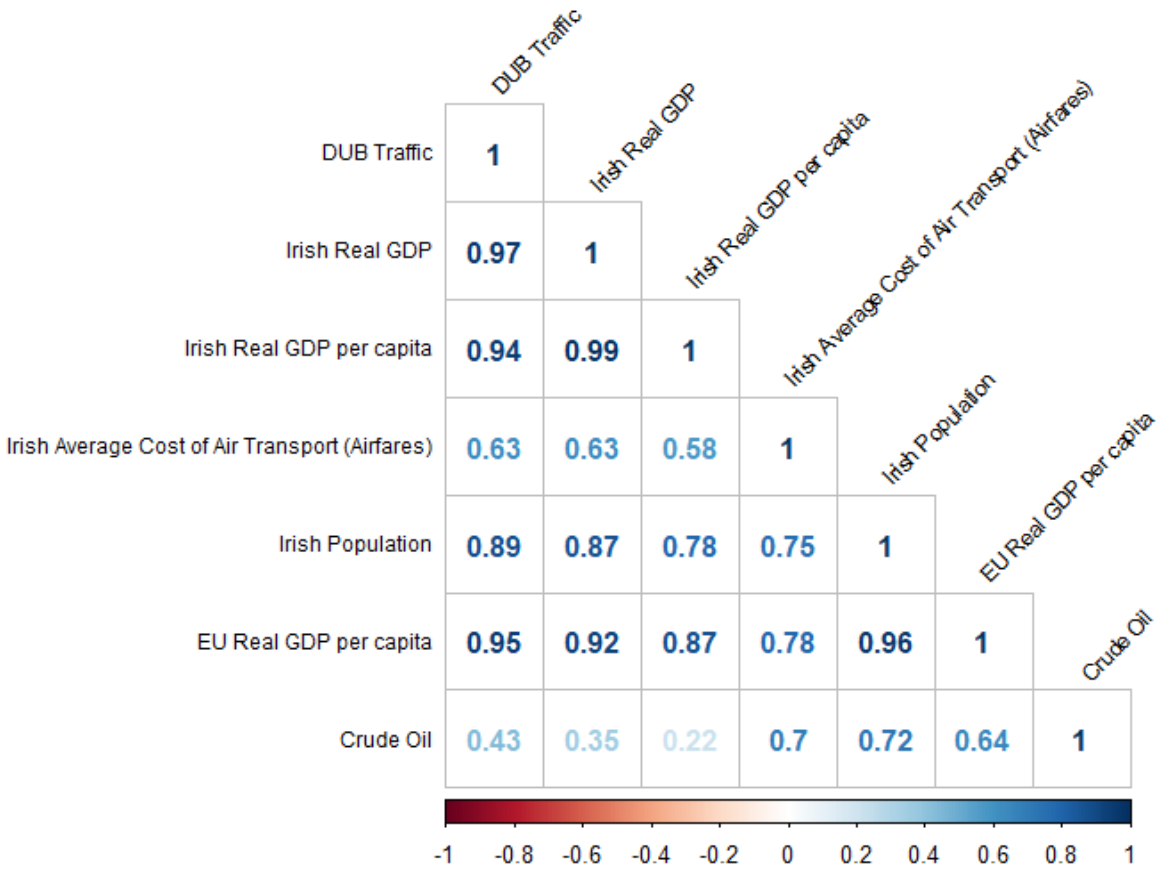
The existence of multicollinearity can be recognized by looking at the simple correlation matrix and then choosing for inclusion in the econometric analysis, only those explanatory variables that

[13] Composed of 28 countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Romania, and United Kingdom.

[14] De Wit, J., and Zuidberg, J. (2012). The growth limits of the low-cost carrier model. Journal of Air Transport Management, 21, 17-23.

are not highly correlated with each other. Ideally, the goal is to select explanatory variables that are highly correlated with traffic but are not correlated with each other.

Figure 3: Correlogram of Dublin Airport Passenger Traffic Econometric Drivers



Source: Mott MacDonald analysis of daa traffic data and socio-economic data sourced from IMF (April 2019 Edition)

2.2 Autocorrelation

In econometric models, it is common that errors are correlated over time (autocorrelation). In such cases, the estimation procedure does not yield the best linear unbiased estimates. Analysis of the residuals and their patterns may help detect the existence of autocorrelation. When error terms are serially correlated, they seem to be either always positive or negative, in successive periods.

Autocorrelation may be detected by the Durbin-Watson statistic. The Durbin-Watson statistic is a measure of correlation between residuals over successive time intervals. The value of this statistic ranges from zero to four. If no autocorrelation is present, the expected value should be around two. In principle, values less than two and approaching zero indicate positive autocorrelation, while values greater than two and approaching four indicate negative autocorrelation.

The Durbin Watson Statistic for the CAR model is 0.58, therefore there is a detection of positive correlation in the model. In general, however, the estimates for air traffic demand itself are not affected much by autocorrelation, so it is seldom necessary to make any corrections unless the error term from the model appears to be either always positive or negative throughout the historical time period concerned.

A solution to autocorrelation, should it be present, is to formulate the model in terms of first differences, i.e. period-to-period changes in the dependent variable are related to period-to-period changes in the explanatory variables. This can, however, be worse than the problem itself for long-range forecasting in that the first difference models are generally used to estimate short-term effects instead of long-range effects. When residuals are not independent, other implications can be that an important explanatory variable has been left out or the wrong functional form has been used in the model formulation.

2.3 Alternative Regulatory Forecast Approaches

The traffic forecast approaches adopted at some other comparable regulated airports are presented below:

Heathrow

The UK CAA does not produce its own traffic forecasts, but bases its regulatory determination on forecasts supplied by Heathrow Airport Limited (HAL) modified by the CAA after consultation with stakeholders. For its 2014 determination[15], HAL's traffic forecasting methodology consisted of two separate forecasting models: an econometric model, which analyses likely future demand, and a capacity model, which extrapolates from trends in supply and known airline capacity plans. Both models include an allowance for non-economic demand 'shocks' and generate a probability distribution of future traffic through a 'Monte Carlo' technique[16]. The HAL forecasts, adopted with slight modification by the CAA, forecast demand by world-region market and takes account of Heathrow's capacity constraints. The demand shocks incorporated into the Monte Carlo approach downgrade the forecasts by -1.2% per annum, based on analyses of historic demand shocks such as 9/11, SARS, terrorist attacks, volcanic ash, snow and the Olympics.

Gatwick

The UK CAA does not produce its own traffic forecasts, but bases its regulatory determination on forecasts supplied by Gatwick Airport Limited (GAL) modified by the CAA after consultation with stakeholders. For its 2014 determination[17], GAL's traffic forecasting methodology consisted of a 'bottom-up' short-term capacity forecast for the first three years and a 'top-down' econometric forecast over the medium and longer term. The top down econometric model forecasts total unconstrained London traffic (segmented by long haul, short haul and domestic) based on a regression analysis of London passenger traffic for the period 1990 to 2012, against economic, oil price and average airline fare variables. This forecast applies different market maturity assumptions to each market segment. The constrained forecast takes into account capacity constraints in the London airport system (including Gatwick's own constraints) and the reallocation of passengers that cannot be accommodated at their preferred airport as that airport becomes full.

Aeroports de Paris

The traffic forecasting approach adopted by Aeroports de Paris for its economic regulation are based on[18]:

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15 CAP1103, Chapter 3, http://publicapps.caa.co.uk/docs/33/CAP%201103.pdf

16 Each input is considered as a range of possibilities and multiple forecasts are generated. Each uses particular input values chosen from those ranges.

17 CAP1102, Chapter 3, http://publicapps.caa.co.uk/docs/33/CAP1102.pdf

18 Section 1.1, https://www.parisaeroport.fr/docs/default-source/groupe-fichiers/finance/relations-investisseurs/r%C3%A9gulation/2021-2025/public-consultation-document.pdf?sfvrsn=d78efbbd_4

- Growth factors affecting traffic in regions of destination, in particular Gross Domestic Product (GDP) and the population of each region
- The domestic market, taking into account the development of highspeed rail between 2016 and 2020.

Forecasts for Paris-Orly take account of the airport's capacity constraints (capped at 250,000 annual movements).

The common themes of traffic forecasting approaches at other regulated airports is that the econometric demand forecasts consider different demand drivers for different market segments (eg, global region or short/long haul and domestic splits) and, where appropriate, also consider the impact of capacity constraints on traffic growth potential.

3 Traffic Forecast Validation

This section presents Mott MacDonald's indepdent traffic forecast to the validate CAR's traffic forecast published in the Draft Determination.

3.1 Simple GDP Forecast Models

To assess and validate the CAR traffic forecasts, Mott MacDonald has replicated and refined the approach based on statistical models relating potential traffic growth at DUB to a single macroeconomic indicator. The macroeconomic indicator is Irish Gross Domestic Product ("GDP"). This is the approach adopted by the CAR in its 2019 Draft Determination and in past determinations in 2009 and 2014.

As noted in section 2 above, the CAR has revised its forecast modelling undertaken since the Draft Determination, resulting in a lower Irish GDP elasticity of 1.014 compared with 1.05 in the Draft Determination.

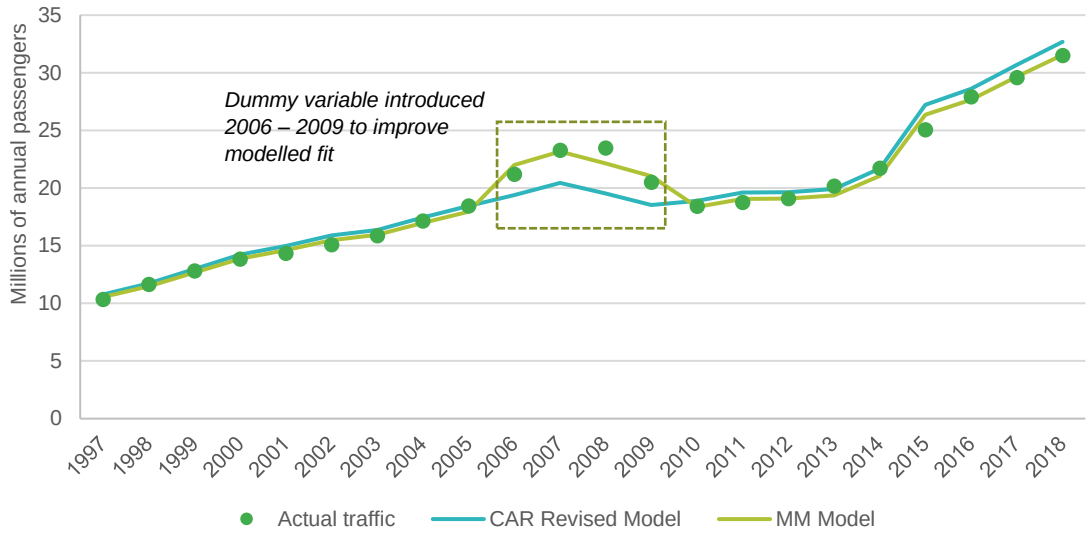
The figure below plots actual passenger traffic at DUB against the results of the CAR revised regression approach over the 1997 to 2018 period, as replicated by Mott MacDonald. The overall fit of the CAR regression is reasonable, with an Adjusted R-squared 'goodness of fit' metric of 94.8%. However, the CAR regression underestimates traffic in the 2006 to 2009 period and slightly over-forecasts demand in recent years.

The 2006 to 2009 period represented a period of extraordinary growth at DUB prior to the recessionary period, and a lagged response to the economic downturn of 2008/09. We found that the overall performance of the regression model could be significantly improved by including a dummy variable in the model for these years, as illustrated below. The 'goodness of fit' Adjusted R-squared metric for the Mott MacDonald simplified forecast model is 99.2%. **The CAR incorporated a similar dummy variable in its 2014 Determination on DUB airport charges[19] and Mott MacDonald recommends, at a minimum, that such a variable is included in the CAR's forecasts for the 2020 to 2024 period.**

The Irish GDP elasticity derived from the Mott MacDonald model is 1.001, compared with 1.014 for the CAR Revised Model.

[19] CP1/2014 Draft Determination, para 3.7

Figure 4: Goodness-of-Fit Regression Model



Source: Mott MacDonald analysis

The table below summarises the outputs of the CAR Draft Determination, CAR Revised Forecast and Mott MacDonald simple forecast models.

Table 3: Traffic Forecast Model Comparison

	CAR 2019 Draft Determination	CAR Revised Forecast	Mott MacDonald Simple GDP Forecast
Formula	Traffic = c_1 + c_2(Irish GDP) + $_{dummy}$ (2008-10 & 2015-16)	Traffic = c_1 + c_2(Irish GDP)	Traffic = c_1 + c_2(Irish GDP) + $_{dummy}$ (2006-09)
Independent Variable	DUB Traffic (1997-2018)	DUB Traffic (1997-2018)	DUB Traffic (1997-2018)
Dependent Variable	CSO Irish Real GDP	CSO Irish Real GDP	CSO Irish Real GDP
Adjusted R-Square	91.46%	94.80%	99.18%
Elasticity	1.047802	1.014233	1.001103

Source: Mott MacDonald analysis

In conclusion, Mott MacDonald's analyses validates that the CAR's Revised Forecast regression, deriving an Irish GDP elasticity of 1.014, has been performed correctly but that the performance of the Irish GDP-based model can be improved through the inclusion of a dummy variable to correct for the variance seen in the 2006 to 2009 period (as per the MM Simply GDP Forecast).

However, a forecast based solely on Irish GDP is too simplistic and a more detailed market-based approach is recommended. Mott MacDonald presents its market-based forecast analyses in the following section 3.2.

3.2 Mott MacDonald Market Forecast Methodology

In this section, Mott MacDonald develops market-based forecasts for DUB which take account of expected differential growth rates by major world-region market served from DUB driven by different levels of economic growth by region and market maturity.

Air travel is a derived demand. Demand for air transportation between origin and destination markets is derived from the socio-economic interactions between these markets, shaped by airlines' networks and available airlift capacity. Generally, business/trade activity and tourism/visitor activity constitute the primary components of air travel at an airport.

Dependable forecasting practice requires awareness of the uncertainties surrounding the forecasts. As described earlier, the Mott MacDonald team has investigated the key factors likely to affect traffic activity at DUB. However, as with any forecasts, there are uncertainties regarding these factors, such as the outlook for the local and world economies and the structure of the airline industry. Mott MacDonald has therefore used a pragmatic yet systematic approach to produce a set of air travel demand forecasts for DUB. The following sections describe the methodology used by Mott MacDonald to forecast air traffic at DUB.

The main assumptions underpinning the traffic forecast include:

Unconstrained Demand Forecast
The forecast assumes that no capacity issue in any component of the system will restrict the evolution of traffic. The term 'component of the system' refers to any element that is crucial for the capacity of an airport from its access, landside infrastructure, and terminal building to its runway and taxiway system, or environmental constraints.

Government Intervention
The present traffic forecasts do not consider or recommend any Government intervention to affect the airlines or destinations distribution at DUB.

Liberalisation
A key aspect in strong passenger travel growth over the past decades is increasingly liberalised markets. Liberalisation has encouraged significant traffic growth by removing restrictions on route entry, pricing, service capacity, and airline cooperative arrangements. As airline competition and operating efficiency have grown, pricing has decreased in real terms. Open Skies agreements have also promoted strong growth in the commercial airline industry, extending liberalisation and higher levels of competition to international and long-haul markets. The forecasts assume a continued liberalised aviation market.

Economic and Geopolitical Shocks
The forecast GDP does not include sharp downturns of the global or local economy. Generally sharp downturns of economic growth would usually result of a decline of air traffic. Likewise, any civil unrest, war, natural disaster, terrorist attack or any other hostile geopolitical event could affect air traffic and is not specifically incorporated into the forecast.

3.2.1 Data Sources

Dublin Airport Authority

Traffic data and additional information has been supplied by the daa to assist the study. The traffic data has a level of granularity which includes the following segments:

- O&D passenger traffic by country;
- O&D passenger traffic by airline;

- Transfer traffic by O&D region;
- Load factor by month of year;
- Busy day passenger and aircraft movements;
- CAR traffic forecast, and methodology; and
- Modelling results of passenger forecasts.

SRS Innovata Schedules

Innovata schedules include global schedules for all commercial aviation flights. They give detailed flight level information and as a result it is possible to identify the airlines operating each route as well as the total seat capacity offered by airlines at each airport.

Sabre MIDT

MIDT (Market Information Data Tape) passenger data calculates total passenger numbers by applying a factor to travel agent air ticket sales. This factor varies depending on the year, airline and route. By extracting the relevant data across a historical period, it is possible to calculate the Point of Sale ("POS") and therefore the 'true' origins and destinations of passengers.

Other data sources which analysed and used in the modelling include:

- Central Statistics Office Ireland;
- International Monetary Fund;
- The World Bank;
- Eurostat;
- OECD;
- IATA Data Subscriptions;
- Centre for Aviation ("CAPA"); and
- Airports Council International ("ACI").

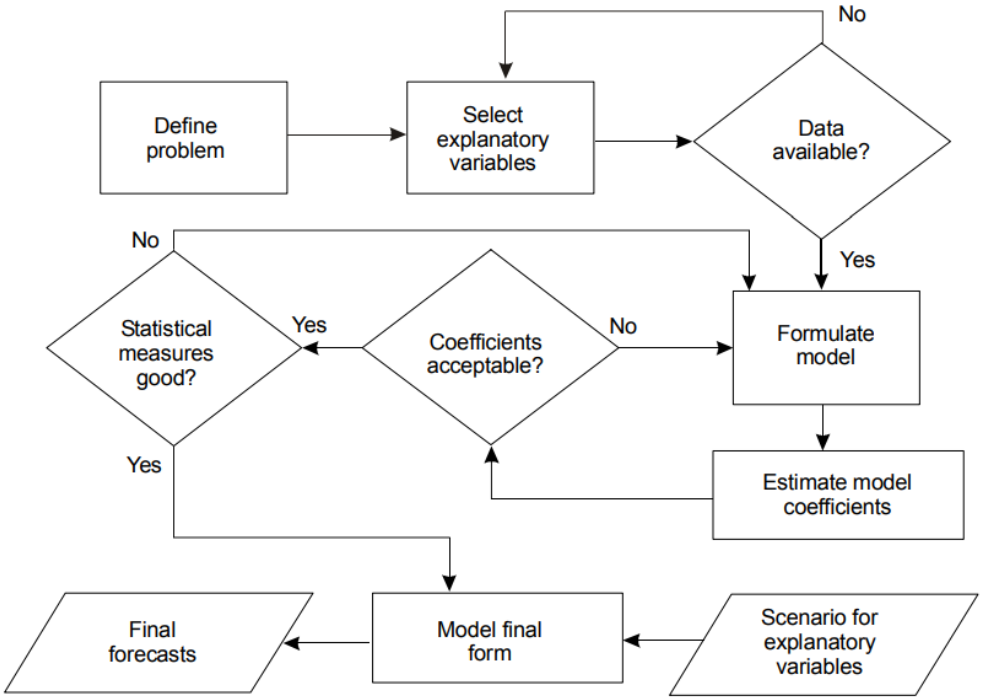
3.2.2 Econometric Approach

To prepare the passenger forecast, Mott MacDonald used an econometric modelling approach. Historic passenger traffic within the major markets at DUB has been related to the historic development of various socio-economic variables, such as the economic growth in Ireland and in origin markets (ie, the other end of the route).

The starting point for an econometric analysis is, in effect, a regression equation model that suggests a causal relationship between a dependent variable (passenger demand) and one or more explanatory variables.

The explanatory (or independent) variables are those variables which would have an influence on the demand for air travel. The econometric model attempts to explain the demand for air travel as being caused by the changes in the explanatory variables. Conceptually, the changes in the explanatory variables are observed independently of the causal relationship expressed by the model.

Figure 5: Development of an Econometric Model



Source: ICAO

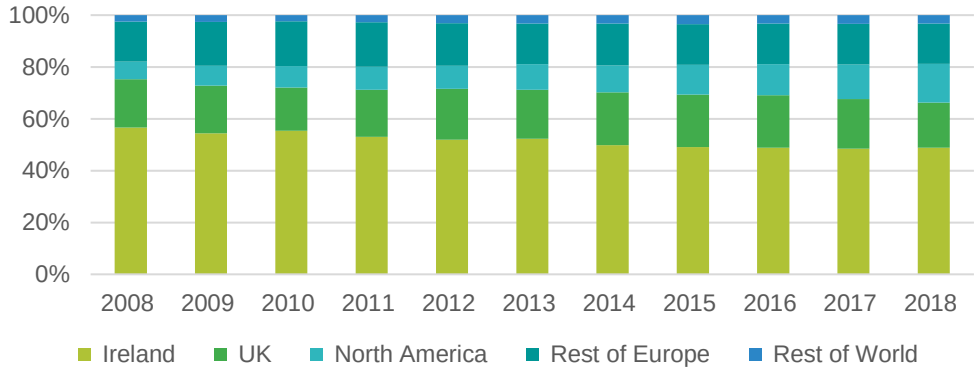
3.2.3 Market Forecast Model

To assess passenger demand for different market segments at DUB, Mott MacDonald developed a market forecast model. Regression analyses derived market elasticities for the major world-region markets operating at DUB.

The explanatory variable was the blended GDP of Ireland and the origin markets at the other end of the route, expressed as the geometric mean of the Irish and other market GDPs[20]. This approach allows the differential growth rates of markets at different stages of maturity to be modelled, and takes account of the fact that market demand is a function of economic conditions in both Ireland and at the other end of the route.

[20] Combining GDPs for Ireland and economies at the other end of the route into a blended explanatory variable (ie, geometric mean) avoids issues of multicollinearity. GDPs of different regions are likely to be highly correlated, so including multiple GDPs in a multiple linear regression is likely to result in multicollinearity, whereas blending GDPs avoids this technical issue. Given that the Irish-residency share of DUB traffic is close to 50% (see Figure 6), the geometric mean is an appropriate method of blending GDPs.

Figure 6: Share of DUB Passengers by Country of Residence



Source: daa data

The figure above shows that the Irish share of passengers at DUB has decreased over the past 10 years from 57% to 49%, and the UK share has also declined from 20% to 17%. Other regions have increased, and in particular North American residents have more than doubled from 7% to 15% since 2008.

The results of this market forecast model are presented in the table below:

Table 4: Mott MacDonald Market Forecast Results

	GDP Elasticity	Adjusted R-squared	Average Growth Rate (2019-2024)
UK – London	0.25	83%	0.56%
UK – Provincial	0.76	81%	1.71%
Western Europe	1.55	94%	3.34%
Southern Europe	1.50	92%	3.35%
Eastern Europe	1.95	86%	5.17%
Transatlantic	1.61	94%	3.62%
Other Long Haul	1.99	94%	6.46%
		Overall	**2.76%**

Source: Mott MacDonald analysis. GDP elasticity is measured against the blended Irish/Other Market GDPs, based on IMF GDP data (April 2019)

The market forecasts show that very mature markets, such as the UK, have low GDP elasticities compared with developing markets in Eastern Europe and for long haul services. These elasticities, combined with different blended GDP growth rates for different markets, result in average market growth rates over the 2019 to 2024 period ranging from 0.6% (UK – London) to 6.5% (Other long haul) per annum. The overall average growth rate for DUB using this model is 2.76% per annum over the 2019 to 2024 period.

3.3 Econometric Forecast Comparison

The results of the forecast models evaluated are presented in the table below. The CAR Draft Determination forecast is based on IMF October 2018 GDP forecasts and assumed a 2019 base year traffic level of 32.4 million passengers.

The table also updates the forecasts to use the latest IMF April 2019 GDP forecasts. The 2019 base year projection has also been revised upwards slightly (based on information provided by daa) to 32.5 million passengers.

Finally, the results of Mott MacDonald's market forecast model are presented.

Table 5: Traffic Forecast Results Comparison

	IMF Irish GDP Forecast	CAR 2019 Draft Determination[1]	CAR Revised Forecast[2]	Mott MacDonald Simple GDP Forecast[2]	Mott MacDonald Market Forecast[2]
IMF October 2018 GDP Forecast					
2019 Traffic (Base Year)		32.40	32.40	32.40	
2020 Traffic	3.5%	33.59	33.54	33.52	
2021 Traffic	3.0%	34.64	34.54	34.52	
2022 Traffic	2.8%	35.66	35.53	35.48	
2023 Traffic	2.8%	36.71	36.52	36.47	
2024 Traffic	2.8%*	37.78	37.55	37.48	
2020-2024 total		**178.38**	**177.68**	**177.47**	
CAGR (2020-2024)		**3.12%**	**2.99%**	**2.95%**	
IMF April 2019 GDP Forecast					
2019 Traffic (Base Year)			32.50	32.50	32.50
2020 Traffic	3.4%		33.64	33.62	33.51
2021 Traffic	3.1%		34.70	34.67	34.47
2022 Traffic	2.9%		35.71	35.67	35.40
2023 Traffic	2.7%		36.68	36.62	36.31
2024 Traffic	2.7%		37.69	37.62	37.25
2020-2024 total			**178.42**	**178.21**	**176.94**
CAGR (2020-2024)			**3.01%**	**2.97%**	**2.76%**

Mott MacDonald recommended unconstrained demand forecast

Sources: (1) CAR 2019 Financial Model Draft Determination 2019 publishable version
(2) Mott MacDonald analysis
(*) For the CAR's Draft Determination, the IMF October 2018 GDP forecast ended in 2023. The CAR assumed 2024 growth is the same as 2023. The IMF April 2019 GDP forecast incudes forecasts for 2024.

In conclusion, based on the latest analyses and adopting the best-fit model for a simple forecast model using only Irish GDP forecasts as the explanatory variable, the GDP elasticity should be 1.001 (based on the Mott MacDonald Simple GDP Forecast), compared with 1.05 used by the CAR in its draft determination. This change, combined with adoption of the latest IMF April 2019 GDP forecasts, results in a lower average growth rate over the 2019 to 2024 period of 2.97%, compared with 3.12% in the CAR's Draft Determination.

This revised forecast is still slightly higher than Mott MacDonald's forecasts using a more complete model, taking account of differential demand growth rates by major market served by DUB. Our market model predicts a lower overall demand growth rate of 2.76% per annum over the 2019 to 2024 period.

Mott MacDonald's recommendation is that a more complete model, considering passenger demand by major market, provides the most robust forecasts of overall demand growth.

However, these passenger demand forecasts do not take account of the severe capacity constraints limiting DUB airport's ability to grow over the next 5 years and the significant down-side traffic risks associated with a softening global economy and other risks such as Brexit. These effects are discussed in the following section.

4 Dublin Airport Traffic Risks

This section evaluates the traffic forecast risks over the 2020 to 2024 quinquennium, exploring macroeconomic and industry traffic risks and the likely impacts of capacity and scheduling constraints at the airport

Section 3 of this report validated the CAR traffic forecast methodology and results, and recommends revised forecasts compared with the CAR's Draft Determination on May 2019 base on revised econometric regressions and adopting the IMF's latest (April 2019) GDP forecasts as the primary driver of air travel demand, as well as presenting the results of more detailed market forecast analyses.

The demand forecasts of Section 3 represent base case forecasts assuming favourable economic and aviation industry conditions. They are also unconstrained forecasts and do not consider the capacity and scheduling constraints applicable at Dublin Airport.

Normally, a 'base case' traffic forecast has relatively symmetric uncertainty with balanced risks of over or under performing the forecast over the prediction time horizon. This symmetry is particularly important in the context of traffic forecasts used to determine an airport's regulated charges settlement – the traffic risk component of the regulatory settlement should have upside opportunities and incentives for the airport operator to outperform the forecasts broadly in proportion to the downside risks.

The CAR's 2019 Draft Determination states[21]:

> *We continue to set a per passenger price cap which assigns symmetric (upside and downside) volume risk to Dublin Airport. We assign the volume risk to Dublin Airport as it is best placed to influence passenger numbers and/or respond to changing levels of traffic. This volume risk allocation incentivises the airport to increase traffic in order to increase revenue. Allocating volume risk in a different manner would weaken the incentive for Dublin Airport to grow traffic and respond to changing levels of demand.*

However, due to both the current economic outlook and Dublin Airport's capacity constraints, the traffic forecasts of Section 3 have significantly more downside risks than upside opportunities. Dublin Airport's capacity constraints can be expected to prevent daa from benefiting fully from any upside traffic opportunities, while daa is fully exposed to down-side traffic risks, creating an asymmetry in traffic risk allocation.

4.1 Macroeconomic Risks

4.1.1 Brexit

The UK is a significant market, not only for DUB but for Ireland as a whole. According to statistics published by Tourism Ireland, 44% of overseas visitors to Ireland in 2017 came from the UK[22]. At DUB, 30% of passengers in 2018 were travelling on flights to or from the UK[23] and, as illustrated in Figure 2, a little under 17% of the airport's passengers resided in the UK. It is likely, therefore, that effects resulting from 'Brexit' (the UK's impending withdrawal from the European Union) will have an impact on DUB's traffic. Brexit has the potential to affect demand

[21] CP3/2019 Draft Dtermination, para 5.9

[22] Tourism Ireland 2017 Facts and Figures

[23] 2018 daa statistics

for aviation through its impact on the economy, exchange rates and any increased regulatory obstacles to travel and uncertainty appears likely to affect European aviation for some time.

As of June 2019, the UK and the EU have yet to agree a withdrawal agreement, which increases the possibility of a no-deal Brexit. In April 2019 the IMF warned that even with a relatively orderly no-deal scenario (one with no delays at borders and minimal financial upheaval), the UK's economy would grow 3.5% less by the end of 2021 than it would under a smoother exit and an increase in trade barriers would have immediate negative impacts on the UK's economy[24] - any resulting impacts on UK-Irish trade would likely impact DUB's traffic.

One of the main ways in which Brexit can affect outbound travel from the UK is the weakening of the UK pound versus the euro. Prior to the Brexit vote in June 2016 the UK to euro exchange rate was approximately 1.30, whereas currently (early June 2019) it is approximately 1.13[25], making it relatively more expensive for UK residents to travel to euro countries. While there may be corresponding positive effects on UK inbound travel, the net impact is likely to be negative as the outbound market is larger[26], which in turn is likely to negatively impact DUB's UK-dependent traffic segment.

There is also a risk, should the UK leave the EU without a deal, that passengers travelling between the UK and the EU may become subject to new visa regimes, which are likely to mean more costs and more time for all involved[27]. A combination of a weaker UK economy, a higher UK pound to euro exchange rate, and greater border formalities between the UK and the EU would all suggest that DUB's UK traffic may be subject to more downside than upside risks in the short to medium term.

4.1.2 Global GDP

Table 6 shows the variance in GDP growth rates in selected markets between the IMF's April 2019 forecast and its corresponding October 2018 forecast:

Table 6: IMF GDP Forecast Comparisons April 2019 v October 2018

GDP growth rate changes (IMF April 2019 v IMF October 2018)

	2019	2020	2021	2022	2023
Ireland	0.1%	-0.1%	0.1%	0.1%	-0.1%
United Kingdom	-0.3%	-0.1%	-0.1%	0.0%	0.0%
United States of America	-0.2%	0.1%	0.1%	0.1%	0.2%
European Union	-0.4%	-0.1%	0.0%	-0.1%	0.0%
Advanced Economies	-0.3%	0.0%	0.0%	0.1%	0.1%
World	-0.3%	0.0%	0.0%	0.0%	0.0%

Sources: IMF World Economic Outlook April 2019, IMF World Economic Outlook October 2018

In its World Economic Outlook April 2019, the IMF announced that it was projecting a decline in global growth in 2019 for 70% of the global economy, downgrading its global growth forecast for

[24] UK.reuters.com, April 2019

[25] Poundsterlinglive.com

[26] Centre for Aviation (CAPA) analysis, February 2019

[27] Aviationcv.com, February 2019

2019 from 3.6% in October 2018 to 3.3% in its April 2019 update, a decrease of 0.3% as shown in Table 6[28]. This was based on softening economic growth during the latter half of 2018, with trade tensions between the US and China, a decline in business confidence and higher policy uncertainties factors across many economies[29]. While the IMF predicted economic growth in 2020 returning to 3.6%, it pointed out that there are many downside risks, citing as examples a flare-up of trade tensions and softer growth in China, as well as Brexit uncertainties, and stressing that 'a realization of these downside risks could dramatically worsen the outlook'[30].

Focus Economics agrees that the US-China trade dispute is a key downside risk, and for the US (one of DUB's larger markets), it constitutes the major downside risk. For the Euro area, Focus Economics is predicting a growth of 1.2% in 2019 and 1.4% in 2020, with downside risks such as a slowdown in China and weakness in the manufacturing sector having the potential to limit growth[31].

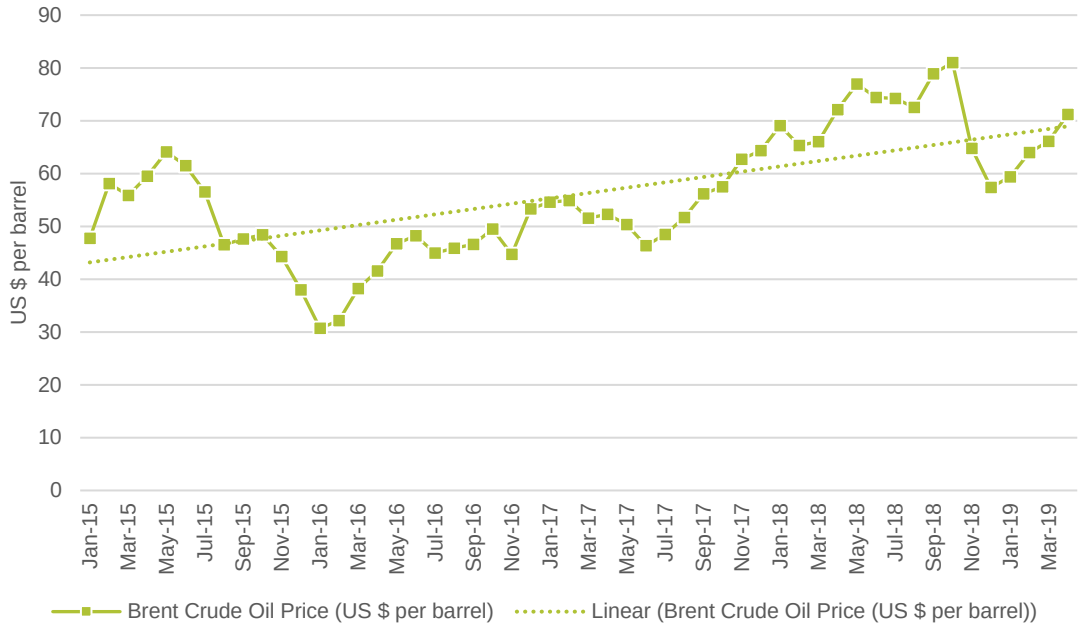
4.1.3 Aviation Industry

DUB's largest airline, Ryanair, reported its lowest profit in four years for the year ending March 2019. This was attributed to falling air fares and higher fuel costs, and Ryanair expects further falls in air fares in 2020, citing risks such as Brexit developments, ATC disruption and security events[32]. However, Ryanair has historically reported better margins than the rest of Europe's large airline groups (IAG, easyJet, Lufthansa Group, Air France-KLM) so its cautionary profit guidance for 2020 may signal a more general downturn in airline profitability[33].

Should aviation demand in Ireland soften in the short-term, it is likely that air fares will fall as Ryanair suggests. Concurrently, oil prices (which have a large influence on aviation fuel costs) have been rising of late, as illustrated in Figure 7 - the general trend has been upwards over the last four and a half years:

[28] IMF, World Economic Outlook, April 2019, pxiii
[29] IMF, World Economic Outlook, April 2019, p1
[30] IMF, World Economic Outlook, April 2019, pxiii
[31] Focus Economics, Major Economies, May 2019
[32] Centre for Aviation, May 2019
[33] Centre for Aviation, May 2019

Figure 7: Brent crude oil prices January 2015-April 2019



Source: Energy Information Administration, accessed June 2019

Forecasting future oil prices is challenging, however the Energy Information Administration (EIA) currently predicts that while Brent crude oil prices will be at an average of $69.64 per barrel in 2019 and $67 per barrel in 2020[34], which is higher than levels seen during much of the last four years. Airlines may continue to experience pressure from a combination higher fuel prices and lower fares. There have been several European airline collapses during the last 18 months - flybmi, Monarch, and WOW Air for example. Flybmi attributed its failure to factors such as recent spikes in fuel and carbon costs and the uncertainty created by the Brexit process[35], reasons which sum up the key challenges faced by many European airlines.

IATA has downgraded its 2019 outlook for the global aviation industry to from a $35.5 billion profit forecast, as of December 2018, to a $28 billion profit forecast as of June 2019, citing rising fuel prices and a weakening of world trade as key reasons – Europe, according to IATA, is one of the more exposed regions to weaker international trade. Alexandre de Juniac, IATA's Director General and CEO, summed up the outlook as saying 'Airlines will still turn a profit this year, but there is no easy money to be made'[36].

[34] Energy Information Administration, Short Term Energy Outlook, May 2019

[35] Centre for Aviation (CAPA), February 2019

[36] IATA.org, Press Release Number 27, 2nd June 2019

4.2 Dublin Airport Infrastructure Constraints

Dublin Airport is a highly slot constrained airport, and its capacity constraints will become a greater limitation on the airport's growth until the new North Runway becomes fully operational[37].

The opening of the new runway does not fully alleviate the airport's capacity constraints, however. Dublin Airport will continue to experience terminal and stand constraints – aircraft parking stand capacity constraints are expected to be a significant constraint on growth until 2024.

4.2.1 Runway Capacity Utilisation

Dublin Airport's runway capacity utilisation has increased dramatically in recent years. Dublin Airport is now Europe's 4th most capacity-constrained airport, as shown in the table below.

Table 7: Top 10 European Airports by Slot Utilisation

		Utilisation*
LHR	London-Heathrow, GB	98%
LIS	Lisbon, PT	97%
LGW	London-Gatwick, GB	95%
DUB	**Dublin, IE**	**93%**
SAW	Sabiha Gokcen, TR	92%
SVO	Moscow-Sheremetyevo, RU	89%
IST	Istanbul, TR	89%
LIN	Milan-Linate, IT	86%
DUS	Duesseldorf, DE	86%
FRA	Frankfurt, DE	85%

(*) Summer season busy week slot utilisation – busy 16-hour average over busiest 5 days-of-week – based on declared runway capacity

Sources: ACL (www.online-coordination.com) for LHR, LGW and DUB; Mott MacDonald analysis of SRS schedules and declared capacities for other airports

Figures 8 and 9 below show Dublin Airport's slot availability for the Summer 2019 season in a busy week (Figure 8) and over the full season (Figure 9). These figures show that that there is only fragmentary slot availability (on certain days-of-week and for certain parts of the season). In general, there are no slots available for a new daily service between the hours of 06:00 to 19:59.

The peak departures hours of 06:00 and 07:00 are particularly constrained. This prevents growth in the number of Dublin-based aircraft by Aer Lingus and Ryanair (and other airlines) operating short-haul services to the UK and mainland Europe. Short-haul services operated by Dublin-based airlines represents over 70% of the airport's traffic, so constraints at this time of day represent a strong limitation on the airport's overall growth potential.

[37] The new North Runway is due to be operational by the end of 2021, but its capacity is not expected to be available for allocation before the Summer 2022 season

Figure 8: Dublin Airport Summer 2019 Slot Availability – Peak week

	ARRIVALS							DEPARTURES							
Hour (LT)	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Hour (LT)
0600	2	4	3	2	4	1	3	0	0	0	0	0	0	0	0600
0700	0	1	0	0	0	1	3	0	1	0	0	0	1	3	0700
0800	1	4	2	2	2	6	7	1	6	2	2	4	7	8	0800
0900	0	0	1	0	0	1	3	0	0	1	0	0	1	4	0900
1000	5	3	3	2	2	4	4	5	3	3	2	2	7	5	1000
1100	2	4	6	1	3	1	1	2	4	6	1	3	1	1	1100
1200	0	2	3	0	1	2	2	0	2	3	0	1	2	2	1200
1300	1	3	0	2	2	4	0	0	0	0	1	0	3	0	1300
1400	2	6	3	2	3	0	4	2	5	2	2	3	0	2	1400
1500	0	3	3	4	1	6	3	0	3	2	4	1	2	3	1500
1600	2	6	3	2	2	10	1	2	4	4	2	2	6	1	1600
1700	1	1	0	0	0	5	0	1	1	0	0	0	5	0	1700
1800	0	2	2	1	1	4	0	0	2	2	1	2	4	0	1800
1900	1	2	0	1	0	12	3	1	2	0	1	0	9	3	1900
2000	6	9	8	10	7	14	11	6	9	7	9	8	15	10	2000
2100	12	9	12	12	10	14	8	15	15	14	14	15	19	14	2100
2200	5	5	6	6	4	13	8	6	5	8	8	4	15	11	2200
2300	4	10	5	10	7	8	1	7	14	8	14	10	11	5	2300

Source: ACL (www.online-coordination.com) for the week 8-14 July 2019 (accessed 11 June 2019)

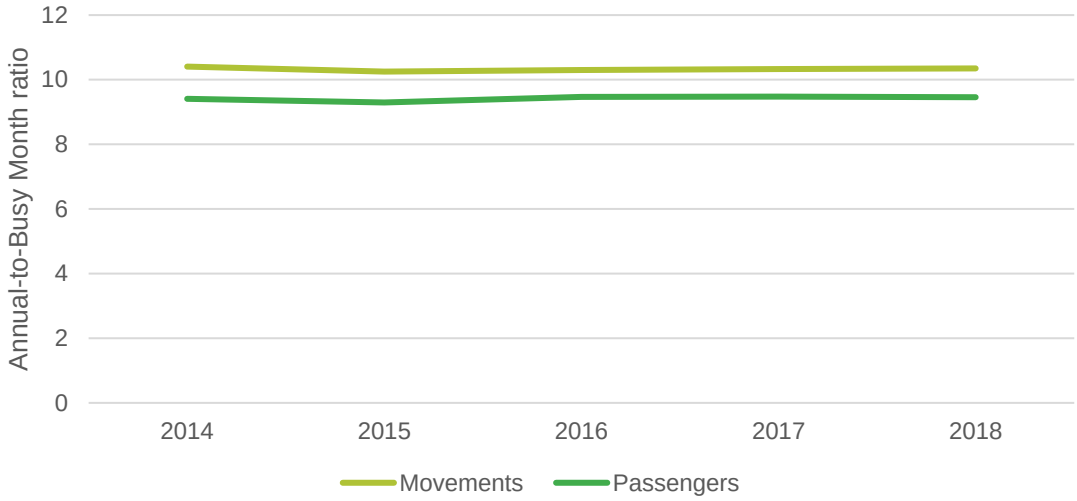
Figure 9: Dublin Airport Summer 2019 Slot Availability – Full season (Friday)

		06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
ARRIVALS	05Apr	3	3	4	3	4	3	3	4	2	2	3	0	4	4	10	11	6	8	05Apr
	12Apr	5	2	5	4	2	4	1	1	1	1	1	0	1	0	10	8	7	10	12Apr
	19Apr	5	2	6	4	6	6	4	5	3	0	4	0	0	2	10	12	6	9	19Apr
	26Apr	5	0	5	3	4	2	2	5	5	0	3	1	0	1	10	9	6	9	26Apr
	03May	4	0	5	3	0	1	1	1	1	0	7	0	0	2	10	10	5	9	03May
	10May	3	0	4	2	4	2	1	2	0	0	0	0	1	1	8	10	3	8	10May
	17May	3	0	1	0	2	1	0	2	2	1	0	0	1	1	8	10	5	9	17May
	24May	4	0	3	2	2	1	1	1	0	0	0	0	0	0	5	10	5	9	24May
	31May	4	0	4	3	3	0	0	0	3	1	0	0	0	2	6	9	6	7	31May
	07Jun	4	0	2	0	1	1	1	2	1	1	0	0	0	0	8	10	5	9	07Jun
	14Jun	5	0	0	0	0	0	0	1	1	0	0	0	0	0	4	9	3	9	14Jun
	21Jun	4	1	2	0	2	1	0	0	0	0	0	0	0	0	8	10	5	7	21Jun
	28Jun	4	0	4	1	3	0	0	2	4	2	1	0	2	1	8	10	5	7	28Jun
	05Jul	4	0	1	0	1	1	0	2	4	1	1	0	1	1	7	10	5	7	05Jul
	12Jul	4	0	3	0	1	3	0	2	4	1	2	0	1	1	7	10	5	7	12Jul
	19Jul	4	0	3	0	1	3	0	2	3	1	2	0	1	2	7	10	5	7	19Jul
	26Jul	4	0	3	0	1	3	0	2	3	1	2	0	1	2	7	10	5	7	26Jul
	02Aug	4	0	4	0	0	5	0	2	0	1	2	0	1	2	7	10	5	7	02Aug
	09Aug	4	0	4	0	2	5	0	2	0	0	2	0	1	2	6	10	6	7	09Aug
	16Aug	4	1	3	1	3	1	0	1	0	0	2	0	2	3	8	9	5	8	16Aug
	23Aug	4	1	3	1	2	0	0	1	0	1	2	0	2	3	8	9	5	8	23Aug
	30Aug	4	0	3	0	3	1	0	1	0	1	2	0	2	3	8	9	5	8	30Aug
	06Sep	4	1	3	1	3	0	0	2	0	1	2	1	2	1	9	9	5	8	06Sep
	13Sep	4	1	3	1	2	0	0	2	0	2	1	1	2	1	8	9	5	8	13Sep
	20Sep	4	2	3	1	3	1	1	2	1	2	2	2	2	1	10	9	5	9	20Sep
	27Sep	4	2	3	1	4	1	1	2	1	2	3	2	2	2	11	9	5	9	27Sep
	04Oct	4	3	3	1	4	4	2	3	0	2	4	1	3	3	10	9	5	9	04Oct
	11Oct	4	4	3	1	4	4	2	3	1	1	5	2	4	3	10	9	5	9	11Oct
	18Oct	4	2	4	1	4	4	2	3	3	1	5	2	4	3	10	9	5	9	18Oct
	25Oct	4	2	4	1	4	4	3	3	3	0	5	2	4	3	10	9	5	9	25Oct
		06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
DEPARTURES	05Apr	0	1	6	4	4	3	3	2	2	1	4	0	4	4	9	17	7	12	05Apr
	12Apr	1	0	6	5	3	4	1	0	1	1	1	0	1	0	9	16	8	14	12Apr
	19Apr	2	0	9	4	5	6	4	3	3	0	4	0	0	2	7	17	8	13	19Apr
	26Apr	1	0	7	3	4	2	2	2	6	0	2	1	1	1	9	16	7	12	26Apr
	03May	0	0	6	3	0	1	1	0	1	0	5	0	1	2	9	16	6	13	03May
	10May	0	0	6	2	5	2	1	2	0	0	0	0	1	1	6	16	3	11	10May
	17May	0	0	6	0	2	1	0	0	2	1	0	0	2	1	8	17	5	13	17May
	24May	0	0	5	2	2	1	1	0	0	0	0	0	0	0	6	17	5	10	24May
	31May	0	0	5	3	3	0	0	0	2	1	0	0	0	2	8	17	6	11	31May
	07Jun	0	0	4	0	1	1	1	0	1	1	0	0	0	0	7	18	5	13	07Jun
	14Jun	1	0	0	0	0	0	0	0	1	0	0	0	0	0	4	16	3	13	14Jun
	21Jun	0	1	7	0	2	1	0	0	0	0	0	0	0	0	7	17	5	10	21Jun
	28Jun	0	0	8	1	3	0	0	0	4	2	1	0	2	1	8	17	5	10	28Jun
	05Jul	0	0	4	0	1	1	0	0	4	1	1	0	2	1	8	16	5	10	05Jul
	12Jul	0	0	6	0	1	3	0	0	5	1	2	0	2	1	8	16	5	10	12Jul
	19Jul	0	0	6	0	1	3	0	0	3	1	2	0	1	2	8	16	5	10	19Jul
	26Jul	0	0	6	0	1	3	0	0	3	1	2	0	1	2	8	16	5	10	26Jul
	02Aug	0	0	7	0	0	5	0	0	0	1	2	0	1	2	8	16	5	10	02Aug
	09Aug	0	0	7	0	2	5	0	0	0	0	2	0	2	2	8	16	6	10	09Aug
	16Aug	0	1	6	1	3	1	0	0	0	0	2	0	2	3	8	17	5	11	16Aug
	23Aug	0	1	6	1	2	0	0	0	0	1	2	0	3	3	8	17	5	11	23Aug
	30Aug	0	0	7	0	3	1	0	0	0	1	2	0	3	3	8	17	5	11	30Aug
	06Sep	0	1	7	1	4	0	0	0	0	1	2	1	2	1	8	17	5	11	06Sep
	13Sep	0	1	7	1	2	0	0	0	0	2	1	1	2	1	8	16	5	11	13Sep
	20Sep	0	2	7	1	3	1	1	0	1	2	2	2	2	1	8	17	5	12	20Sep
	27Sep	0	2	7	1	4	1	1	0	1	2	3	2	2	2	8	17	5	12	27Sep
	04Oct	0	2	7	1	4	4	2	0	0	2	4	1	4	3	8	17	6	13	04Oct
	11Oct	0	3	7	1	4	4	2	0	1	1	4	2	5	3	8	17	6	13	11Oct
	18Oct	0	2	8	1	5	4	2	0	3	1	4	2	5	3	8	17	6	13	18Oct
	25Oct	0	2	8	1	5	4	3	0	3	0	4	2	5	3	8	17	6	13	25Oct

Source: ACL (www.online-coordination.com) (accessed 11 June 2019)

DUB's seasonality has remained quite constant in recent years. The figure below shows the ratio between annual traffic (passengers and movements) to the busy month[38]. The degree of seasonality is a function of the general patterns of demand, and there is no trend towards DUB's traffic becoming less seasonal.

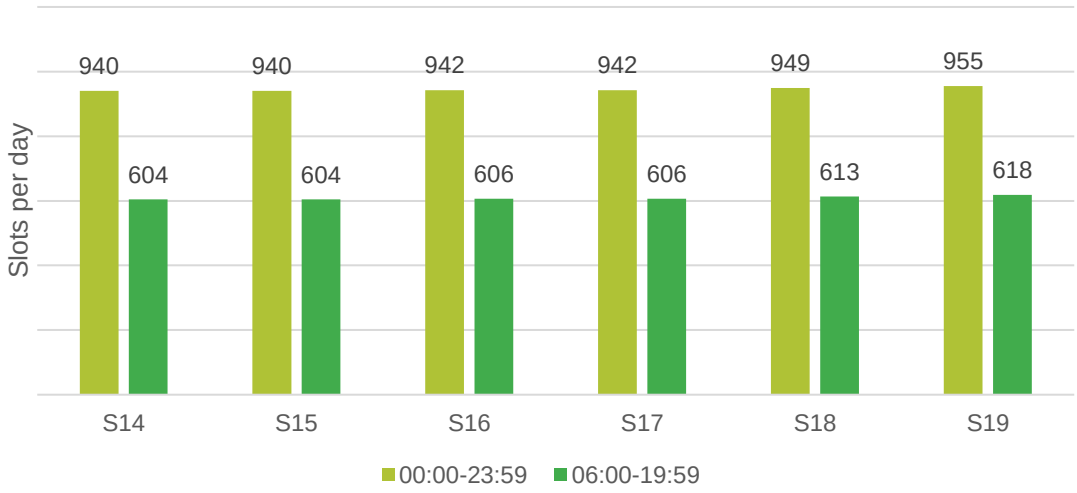
Figure 10: DUB Seasonality



Source: daa data

The figure below shows the number of slot available (declared capacity) at Dublin Airport in recent years. There have been some modest capacity increases in the past 2 years, over the full 24-hour day and in the busiest 14-hour period. The capacity increase since 2017 in the constrained 06:00 to 19:59 period has been 12 new slots – equivalent to 1% per annum growth.

Figure 11: Dublin Airport Declared Runway Capacity – summer seasons



Source: CAR capacity declarations and ACL seasonal reports

[38] A ratio of 12:1 would represent a flat, year-round traffic profile. Lower ratios are more peaky traffic.

There is very limited scope for DUB to grow in a runway-constrained environment prior to the opening of the new North Runway from 2022.

- New Runway Capacity – Scope to grow is limited to around 1% per year over the 14-hour core daytime period, continuing recent trends.
- Slot Utilisation – Scope to grow is limited to around 1% per year, increasing DUB's slot utilisation from and already-high 93% to around 95% (equivalent to Gatwick Airport) by 2022. Higher levels of slot utilisation are not realistic.
- Seasonality of traffic – As illustrated in Figure 10 above, there is no trend towards improved capacity utilisation through reduced seasonality of traffic
- Passengers-per-ATM – The aircraft sizes in operation at DUB are determined by airlines' long-term fleet plans. Given that DUB will only be highly constrained for a few years during the 2020-2024 period, it is unlikely that airlines will acquire larger aircraft than currently planned. Similarly, load factors at DUB are already high – 90% on average in the busy summer months and 83% year-round[39].

Therefore, the scope for growth, taking account of DUB's runway capacity constraints in 2020 and 2021 is limited to around 2% per annum – 1% per annum due to increased slot utilisation and 1% per annum due to potential incremental runway capacity increases.

4.2.2 Stand Capacity Utilisation

Dublin Airport is not only constrained by runway capacity – it also has terminal and aircraft parking stand constraints. When the new North Runway becomes fully operational in 2022, it will alleviate the runway capacity constraint, but stand capacity is then expected to be the primary limitation on traffic growth until significant stand and apron developments are complete (expected by the Summer 2024 season).

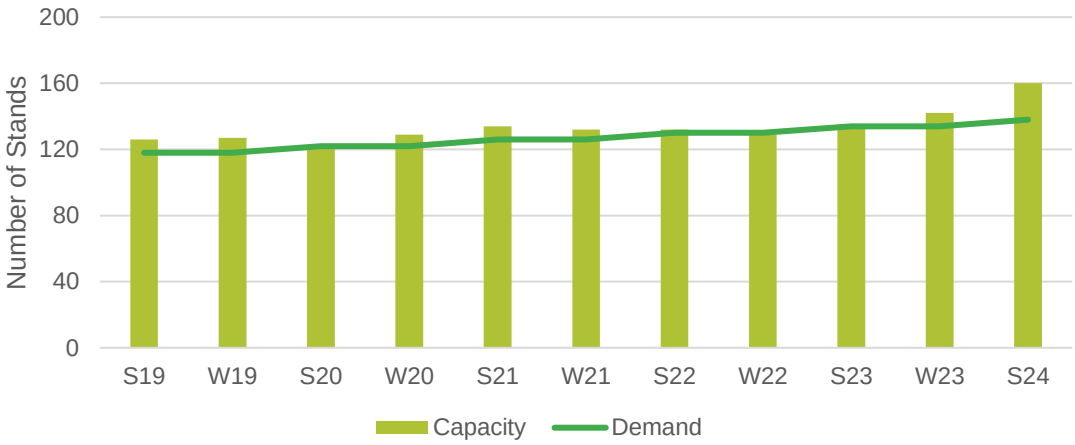
Figure 12 below plots the total Dublin Airport stand capacity against forecast stand demand. Stand demand is forecast to grow at +3% per year in line with the unconstrained traffic forecasts presented in Table 5 of Section 3.3.

The stand supply depicted in Figure 12 shows that stand availability varies both up and down over the period to 2023 as various apron developments are implemented. The stand capacity constraint is only alleviated in Summer 2024.

This means that the Dublin Airport's growth potential will continue to be capacity constrained after the opening of the new North Runway until at least 2024.

[39] Daa data, 2018

Figure 12: Dublin Airport Stand Supply and Demand by season (2019 to 2024)



Source: daa; narrow body equivalent stand capacity and demand

4.2.3 Dublin Airport Constrained Traffic Forecasts

The analyses of runway and stand capacity constraints indicate that the unconstrained demand forecasts validated in Section 3 need to be tempered to take account of these constraints.

Mott MacDonald's **Constrained Case** is constrained on the basis of runway capacity in 2020 and 2021 and, after the opening of the North Runway, by stand capacity in 2022 and 2023. When stand capacity become sufficient to meet demand in 2024, traffic can recover to the unconstrained demand level.

The assumptions underpinning the Constrained Case are:

- **Pre North Runway** (2020 to 2021), runway slot utilisation increases by 1% per annum from 93% to 95% (equivalent to Gatwick Airport) and busy 14-hour period declared capacity increases by 1% per annum. This gives constrained growth of 2% per annum in 2020 and 2021.
- **Post North Runway** (2022 to 2023), new runway slots become available but traffic is constrained by stand capacity so grows at the unconstrained market growth rate.
- **In 2024**, when sufficient stand capacity becomes available, traffic is able to recover to the unconstrained demand level of 37.3 mppa.

Total traffic over the 2020 to 2024 period is 2.4 million passengers lower than the Mott MacDonald Market Forecast unconstrained case (and 3.9 million passengers lower than the CAR Revised forecast based solely on an Irish GDP explanatory variable).

The constrained case is summarised in the table below.

Table 8: Constrained Traffic Forecast Results Comparison

	IMF Irish GDP Forecast (April 2019)	Mott MacDonald Market Forecast (Unconstrained)	Mott MacDonald Constrained Case (Runway & Stands)
IMF April 2019 GDP Forecast			
2019 Traffic (Base Year)		32.5	32.5
2020 Traffic	3.4%	33.5 (3.1%)	33.2 (2.0%)
2021 Traffic	3.1%	34.5 (2.9%)	33.8 (2.0%)
2022 Traffic	2.9%	35.4 (2.7%)	34.7 (2.7%)
2023 Traffic	2.7%	36.3 (2.6%)	35.6 (2.6%)
2024 Traffic	2.7%	37.3 (2.6%)	37.3 (4.6%)
2020-2024 Total Traffic		**176.9**	**174.6**
CAGR (2020-2024)		**2.76%**	**2.76%**

Source: Mott MacDonald analysis

A. Appendix – Raw Data

The following data was used in the regression analysis. IMF GDP is reported in Real GDP (USD billions), whereas the CSO is reported in Real GDP (Euro millions).

Table 9: Raw Data used in Regression Analysis

Year	Dublin Airport Traffic	IMF October 2018	IMF April 2019	CSO
1996	9,092,000	94.12	94.12	
1997	10,333,000	104.23	104.23	104,307
1998	11,641,100	113.25	113.25	113,351
1999	12,802,031	125.16	125.16	125,280
2000	13,843,528	137.02	137.02	137,126
2001	14,333,555	144.35	144.35	144,420
2002	15,084,667	152.94	152.94	152,982
2003	15,856,084	157.50	157.50	157,502
2004	17,138,373	167.95	167.95	167,850
2005	18,450,439	177.49	177.49	177,364
2006	21,196,382	186.45	186.45	186,311
2007	23,287,438	196.26	196.26	196,203
2008	23,466,711	187.62	187.62	187,559
2009	20,503,677	178.14	178.14	178,139
2010	18,431,064	181.48	181.48	181,563
2011	18,740,592	188.16	188.16	188,320
2012	19,099,649	188.52	188.52	188,664
2013	20,166,759	191.04	191.04	191,186
2014	21,711,967	207.76	207.76	208,011
2015	25,049,779	259.71	259.72	260,258
2016	27,907,384	272.47	272.45	273,238
2017	29,582,308	292.11	292.09	292,971
2018	31,495,604	305.88	311.99	311,567
2019		318.13	324.93	
2020		329.15	336.13	
2021		338.89	346.64	
2022		348.38	356.58	
2023		358.02	366.10	
2024		367.93	376.03	

Source: daa, IMF, CSO

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