APPENDIX VI TO CP8

Aer Rianta's Cost of Capital

Report by Professor Colm Kearney and Elaine Hutson

Dublin City University

CP8
Appendix VI

Aer Rianta's Cost of Capital

Report to the Commission for Aviation Regulation

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Colm Kearney,
Professor of Finance

Elaine Hutson,
Lecturer in Finance

Dublin City University,
Glasnevin, Dublin 9.
Email: Colm.Kearney@dcu.ie
Email: Elaine.Hutson@dcu.ie

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Executive Summary

The weighted average cost of capital (WACC) approach is used to estimate Aer Rianta's cost of capital. To implement this approach, it is necessary to estimate Aer Rianta's cost of equity, its cost of debt and its gearing ratio. The cost of equity is discussed in Section 2 of the Report, the cost of debt is discussed in Section 3, Aer Rianta's gearing is discussed in Section 4, and Section 5 brings these together in the WACC calculations to derive the estimate of Aer Rianta's cost of capital.

The estimated value for the real risk-free rate is 2.6%. The estimated equity risk premium is 6.0%. Aer Rianta's asset beta is estimated at 0.50 and its equity beta is estimated at 0.93. The resulting estimate of Aer Rianta's real cost of equity is 8.1%.

With a real risk-free rate of interest at 2.6%, and an estimated debt premium of 1.1%, the resulting estimate of Aer Rianta's real cost of debt is 3.7%.

Aer Rianta's gearing is estimated at 50%.

The corporate tax rate that applies over the coming years is estimated at 13.2%.

The resulting estimates of Aer Rianta's post-tax WACC is 5.7%, and the pre-tax WACC is 6.6%.

Given the uncertainties that apply to these estimates, this report suggests that the best estimate of Aer Rianta's real post-tax WACC is 6%, for the pre-tax WACC, 7%.

[1] Introduction and Overview

Financial theory has much to offer in setting the appropriate cost of capital for regulated corporations. In applying the theory to real business situations, however, it is necessary to make subjective judgements. This arises because many of the concepts and variables that are defined precisely in theory are not readily measurable in practice, and have to be estimated in some way. Examples of these include the real risk free rate of interest and the equity risk premium, both of which are integral to calculating the cost of capital. These practical difficulties in estimating the cost of capital imply that the 'true' cost of capital cannot be known precisely, and uncertainty will be attached to the estimate. The CAA (2001) observes in its recent position paper on the cost of capital for the UK's regulated airports:

> *"This is not a precise science and judgement will be needed in coming to a view…"*.
>
> *[CAA (2001), p4].*

It is important for the long-term development of airport infrastructure in Ireland that Aer Rianta is able to make a reasonable rate of return on its assets. The permitted rate of return must be sufficient to successfully attract future funds that are necessary to maintain and develop the necessary airport infrastructure. Given the uncertainty that attaches to any estimate of Aer Rianta's 'true' cost of capital, it is preferable that the regulator sets a rate that is more likely to err on the high side rather than on the low side. This is particularly relevant to Aer Rianta to the extent that it is operating under current or envisaged future capacity constraints that require substantial infrastructure investment.

In order to estimate Aer Rianta's cost of capital, we use the weighted average cost of capital (WACC) approach. The WACC approach has a long pedigree of use to estimate the cost of capital for regulated utilities throughout the world including Australia, North America, the UK and Ireland.

The WACC approach calculates the cost of capital as the weighted average of the cost of debt and the cost of equity, according to their relative weights in the company's capital structure. To implement this approach, it is necessary to estimate Aer Rianta's cost of equity, its cost of debt and its gearing ratio. The cost of equity is discussed in Section 2. The cost of debt is discussed in Section 3. Aer Rianta's gearing is discussed in Section 4. Section 5 brings these together in the WACC calculations to derive our estimate of Aer Rianta's cost of capital.

[2] The Cost of Equity

Three alternative models are available to measure the cost of equity. These are the capital asset pricing model (CAPM), the dividend growth model, and the arbitrage pricing theory model. The CAPM is the best-accepted and most widely used approach. There is an extensive literature on both the theoretical and practical problems related to its usage in many different applications, (see, for example, Harrington (1987), Cochran (1999), and the CAA (2001)).

The CAPM model is written in equation form as follows.

$$E(R_i) = r_i + \beta_i [E(R_m) - r_f] \qquad (2.1)$$

where;

$E(R_i)$ is the expected return on stock *i*;

r_f is the risk-free rate of interest;

$E(R_m)$ is the expected return on the market portfolio; and

β_i is the asset's 'beta', representing the systematic risk of stock *i*.

The CAPM states that the return on equity is equal to the risk free rate, r_f, plus a premium for risk, $\beta_i[E(R_m) - r_f]$. The risk premium is defined as the quantity of risk multiplied by the price of risk. The quantity of risk is measured by the systematic risk of the stock as idea behind the model is that in order to invest in equity rather than purchase a risk-free measured by β_i (the covariance of the stock's return with the return on the overall market), and the price of risk is measured by the equity risk premium, $[E(R_m) - r_f]$. The essential asset, investors expect to earn the risk free rate of interest plus a premium for the risk associated with holding equity.

The CAPM is a theoretical model that is built upon a number of assumptions. These include the following,

- All investors are risk-averse expected utility maximisers,
- Asset quantities are fixed and all assets are divisible and marketable,
- Markets are competitive and frictionless, with costless information simultaneously available to all investors, and
- There are no taxes, regulations, or other restrictions on market behaviour.

Although these assumptions do not hold strictly in real world situations, they can generally be relaxed at the cost of additional complexity in the derivation of the model. The simple form of the CAPM as stated above remains very useful for financial decision-making and utility regulation, because it provides a universally accepted methodology for quantifying and pricing equity risk. It should be noted, however, that the CAPM is an expectational model that does not purport to explain historical stock returns. Important problems arise in implementing the CAPM due to the necessity to estimate its three parameters. In most cases, we have only historical information with which to estimate them.

2.1 The Risk-Free Rate

The risk-free rate of interest is a theoretical construct defined as the rate of interest that has no variance and no covariance with the market. It is commonly proxied by the yield on liquid government securities such as treasury bills or government bonds. Such instruments are the lowest risk securities available in the market. They are assumed to be default risk-free, although in a multi-period setting they are not free of price risk.

There are several issues to consider when selecting the most appropriate risk free rate for cost of capital calculations applied to regulated utilities. These are:

- Which government-issued security should be used?
- What maturity should be used?
- Should current rates or historical averages be used?
- How is the real rate adjusted for the inflation risk premium?

There is an extensive literature on these issues (see, for example, Harrington (1987) (Chapter 5), Weil (1989)).

2.1.1 Which government-issued security should be used?

Our task is to estimate Aer Rianta's real cost of capital. This requires an estimate of the real risk-free interest rate. Reflected in any nominal interest rate or yield is a real rate of interest and an expected rate of inflation. This is described in the Fisher equation:

$$(1 + r_{nominal}) = (1 + r_{real})(1 + I_{expected}) \qquad (2.1)$$

where r denotes the interest rate and I denotes inflation. Neither the real rate of interest nor the expected rate of inflation is directly observable, and both must be estimated. Stripping out the expected inflation component to derive estimates of the real rate is complex, and many different techniques have been applied to this problem. In the UK, however, a ready estimate of the real risk-free rate of interest is available: the yield on index-linked gilts. As the cash flows associated with these gilts are CPI-linked, the yields that they trade at are free of the expected inflation component. The CAA (2001) provides a summary discussion of how this instrument has been used in recent regulatory determinations.

We propose to use a German government bond rate. There are three reasons for this. *First*, it is more appropriate to use the yield on a European rather than UK government security, given Ireland's membership of the eurozone and the UK's absence from it. *Second*, a European rate as a benchmark is preferable to an Irish government rate. Ireland is a small open economy in which many of the larger companies and utilities increasingly source their financing offshore, particularly in the euro-denominated public debt markets. *Third*, it has become standard practice in the markets for European corporate and utility debt to be priced relative to German government rates.

The disadvantage of using a German government bond rate is that no index-linked security is issued by the German government. We therefore need to estimate the real risk-free rate from nominal bond yields.

2.1.2 The appropriate maturity

There is divergence of opinion about whether short-term or long-term government rates are the best proxy for the risk-free rate of interest. Short-term rates are a 'purer' measure because they are free of the maturity premium that is associated with long-term debt instruments. In addition, short-term nominal rates are not as strongly affected by the inflation prediction premium (see Fischer (1975)).

There are, however, three reasons why it is more appropriate to use a long-term rate to estimate Aer-Rianta's cost of capital. *First,* early tests of the CAPM in which portfolio betas were regressed cross-sectionally against average monthly returns found that the intercept term (which should be equal to the risk-free rate) was consistently higher than the Treasury bill rate (see Harrington (1987), chapter 3.) For this reason, many practitioners have suggested the use of a long-term government security yield as a better proxy. *Second*, short-term rates are subject to higher volatility than long-term rates. They are also more influenced by intervention carried out by authorities for monetary policy purposes, and are therefore not 'pure' market rates. *Third*, both academic and applied financial analysts have argued that the appropriate risk-free rate for cost of capital purposes is the yield on a government security whose term to maturity best matches the life of the proposed projects to be undertaken (see, for example, Peirson *et al* (1998)). This is tempered, however, by the need to pick a security with liquid markets to ensure a high quality pricing signal. A common practice is to choose a 10-year government bond. For these reasons, we propose to use the 10-year Bund yield as the appropriate proxy for the nominal risk-free rate of interest.

2.1.3 Current rates or historical averages

In its determinations in relation to BAA in 1996, Manchester Airport in 1997, Northern Ireland Electricity in 1997, and Celnet/Vodafone in 1999, the UK Monopolies and mergers Commission (MMC) used real risk-free rates of between 3.5% and 3.8%. Recent determinations by Ofgem, Ofwat, ORR used risk-free rates in the range of 2.25% to 3%. The main reason for the discrepancy is that the MMC (and its reconstituted body, the Competition Commission (CC)) have used historical data on index-linked gilts, whereas the other regulators have used current yields on index-linked gilts. The CC argues that longer-term historical averages are preferable because short-term interest rates have recently experienced considerable volatility. Given that airport infrastructure investment has a long-term investment horizon, and in order to avoid the risk of adopting too low an estimate of the cost of capital, the CAA (2001) has recently advocated a 3% central estimate of the real risk-free rate for its regulation of UK airports.

The choice of whether to use current long-term rates or to calculate some historical average is a difficult one, and debate about this is ongoing. The CAA (2001) provides a summary discussion (see paragraphs 2.1-2.4) of the issues and regulatory practices in the UK. The importance of this choice arises particularly when current rates are significantly different from their long-term historical averages. Because current interest rates are below their historical averages, the issue remains important.

This can be illustrated with the aid of Figure 1, which plots nominal interest rates, inflation, and real interest rates in Germany, the UK and the US, from March 1984 to May 2001. The data has been obtained from Datastream, and includes the rates on 10-year government bonds, and consumer price inflation for each country. The top and middle parts of the Figure show nominal rates and ex-post inflation, while the lower part labelled the real interest rate, is calculated as the nominal rate minus ex-post inflation.

The nominal yields on the three country's government bonds tend to move together. There is considerable variation over time, but a distinct downward trend is visible, from an average of approximately 10% in the mid-1980s to just over 4% in mid-2001. The nominal 10-year rate has been highest in the UK over the period with an average of 8.5%. Germany has had the lowest nominal 10-year rate over the period at 6.5%, and the US has been in between with an average of 7.6%. The average nominal 10-year government bond rate for all three countries over this period is 7.5%.

The middle part of Figure 1 depicts inflation over the same period. Inflation has been lowest in Germany with an average of 2.1%, highest in the UK at double this rate (4.2%), with the US equalling the average of the three countries at 3.1%. The Figure illustrates that co-movement in inflation is less than co-movement in nominal interest rates. During the late 1980s, for example, UK inflation hovered around 8% while German inflation averaged about 2%. The lower part of the Figure, in which the ex-post inflation rate has been subtracted from the nominal yields, demonstrates the importance of taking long-term averages when estimating real interest rates in order to smooth out short-term fluctuations in the data. These series show considerable variation over time, from an average of about 7% during the mid-1980s to about 2% in 2001. For the US, the real interest rate was approximately 9% during 1985, but this declined to about 5% during 1987 and to about 3% during 1990, before rising to 6% during 1992, and declining again to about 2% in 2001.

2.1.4 Previous estimates of the real risk-free rate

In the absence of index-linked German bonds, real interest rates must first be estimated by removing the expected inflation component from nominal interest rates. This can be done using two different approaches. *First*, measures of expected inflation, for example from survey data, can be used. By using expected inflation data, it is a reasonably simple exercise to strip the expected inflation component out of either current yields or historical average yields. *Second*, ex-post inflation measures can be used as a proxy for expected inflation. The ex-post inflation figures, however, must be used with care. It is important to recall that nominal rates of interest reflect expected inflation, which seldom equals ex-post inflation. As Figure 1 illustrates, the use of ex-post inflation should be conducted over long-term horizons, because only then will actual ex-post inflation approximate expected inflation. Having obtained the real interest rates, the inflation risk premium must then be subtracted in order to obtain the estimate of the real risk-free rate.

A number of researchers and financial analysts have spent considerable effort in estimating the real risk-free rate of interest. Table 1 summarises the findings of several recent studies. It presents estimates of the risk-free rate of interest defined over various time periods, ranging from 1 year to 10 years, 16 years, 30 years, 75 years and 100 years or more. The first row in the Table shows NERA's (2001) estimate of the real risk-free rate over 1 year, derived from using 10-year German bonds as the benchmark. This is obtained by subtracting average expectations of future inflation (obtained from the National Institute for Economic and Social Research) of 1.7% for the period 2001-2007 from the 1-year 10-year German bond rate (averaged over the period June 2000-June 2001).

The entries in the Table under '10 years' and '30 years' are also obtained from NERA (2001). As indicated in the Table, these rates are nominal, and as NERA (2001) does not provide any estimates of inflation for these periods, they cannot be converted into real rates. The entries under '16 years' are sourced from Table 2 which will be further discussed below, and are our estimates of the real risk-free rate using 10-year government bond data from the period 1984-2001. The entries under '75 years' and under '100 years or more' include long-term estimates using either bills or bonds. It is well known in the literature that using bills rather than bonds as the benchmark tends to provide lower estimates of the real risk-free rate. The estimates from long time-series based on bonds include those of Annin and Falaschetti (1998) and Ibbotson and Chen (2001) for the US, and Jenkinson (1999), CSFB (2001) and LBS/ABN Amro (2001) for the UK. Taking the estimates from studies using 75 years or more of bond yield data gives an average real risk-free rate of 1.8%.

As mentioned above, it is necessary to subtract an estimate of the inflation risk premium from the real interest rate when the latter is obtained by deflating nominal yields by the ex post inflation rate. None of the studies reported in Table 1 (with the exception of Kearney (2001) do this, mostly because the data does not exist to allow the calculation of the inflation risk premium. We now turn to discuss this further.

2.1.5 Adjusting for the inflation risk premium

Fischer (1975) was the first to suggest that yields on debt securities include a premium for inflation risk. Investors are most interested in the real return that a security can offer, and the inflation component exists to compensate them for the loss of purchasing power. Because actual (or ex-post) inflation will seldom be exactly as expected, investors are concerned that actual inflation may turn out to be more than expected, in which case their real return will be eroded. The inflation risk premium is the additional yield required by investors to compensate them for the probability that ex-post inflation is greater than the expected rate impounded in the yield when they purchased the security. Expected inflation can be viewed as a random variable that follows some underlying distribution, and the longer the maturity of the instrument, the greater is the dispersion of the distribution. It is intuitive, therefore, that long-term bonds should be associated with a larger inflation prediction premium than short-term bonds or bills.

In a study for the Bank of England, Breedon and Chadha (1997) compared the 'inflation term structure' (that is, the market's estimate of future inflation calculated as the yield on nominal government bonds less the yield on index-linked bonds) to ex-post inflation rates. They found that for bonds with maturities of 1 to 5 years over the period 1982-1996, the market appears to significantly over-predict inflation by an average of 1.7% – 1.8%. While it is possible that the market's estimate of inflation is biased, Breedon and Chadha (1997) argue persuasively that most of this 'over-prediction' can be explained by the inflation risk premium.

Table 2 provides the background information to the calculation of the real risk-free interest rate estimates of Kearney (2001) in Table 1. It tabulates the average nominal 10-year bond interest rates, inflation and real rates for Germany, the UK and the US for the period 1984–2001 that are depicted in Figure 1. These figures are presented in the first 6 rows of the Table. The final two rows of the Table that appear under the heading of 'the estimated real risk-free rate' deducts our estimate of inflation risk. We estimate inflation risk to be approximately 40% of the figures in row 3, which is Breedon and Chadha's (1997) lower estimate of the inflation risk premium as a proportion of the UK real rate. While it is acknowledged that, given their respective inflation performance histories, the German inflation prediction premium is likely to be less than the UK one, the longest security used by Breedon and Chadha to estimate the inflation risk premium is 5 years, and it is likely that at longer maturities, the inflation prediction premium is higher.

2.1.6 The recommended real risk-free rate

Comparing Table 1 (which summarises previous estimates of the real risk-free rate of interest over the very long-term) to Table 2 (which summarises our estimates of the real risk-free rate during the period 1984-2001) shows that our estimates (2.6% for Germany and the UK, 2.7% for the US, and an average of 2.6% for all three countries) are considerable higher than the long-term estimates from Table 1 (which average 1.8% for the UK and the US estimates that use bonds as their benchmark).

We therefore propose to use our own estimates of the risk free rate, based on 16 years of data. Our estimate of the risk free rate is, therefore, 2.6%. This estimate lies within the range of estimates reviewed by the CAA (2001) that have been applied in recent regulatory determinations the UK (see CAA(2001), Table 1), and it is somewhat below the CAA's (2001) suggested range of 2.75%-3.25% which centres on 3%. The main reason for our lower estimate is that ours includes the adjustment for the inflation risk premium.

2.2 The Equity Risk Premium

The equity risk premium is the return that investors require to induce them to purchase and hold equity rather than risk-free bonds. As the CAPM is an expectational model, the concept of an equity risk premium is also a forward-looking one in the sense that it reflects the expectations of what investors require in the future. As such, the equity risk premium cannot be directly observed, and it is difficult to measure. There is ongoing debate amongst academics and practitioners regarding the determinants of the equity risk premium, how best to estimate it, and what measure is most appropriate for the regulation of public utilities. It follows that an element of judgement is required in setting an appropriate equity risk premium as an input into the cost of capital calculation.

Much recent work in finance has been devoted to measuring the equity risk premium. An influential study by Mehra and Prescott (1985) used annual United States data from 1889-1978, and found that the sample mean of the return on equity (measured by the S&P 500 index) was 7%, while the estimated risk free rate (measured by the sample mean of the return on bills) was 1%. The difference of 6% is their estimated risk premium. Many other studies have estimated the equity risk premium. Kocherlakota (1996) and Siegel and Thaler (1997) provide reviews of this literature.

2.2.1 The Preferred Estimation Method

There are essentially three methods that can be used to derive estimates of the equity risk premium. The *first* is to use historical time series data to calculate the difference between the long-run return on some stock market index, and the long-run return on risk-free bills or bonds. The *second* method uses models that incorporate fundamental information such as earnings, dividends and/or economic productivity (see, for example, Diermeier, Ibbotson and Siegel (1984), Shiller (2000) and Fama and French (2001)). The *third* method uses surveys of the views of professional financial analysts (see, for example, Welch (2000) and NERA (2001)).

In using the *first* of these approaches, the analyst/researcher faces a particular challenge. This is because the equity risk premium is the expected return on the market *minus* the risk-free rate. Estimates of both have to be made. We have already discussed the difficulties associated with estimating an appropriate risk-free rate of interest. Estimating the expected return on equity is just as fraught, and is subject to ongoing debate as to the most appropriate approach. The historical approach, however, is the most commonly used method and is discussed further in section 2.2.2. The *second* approach, using models that incorporate fundamental economic and corporate information, has not yet been used in calculating the cost of capital for the regulation of utilities. Such models are not the preferred method because they are difficult to use and often complex. The CAA (2001) recently voiced its reluctance to embrace such models. Annin and Falaschetti (1998) summarise the preference for the historical approach as follows.

> *"Most equity risk premium models use historical data and assume that some period of the past provides the best indication of what the future will hold. To our knowledge, there is no functioning ERP model that uses [model based] future projections as its base".*
> [Annin and Falaschetti (1998), pg 2, term in brackets added.]

The *third* approach involves using surveys of financial analysts' opinions as to the size of the equity risk premium. NERA (2001) summarises the survey-based equity risk premium calculations that have been referred to in regulation in the UK and the US. These surveys (see NERA (2001), Table 4.8, pg 19) provide an average estimate of the equity risk premium of 3.8% in the UK and 6.4% in the US, which averages to 4.9% overall. In commenting on the usefulness of survey data of this sort, NERA (2000) make the intuitive observation that these surveys suffer from small sample bias, questionnaire bias, difficulty of interpretation and short time horizons. They can, nevertheless, provide a comparison and useful crosscheck on the historical data estimates.

2.2.2 Estimating the equity risk premium with historical data

We propose to use long historical time-series data to estimate the equity risk premium. As with the risk-free rate, it is widely accepted that expected equity returns can only be approximated by actual (ex-post) equity returns over considerable periods of time. Equity markets are well known to move in a cyclical fashion and to lead the business cycle. Long periods of bull market conditions are common, and are often followed by bear market conditions. Care must be taken to include data from both types of periods. If, for example, data is drawn from a bear market period only, the calculation could result in a negative equity premium. Equally, use of data from only a bull market will produce overestimates of the equity risk premium. The world's major equity markets have been in a bullish phase for most of the past decade.

Figure 2 depicts the levels, percentage returns and standard deviations for the stock markets in Germany, the UK and the US over the period from 1984 to 2001. Looking firstly at the levels in the top part of the Figure, it is clear that although the markets diverge in the short-term, all three stock markets tend to move together over time. This Figure also shows the strong upward trend in the markets, particularly from 1992 onwards. The middle part of the Figure shows that the returns have been more volatile during the late-1980s, around the time of the October 1987 crash, and again towards the end of the data period coinciding with the end of the 1990s boom market. The bottom part of the Figure makes this point more obvious by depicting the 12-month rolling standard deviations of returns. It is clear that although the market volatilities tend to move together over time, they vary considerably in the short term. This shows that estimates of the equity risk premium should be based on long runs of historical time series data in order to smooth out the shorter-term trends.

2.2.3 Estimates from academic and practitioner studies.

There exists a number of widely used financial datasets that can be used to calculate long-run historical estimates of the equity risk premium. The main ones include Bloomberg, Datastream and Reuters. In addition, a number of firms such as Ibbotson Associates and LBS/ABN AMRO have constructed and maintain their own datasets. Ibbotson Associates, for example, uses equity data from the Centre for Research in Security prices (CRSP) at the University of Chicago. The CRSP is commonly used in studies of the equity risk premium and beta. This data set starts in 1926 when high quality financial data became available in the US. It incorporates one full business cycle of data prior to the stock market crash of 1929. The LBS/ABN Amro Millenium Book uses data from the start of the 20th century, excluding 1922/23 because hyperinflation at that time distorted the equity risk premium calculations.

Table 3 summarises the estimates of the equity risk premium from a selection of previous studies. In a similar fashion to Table 1, it presents the studies by time horizon of the data used, starting with the most recent 10 years, followed by 16 years, 30 years, 75 years, and 100 years or more. Looking firstly at the 10 years estimate, NERA (2001) provides an average risk premium estimate for the UK and the US of 7.0%, with the US figure being more than twice that for the UK. Over the 16 years horizon, our analysis provides an average risk premium estimate for Germany, the UK and the US, of 8.9%. As mentioned above, however, both these estimates are likely to be inflated because of the recent bullish conditions in world equity markets. This is confirmed by the 30 years analysis of NERA (2001), which gives an average equity risk premium of 5.3% for the UK and the US. It is noticeable that in this estimate, the US equity premium of 4.8% is slightly less than the UK estimate of 5.9% which contrasts with the 10 years finding that the US equity premium is over twice that of the UK. Once again, this serves to highlight the importance of using long runs of historical time-series to calculate the equity risk premium.

Looking further down Table 3 at the 75 years horizon, Annin and Falaschetti (1998) use Ibbotson Associates data to derive their estimate of the equity risk premium of 7.3% for the US over the period 1926-1996. These researchers also demonstrate the extent of variation in the risk premium over time. It has ranged from 17.6% during the period 1926-1929, to 2.3% during the 1930s, 8.0% during the 1940s, 17.9% during the 1950s, 4.2% during the 1960s, 0.3% during the 1970s, 7.9% during the 1980s and 7.9% during the 1990s. The variability in these sub-period findings further illustrates the importance of using very long time-series to estimate the equity risk premium.

In his recent influential book, Cornell (1999) also uses data from 1926 to 1997, and estimates the US equity premium at 4.5%. In arriving at this lower estimate than that obtained by Annin and Falaschetti (1998), Cornell (1999) argues that the survival bias inherent in the US stock market has inflated previous estimates of the equity risk premium. A more recent analysis by Ibbotson and Chen (2001) examines the equity risk premium using a number of alternative models, again using Ibbotson Associates data from 1926–1990. Using a combination of the historical data method together with supply side models, they calculate the US equity premium at 6%.

Looking at the 100 years or more horizon, both Mehra and Prescott (1985) and Siegel (1992) derive their estimates of the equity risk premium in the US based on risk-free rate estimates using bills rather than bonds. The average of their estimates of the equity risk premium is 5.6%. This is coincidentally close to the average figure of 5.3% obtained by NERA (2001) for the 30-year horizon estimates in the UK and the US. Another recent estimate of the equity risk premium from long historical time series is provided by LBS/ABN Amro (2001). They provide estimates for Germany, the UK and the US of, respectively, 9.9%, 5.6% and 6.9%. They also provide a world average figure of 6.7%, which includes Australia, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, the UK and the US.

As mentioned at the start of this section, estimating the equity risk premium requires judgement. Our assessment of the overall evidence suggests that an appropriate figure for the equity risk premium is 6.0%.

2.3 Beta

The equity beta (β) of a stock is its systematic (or market) risk. A stock's risk can be divided into two parts: systematic and unsystematic (also known as idiosyncratic or stock-specific risk). It is well established in finance theory that only systematic risk is priced by the market – that is, it is only the systematic risk of the stock that investors should expect to be compensated for in terms of additional return. This is because it is easy for investors to diversify their portfolios such that idiosyncratic risk is washed out.

For cost of capital purposes, an estimate of future equity beta is required. The starting point for its estimation, however, necessarily requires the use of historical returns data. The most common approach is to estimate the following time series regression:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_i \qquad (2.2)$$

where $R_{i,t}$ is the return on stock *i* at time period *t*, and
$R_{m,t}$ is the return on the market at time period *t*.

The slope of the resulting regression line is the stock's beta. This slope has the expression

$$\beta_i = \frac{cov(R_i, R_m)}{var(R_m)} \qquad (2.3)$$

Estimating beta is an inexact science. As explained in equation (2.2) with the error term ε_t, the estimate of beta is associated with considerable error. Further, as discussed below in section 2.3.2, very different estimates of beta will result depending on what time horizon, data interval and stock market index is used.

2.3.1 Estimation of an equity beta for Aer Rianta

Our approach to beta estimation described above requires that the company whose beta is being estimated has been listed on a stock exchange for a sufficient period. As Aer Rianta is an unlisted company, we use BAA as the appropriate comparator company. Using a comparator company to estimate an unlisted company's beta requires adjustments to the equity beta calculated for the listed company. The two companies may have significantly different business and financial risks. If so, business and financial risk must be adjusted for separately. This is commonly conducted via a three-step process.

The estimated equity beta for the listed company – in this case BAA – goes through a process of 'de-gearing', producing an *asset beta*, which is the beta for an equivalent company that has no debt in its capital structure.

The asset beta for BAA is adjusted for any differences in business risk between BAA and the unlisted company, in this case Aer Rianta. This produces an estimate of the asset beta for Aer Rianta.

Aer Rianta's asset beta is 're-geared' according to Aer Rianta's capital structure. This produces an estimate of Aer Rianta's equity beta, which is used in the CAPM estimate of required return on equity.

2.3.2 Estimating historical betas

The appropriate time horizon

While the statistical approach described above is the obvious starting point for beta estimation, when using the CAPM for the purpose of computing a company cost of capital, the beta should be an estimate of future beta. Equity betas change over time in line with changes in the fundamental characteristics that affect a company's systematic risk. The further back in time that the data is drawn from, the less relevant it will be for estimates of future beta. The most recent data is therefore the best.

While it is well accepted that the most recent return observations should be used, the appropriate time horizon for optimal beta estimation is subject to debate. This issue is highly related to data interval. There is a tradeoff between obtaining the best estimate of future beta, and gathering sufficient observations for a valid regression estimate. For example, if weekly data is used, 1 year's data should be sufficient. However, with monthly data the researcher will have to go back 4 or 5 years in order to garner sufficient observations for an optimal regression estimate.

The data interval

Different data intervals can result in different beta estimates. Short interval data, such as daily or weekly observations, can introduce bias due to non-synchronous trading. This occurs when thin trading in the stock means that, for example, end of day prices are stale, and therefore not an accurate measure of the company's value at that time. This results in the underestimation of beta. Non-synchronous trading is, of course, less of a problem the greater the data interval. It is generally recommended, therefore, that monthly data be used for beta estimation. The monthly interval has the dual benefit of being the least biased data interval and allowing a sufficient number of observations for valid regression analysis within a reasonable time-frame. The most common approach to beta estimation uses data from a 5-year time horizon with a monthly interval.

The choice of stock market index

Estimated betas will vary depending on the index used. We use two indices to estimate BAA's beta. Because it is a UK company, we use the FTSE 100 index. However, it could be argued that a European index should be used because we are ultimately estimating the beta of an Irish company, operating in an economy that is increasingly integrated in Europe. For this reason we also use the Dow Jones European index to estimate BAA's beta.

2.3.3 BAA's historical equity beta

Figure 3 presents rolling beta values estimated for BAA using ordinary least squares (OLS) regression techniques. It is calculated with 5 years of monthly data. The dates on the horizontal axis are the time of conclusion of the beta estimation period. As can be seen in the Figure, the estimated beta varies considerably over time. For example, using the FTSE 100 as the index, the beta estimated from 1987-1992 is 0.65. This rises to 1.1 for the interval 1992 to 1997, with the estimate 2 years later at approximately 0.8. Thereafter, the beta estimate falls off dramatically towards the end of the data period to a value of 0.36.

Figure 4 casts light on why BAA's beta has declined so dramatically in the last 2 years. It plots the constituent parts of the beta estimate (that is, the numerator which is the covariance of BAA's return with respect to the FTSE 100, and the denominator which is the variance of the market) along with the variance of BAA's return. The variance of the market hovered around an average of 25 during the early 1990s, and this declined to 10 during 1997 before rising to above 15 by the end of the data period. The covariance of BAA's return with the return on the FTSE hovered around 18 during the early to mid-1990s before declining to 10 during 1997, rising to about 15 during 1998, and then declining to below 10 since the beginning of 2000. This decline in the covariance results from a steep rise in the variance of BAA's returns in late 1999. With the declining numerator (that is, the covariance term) together with a slightly rising denominator term (that is, the variance of the FTSE 100), BAA's beta has declined steeply since the beginning of 2000. It is impossible to determine whether this is a short-term trend that will be self-correcting over future months, or whether it represents the beginning of a permanent decline in BAA's beta. An element of judgement is required. Our estimate for BAA's beta reflects our belief that some component of the recent decline is probably temporary in nature.

The average of the monthly rolling equity betas for the full period are 0.80 when the FTSE 100 is used as the index, and 0.66 when the Dow Jones European index is used. We propose to take the midpoint of these two as our recommended equity beta for BAA. Our recommended equity beta for BAA is 0.73.

2.3.4 BAA's asset beta

Two established approaches to de-gearing an equity beta to obtain an asset beta are as follows:

$$\beta_{equity} = \beta_{asset}\left(1 + \frac{D}{E}\right) \tag{2.4}$$

$$\beta_{equity} = \beta_{asset}\left(1 + (1 - T_c)\frac{D}{E}\right) \tag{2.5}$$

where T_c is the corporate tax rate, D is the company's total debt and E is the company's total equity. (See Copeland and Weston (1988) for a derivation of equation 2.5.) These equations define the equity beta as the asset beta adjusted for gearing as defined as the debt-to-equity ratio. Equation (2.5) adjusts the debt-to-equity ratio for the tax benefit of debt. This applies in a 'classical tax system' where there is no dividend imputation, such as in the US. Equation (2.6) acknowledges the corporate tax benefits of debt and the offsetting effect of this benefit in taxation systems with dividend imputation:

$$\beta_{equity} = \beta_{asset}\left(1 + \left(\frac{1 - T_c}{1 - T_s}\right)\frac{D}{E}\right) \tag{2.6}$$

where T_s is the imputation tax credit rate. This equation, however, is difficult to use in practice. The UK taxation system is a partial imputation system whereby the tax credit given to any particular shareholder depends on their income level. It is not easy, therefore, to estimate T_s for any particular company. The best practical estimate of BAA's asset beta, therefore, can be obtained by estimating both equations (2.4) and (2.5) and taking the midpoint. The British corporate tax rate is 30%. The debt-to-equity ratios for BAA and Aer Rianta appear in Table 4 and are discussed further in section 4 of this report. Applying these to (2.4) and (2.5) gives the following.

$$\beta_{asset} = \frac{\beta_{equity}}{1 + \frac{D}{E}} \tag{2.4}$$

$\beta_{asset\ (BAA)}$ = 0.73/(1+.59)

= 0.46

$$\beta_{asset} = \frac{\beta_{equity}}{1 + (1 - T_c)\frac{D}{E}} \tag{2.5}$$

$\beta_{asset\ (BAA)}$ = 0.73/(1+(1-.30)0.59)

= 0.52

The mid-point between these two estimates is 0.49. Our recommended asset beta for BAA is 0.50.

2.3.5 Aer Rianta's asset beta

Aer Rianta's operational and business risks are not sufficiently different from BAA's to warrant significant adjustment to BAA's asset beta. Both are in a very strong competitive position in their respective markets, they have similar passenger profiles, and both are committed to major capital expenditure projects in the short to medium term. They are similarly rated by Standard and Poor's (with BAA rated AA- and Aer Rianta AA+), despite Aer Rianta having higher leverage (see Table 4). Both companies have a high proportion of non-aeronautical revenues, and both have extensive interests in duty free. While BAA's aeronautical revenues are currently a much higher proportion of total revenues than Aer Rianta's (28.5% compared to 17.5%), the report on Aer Rianta by Standard and Poors (2000) makes it clear that market expectations envisage that Aer Rianta will have to increase its aeronautical tariffs, as they have not changed since 1987:

"These aeronautical revenues will increase in the future owing to the unwinding of airline discounts and expected tariff increases and a more balanced revenue composition is expected as a result."
[Standard and Poors, (2000)].

Our recommended asset beta for Aer Rianta is consequently 0.50.

2.3.6 Aer Rianta's equity beta

In order to determine Aer Rianta's equity beta from its asset beta, we need the appropriate corporate tax rate. The projected tax rates for Ireland are 16% in 2002, declining to 12.5% in 2003 and thereafter. The average tax rate for the 5-year period from 2002 to 2006 is consequently 13.2%. The debt-to-assets ratio for Aer Rianta is approximately 50%, so the debt-to-equity ratio is 1.

$$\beta_{equity} = \beta_{asset}\left(1 + \left(1 - T_c\right)\frac{D}{E}\right) \qquad (2.5)$$

β_{equity} = 0.50(1+(1-.135)1)
= 0.93

Our recommended equity beta for Aer Rianta is consequently 0.93.

[3] The Cost of Debt

The cost of debt component for the weighted average cost of capital (WACC) calculation is easier to estimate that the cost of equity. While the cost of equity is not observable and must be estimated by some economic model, the cost of debt for most companies is readily available. If the company in question has publicly traded debt outstanding, the common method for estimating the nominal cost of debt is to take the current market yield on that debt. If the real cost of debt is required, as it is in this case, the spread over benchmark that the public debt is quoted at is the best measure of estimating the debt premium. This is then added to the estimated real risk-free rate of interest.

3.1 The Debt Premium

It is well understood that, in order to hold corporate debt, investors must be offered a premium over and above the return on the risk-free asset in order to compensate them for the additional risk associated with corporate debt. The debt premium is therefore commensurate with the likelihood that the company will default on its debt obligations. It is determined by both the business and financial risk of the company, and is usually determined by fundamental analysis of the company and its industry.

If a company's debt is rated by one of the ratings agencies (such as Moody's and/or Standard and Poors) but does not have public debt, the debt premium can be estimated by examining the debt premiums of other similar companies with the same rating. If its debt is not rated, comparisons can be made with other (rated) companies in the same industry, and adjustments to their costs of debt made on the basis of relative fundamentals. For example, the CAA (2001) suggests that the debt premium of BAA is 140 to 145 basis points and Manchester Airport is 80 basis points. The average of the mid-point of the BAA range and the estimate for Manchester Airport is 111 basis points. This could arguably be used as a starting point for estimating a debt premium for Aer Rianta. In this case, assessments of the business and financial risk of Aer Rianta relative to the two British airports could be used to argue whether the appropriately estimated debt premium for Aer Rianta should be above or below 1.1%.

However, a much more straightforward and accurate estimate Aer Rianta's debt premium can be gleaned directly from financial markets. Early in 2001, Aer Rianta conducted its first public issue in the Euro-denominated bond market of Euro250 million. Being market-determined, the best estimate of Aer Rianta's debt premium is therefore the quoted yield spread over the benchmark rate. This will be the most accurate and up-to-date assessment of the cost associated with Aer Rianta's borrowing. An added advantage of using the spread over benchmark on this new Eurobond issue is that it has a 10-year maturity, which matches the maturity of the reference rate chosen for the risk-free rate in our CAPM calculation, and which will be used to estimate Aer Rianta's real cost of debt. Further, the benchmark rate used in the Eurobond market is the 10-year Bund (German government bond) rate, which matches our choice of the risk-free rate.

Standard & Poor's has assessed Aer Rianta's debt as A+/Stable/A-1. This rating is based on the company's currently strong financial position and business fundamentals, coupled with equally strong projections for the future. The yield on their Euro-denominated bonds is 6.002% as at 30th July 2001. This represents a spread over the benchmark rate (the 10-year German government bond yield) of 113 basis points. This spread corresponds very closely to the average debt premium of 111 basis points calculated above from the CAA's (2001) estimated debt premiums for BAA and Manchester airports.
In summary, therefore, we estimate Aer Rianta's real cost of debt as our risk-free rate estimate of 2.6% plus 113 basis points for the debt premium. The resulting real cost of debt estimate for Aer Rianta is 3.7%.

[4] Gearing

The weightings applied to the estimates of the cost of debt and equity in the WACC should ideally be based on the firm's optimal capital structure. The term 'optimal' capital structure is based on the fact that, as the interest payments on debt are tax deductible, raising the quantity of debt in the capital structure adds to company value. The 'optimal' capital structure gives a level of debt at which the tax benefits of debt begin to be outweighed by the costs of financial distress caused by difficulties associated with servicing high debt obligations. The problem with the concept, however, is that the 'optimal' capital structure difficult to determine, and there is no guiding theory as to how to estimate it.

Furthermore, in countries like Ireland where there is a low corporate tax rate, or where a dividend imputation system reduces the tax benefit of debt, the concept of an 'optimal' capital structure is less important to company value. For Aer Rianta, therefore, our preferred approach to estimating gearing for the WACC calculation is to use either its actual current gearing or its expected average gearing for the forecast period. This is also the preferred approach of the CAA (2001).

Table 4 summarises the current capital structure of Aer Rianta. (The Table includes comparable ratios for BAA as these were needed to de-gear BAA's equity beta in section 6.) The information has been obtained from Aer Rianta's balance sheet as at 31st December 2000. Total debt amounted to £324 million and total equity amounted to £280 million. This gives a debt-to-equity ratio of 116% and a gearing ratio (that is, debt to debt plus equity) of 54%. The gearing ratio was unchanged from the 1999 accounts. In its ratings commentary issued just before Aer Rianta's recent bond issue, Standard & Poor's (2000) described the corporation's current debt maturity structure as well balanced. It also forecast that Aer Rianta's gearing ratio will not exceed the 54% during the coming 5 years, and that it will peak at that rate before declining to 43%.

Given that Aer Rianta's current gearing ratio is 54%, and given the projection by Standard & Poor's (2000), it is appropriate to use this information as the most reliable estimator of the company's gearing ratio in the coming years. Accordingly, a gearing ratio of 50% is adopted for the purpose of calculating the cost of capital. This is considerably higher than BAA's gearing ratio of 37% (measured in book value terms) or 40% (measured in market terms). It is, however, considerably lower than the gearing ratio in many North American airports.

[5] The Weighted Average Cost of Capital

A summary of our findings for the WACC and its components can be found in Table 5. In the final cost of capital estimation, we follow the methodology adopted by the CAA (2001). The CAA uses estimates of the real cost of equity and the real cost of debt in the following equations.

Post-tax WACC:

$$WACC_{post-tax} = \frac{D}{D+E}\left(r_f + \rho\right)\left(1 - t_c\right) + \frac{E}{D+E}\left(r_f + \left[ERP\right]\beta\right) \qquad (5.1)$$

Pre-tax WACC:

$$WACC_{post-tax} = \frac{D}{D+E}\left(r_f + \rho\right) + \frac{\frac{E}{D+E}\left(r_f + \left[ERP\right]\beta\right)}{\left(1 - t_c\right)} \qquad (5.2)$$

where D = total debt

E = total equity

r_f = the real risk-free rate of interest

ρ = the debt premium

t_c = the corporate tax rate

ERP = the equity risk premium

β = equity beta

The expression $(r_f + \rho)$ is the company's real return on debt, and $(r_f+[ERP]\beta)$ is the company's real return on equity using the CAPM.

Inserting our estimates of the inputs to the WACC calculations provides our estimates of Aer Rianta's cost of capital follows:

Post-tax WACC:

$$WACC_{post-tax} = \frac{D}{D+E}\left(r_f + \rho\right)\left(1 - t_c\right) + \frac{E}{D+E}\left(r_f + [ERP]\beta\right) \qquad (5.1)$$

$$= 0.5\left(2.6 + 1.1\right)\left(1 - .132\right) + 0.5\left(2.6 + [6]0.93\right)$$

$$= 5.7$$

Pre-tax WACC:

$$WACC_{post-tax} = \frac{D}{D+E}\left(r_f + \rho\right) + \frac{\frac{E}{D+E}\left(r_f + [ERP]\beta\right)}{\left(1 - t_c\right)} \qquad (5.2)$$

$$= 0.5\left(2.6 + 1.1\right) + \frac{0.5\left(2.6 + [6]0.93\right)}{\left(1 - .132\right)}$$

$$= 6.6$$

Our resulting estimate of Aer Rianta’s post-tax WACC is 5.7%, and its pre-tax WACC is 6.6%. Our estimate of Aer Rianta’s real post-tax WACC of 5.7% is very close to the 5.4% estimated WACC figure applied by Ofwat in its regulation of water and sewerage charges. Our real pre-tax WACC is within the range of the real pre-tax WACC of 6.4 to 8.3% applied by the MMC to BAA in 1996. Our pre-tax WACC is also within the range of 6.0 to 6.9% applied by Ofgem in 1999. Finally, our post-tax WACC estimate of 5.7% lies within the post-tax WACC range of 4.3% to 6.6%, and our pre-tax WACC estimate of 6.6% lies within the pre-tax WACC range of 6.1% to 9.1% proposed by CAA (2001) for application to regulated airports in the UK.

Given the uncertainties that apply to these estimates, this report suggests that the best estimate of Aer Rianta’s real post-tax WACC is 6%, and the best estimate of its pre-tax WACC is 7%.

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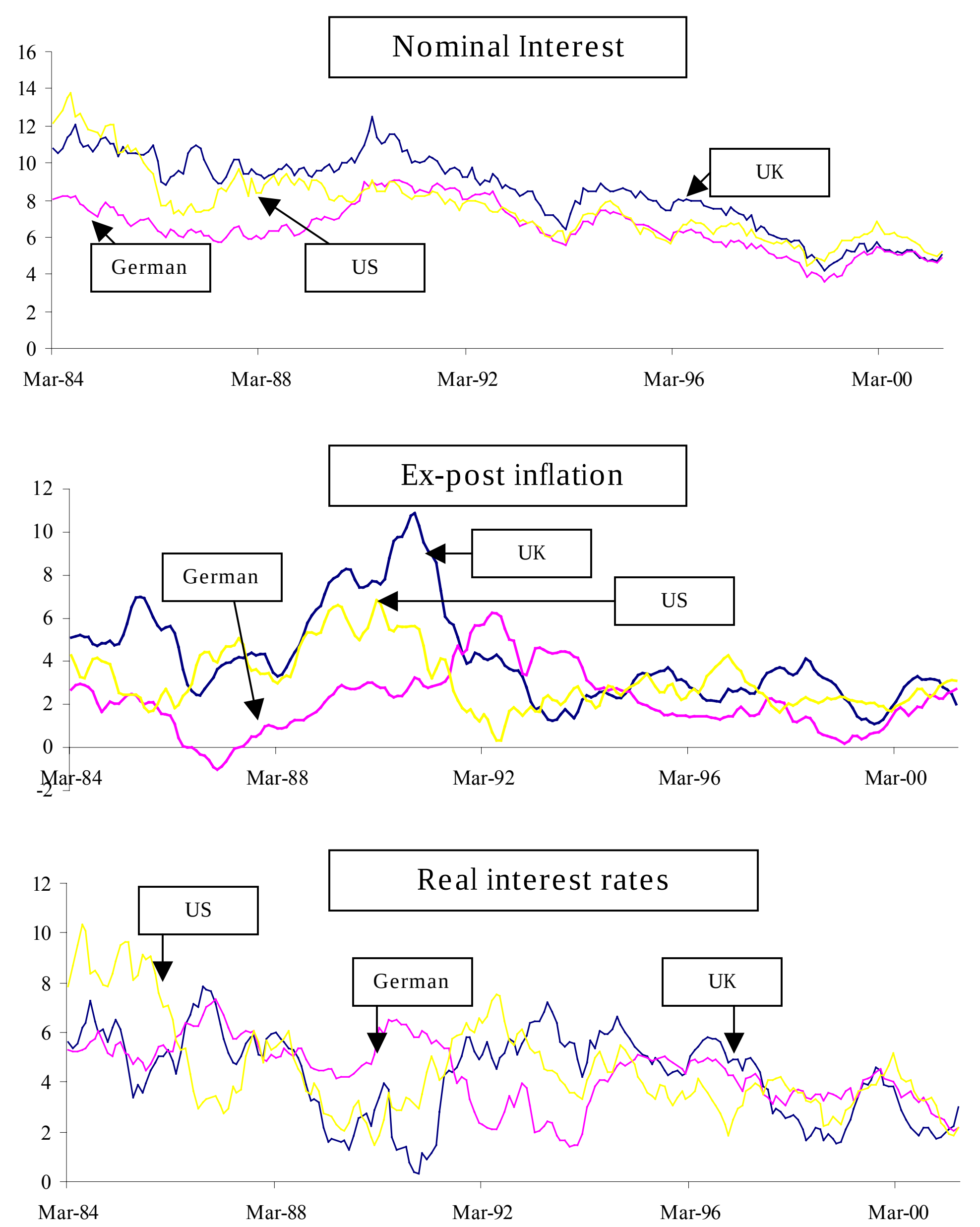
Figure 1
Nominal Interest Rates, Inflation and Real Interest Rates
in Germany, the United Kingdom and the United States

Monthly 10 Year Bond Rates, March 1984 – May 2001.



Notes. All data is obtained from Datastream. Observations are at the beginning of the month.

Table 1
Estimates of the Risk Free Rate Using Historical Data

Data and Study	Period	Bills / Bonds	Germany	UK	US	World / Average
			Country			
1 Year						
NERA (2001)	2000-2001	Bonds	3.2			
10 Years						
NERA (2001) – nominal	1991-2001	Bonds	5.6	7.3	6.2	6.4
16 Years						
Kearney (2001)	1984-2001	Bonds	2.6	2.6	2.7	2.6
30 Years						
NERA (2001) – nominal	1971-2001	Bonds	6.8	4.6	8.1	6.5
75 Years						
Siegel (1992)	1926-1995	Bills			0.7	
Annin and Falaschetti (1998)	1926-1996	Bonds			2.0	
Jenkinson (1999)	1919-1998	Bonds		2.1		
Ibbotsen and Chen (2001)	1926-2000	Bonds			2.0	
100 years or more						
CSFB (2001)	1869-2000	Bonds		1.8		
LBS/ABN AMRO (2001)	1900-2000	Bonds		1.0		
Mehra and Prescott (1985)	1889-1978	Bills			1.0	

Notes. All rates are real risk-free rates except where indicated otherwise for NERA (2001). The estimates are grouped into studies using 1 year, 10 years, 16 years, 30 years, 75 years and 100 years or more of data. These groupings are approximate with respect to the number of years included, particularly for the 75-year grouping. The estimates for NERA (2001) are obtained from Table 0.2 in Attachment B, page 47. The Ibbotson measure is used by many finance practitioners, particularly in North America. Information on this methodology is available in Annin and Falaschetti (1998).

Table 2
Nominal Interest Rates, Inflation, Real Interest Rates and the Real Risk-Free Rate in Germany, the United Kingdom and the United States

Average monthly 10 Year Bond Rates, March 1984 – May 2001.

	Germany	UK	US	Average	
	(1) Nominal Interest Rates				
March 84 – May 01	6.5	8.5	7.6	7.5	
Jan 90 – May 01		6.4	7.6	6.7	6.9
	(2) Ex-post Inflation				
March 84 – May 01	2.1	4.2	3.1	3.1	
Jan 90 – May 01		2.5	3.6	2.7	2.9
	(3) Real Interest Rates				
March 84 – May 01	4.4	4.3	4.5	4.4	
Jan 90 – May 01		3.9	4.9	4.0	4.0
	(4) The Estimated Real Risk-Free Rate				
March 84 – May 01	2.6	2.6	2.7	2.6	
Jan 90 – May 01		2.3	2.9	2.4	2.5

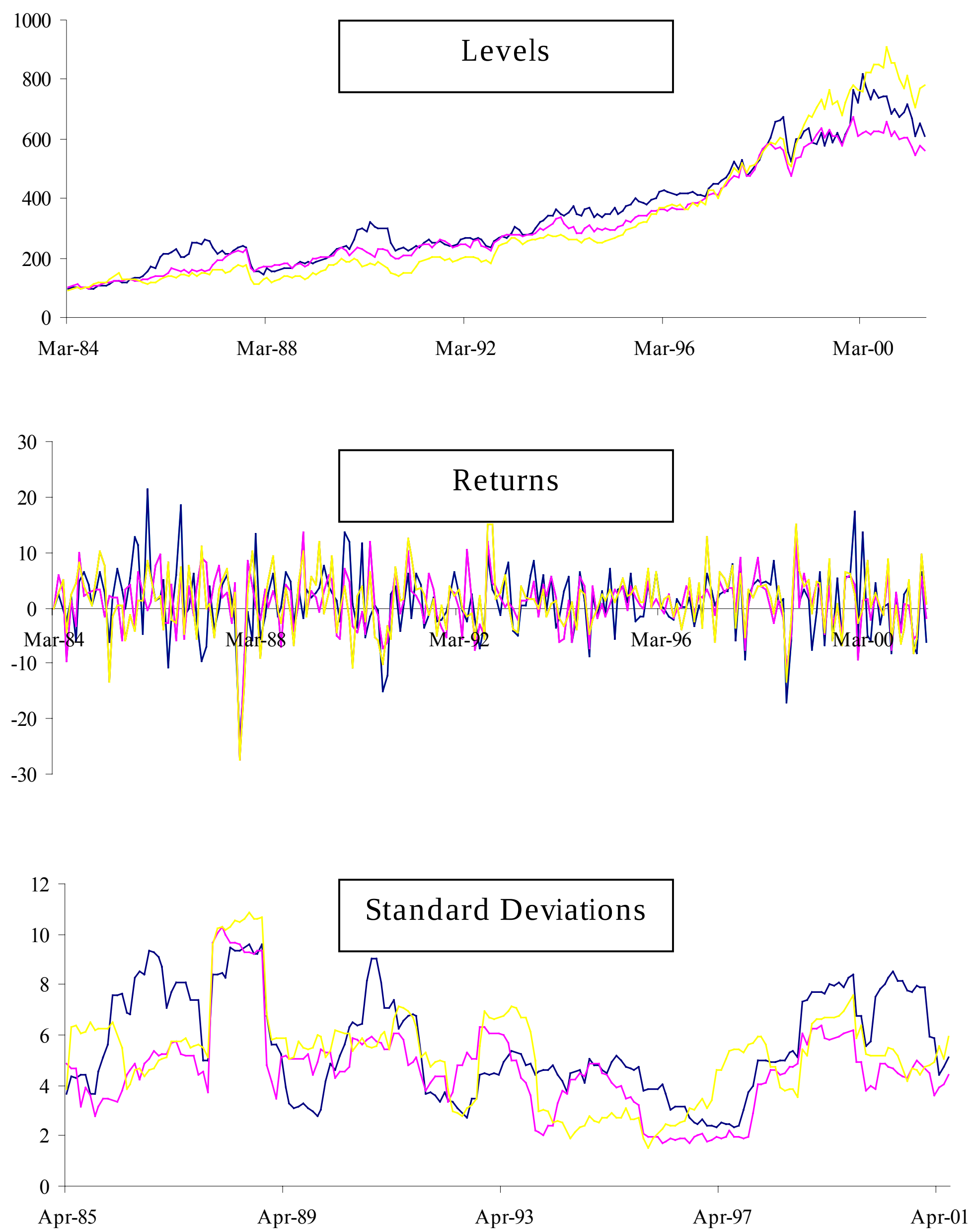
Notes. All data is sourced from Datastream. Observations are taken from the beginning of the month. Estimates of the real risk-free rate are obtained by subtracting the ex-post inflation rates (2) from the nominal rates (1)giving the preliminary real rate (3). The final estimate (4) results from deducting an inflation prediction premium of 40%, as estimated for the UK by Breedon and Chadha (1997).

Figure 2

Stock Market Levels, Returns and Standard Deviations

In Germany, the United Kingdom and the United States

Monthly, March 1984 – June 2001.



Notes. All data is obtained from Datastream. Observations are at the beginning of the month.

Table 3
Estimates of the Equity Risk Premium Using Historical Data

			Country			
Data and Study	***Period***	***Bills / Bonds***	***US***	***Germany***	***UK***	***World / Average***
10 Years						
NERA (2001)	1991-2001	Bonds		4.2	9.9	7.0
15 Years						
Kearney (2001)	1984-2001	Bonds	9.6	7.6	9.5	8.9
30 Years						
NERA (2001)	1971-2001	Bonds		5.9	4.8	5.3
75 Years						
Annin and Falaschetti (1998)	1926-1996	Bonds				7.3
Cornell (1999)	1926-1997	Bonds			4.5	
Ibbotsen and Chen (2001)	1926-2000	Bonds				6.0
100 years or more						
Mehra and Prescott (1985)	1889-1978	Bills				6.0
Siegel (1992)	1802-1990	Bills			5.3	
LBS/ABN AMRO (2001)	1901-2000	Bonds	9.9	5.6	6.9	6.7

Notes. The estimates are grouped into studies using 10 years, 15 years, 30 years, 75 years and 100 years or more of data. These groupings are approximate with respect to the number of years included, particularly for the 75 year grouping.

Figure 3
Estimated Equity Betas for BAA

Calculated over 5 years of Rolling Monthly Data for the FTSE and DJ Euro Indices for the Period 1987-2001

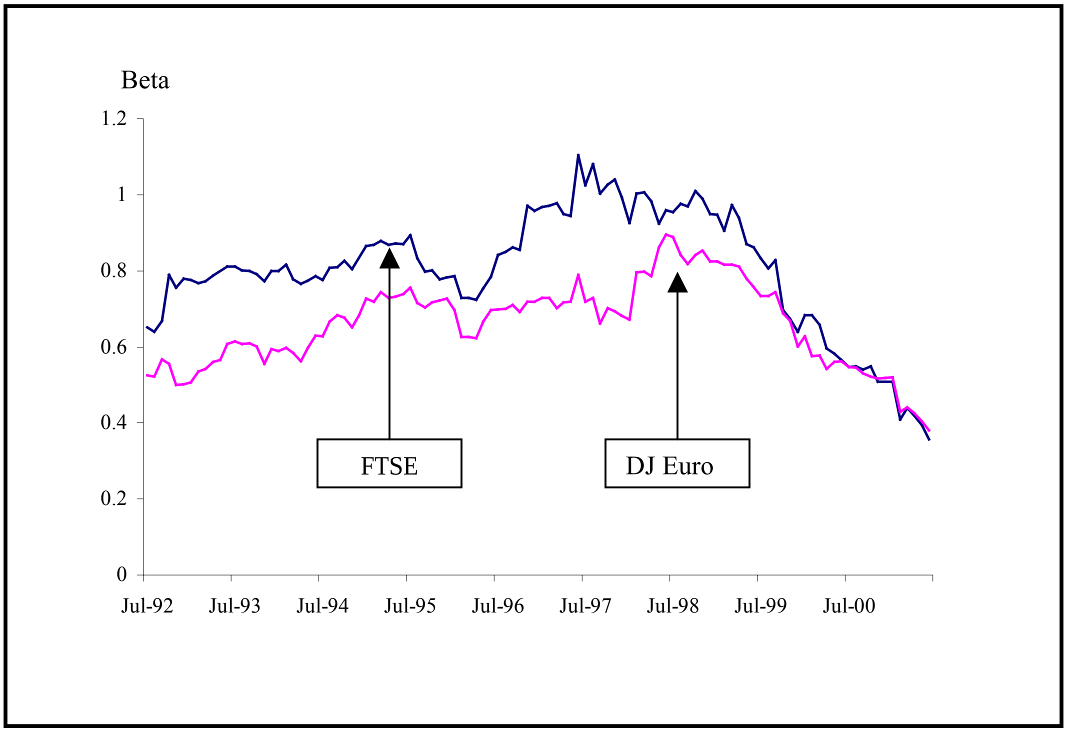


Figure 4
BAA's and the FTSE's Stock Return Variances and their Covariance

Rolling Monthly data over 5 years for the period 1987-2001

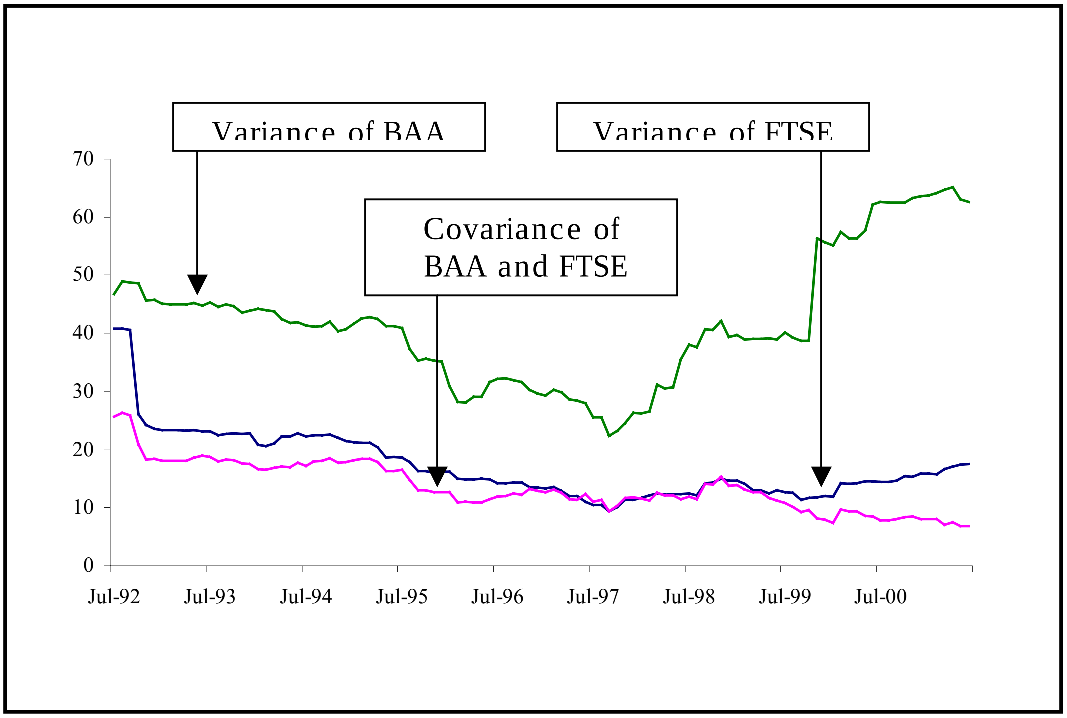


Table 4

Gearing ratios of BAA and Aer Rianta 2000

	Financial Statement information (£m)			Gearing ratios			
				Debt/Assets		Debt/equity	
	debt	equity	MV equity (30/3/00)	$\frac{D}{D+E}$	$\frac{D}{D+MV(E)}$	$\frac{D}{E}$	$\frac{D}{MV(E)}$
BAA	2704	4565	4070	37%	40%	59%	66%
Aer Rianta	324	280	-	54%	-	116%	-

Table 5
Estimates of WACC for Aer Rianta

Parameter	Estimate	
Cost of equity		
Real risk-free rate	2.6%	
Equity risk premium	6.0%	
Asset beta	0.50	
Equity beta	0.93	
Real cost of equity	8.1%	
Cost of debt		
Real risk-free rate	2.6%	
Debt premium	1.1%	
Real cost of debt		3.7%
Gearing	50%	
Corporate tax rate	13.2%	
Post-tax WACC	5.7%	
Pre-tax WACC	6.6%	

See text for explanation of the derivation of each component of the WACC estimates.

APPENDIX VII TO CP8

IMG Benchmarking Report

Benchmarking Final Report

Commission for Aviation Regulation

Infrastructure
Management Group, Inc.

23 August 2001

Overview

This final report is divided into several sections to present results from the benchmarking analysis

1. Scope of Work
2. Methodology
3. Results: Dublin Peer Group
4. Results: Leading European Airports Peer Group
5. Results: Shannon/Cork Peer Group
6. Summary

Appendix A: Overview of Benchmark Airports

1. Scope of Work

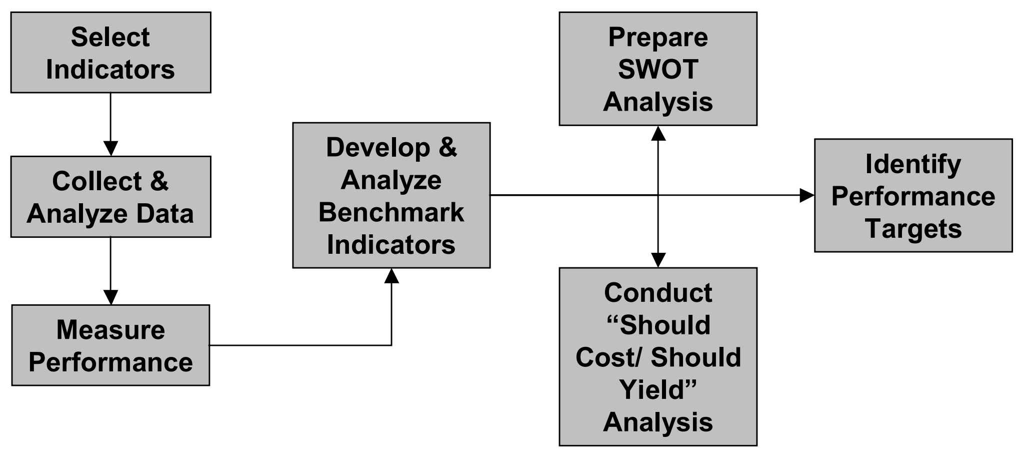
The benchmarking effort is intended to support overall analysis of the efficiency of Aer Rianta (ART) as part of the Commission on Aviation Regulation's (CAR) mandate

Purpose: to assess the efficiency of ART from an operational and financial standpoint

- The benchmarking effort analyzes performance of ART's three airports and that of benchmark partners
  - to determine efficiency of ART operations (cost and service efficiency)
  - to assess adequacy of funding amounts and revenue streams to support operations
- Review of benchmarking partners also provides an understanding of the regulatory context of other countries

1. Scope of Work

Infrastructure Management Group (IMG) and CAR completed the benchmarking analysis through a series of inter-related tasks



2. Methodology

IMG and CAR identified an initial list of airports for inclusion as comparator airports. Airports were then examined according to several criteria

- Volume of Services
  - Annual Passengers
  - Total Annual Cargo Moved
  - Workload Units
  - Aircraft Movements
  - Average Passengers per Aircraft
- Airport Characteristics
  - Total airport acres
  - Number of stands
  - Terminal Capacity
  - Level of service
    - international
    - O&D
  - CAPEX levels

2. Methodology

IMG and CAR considered results of the criteria examination to refine the list of potential airports with similarities to Irish airports

- It was recognized that airports would not provide direct comparability to Dublin, Shannon or Cork according to each criterion
- Criteria were considered in aggregate to focus the list of comparator airports
- The Dublin peer group list was refined from a potential group of 21 to 18 through several changes (e.g., dropped Berlin airport group)
- The Shannon/Cork peer group was narrowed from 30 to 16 target airports to focus on UK and select European airports (e.g., dropped Luxembourg, added Southampton and Leeds/Bradford)
- US airports were included in the Dublin peer group to test reasonableness of findings. They were not included in averages of results due to significant differences in operating environments

2. Methodology

IMG and CAR made direct efforts to obtain data from targeted airports; not all airports were cooperative

- IMG and CAR made numerous attempts via e-mail, fax, and telephone to obtain data from airports
- While some airports were cooperative, others did not provide data in time for consideration by the 26 August final determination deadline
- Airports were not randomly excluded; every effort was made to expand the base of airports. Any airport submitting data in a comparable format within the timeframe was considered in the peer analysis

Response by Airports Contacted

Peer Group	*Airports*		Response Rate
	Contacted	**Provided Data**	
Dublin	18	13	72.2%
Leading European	8	6	75.0%
Shannon/Cork	16	6	37.5%

The lower response rate by smaller airports is attributed to them having fewer staff to prepare response materials to our request and to their limited financial and operating information provided for public review on websites.

2. Methodology

Performance measures were identified and developed in consideration of the goals of the *Aviation Regulation Act*

- The identification of performance measures was intended to support the legislative basis for CAR's work
  - *"the cost competitiveness and operational efficiency of airport services at the airport with respect to international practice." -- Aviation Regulation Act, Section 33(h)*
- CAR and IMG initially identified over 45 performance indicators to consider in the benchmarking analysis
- Certain indicators could not be calculated due to lack of data provided by airports (e.g., ratio of average EPAX per peak hour compared to average EPAX per non-peak hour)
- CAR and IMG were able to calculate over 30 indicators in the benchmarking template model where data was available
- CAR and IMG worked together to narrow down indicators to those which focus on "cost competitiveness and operational efficiency"

2. Methodology

A total of 11 key performance indicators were selected to assess the results of the benchmarking

- Primary tier: indicators to support cost efficiency and revenue potential analysis
- Secondary tier: indicators to measure ongoing service efficiency and more detailed financial performance

Performance Indicator	Primary Tier	Secondary Tier
Service Efficiency		
Average Work Load Unit per Employee		X
Average Work Load Unit per Aircraft Movement		X
Cost Efficiency		
Operating Expense per Work Load Unit	X	
Maintenance Expense per Work Load Unit		X
Operating Expense per Employee	X	
Labor Expense per Employee	X	
Revenue Effectiveness		
Operating Revenue per Work Load Unit	X	
Aeronautical Revenue per Work Load Unit	X	
Percentage of Revenue from Non-Aeronautical Revenue Sources		X
Concession Revenue per Enplaned Passenger		X
Operating Income (Rev - Exp) per Work Load Unit	X	

2. Methodology

Each indicator serves a different purpose to assess the airport's overall performance

Performance Indicator	Purpose of Measure
Service Efficiency	
Average Work Load Unit per Employee	a common airport labor productivity measure that considers passenger throughput and cargo capacity
Average Work Load Unit per Aircraft Movement	a common airport productivity measure, which also reflects passenger load factors and aircraft size
Cost Efficiency	
Operating Expense per Work Load Unit	most common measure of airport cost-efficiency
Maintenance Expense per Work Load Unit	measures relative cost efficiency of maintaining the airport
Operating Expense per Employee	companion measure to expense per WLU; measures amount of leverage airports exert through staffing efficiency and innovations to direct operations
Labor Expense per Employee	measures relative labor cost efficiency for labor at the airport, considering overhead and benefits
Revenue Effectiveness	
Operating Revenue per Work Load Unit	measures effectiveness of airport's overall revenue structures
Aeronautical Revenue per Work Load Unit	measures effectiveness of airports direct revenues generated by airlines' use of all facilities (airside and terminal)
Percentage of Revenue from Non-Aeronautical Revenue Sources	measures degree of "commercializiation" of the airport; degree to which airport able to generate revenues from non-aeronautical sources
Concession Revenue per Enplaned Passenger	measure of relative effectiveness and profitability of airport's concessions
Operating Income (Rev - Exp) per Work Load Unit	measures overall profitability of the airport

2. Methodology

Definitions for components of indicators are explained below

- Work Load Unit: Total Passengers + (Total Metric Tonnes of Cargo*10)
  - Total Passengers reported in 1999 by Airports Council International (ACI)
  - Total Metric Tonnes reported in 1999 by ACI and includes mail + freight
- Employees: Total Full Time Equivalents (FTE)
  - FTEs reported at fiscal year end or as average for fiscal year in annual report
  - Number of FTEs corresponds to annual report definitions for operating expenses
- Aircraft Movements
  - Total aircraft movements reported by ACI in 1999
  - Reflects passenger, cargo, and general aviation traffic
- Operating Expenses
  - Operating expenses correspond to direct airport operations where available
  - Excludes depreciation costs in calculated ratios
- Labor Expenses
  - Labor expenses (including fringe benefits, pension) reported directly in annual reports
- Maintenance Expense
  - costs for maintenance (and supplies) in annual reports

2. Methodology

Definitions for components of indicators are explained below (con't)

- Operating Revenues
  - Total revenues for airports as reported in annual reports
- Aeronautical Revenues: total airline rentals and fees in annual reports
  - Airfield revenues (e.g., landing fees, parking, airbridge hires)
  - Terminal revenues (e.g., passenger loading fees)
  - Airfield rentals (e.g., cargo, hanger, maint. facility)
  - Terminal rentals (e.g., check-in desk, rents)
- Non-Aeronautical Revenues
  - All revenues excluding aeronautical revenue (generally commercial-type revenues)
- Concession Revenues
  - Includes concession revenues as reported in annual reports
  - Contains duty-free retail, non duty-free retail, and food and beverage revenues
  - Does not include catering, fuel, or other special services
- Operating Income
  - Indication of overall profitability
  - Calculated as Operating Revenues - Operating Expenses (excluding depr.)

2. Methodology

The Work Load Unit (WLU) was selected as the primary unit of measure for benchmarking indicators

- The WLU considers the slight impact that cargo can have on the efficiency of an airport
- The aviation industry accepts the WLU as a common form of measurement
- Data for the WLU is readily available and reported in a consistent format by airports to the Airports Council International (ACI)
- Other units of measure were also considered but discounted for various reasons
  - Data for the Air Transport Unit (ATU) is not readily available or publicly reported in a consistent manner
  - EPAX or total passengers isolate for effects of cargo, but provide similar rankings as the WLU basis

2. Methodology

The benchmarking effort is organized according to three distinct groups

- Dublin Peer Group
  - Airports close to size of Dublin
  - Also includes airports matching “what Dublin might be”
  - Range from 5 million passengers to 20 million passengers
- Shannon/Cork Peer Group
  - Smaller airports with similar operating requirements to Shannon/Cork
  - Airports under 5 million passengers
- Leading European Airports Group
  - Larger in scope than Dublin
  - Airports recognized for innovations in service
  - Useful comparison against “best in class”

2. Methodology

Key indicators were calculated to address operational and financial performance

- Operational Performance
  - Cost Efficiency
  - Labor Efficiency
  - Service Efficiency
- Financial Performance
  - Revenue Results
  - Profitability

2. Methodology

Data was examined and normalized for accurate comparison among benchmark partners

- Ensure numbers compared are consistent
  - Euro conversion rates coincide with timeframe of annual report data
  - Cost of living adjustments account for CPI differences among countries
  - FY 99 or FY00 annual report data conforms to calendar year 1999
- Examine factors influencing results of indicators
  - Careful review of operating environment
  - Consideration of unique operations (e.g., contracted services, cost variances)
- Identify strengths that may cause airports to have different results
- Adjust for different environments or unique enablers that impact performance
- Aggregate data to develop composite ratios
  - European and UK
  - UK only
  - US data presented as information, but not included in aggregate

3. Preliminary Results: Key Indicators

All results must be considered within the context of the capabilities and limitations of benchmarking

- The benchmarking analysis targeted calendar year 1999, the most recent year of consistent available data when the effort was started. Websites, ACI reports, and individual airport annual reports for FY99 or FY00 were analyzed as appropriate to obtain data corresponding most closely to CY99

- While annual reports contain fairly standard reporting data, some variances are expected among airports due to different accounting requirements. General conclusions and findings are to be considered in greater detail

- Even when differences in reported performance vary, one must consider individual airport priorities and objectives - higher or lower results do not automatically translate to better or worse - trade-offs and local conditions account for some performance differences

The remainder of the report presents the benchmarking results

3. Results: Dublin Peer Group

This section focuses on results from the Dublin peer group

- UK Airports
  - Birmingham (BHX)
  - Glasgow (GLA)
  - Manchester (MAN)
  - Stansted (STN)
- European Airports
  - Brussels (BRU)
  - Copenhagen (CPH)
  - Dusseldorf (DUS)
  - Munich (MUC)
  - Oslo (OSL)
  - Vienna (VIE)
- US Airports
  - Baltimore/Washington (BWI)
  - Ft. Lauderdale (FLL)
  - Honolulu (HNL)

Data on US airports is presented for reference only; it is not included in peer averages

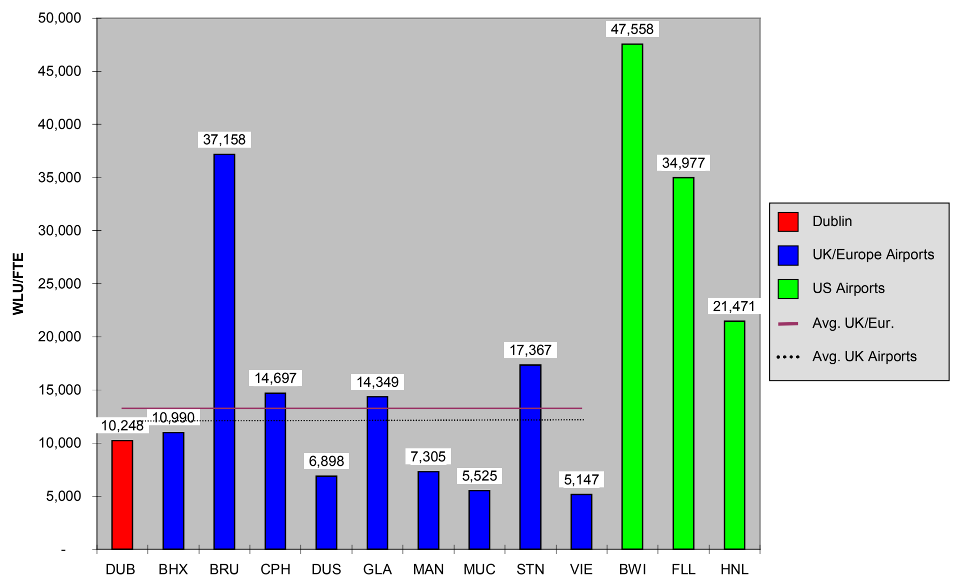
3. Results: Dublin Peer Group

Dublin's *service efficiency* is slightly lower than peers, with the airport processing fewer *work load units per employee*

Dublin: 10,248
UK Avg: 12,502
Eur/UK Avg: 13,270

- Strong performers have highly outsourced staff
- Vienna and Munich both provide numerous services in-house through subsidiary companies
- US airports outsource functions provided directly by European airports

Average WLU per Employee

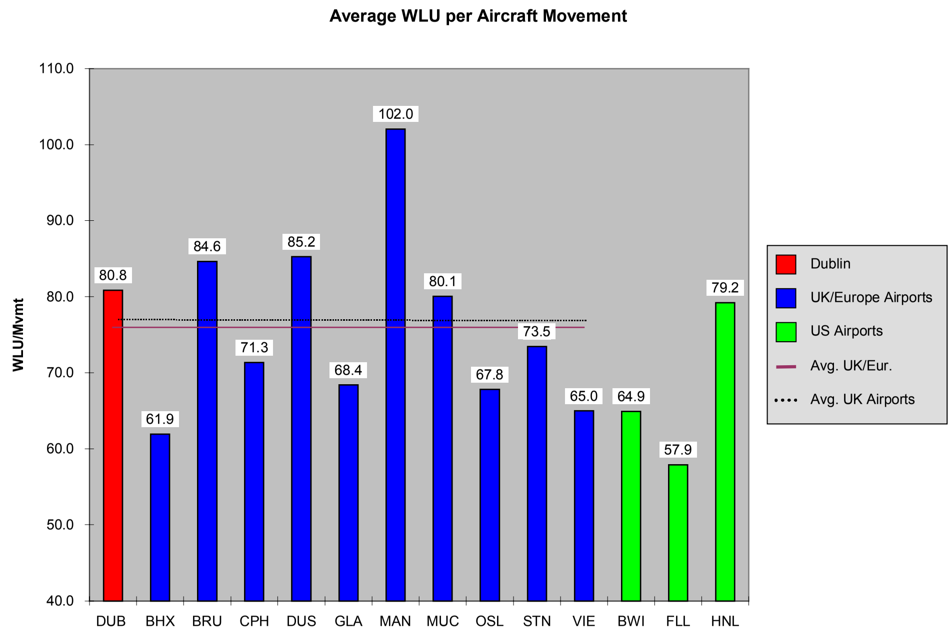


3. Results: Dublin Peer Group

Dublin's *average work load unit per movement* is in the top tier, reflecting the growth of long-haul services with wide-body aircraft

Dublin: 80.8
UK Avg: 76.5
Eur/UK Avg: 76.0

- Dublin's growth in long-haul passenger services is reflected in this analysis
- Significant levels of long-haul service place unique demands on airports (e.g., baggage delivery)
- High levels of connecting service at other airports provide different demands (e.g., baggage transfer at CPH)



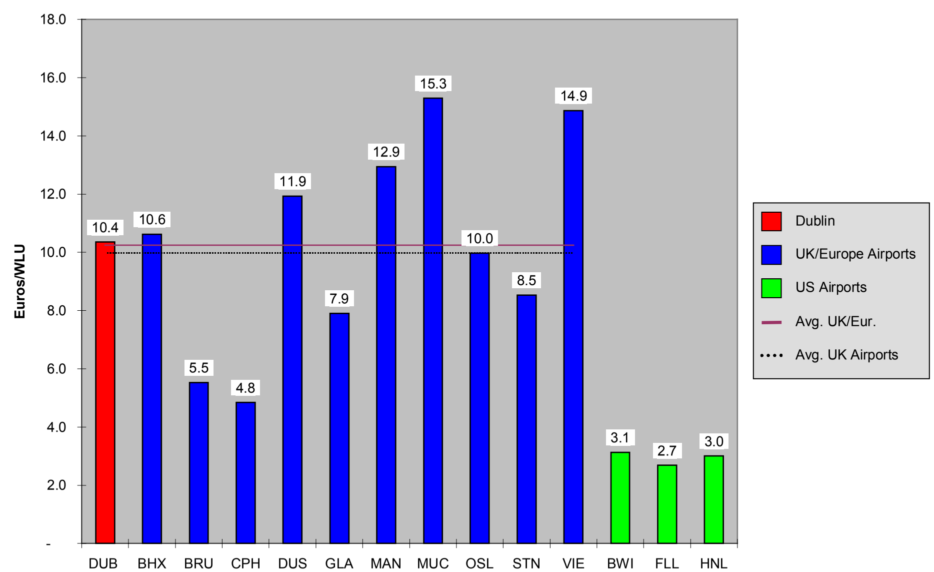
3. Results: Dublin Peer Group

Dublin's *cost efficiency expressed in operating expenses per WLU* (less depreciation) is in-line with peers; some peers are better

Dublin: 10.4 euros
UK Avg: 10.0 euros
Eur/UK Avg: 10.3 euros

- Dublin is close to the peer averages for UK and European airports
- However, Dublin's cost per WLU is 29% higher than the average of the best of peers (e.g., BRU, CPH, GLA, OSL, STN)
- When OSL is excluded from the best of peers (its performance is actually close to Dublin), the gap reaches 35%

Operating Expense per WLU

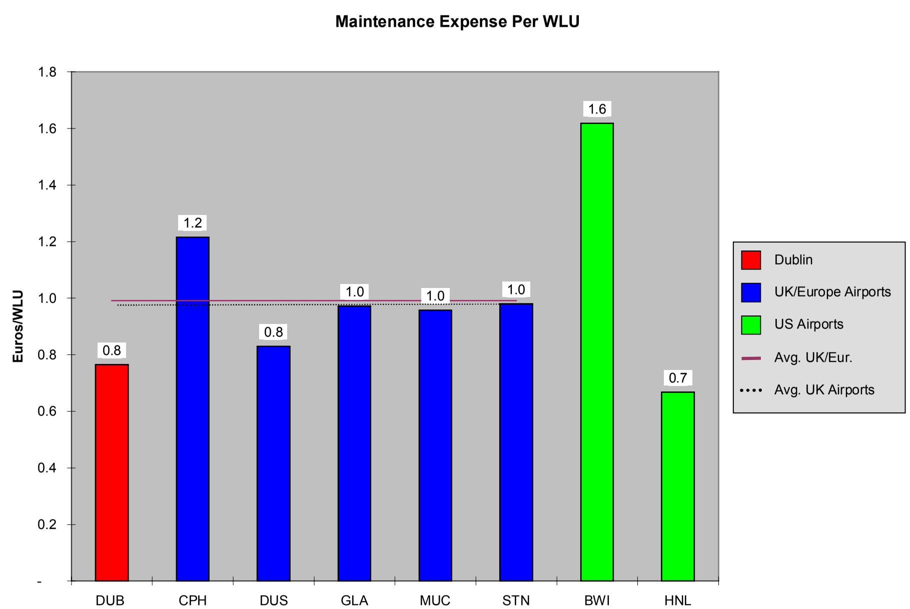


3. Results: Dublin Peer Group

Dublin's *maintenance cost per WLU* is below that of all peers (where data is available)

Dublin: 0.8 euros
UK Avg: 1.0 euros
Eur/UK Avg: 1.0 euros

- New airports tend to have lower maintenance costs on a per unit basis
- CPH only opened its new terminal midpoint through 99, with the balance of the year accounting for an older terminal operation

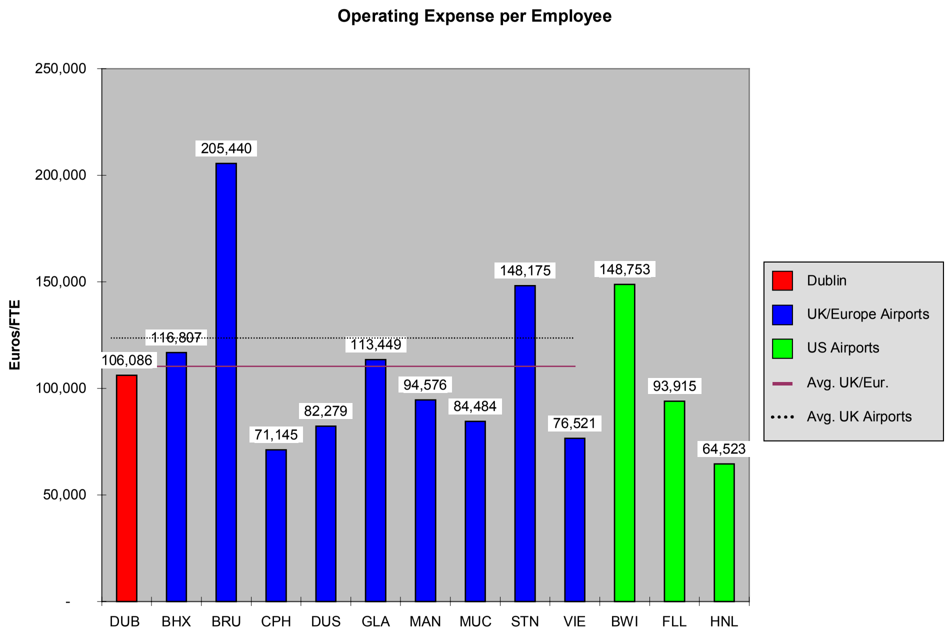


3. Results: Dublin Peer Group

Dublin's *operating expense per employee* (less depreciation) is below that of peers, but behind the most efficient airports

Dublin: 106,086 euros
UK Avg: 118,251 euros
Eur/UK Avg: 110,319 euros

- Dublin performs well against UK and European peers as a whole
- However, Dublin's cost per employee is about 30% higher than the average of the best of the peers (CPH, DUS, MAN, MUC and VIE)
- This comparison indicates the potential for DUB to improve cost efficiency per employee

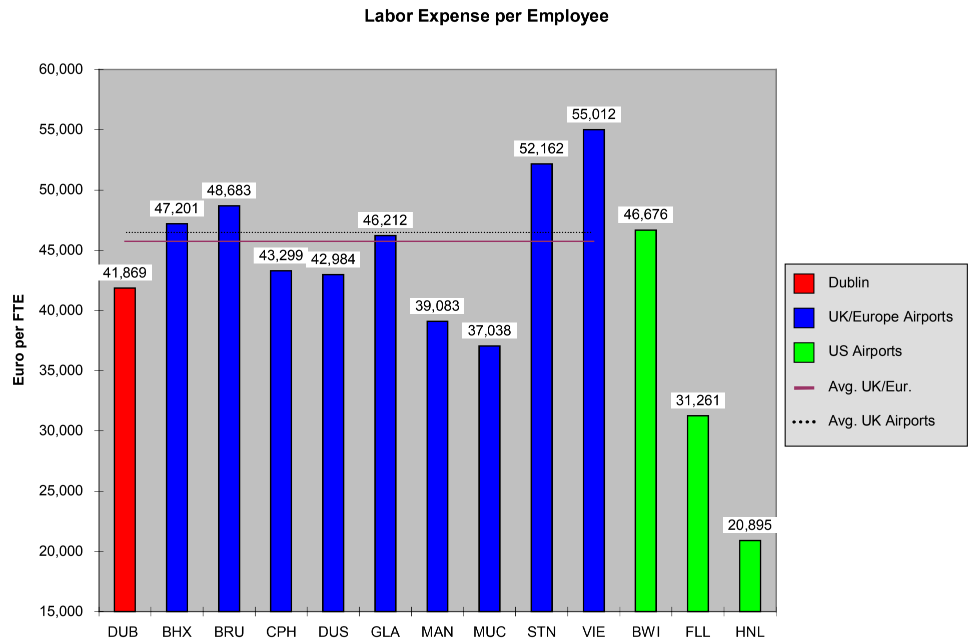


3. Results: Dublin Peer Group

Dublin's *labor cost per employee* is slightly below peers, but within the standard deviation for UK and UK/European airports

Dublin:	41,869 euros
UK Avg:	46,164 euros
Eur/UK Avg:	45,742 euros

- MAN and CPH, both strong performers, have high levels of outsourcing
- MUC isolates labor costs through subsidiary companies, which do not hit the labor expense line items in annual reports

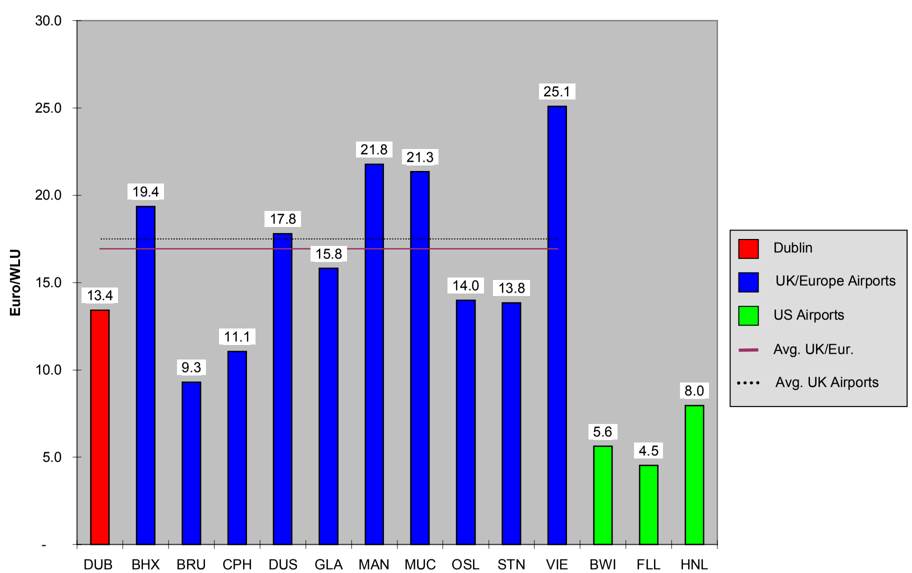


3. Results: Dublin Peer Group

Dublin's *operating revenue per WLU* is lower than all but two peers

Dublin: 13.4 euros
UK Avg: 17.7 euros
Eur/UK Avg: 16.9 euros

- UK airports generally perform better than European airports in this category
- Both peers with lower revenue per WLU than DUB are in Europe (BRU and CPH)
- CPH raised rates 28% from 1999 to 2001 to improve revenue performance

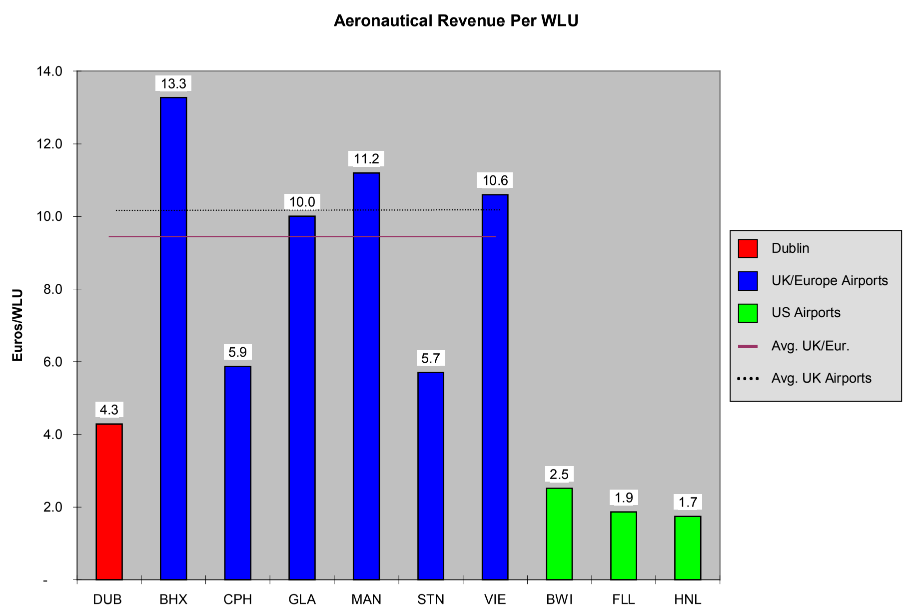


3. Results: Dublin Peer Group

Dublin's *aeronautical revenue per WLU* is the lowest among peers

Dublin: 4.3 euros
UK Avg: 10.1 euros
Eur/UK Avg: 9.4 euros

- Dublin's aeronautical revenue per WLU is lower than all peers
- Aeronautical revenue per WLU at select UK airports is almost double that of Dublin
- US airports have different revenue structures and regulatory structure, placing them outside the norm in this measure



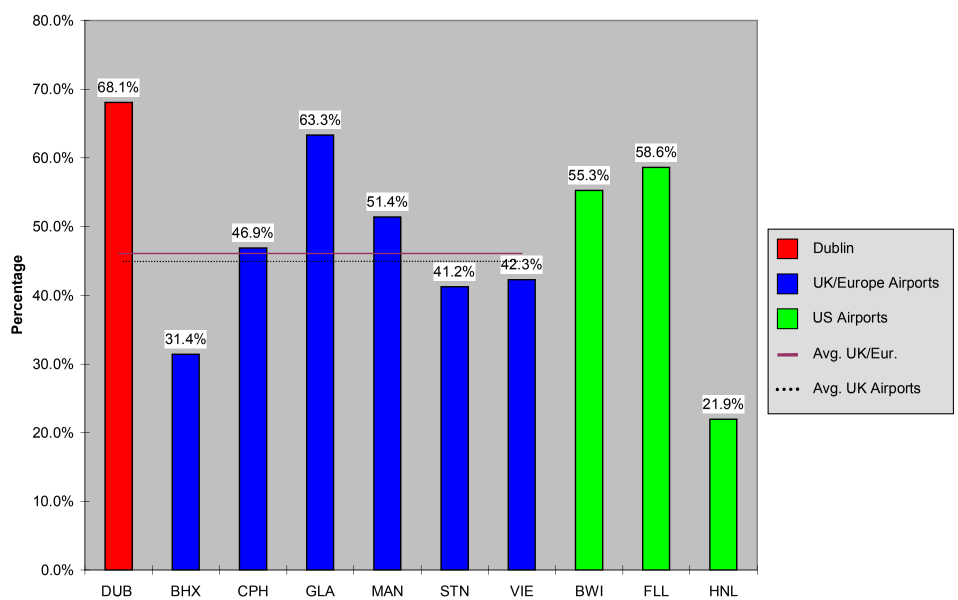
3. Results: Dublin Peer Group

Dublin relies much more on revenue from *non-aeronautical revenue* sources than other peers

Dublin: 68.1%
UK Avg: 46.0%
Eur/UK Avg: 47.2%

- Dublin leads the peers in terms of its reliance on non-aeronautical revenue sources
- On average, most airports attempt to strike a balance between reliance on aeronautical and non-aeronautical revenue sources

Percentage of Revenue from Non-Aeronautical Sources

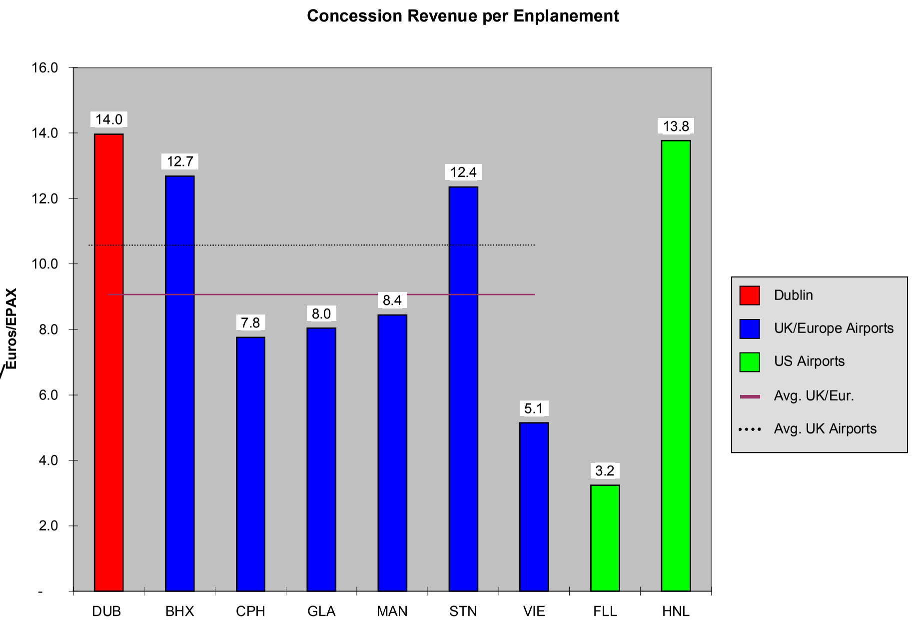


3. Results: Dublin Peer Group

Dublin is a leader among peers in the level of *concession revenue per enplaned passenger*

Dublin: 14.0 euros
UK Avg: 10.4 euros
Eur/UK Avg: 9.1 euros

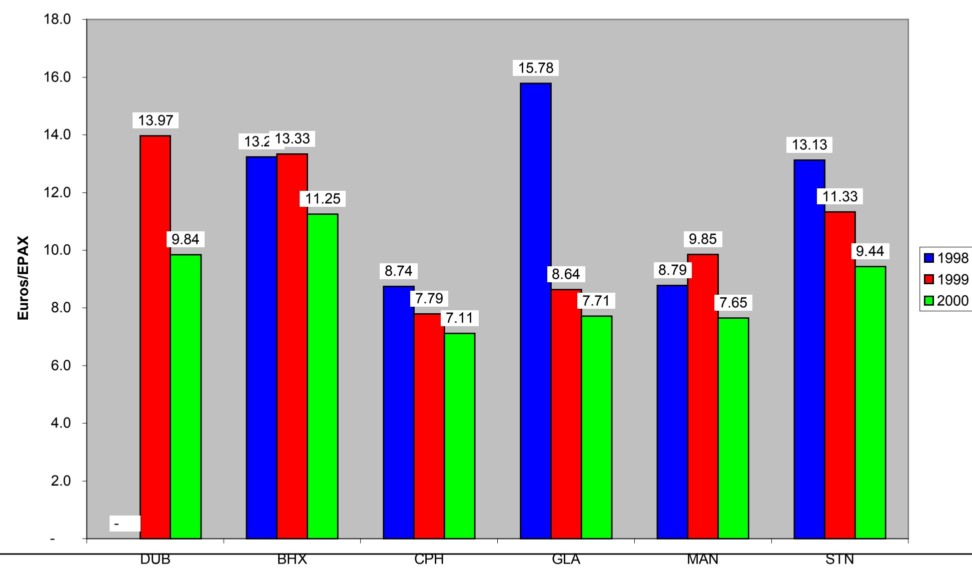
- DUB is strong in this performance indicator, ahead of all UK airports
- UK airports perform better than European airports in this category



3. Results: Dublin Peer Group

Peer airports reported a drop in *concession revenue per enplaned passenger* in 1999 due to changes in EU requirements

TREND ANALYSIS:
Average Concession Revenue Per Enplaned Passenger

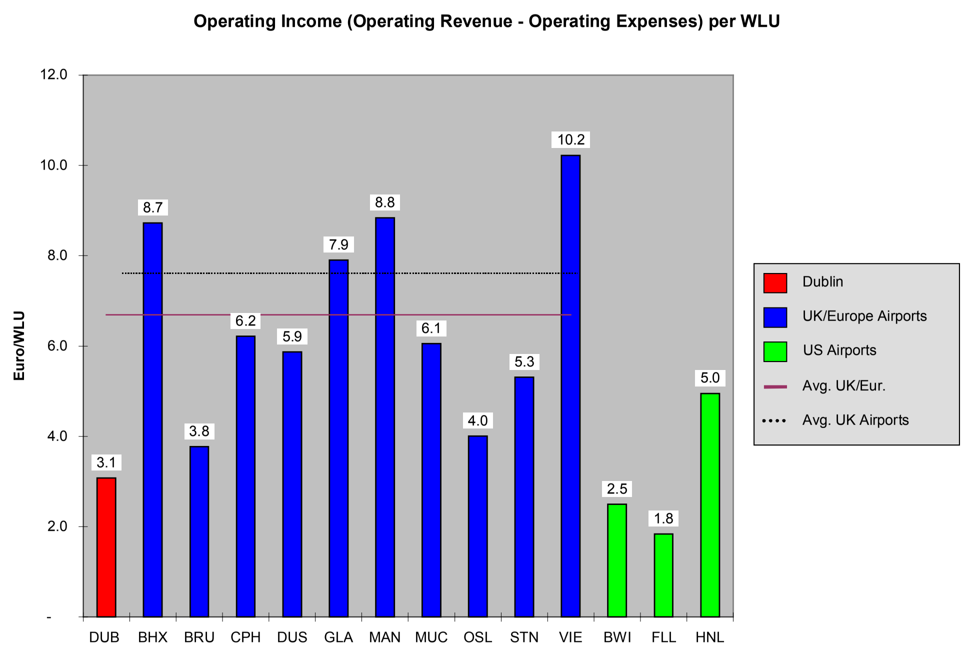


3. Results: Dublin Peer Group

Dublin is lowest among peers in terms of *operating income per WLU*

Dublin: 3.1 euros
UK Avg: 7.7 euros
Eur/UK Avg: 6.7 euros

- This measurement reflects profitability, taking into account operating revenues less operating expenses
- UK airports generally perform quite well in this category
- Two of the lowest performers, BRU and OSL, both opened new facilities in 99



4. Results: Leading European Airports Group

Results for the Leading European peer group focus on airports in the UK and on the continent

- London Heathrow (LHR)
- London Gatwick (LGW)
- Frankfurt (FRA)
- Paris (CDG and ORY)
- Rome (FCO)

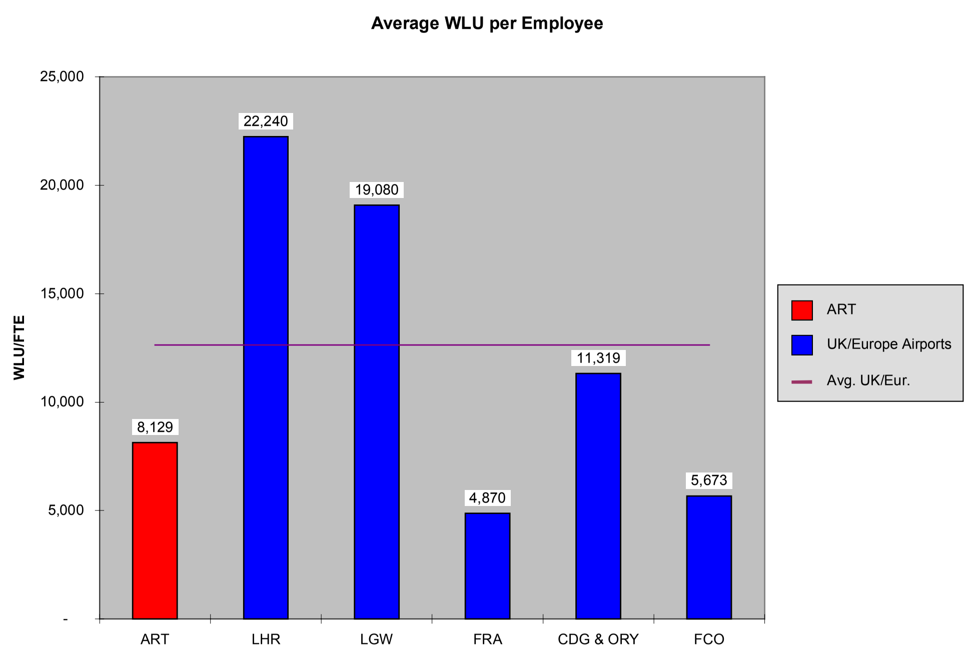
Note that Leading European peer group results are compared against a combined ART performance for Dublin, Shannon and Cork airports (excluding ART hotel and other categories)

4. Results: Leading European Airports Group

ART's *service efficiency* expressed in *average WLU per employee* is lower than the average of European airports

ART: 8,129
Eur/UK Avg: 12,636

- ART's airports handle much smaller aircraft, on average, than the leading airports in Europe
- Larger European airports gain in efficiency through economies of scale and the sheer volume of their operations

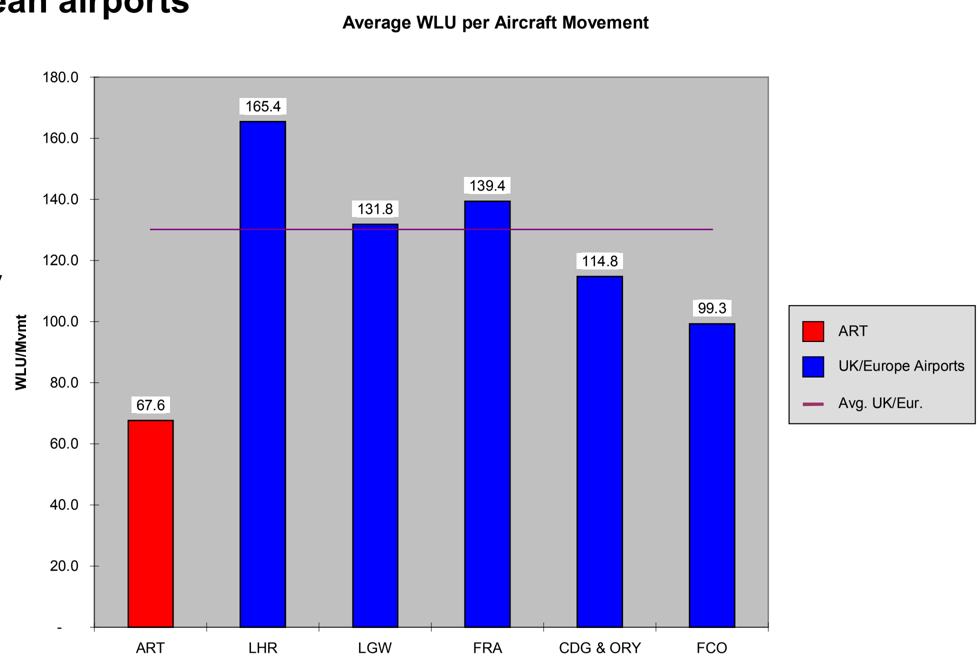


4. Results: Leading European Airports Group

ART's *average WLU per aircraft movement* is lower than the leading European airports

ART: 67.6
Eur/UK Avg: 130.2

- Larger European airports handle a more significant volume of wide-body aircraft (777, 747, A340) through services across the Atlantic and to Asia
- ART's average is skewed slightly by adding Cork and Shannon. Dublin's average alone (80.9 WLU per aircraft movement) is still below the peers

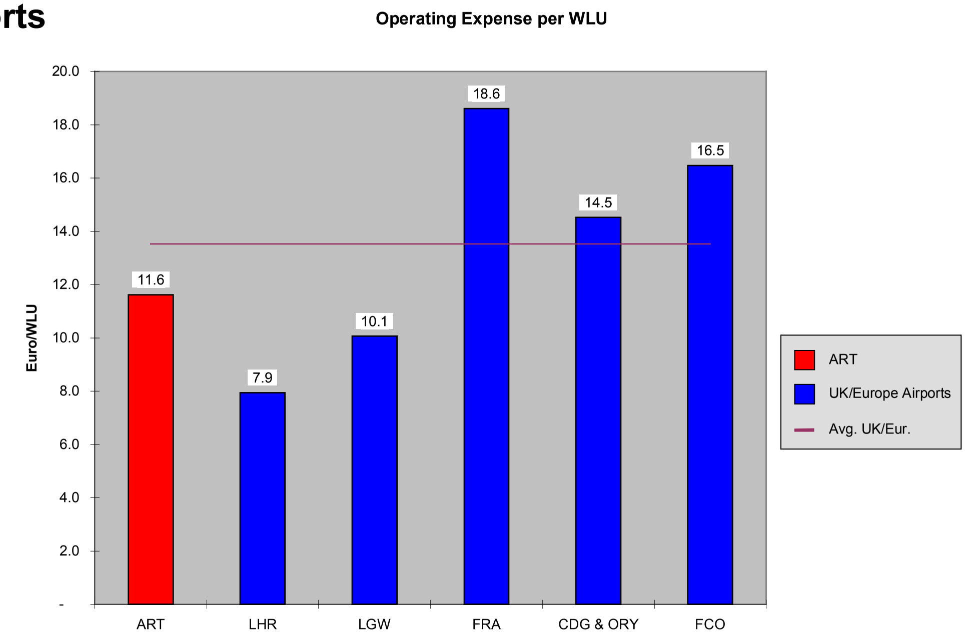


4. Results: Leading European Airports Group

ART is more *cost efficient in terms of operating expense per WLU* (less depreciation) than larger European airports, but less so than the larger UK airports

ART: 11.6 euros
Eur/UK Avg: 13.5 euros

- ART's operating expense per WLU is 42% lower than the average of FRA, Paris, and Rome
- ART's operating expense per WLU is 23% higher than the average of the larger UK airports



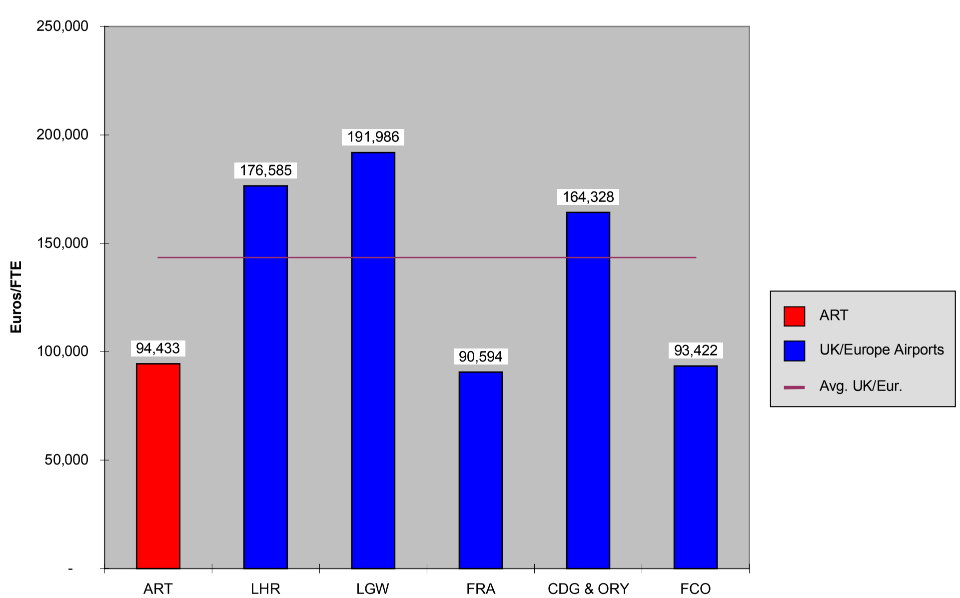
4. Results: Leading European Airports Group

ART's *operating expense per employee* is below that of larger European airports

ART: 94,433 euros
Eur/UK Avg: 143,383 euros

- Operating expense per employee is close to that of FRA and FCO
- UK airports have a much higher operating expense per employee

Operating Expense per Employee



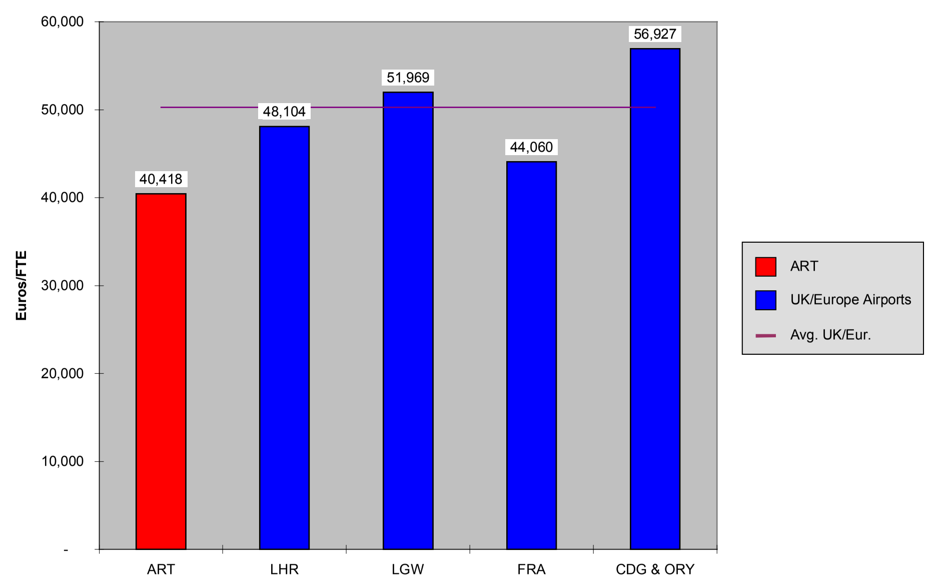
4. Results: Leading European Airports Group

ART's *labor cost per employee* is lower than all the larger European airports

ART: 40,418 euros
Eur/UK Avg: 50,264 euros

- ART's labor cost per employee is about 20% lower than that of the larger European airports
- There is about a 10 percent standard deviation from the mean for labor costs

Labor Expense per Employee

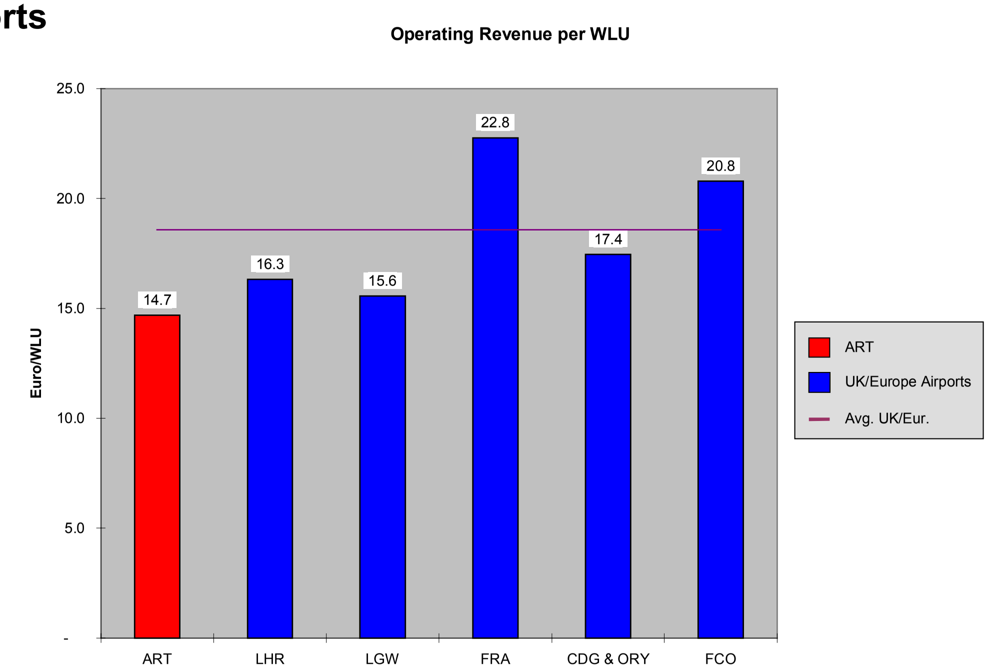


4. Results: Leading European Airports Group

ART's *operating revenue per WLU* is also lower than all the larger European airports

ART: 14.7 euros
Eur/UK Avg: 18.6 euros

- ART's operating revenue per WLU is about 33% lower than the average of larger European airports
- FRA, the highest cost airport, also has the highest revenue per WLU

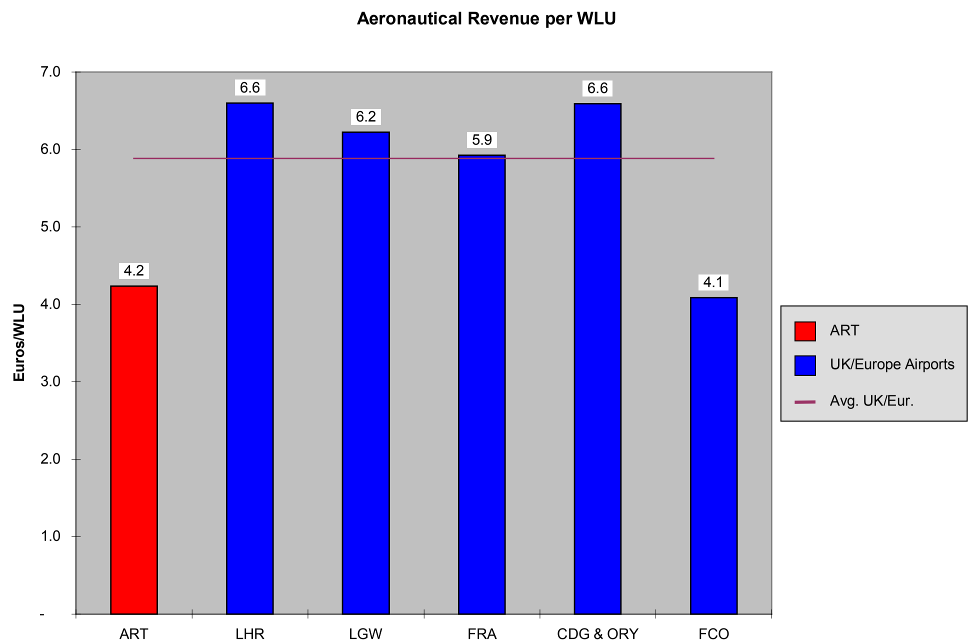


4. Results: Leading European Airports Group

Larger European airports tend to have have a higher ratio of *aeronautical revenue per work load unit*

ART: 4.2 euros
Eur/UK Avg: 5.8 euros

- All airports discussed here operate under regulatory requirements in their respective countries
- Rome (FCO) is the only peer with a lower rate of aeronautical income per WLU than ART

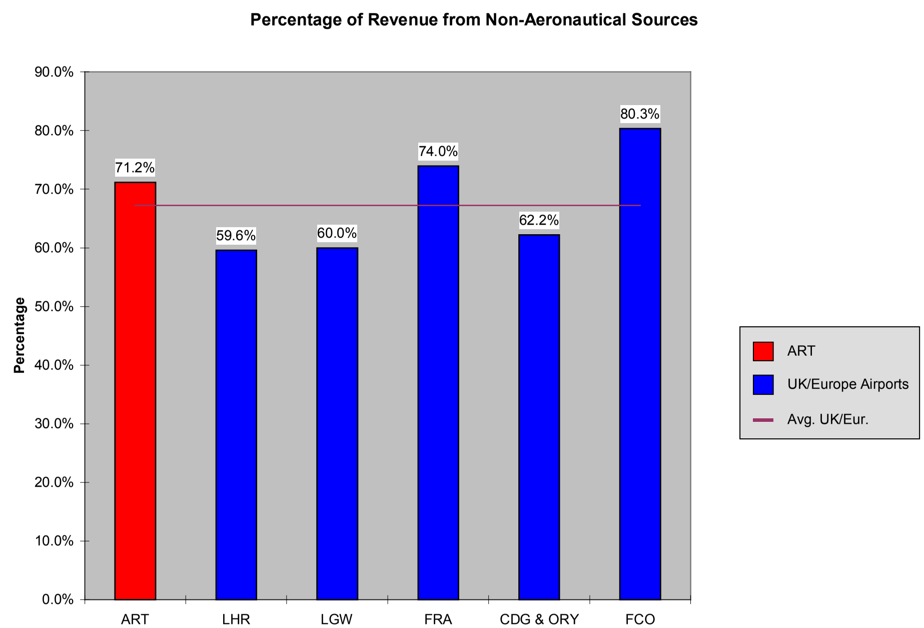


4. Results: Leading European Airports Group

ART's reliance on revenue from *non-aeronautical sources* is higher than the average of European peers

ART: 71.2%
Eur/UK Avg: 67.0%

- ART's reliance on non-aeronautical sources for revenue is higher than all but FRA and Rome (FCO)

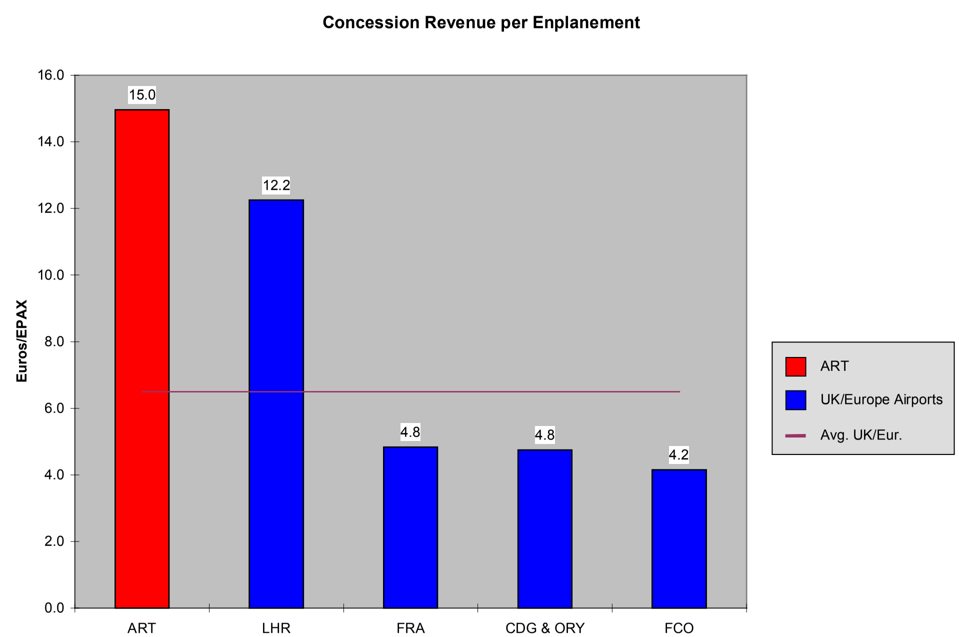


4. Results: Leading European Airports Group

ART performs well against larger peers in terms of *concession revenue per enplaned passenger*

ART: 15.0 euros
Eur/UK Avg: 6.5 euros

- ART performs above peers in concession per enplanement, even as compared to London Heathrow
- ART's results are triple those of FRA, Paris, and Rome
- Note that results are from 1999, before the full impact of duty-free changes were considered



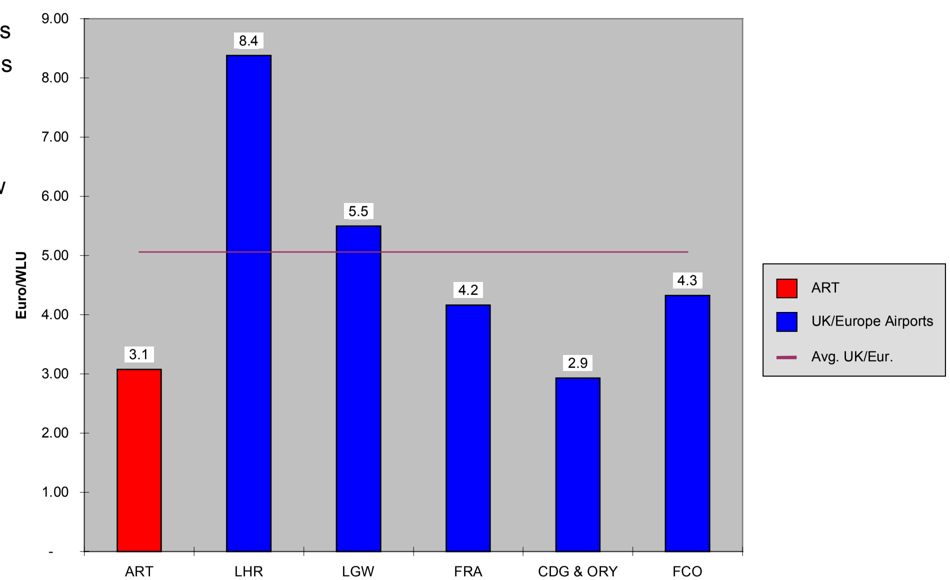
4. Results: Leading European Airports Group

ART's *operating income* per WLU is below the average of European peers

ART: 3.1 euros
Eur/UK Avg: 5.1 euros

- ART's profitability (revenue less expenses) is below that of all peers except Paris

Operating Income (Operating Revenue - Operating Expenses) per WLU



5. Results: Shannon/Cork Airports Group

Results for the Shannon/Cork Peer Group include regional airports in the UK

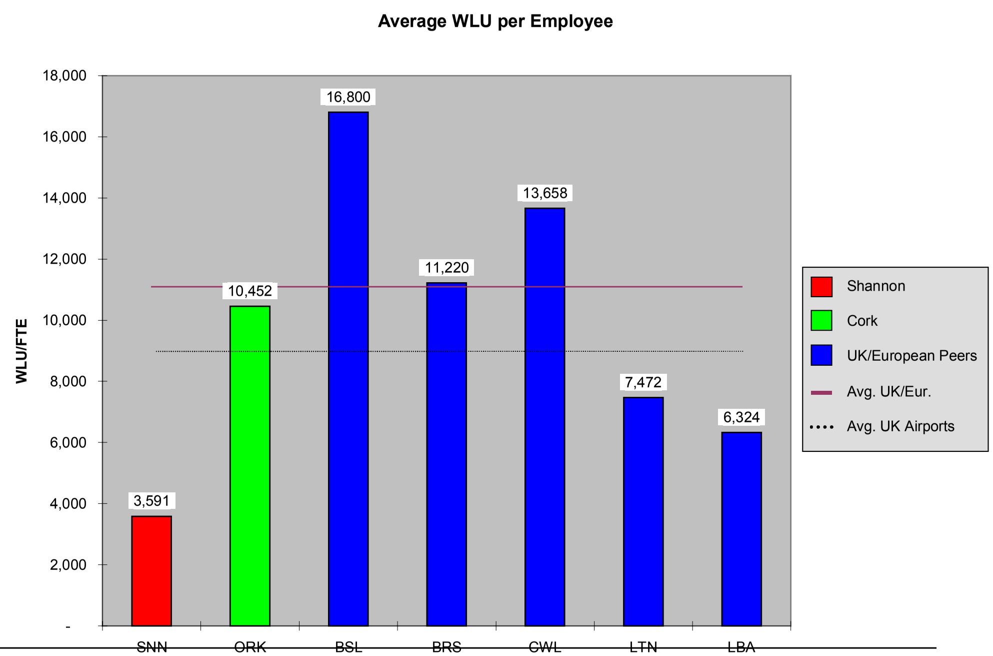
- Basel (BSL)
- Bristol (BRS)
- Cardiff (CWL)
- London Luton (LTN)
- Southampton (SOU)
- Leeds Bradford (LBA)

5. Results: Shannon/Cork Airports Group

Shannon's *service efficiency* in terms of *work load units per employee* is far below peers; Cork is above peers

Cork:	10,452
Shannon:	3,591
UK Avg:	9,669
Peer Avg:	11,095

- Cork moves almost 15% more work load units per employee than the average of UK peers
- Shannon's service efficiency is the lowest of peers and stands significantly outside the standard deviation for the group

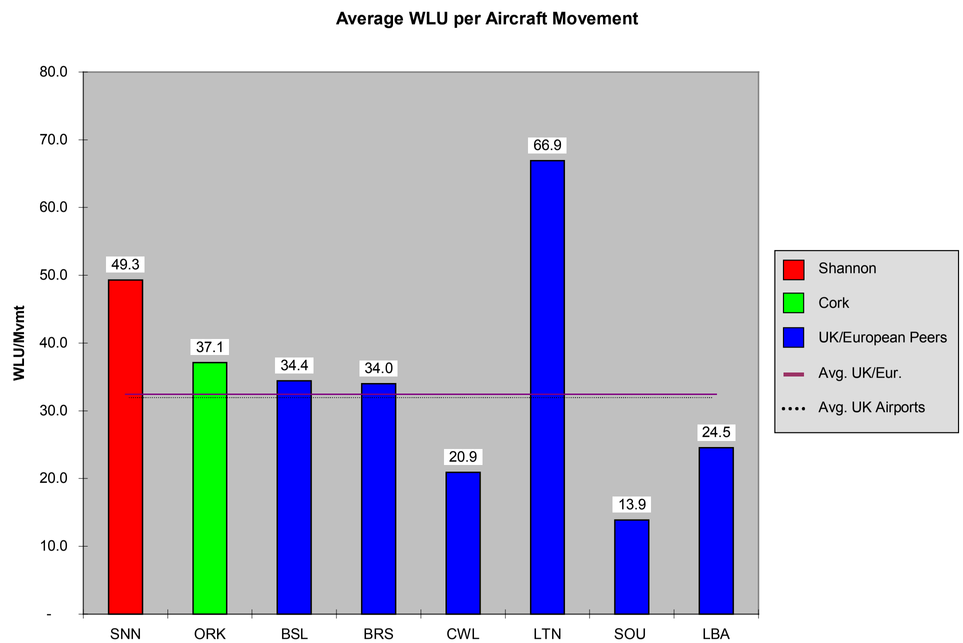


5. Results: Shannon/Cork Airports Group

Cork and Shannon both carry more *work load units per aircraft movement* than the average of peers

Cork:	37.1
Shannon:	49.3
UK Avg:	32.1
Peer Avg:	32.4

- On average, Cork and Shannon handle larger capacity aircraft than peers (except Luton)
- Luton has a fairly high volume of passengers and cargo (about 5M), reflecting its service to a larger, urban area

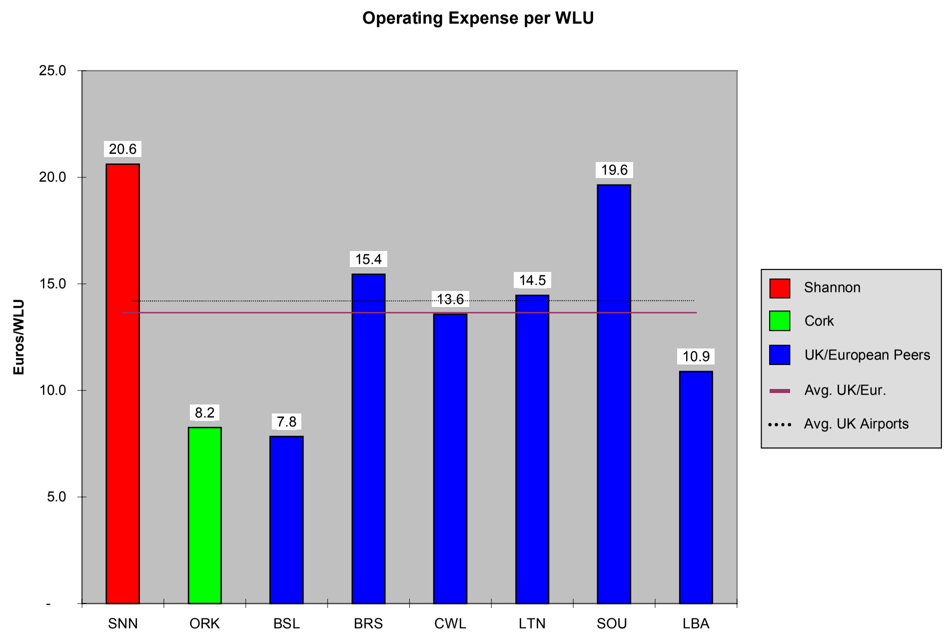


5. Results: Shannon/Cork Airports Group

Cork is more *cost efficient* than peers; Shannon is much less cost efficient that peers (in terms of *operating expense per WLU*)

Cork:	8.2 euros
Shannon:	20.6 euros
UK Avg:	14.8 euros
Peer Avg:	13.6 euros

- Cork is about 44% more cost efficient (in terms of operating cost less depreciation per WLU) than UK peers
- Shannon's cost per WLU is double that of three of the peers (ORK, BSL, LBA)

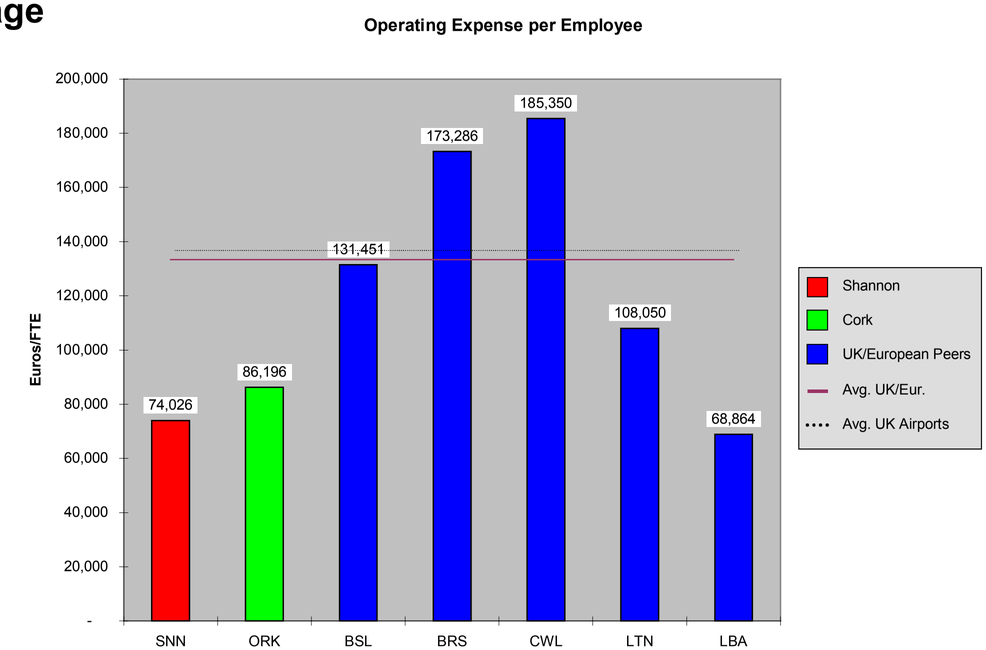


5. Results: Shannon/Cork Airports Group

Operating expense per employee for both Shannon and Cork falls below the average

Cork: 86,195 euros
Shannon: 74,026 euros
UK Avg 133,888 euros
Peer Avg: 133,400 euros

- Shannon has significantly more employees (706 employees) than peers (double the average of 307 employees), driving cost per employee down
- LBA's cost per employee is lower than both Shannon and Cork, reflecting its flexibility to apply staff to different functions

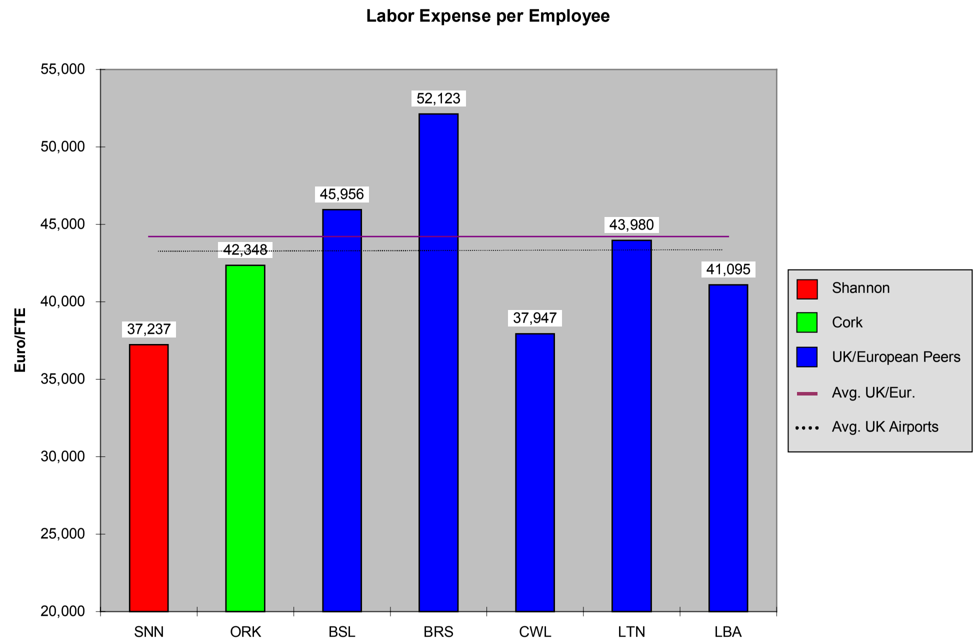


5. Results: Shannon/Cork Airports Group

Shannon's *labor cost per employee* is below the average of peers; Cork is somewhat above the average

Cork:	42,348 euros
Shannon:	37,237 euros
UK Avg:	43,786 euros
Peer Avg:	44,220 euros

- When considered in context of overall cost efficiency, SNN's non-labor costs are quite high
- Cork's labor costs are only slightly lower than that of peers, which is surprising given Cork's smaller size of operations
- Note that labor costs for outsourced services (e.g. Basel and Cardiff) are not included in this audited item

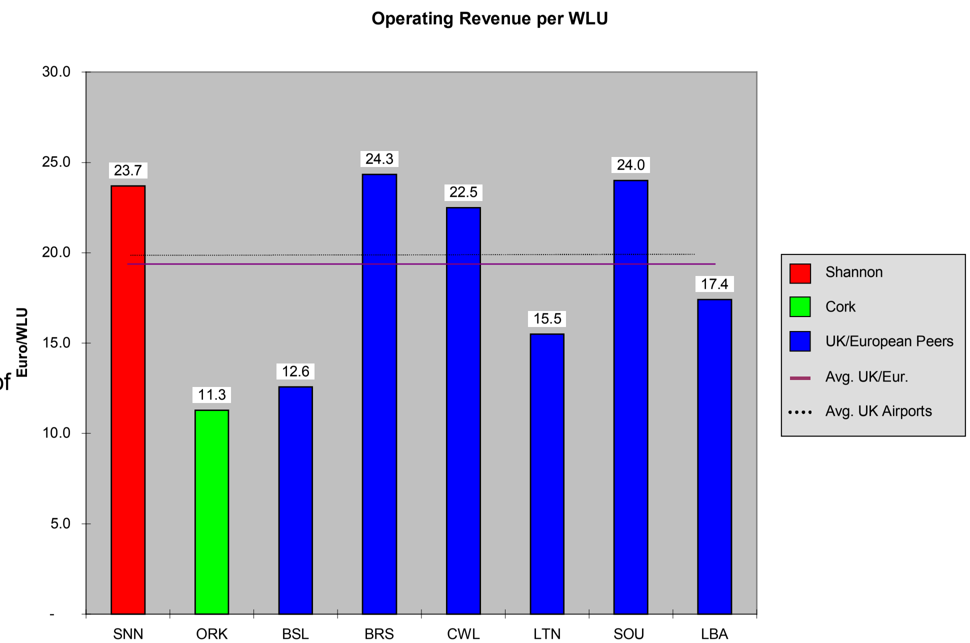


5. Results: Shannon/Cork Airports Group

Shannon's *operating revenue per WLU* is the highest among the peers; Cork's performance is the lowest among peers

Cork:	11.3 euros
Shannon:	23.7 euros
UK Avg:	20.7 euros
Peer Avg:	19.4 euros

- Shannon's operating revenue per WLU is 45% higher than UK peers
- Cork's revenue yield is about 46% below that of UK peers

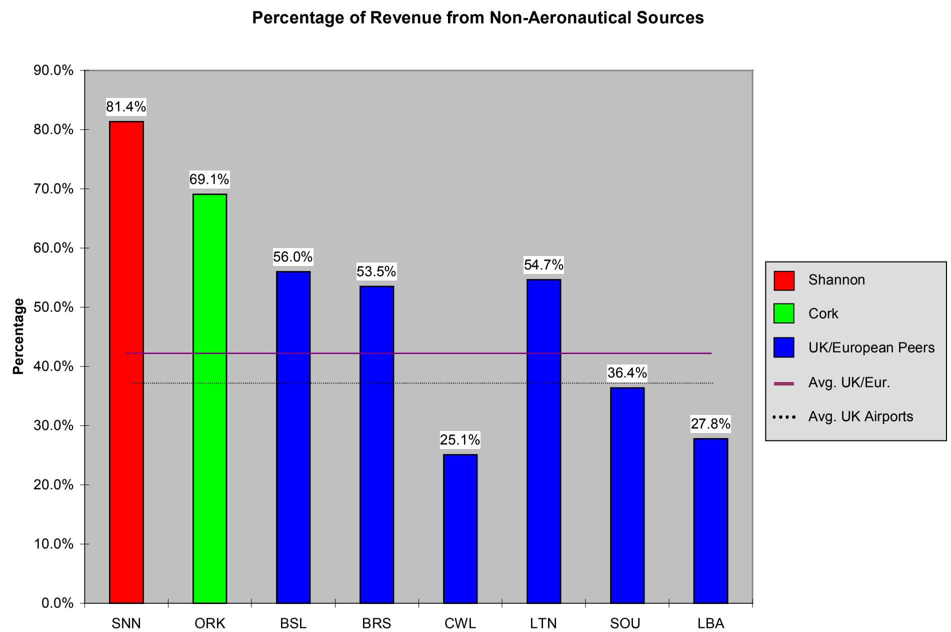


5. Results: Shannon/Cork Airports Group

Both Shannon and Cork receive a significantly *higher percentage of revenue from non-aeronautical sources*

Cork:	69.1%
Shannon:	81.4%
UK Avg:	39.5%
Peer Avg:	42.0%

- Only the largest of the UK peers (LTN) receive more than 50% of revenues from non-aeronautical sources
- Significant reliance on non-aeronautical sources places an airport at greater risk for potential decreases in concession revenues

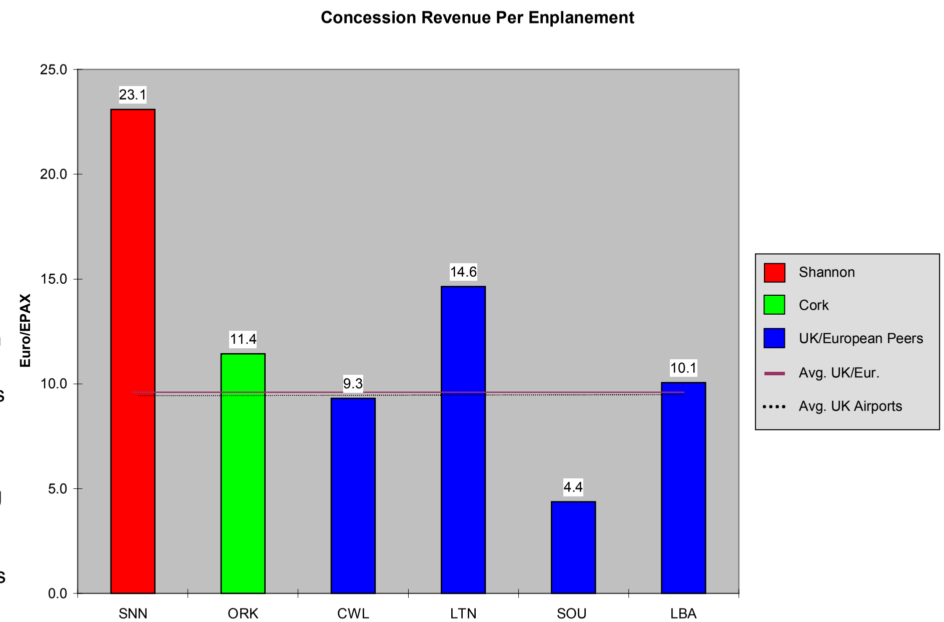


5. Results: Shannon/Cork Airports Group

Shannon's *concession revenue per enplaned passenger* is the highest among all peers (Dublin and Leading European included)

Cork:	11.4 euros
Shannon:	23.1 euros
UK Avg:	9.6 euros
Peer Avg:	9.6 euros

- Shannon demonstrates strong performance in reported concession revenue per enplaned passenger, even above the Dublin and European peer groups
- Shannon's results for this indicator reflect the high level of transit passengers, many of whom shop while waiting at the airport
- Cork's concession revenue per passenger is more in-line with peers



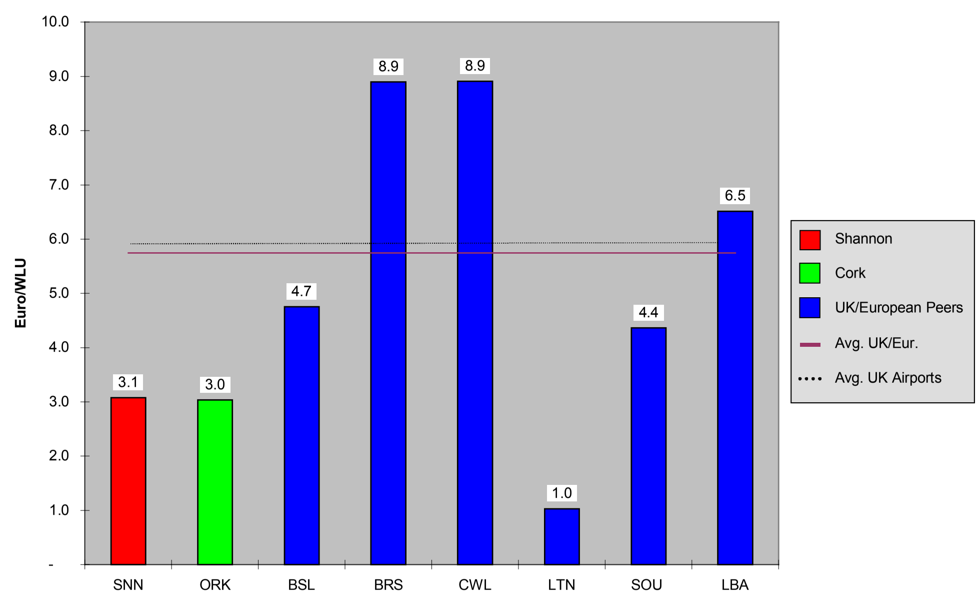
5. Results: Shannon/Cork Airports Group

Operating income per WLU for both Shannon and Cork are below the peer average

Cork:	3.0	euros
Shannon:	3.1	euros
UK Avg:	5.9	euros
Peer Avg:	5.8	euros

- Profitability for both Shannon and Cork is below the peer average and all but one peer (LTN)

Operating Income (Operating Revenue - Operating Expenses) per WLU



6. Summary

This report presents detailed findings from the benchmarking task

- This report explains data from rigorous analysis of annual reports and other information obtained from benchmark partners
- Data has been examined for consistency and to incorporate additional materials obtained from site visits at five airports
  - Manchester
  - Copenhagen
  - Leeds-Bradford
  - London Luton
  - Cardiff
- Results from the benchmarking effort are applied to concurrent tasks
  - Operational Efficiency/Financial Model
  - CAPEX
- The following summary of strengths, weaknesses, opportunities, and threats identified through the benchmarking provides context for the results

6. Summary: Strengths & Weaknesses

Aer Rianta's three airports demonstrate strengths which can be leveraged to improve performance and overcome weaknesses

- Strengths focus on Aer Rianta's ability to leverage concession revenue and the growth in transatlantic traffic at Dublin
  - All three airports have a high level of concession revenue per WLU compared to peers
    - Dublin's concession revenue per EPAX is ahead of all UK/European airports (three times the level of large airports such as Paris, Rome, and Frankfurt)
    - Shannon concession revenue per EPAX is the highest among all peers (including Dublin and Leading European airport peers)
  - Dublin demonstrates a high level of WLU per aircraft movement, reflecting growth in long-haul flights
- Weaknesses highlight the potential to diversify revenue sources and enhance productivity
  - While strong performance in terms of concession revenue per EPAX is a strength, over-reliance on concession revenue can be a weakness. High reliance on concession revenue (68% of total revenues at Dublin; 81% of total revenues at Shannon) can limit flexibility to respond to changing market conditions
  - Overall services efficiency (in terms of average WLU per employee) is below the peer average at Dublin. Shannon is significantly below peers, indicating the need to improve employee productivity

6. Summary: Opportunities & Threats

Opportunities and threats highlight further challenges for Aer Rianta to improve performance

- Opportunities focus on Aer Rianta's chance to improve cost efficiency as compared to the best of peers
  - Dublin's operating expense per WLU is about 29% higher than the best of peers. Aer Rianta can work to close this gap to maximize performance, reduce costs, and enhance profitability
  - Shannon's operating expense per WLU is almost double that of peers, and even twice the level of Dublin. This gap in performance indicates there are opportunities to deliver services in a more cost effective manner at Shannon
- Threats focus on effectiveness of revenue sources, which generally perform at a lower level than that of peers
  - Operating revenue per WLU at Dublin is lower than all but two peers. Cork's operating revenue per WLU is also low among peers (Shannon actually performs well in this measure, with an operating revenue ratio above most larger airports)
  - Aeronautical revenue for Dublin is also below peer average, indicating opportunities for improvement in this measure
  - Operating income per WLU is the lowest among peers for Dublin, Shannon, and Cork

6. Summary

Findings from the benchmarking analysis should be considered within the context of the CAR mandate

- Benchmarking is not an exact science. Results are intended to identify opportunities for improvement in financial and operational performance
- Findings from this analysis should be considered within the methodology, which was developed in strong consideration of CAR's mandate
- As with any benchmarking exercise, differences among target airports and benchmark comparators should be considered when comparing one airport directly to another airport
- Consideration also should be given to where an airport stands against the average of its peer group or against the average of best of peers
- Benchmarking results are intended to identify strengths upon which to continue growth and gaps where performance can be improved

Appendix A:

Overview of Benchmark Airports

APPENDIX A:

OVERVIEW OF SELECT BENCHMARK AIRPORTS

Dublin Peer Group

Leading European Airports Peer Group

Shannon/Cork Peer Group

Dublin Peer Group

Baltimore/Washington (BWI), United States

The Baltimore-Washington International Airport is operated by the Maryland Aviation Administration (MAA), part of the Maryland Department of Transportation. The airport serves the greater Washington and Baltimore areas. It is a major hub to two low-cost carriers: Southwest and Metrojet.

Market Growth

In 1999 passenger traffic at BWI had a 16.2% increase compared to 1998 with a total of 17,437,663 domestic and international passengers. The total Mail handling at BWI had a - 8.3% decrease compared to 1998 with a total of 40,966 metric tons. The total freight handled had a decrease of –3.5% with a total of 184,187 metric tons.

Business Operations

BWI fosters significant employment opportunities within the region. Total employment generated as a result of BWI has had a major change with a total increase of 26,202 employees from 1989 to 1998. The total revenues have also increased from $2.6 billion dollars in 1989 to $5.3 billion dollars in 1998.

Capital Program

BWI recently initiated a major capital expansion program. The airport plans to spend a total of $98 million dollars in FY 2000 and $112 million dollars in FY 2001. These spending will go to continue capital projects such as:

$95 million Pier A/B expansion and renovation
$12.4 million runway 10/28 Deicing/ Aircraft Parking Ramp
Completion $20.5 million MCC Phase I Infrastructure in Spring
Continue with $17.4 million noise Abatement Program.

Birmingham (BHX), United Kingdom

Birmingham Airport (BHX) is operated by Birmingham Airport Holdings Limited (the Company). The Company was fully incorporated in February 1997 with the principal purpose to operate and manage BHX and provide facilities and services to support those operations. Aer Rianta and Bridgeport Capital hold a 48.25% stake in airport. The Seven District Councils (local governments) of West Midlands hold a 49% stake. The remaining 2.75% is held by an employee share trust.

Market Growth

BHX experienced significant growth in 1999, with the number of total passengers increasing 10.7 % from 1998 (reaching over 6.8 million by fiscal year end and over 7 million by calendar year end). Air traffic movements grew by 13 %, year on year. The year 1999 also demonstrated a dramatic increase in UK market share, reaching 4.1% and reflecting an increase of 22% during the 10 year period. BHX is the fifth largest airport in the UK.

The Company focuses on positioning BHX through its strong European network and its increased importance as a regional airport. BHX currently offers service to 39 destinations in the UK and Europe. Dublin is the most popular destinations, serving 8.1 % of all BHX passengers. BHX reaches a 7 million person catchment area within a one hour drive.

Business Operations

The Company withdrew from ground handling operations in 1999, which reduced turnover by a comparable 4.5%. Several strategies were pursued to handle the offset in revenues from the loss of duty-free in July 1999, including expansion of commercial space and the introduction of new shops and catering facilities.

BHX has two terminals, one of which (Eurohub) handles a combination of domestic and international passengers for European flights. The Company establishes as a goal reducing the time to walk for connecting passengers and decreasing transfer time to 25 minutes. The Company is pursuing a public transport strategy to improve and promote access to the airport. Plans are being developed to re-establish air-rail link between the airport and the Birmingham International Rail Station.

Capital Program

The Company continues to implement is planned capital development program, expected to total £260 million through 2007. It has completed a new integrated terminal facility through the linking of the Eurohub and the Main Terminal, expansion of new concession areas, and completion of new and enhanced arrival facilities

Brussels (BRU), Belgium

The Brussels airport is operated by the Brussels International Airport Company (BIAC). BIAC was created through the merger of the former BATC with the ground operations department of RLW/RVA. Under the prior arrangement, a public entity was responsible for administering the whole of the airport while a private company handled the passenger terminal. 1999 represents the first full financial year since the merger of the two companies. Many of the corporate goals focused on aligning the two organizations and implementing a comprehensive change management program.

Market Growth
Within the past five years, the airport has experienced a 59% increase in the number of passengers, a 54% growth in cargo operations, and a 28% growth in air transport movements. From 1998, the number of passengers increased by 8.7% in 1999. The volume of cargo moved increased by 12% over 1998. In addition, the number of air transport movements increased by 4.7% over 1998, indicating the transport of more passengers and cargo by larger aircraft. BRU expects continued growth through its position as the "Airport of the Capital of Europe" and the high concentration of international organizations in Brussels.

Business Operations
BIAC continued efforts to move toward "fully coordinated airport status" under context of IATA and European legislative requirements. Completed administrative requirements through appointment of a coordinator and performance of a study, which identified capacity constraints.

Revenue from retail activities decreased by 22% from 1998 to 1999. This decrease is the result of the abolition of duty-free sales. BAIC initiated several steps to counter the effects of this decline, including marketing, remodeling points of sale to intensify presence of major brands, and renovating the commercial zone of Terminal C. Revenue from restaurant concessions increased by 14% from 1998 to 1999. BIAC attributes some of this growth to the increase in low-fare flights, which do not serve meals. Additional services provided by BIAC at the airport include foreign exchange offices, telephony and telecommunications, business world reception, tourism, advertising, an international hotel, and petrol stations.

Capital Program

BAIC continued expansions and improvements to the airport in 1999. Construction of Concourse A, which is to provide 31 new docking gates, began. A new departure lounge on Concourse B, the addition of new parking spots (2,500), and runway completion work were also completed.

BAIC has established as a goal the increase of public transport to access the airport. The company initiated a rail link study to examine alternatives for direct rail service to the City.

Copenhagen (CPH), Denmark

Copenhagen airport is owned and operated by Copenhagen Airports A/S (CPH), a private company. 51% of the shares of the airport are held by the Kingdom of Denmark, with the remainder being publicly traded. The airport is Scandinavian Airline's (SAS) principal airport of operations. It also serves as the North European hub for DHL.

Market Growth

CPH experienced steady air traffic growth in 1999. The number of take-offs and landings increased by 6.3%, to 298,533 air transport movements. The total number of passengers increased 4.1%, to 17.5 million in 1999. The volume of cargo operations also increased, by 12.7%, reaching 389,318 metric tonnes in 1999. However, the number of cargo transport movements decreased, reflecting the use of larger aircraft for cargo operations.

CPH projects continued growth into the new decade as SAS expands international and European services. The new Oresund Bridge to Sweden is expected to support CPH's position as a traffic hub for Northern Europe. The opening of the bridge increased CPH's catchment area (i.e., number of people who can reach airport by car within 2 hours) from 3.1 to 5.5 million persons.

Business Operations

CPH directly provides several services within the airport, such as special security services, bus transfers and service information. It also supplies some services to handling companies at the airport, including the sorting of baggage. New baggage sorting facilities were brought into use in 1998 after negotiations with handling companies.

Revenue from commercial activities (e.g., turnover paid by shops and restaurants, rent from use of offices, etc.) provides 43% of total revenues for CPH. Revenue from the airport shopping centre decreased by 23.4% from 1998. This decrease is the result of abolition of duty-free sales to intra-EU passengers. CPH developed various strategies to mitigate loss of revenue from those sales (e.g., advertising to intra-EU passengers on tax-free shopping, addition of retail shops in the arrival area).

CPH's expenses for operations, maintenance, and energy increased 7.7% from 1999; the result of continued expansions to the airport. (Total space of terminals and other facilities increased by 38% from 1998). Staffing also increased – by 5.2% – to support operations and maintenance at new buildings.

CPH and the airlines completed a consultation process and agreed to 13% increase in charges effective 1 January 2000. The charges cover various facilities at CPH, including buildings, passenger facilities and aircraft operating areas. The airport and airlines also agreed to per passenger handling charge introduced on 1 January 2000 (DKK 10 per international passenger and DKK 5 per domestic passenger). As part of the agreement, it was determined that charges would not be adjusted for the next three years.

Capital Program
CPH continues its capital development program at the airport, estimated at over Euros 1 billion. In 1999, CPH opened Pier D, the first phase of Terminal 4,which will add 38 gates to the airport. Renovations continued in areas connecting Piers C and D. A major refurbishment began on Terminal 2. Work is also beginning on a multi-story car park at the airport.

Dusseldorf (DUS), Germany

Flughafen Dusseldorf GmbH operates Duesseldorf International airport. The shareholders are Airport Partners GmbH and Landeshauptstadt Dusseldorf.

Market Growth
Passenger numbers increased by 1.1% and on the basis of passenger volumes, Dusseldorf maintained its number 3 position in a national comparison (Frankfurt and Munich being 1st and 2nd respectively). The number of passengers in cross-border air traffic increased by 2.3%, while within EU cross-border traffic increased by 5.9%. Passenger volumes on inner German routes dropped by 2.7%.

Aircraft movements increased by 3.4% (530 take-offs and landings per day). The increase in the number of flight movements exceeds the increase in passenger numbers because of the employment of smaller aircraft. Passenger volume growth figures are less than the national German average of 7%.

Freight turnover fell by 7.9%. The import freight business was hardest hit, while there was only a minor decrease of 0.8% in the export sector. Overall freight volume (which includes trucking) fell by 3.1%.

Business Operations
Total sales revenue increased by 2.7% to DEM 571.9m. Revenues from operation of the airport constituted 71.9% of total sales revenue, rent and lease 24.1% and the freight business 3.9%. Revenues from aviation

increased, which is traced back to changes in landing and handling charges, as well as positive traffic development at the airport.

The duty-free business demonstrated positive growth ratios during the first half of 1999 (almost 15%). However, revenue drops of up to 50% had to be accepted after 1st July 1999 (abolition of duty free).

The installation of additional sales areas implied an increase in revenues from rent and lease. The increase of space rented out for advertising has also contributed to the above-average increase in these revenues. Revenues from freight fell by 3.9% reflecting reduced volumes.

The most important expense items exhibited only minor growth ratios. There was a slight increase in payroll costs. The cost of materials fell by 10.3%, mainly due to the reduction in services provided by external companies, particularly for maintenance and rebuilding measures. There was a drop in depreciation by 8.5%.

The revenue increases and expenditure reductions have led to an increase in net profits. This is also partly traced back to the previous year having received a boost due to the capitalization of reserves as a result of the outcome of an external tax audit.

Flughafen Dusseldorf GmbH consists of the following business divisions:
Operations
Technical Facility and Asset Management
Ground Handling services
Non-aviation
Property development.

Capital Program
CAPEX mainly pertained to expansion work in connection with "airport 2000 plus" as well as the construction activities for the new railway station at

Dusseldorf airport. "Airport 2000 plus" has involved the demolition (of central terminal and pier B) and reconstruction with an expansion of the central airport terminal and a new pier B. The commissioned construction contract amounts to DEM 665m (Euro 340m). The overall cost (including planning and construction services provided in advance, as well as "trend setting" installations and services) equals DEM 775m (Euro 396m).

Total capex for the new railway station and People Mover amount to DEM 350m (Euro 180m). An amount of DEM 60m (Euro 31m) will be required for the construction of the check-in terminal, which will be built by Flughafen Dusseldorf GmbH.

The installation of an additional 10kV power supply station is required in order to fully ensure that the electricity requirements for the new terminal are met.

The volume of capex is 44.3% higher than in the previous year.

Other Controlling Interests
Flughafen Dusseldorf GmbH holds 70% of the interests in the legally independent company Flughafengesellschaft Munchengladbach GmbH. Many of the operational functions of Munchengladbach Airport are performed either directly by Flughafen Dusseldorf GmbH on in connection with Commissions.

Ft. Lauderdale (FLL), United States

The Fort Lauderdale-Hollywood International Airport is owned by Broward County and operated through the Broward County Aviation Department (BCAD). Together with the North Perry Airport they make up the principal airport system of Broward County.

Market Growth:

According to information for 1999 statistics prepared by Airport Council International-North America, FLL was the 31st busiest airport in the United

States and the 33rd busiest airport in North America in terms of total passengers. From 1980 to 2000 the number of enplaned passengers increased an average of 4.7% per year. From 1995 to 2000 passenger traffic at the airport increased an average of 8.9% per year.

The annual tonnage of air cargo has increased steadily over the past five years. In 1999 the airport ranked 33rd in total cargo volume among domestic airports and 71st among worldwide airports. Cargo activities by FedEx account for 53.9% of the total.

Business Operations:

The Fort Lauderdale- New York Market was the fourth busiest market in the United States. FLL has increased its market share of domestic originating passengers from 38% in 1996 to 48% in 1999. The airport has attracted new airlines such as Jetblue (February 2000) and Midway Airlines (1995).

Capital Program:

The car rental and public parking facility which consists of a seven-level concrete garage structure with an estimated cost of about 210 million dollars is projected to be completed in April 2000. The completion of Terminal 1 and Concourse C is also expected for 2001 with a 14.6 million dollar investment. The extension of Concourse C is also expected with nine additional gates.

Glasgow (GLA), United Kingdom

Glasgow Airport Limited owns and is the licensed operator of Glasgow Airport. Glasgow Airport Limited is part of the BAA plc. Group.

Market Growth

Passenger numbers grew by 7.2% with the international sector showing growth of 8.2%, which has been attributed to the continuing recovery of the charter market and the introduction of new routes such as New York Newark.

BAA plc owns Glasgow, Edinburgh and Aberdeen airports (all Scottish). Glasgow is the largest on the basis of passenger numbers, operating expenses and revenues, assets etc. It is consistently listed after Stansted in BAA's annual report (lists are organized according to scale). On the basis of passenger numbers, Glasgow's scale could be interpreted as being two-thirds that of Stansted.

Business Operations

Airport charges increased by slightly less than passenger growth due to a continued policy of price reduction. Retail and property income increased by 6.3% and 5.9% respectively.

Underlying operating costs increased by only 0.6% despite significant passenger growth (this is excluding the intra-group windfall tax charge of £6.2 million in the previous year's results). This reflected productivity improvement of 7.7%.

As the airport owner, BAA reports that it is responsible for the operation of all airport facilities, including all utilities and cleaning; facilities for baggage screening and sorting; airport security including passenger screening; shops and other commercial facilities such as catering, car hire and bureau de change; car parks, flight information display systems; information desks and help points; airport fire services and fire alarms; air bridges; runways, taxiways and aprons. Presumably, this applies to all BAA airports including Glasgow.

Capital Program

Completed the installation of latest technology data communications network. Refurbishment of the main domestic pier continued. Airline executive lounge facilities were enlarged. First phase of the main runway refurbishment began and new security screening equipment was introduced.

According to the BAA annual report, the Glasgow Airport Ltd completed a two-year, Stg£10m runway refurbishment and resurfacing program in March 2000.

London Stansted (STN), England

London Stansted Airport (STN) is owned and operated by Stansted Airport Limited (the Company), BAA plc is the parent company for Stansted Airport Limited. Stansted is the main base in England for low-cost European scheduled airlines. BAA coordinates London Heathrow, Gatwick and Stansted as one integrated airport system.

Market Growth

Stansted is one of Europe's fastest growing airports. It experienced significant growth in passengers and air traffic during FY00 (which covers April 1, 1999 through March 31, 2000). Traffic increased by 34% to 9.9 million passengers, only marginally less than the 35% growth the prior year.

Business Operations

Operations at Stansted continued to focus on improving retail facilities, including shops and catering outlets. Safety and customer service also received a high level of priority.

Stansted continue to focus on expanding its presence both as a European hub and an alternative for transatlantic service. There are 23 airlines offering service at Stansted to over 85 destinations. Air transport movement limit increased from 120,000 to 185,000 after approval by Parliament in July 1999. This was a significant step in Stansted's efforts to double capacity at the airport.

Capital Program

Stansted increased capital expenditure program, beginning construction to its terminal building in 1999. Construction is expected to be completed in Summer 2002. This project is part of a larger £200 million program to develop the airport to a capacity of 15 million passengers. Since 1986, BAA has invested more than £500 in Stansted.

Manchester (MAN), UK

Manchester Airport is owned and operated by Manchester PLC, a private company. A board consisting of representatives from the Manchester City Council and nine local district councils governs the company.

Market Growth

Manchester experienced continued growth in operations in 1999. Annual passenger loads reached over 17 million total passengers. The airport handled a record of 115,000 tonnes of freight, and over 185,000 aircraft movements.

In 1999, Manchester focused on core strategic areas: public transport, route development, technology investment and leveraging growth of the airport. The airport also continued effort to promote "open skies" legislation. Route development focused on key transatlantic markets, such as Philadelphia and Athens. Additional services were also provided on other key routes, such as Milan, Paris, Helsinki, Frankfurt, and Dublin. Introduction of these new routes also increased cargo capacity, as 70 percent of all cargo is handled on passenger carrying aircraft.

Manchester attributes much of its success to outstanding customer service, reflected by its number three rating in the annual IATA survey. Manchester was rated in the top three airports in courtesy and friendliness of staff, parking facilities, customs, passport inspection and availability of baggage trolleys.

Business Operations

The reduction in duty free income was a significant impact on the airport. The airport worked to raise awareness among the public about destinations still eligible for duty free. The airport focused on consolidation and refinement of existing products in Terminals 1 and 3 during the year. The airport also expanded its car parks business, with a "premier park" facility where customers can call ahead and book their spaces in advance.

Manchester Airport PLC has a subsidiary company, Ringway Handling Services, which provides services to airlines, such as baggage handling and ground support.

Capital Program

The airport initiated a £60 million "Transport Interchange" project to house all bus, coach and rail services. This facility will consolidate all public transport services into one hub location.
Manchester also made substantial improvement to its baggage screening systems. Some £15 million was allocated to improve current facilities, with another £10 million set aside for future improvements. Other improvements include new check-in desks at Terminal 1 and expansion of retail facilities.

The airport currently has one runway, with plans to open second runway in 2001. The estimated cost for this project is £172 million.

Munich (MUC), Germany

The Munich Airport (MUC) is operated by Flughafen Munchen GmbH (FMG), also known as the Munich Airport's Authority. The operating company is an enterprise owned in partnership by the federal, state and city governments. The airport has experienced significant growth since opening at its new site in 1992.

Market Growth

In 1999, MUC experienced significant growth across all forms of passenger and freight movements. The number of total passengers reached over 21 million, a 10.1% increase over 1998. Air transport movements increased also, but by 7.4% from 1998 to 1999, indicating a much higher load factor per aircraft. The volume of air cargo moved increased by 20.1% from 1998, reaching 114,259 metric tonnes in 1999. FMG attributes the significant growth in cargo traffic to increases in service to long-haul markets and a rise in bellyhold freight capacity.

FMG cites its collaborative European hub development strategy as a key driver behind continued growth at the airport. The strategy has been pursued through a joint partnership between Lufthansa and FMG. FMG supports this strategy by establishing a goal to reduce connecting times among aircraft to 35 minutes. This would represent that shortest connection time among Europe's aviation hubs. A new baggage transfer facility (see below) is being developed to support this strategy.

Business Operations

FMG experienced an increase in overall operating of 9% from 1998 to 1999, partially due to increased traffic growth. Costs of materials and outside purchases were 14% higher than in 1998. Personnel costs increased by 6.2% from 1998, resulting from the increase in staff to support higher levels of airport traffic.

FMG includes several subsidiary companies, all of which provide services at MUC that generate revenues for the company. While these services are provided by subsidiary companies, they are generally core activities that may be sponsored by airports in Europe. The following exhibit includes a summary of these subsidiaries and companies.

FMG Subsidiary Companies

Company	Function	# Employees	1999 Revenue (DM million)
Aerogate	provide handling services in areas not ordinarily handled by ramp services	260	22.00 DM
Allresto Hotel	operates restaurants, bars in terminal, employee canteen, and airport hotel	NA	93.00 DM
Civil Aviation Protection	provides guard and security services at Munich	NA	15.00 DM
Cargogate	specializes in handling air cargo at MUC	200	20.00 DM
EFM	provides de-icing, pushback and towing services at MUC	110	37.00 DM
Eurotrade	runs shops in public and non-public areas of airport	NA	116.00 DM
FMV	brokers insurance and provides consulting services	NA	0.70 DM
IMMO	finance and build passenger Terminal 2	NA	NA
MOB	purchase and manufacture technical equipment needed to operate Terminal 2	NA	NA
TOTAL		NA [Note 1]	303.70 DM

Source: 1999 Annual Report

Notes: 1] FMG indicates a figure of 1,800 total employees at subsidiary companies. However, the annual report only indicates the number of employees for select subsidiary companies, it does not provide detail for other companies.

FMG also provides other services within the airport through its direct operating units. These services that generate revenue for FMG include aviation fuel provisioning, rental of advertising space, sale of promotion campaigns, and third-party services.

Similar to other European airports, FMG experienced a decrease in license (concession) revenue due to elimination of duty free privileges within the EU. The downtown from loss of duty-free revenue is estimated at between 20% and 25%. FMG is taking several steps to combat this trend, including a focus on enhancing and extending retail, restaurant and service offerings. This includes remodeling the main concourse to improve access to retail outlets.

Improvements to check-in counters are designed to decrease waits at check-in and to give customers more time to browse retail offerings.

Capital Program

FMG completed several projects in 1999, including the southern extension to the terminal (60 meters to create a 1,000 square meter lounge). FMG also commissioned new sorting system to handle transfer baggage and reduce time required for hub operations. This facility is solely for transfer baggage and located in utility building on apron. FMG also opened Munich Airport Center (MAC). This business and services center provides office space and is located in the middle of the airport.

FMG initiated preliminary work on Terminal 2, a new passenger facility that is co-financed by FMG and Lufthansa.

Oslo (OSL), Norway

Oslo's new international airport opened in October 1998. The airport brought together all flight operations that were handled previously by two separate airports in the region. The new airport is operated by a limited company, Oslo Lufthavn AS, which is owned by the Norwegian Civil Aviation Administration. The company was formed in 1992 to plan, construct and operate the airport.

Market Growth

The Oslo airport experienced growth upon opening. Both scheduled and charter service increased capacity substantially initially in 1998, above the combined totals from the two previous airports. However, 1999 saw a slight decline in passengers (about 14.1 million) as airlines consolidated scheduled air service.

Business Operations

The operating company has focused on improving services offered through the new terminal during the first two years of operations. The new terminal has capacity for 2,800 passengers departing and 2,800 passengers arriving per hour, with an annual capacity of about 17 million persons). The building is designed to accommodate continued growth, with ability to handle 5,000 items o baggage.

The new airport was constructed with single terminal complex, containing arrival and departure halls and Pier A. A second Pier B is planned and can be accommodate within the current site plan layout. The total cost for new terminal, was NOK 2 billion. The terminal has 64 check-in counters and more than 50 shops, restaurants, and other service facilities. The terminal also includes an airport hotel with 350 rooms.

Capital Program

The new airport has a dedicated airport express train, operating between Oslo Airport and Asker to west of Oslo. It has two parallel runways (2,950 meters and 3,600 meters), with runway capacity of 80 movements per hour. There are 6,800 car park spaces, 4,000 of which are in multi-story building.

Vienna (VIE), Austria

As a result of a change in ownership last year, *Flughafen Wien AG* (the management board) is now only one of three publicly traded European airports in which the State holds a minority interest in Vienna (VIE). The annual report for 2000 presents record earnings for the third year. Net profit for the year increased by 18% to €73.1 million, earnings before interest and tax went up 4.0% to €93.1 million, and profit before tax rose by 7% to €102.6 million.

Vienna is a major transfer airport between East and West Europe and it is also of major economic importance for the region. It consists of 198 companies employing 12,000 people at the site (a further 12,000 jobs have been created indirectly). The value added by the airport to the Austrian economy exceeds €2.1 billion or roughly 1% of the Austrian GDP.

Market Growth

Development of traffic during 2000 exceeded forecasts. The number of passengers increased by 6.6% (compared to a forecast of 6%) to 11,940,000. The entry of the Austrian Airlines Group into the Star Alliance triggered competition between the Qualiflyer Group and Star Alliance and led to unexpected growth in flight movements.

Growth has been attributed to the following success factors: transfer speed, high-tech handling, and development of the East-West Hub, on-time performance, customer service and also the success of non-aviation activities.

Share Performance

Despite a decline in international stock exchanges in 2000, airport shares were in demand. With a 16.78% increase in the share price in 2000, Flughafen Wien AG shares were one of the top performers in the Austrian ATX Index.

Business Operations

The Flughafen Wien Group recorded an increase of 4.7% in turnover to €327.4 million during 2000. At 42%, the airport segment provided the largest share of revenues. Turnover in the airport segment is comprised of charges for landing, passengers, infrastructure, which did not increase during 2000. The Handling segment generated 36% of total group turnover in 2000, and recorded 8.9% higher revenues supported by an 8.6% increase in flight movements. The non-aviation segment contributed 22% to Group turnover. Operating expenses rose by 5% (due to higher prices for fuel, district heating and third party services for customers and handling).

Capital Program

At €28.5 million, capital expenditure for the reporting year was €24.4 million below 1999 and considerably lower than the 2000 forecast of €73 million. This was due to a review of investment plans to permit more flexible response to traffic development With no impairment of quality, the final date for completion of eight international bus gates was moved forward to 2003 and construction on the Northeast Terminal is now scheduled to be completed in 2007.
Major investments in 2000 included the acquisition of real estate, completion of car park 4 and the purchase of equipment and vehicles for the handling segment.

Planned expansion of the airport will be reflected in capital expenditure of slightly over €€1 billion up to 2006. Major projects include expansion of the terminal, extension of the aprons, and the purchase of real estate for future airport development. Also based on current growth forecasts, Vienna International Airport will need to construct another runway by 2010.

Leading European Airports

London Heathrow (LHR), United Kingdom

Heathrow Airport Limited owns and is the licensed operator of Heathrow airport. BAA plc is the ultimate parent company and all Heathrow airport staff are employees of that group.

Market Growth
During the financial year ended 31 March 1999, the number of terminal passengers handled by the airport increased by 4.9% to a total of 61 million. This compares with a growth rate of 3.6% in the financial year 1997/98. International traffic grew by 5.7%, while domestic passenger numbers fell very slightly. The Company sees this as indicative of the continued importance to its airline customers of Heathrow as an international hub.

During the financial year ended 31 March 2000, the number of terminal passengers increased by 2.1% to a total of 62.3 million. This lower growth (relative to 1998/'99) reflects, according to the Company, reduced air traffic over the millennium and the timing of the UK Easter holidays (presumably, they fell outside this financial period). International traffic grew by 2.4%, while the number of domestic passengers fell slightly again.

Business Operations
The abolition of duty free for travelers within the EU from July 1999 has had a negative impact on revenue from retail activities. However, partial recovery has been made through increases in aircraft charges and the introduction of new retail offers. Operating profit for the financial year 1999/'00 was Stg£324.5 million compared to Stg£323 million in financial year 1998/'99, which amounts to only 0.5% nominal growth. After tax and interest, profitability fell by 14.5% to Stg£190.4 million. This reflects the impact of increased interest charges reflecting a full year's Heathrow Express operation. Operating costs have been controlled, but depreciation has increased substantially as a result of capital investment.

The Heathrow Express rail service commenced full services in June 1998 between the airport and London's Paddington station with a 15-minute frequency. The service is popular and the passenger base has continued to grow up to end of the financial year 1999/'00. The airport's target is to achieve 50% of passengers traveling to and from the airport by public transport. Rail access is a key component in achieving this target and further opportunities to increase rail services to the airport were being studied during the financial year 1998/'99. A new check-in facility was opened at Paddington station during 1999/'00.

Heathrow airport has a programme to promote public transport initiatives through the support of local bus services and by investment within the central area transport interchange.

According to the financial reports, Heathrow Airport staff continue to provide excellent service and passengers give their 'professionalism' and 'helpfulness' a high rating in all surveys undertaken.

Capital Program

A key strategy for Heathrow is to fulfill airline demand and the airport's management continue to seek innovative solutions to handling increased passenger numbers through existing facilities while maintaining and improving services standards.

The public planning inquiry for the construction of a fifth passenger terminal was completed in March 1999. The official report of the Inspector was expected to be published in the autumn of 2000. However, this has not happened as yet. Assuming a favorable outcome, Terminal 5 has a planned opening date in 2006/'07. Delays in producing the report are likely to feed into this timeframe however. Stg£23 million was capitalized in the financial statements 1999/'00 in respect of Terminal 5.

Capital expenditure for 1998/'99 amounted to Stg£226.6 million, reflecting completion of the Heathrow Express, Terminal 1 domestic, Terminal 2 check-in and landside facilities and the redevelopment of office and check-in accommodation at Terminal 3. The dedicated system for the transfer of connecting bags between Terminal 1 and 4 was completed in the financial year and is being remunerated by users. Further enhancements to common user transfers infrastructure at a cost of Stg£15.5 million were completed in the year and a new transfers systems charge introduced to fund their construction.

Capital expenditure for the year 1999/'00 amounted to Stg£176.6 million. Project work to expand the Terminal 3 departure lounge and provide improved pier service progressed during the year, having commenced during 1998/'99. The subway complex in the central area has been substantially upgraded and enhanced. The airport's aircraft stands and taxiway network has also witnessed further improvements.

London Gatwick (LGW), United Kingdom

London Gatwick Airport (LGW) is operated and owned by Gatwick Airport Limited (the Company). BAA plc is the parent company for Gatwick Airport Limited. The airport is the busiest single airport runway in world, serving over 30 million passengers annually. Gatwick, Heathrow, and Stansted work together as one integrated airport system within the London area. FY00 data is used since the fiscal year for BAA ends in March.

Market Growth

The number of passengers increased by 3.0% to a total of over 30 million passengers in FY00. This compares with a growth rate of 8.1% from FY99 to FY00. International traffic grew by 3.3% in FY99 and domestic passengers by 0.2%. This reflects a strong focus by the Company on increasing LGW's position as an international hub and its presence as a leading charter airport in the UK.

Business Operations

The Company experienced the impact of the loss of duty-free revenue from 1 July 1999. This caused a reduction on net retail income, which partially explains the fall in the Company's profits. Addition of new retail space and increased customer awareness has provided some recovery since July.

The Company also is carrying out its property initiative to increase office space for business partners located at LGW.   An additional 47,900 square foot of office space was planned to come on-line in 2000 with extension to Concorde House, which is next to the South Terminal.

The Company is also working with the local community to prepare for future growth, projected to reach 40 million passengers. The associated development plan will allow the airport to handle these passengers within the existing runway, two terminals, and existing boundary.

BAA continues to operate Gatwick Express, which provides non-stop rail service between the airport and downtown London.

Capital Program

Focus continued on improved customer service and airport facilities. Capital expenditure for the year was £86 million. This reflected ongoing work to extend the North and South Terminal International Departure Lounges. T also included a new airside coaching station and a major refurbishment program for the South Terminal.

Frankfurt (FRA), Germany

Frankfurt Airport is one of the leading European airports, and serves as the number one air cargo hub in Europe. It also acts as the home base for Lufthansa and the hub of the Star Alliance. Frankfurt Airport is owned and operated by Flughafen Frankfurt/Main AG (FAG).

Market Growth

Frankfurt experienced significant growth in 1999. Passenger traffic reached new record levels. Almost 46 million travelers used Germany's largest airport in 1999 (compared to 42.7 million in 1998). Aircraft movements increased by 5.5% in 1999, reaching 439,093 movements. The cargo business continued to grow by almost five percent, reaching 1.43 million metric tonnes of airfreight.

The Frankfurt airport serves as largest employment site in Germany and most important employer in the State of Hesse. In total, there are 62,000 employees at FRA, of which 12,600 are direct FAG employees,

Business Operations

FAG developed a new traffic and terminal management strategic business division. This group is accountable for all core airport businesses to focus service on customer needs and requirements (both landside and airside). Ground handling services for aircraft, passengers and cargo is a core competency for FAG.   FAG continued to improve efficiency of airside and landside operations to address limits on slots available at the airport.

Capital Program

Frankfurt is unique in that it integrates various modes of transpiration at the airport. FAG continues to position the airport among European competitors as "intermodal travel port," featuring three railway interfaces and location next to Germany's busiest autobahn. In 1999, FAG connected a new rail station for long-distance services with Terminal 1 (a project costing DM 102.7 M)

FAG began expansion of Pier A in 1999, to add 13 aircraft docking positions in summer of 2000. FAG also initiated the mediation process to consider possible expansion of Frankfurt Airport's runway system. The modernization and expansion of Transit Area B (Terminal 1) was completed (required total investment of DM300 million).

FAG continues its investment in cargo growth, providing more than DM35 million to improve cargo facilities at Frankfurt airport. Federal Express inaugurated new Frankfurt hub in 1999.

Paris (CDG & ORY), France

The Paris Orly and Charles de Gaulle Airports are operated by Aéroports de Paris (ADP). These two airports handle the largest volume of passenger traffic and the greatest number of civil flights in continental Europe. The annual report for ADP presents combined data for financial performance. As a result, these airports are considered within the ADP combined reports.

Market Growth

The Orly and Charles de Gaulle Airports have experienced a significant growth in air traffic with an increase in 8.44% for 1999. Since the obtained data was not separated by airport, it can only be estimated from air traffic information that 36.8% of the total air traffic growth corresponds to Orly and 63.2 % to Charles de Gaulle.

Freight and mail have also had a significant change in 1999 with a 5.9% increase since 1998 and a total of 1,361,000 tonnes. This freight increase could be attributed to the opening up of Fed Ex's new European freight hub at CDG in September 1999.

In 1999 there was also a significant increase in commercial aircraft movement (708,000) with a rise of 6.7% since 1998. This could be broken down into 65.9% for CDG and 34.1% for ORY. The rise in the international movements was 9.2% (466,000) while domestic movements were up 2.2% (242,000).

Business Operations

At the end of 1999 ADP had a total of 7,855 employees on its payroll with 7,178 of these on permanent contracts. There was a 2.14% general staff increase and a 2.17% permanent staff increase during 1999.

In January 1999 ADP Management (ADPM) acquired 25% stake in Liége Airport, Belgium with an alternative to develop freight activities with TNT that has been operating at that airport since 1998. In November 1999 ADPM signed a strategic partnership agreement with Beijing Capital International Airport (BCIA) in which ADPM agreed to buy 9.9% of BCIA's shares starting in the year 2000.

Capital Program

The total investment spending for 1999 was 2,419 million French Francs of which 1,595 million were spent on CDG and 299 million on ORY. The remaining 525 million was spent on consultancy costs and studies.

The double- up southern runways, the aircraft parking zone for future CDG 2E terminal and the southern control tower are some of the major improvements accomplished in 1999 at CDG. At ORY the refurbishment of check-in zone Orly South, separation of arrival and departure passenger flows, 12,000 square meters of aeronautical surface upgrade and the treatment of hot water distribution networks were the major accomplishments for 1999.

Rome (FCO), Italy

The Leonardo Da Vinci (Fiumicino) Airport is operated by Aeroporti Di Roma Societa Per Azioni (ADR). Recently completed projects and additional projects underway will raise the capacity of Fiumicino (FCO) to over 30 million passengers. The company considers FCO as a strategic hub representing the gateway to Europe for traffic from the Southern Hemisphere.

Market Growth

FCO has experienced a decrease in passenger traffic with respect to 1998. Statistics show that the number of passengers decreased by 5.2%

(24,029,000). Aircraft movement did not show a major change for 1999 with a 0.9% increase(261,000). Tonnage dropped 20.1% and freight went down 63.2%. These results for 1999 can be attributed to the reduction of Alitalia's flight service because of their transfer to Malpensa and an opposing increase in activity of all other carriers.

Business Operations

In 1999, despite the low growth trends, FCO increased the number of commercial facilities in the airport. There was a sub-concession revenue decrease of 4.4% (103 billion Lire) compared with 1998.

With the opening up of Terminal B and the new "Satellite" there was a new area of about 4,700 meters squared, which brought revenues in sales and advertising space with a 15.8% increase compared with 1998. The parking system at FCO generated a total of 31 billion Lire which is a 10% increase over the preceding year.

Capital Program

The major accomplishments during for this year were the completion of the new Terminal B that is capable of processing 7 million passengers per year. The "Satellite," which is a three story facility, is capable of processing 9 million passengers per year. It has a total surface area of approximately 32,000 square meters. The "Sky Bridge" is an automated rapid transit system linked to the "Satellite".

Shannon and Cork Peer Group

EuroAirport Basel-Mulhouse (BSL), Switzerland/France

The EuroAirport was among those airports in 1999 showing above average growth. Reasons for this can be attributed to various new destinations and also great demand in all segments as well as dynamic airlines led by Crossair in a commercially successful Regio TriRhena. The airport employed 6,038 in

December 1999, 757 more than the previous year. This represents an increase of 14%. 148 companies were based at the airport in 1999.

Market Growth

In 1999, the EuroAirport recorded 3.6 million passengers, an increase of 18% compared to the previous year and this compared very favorably with other European airports. A large part of this development is due to 'EuroCross', the successful transfer concept of home carrier, Crossair.

The airport benefits from a successful summer season, acting as a gateway to the south. From April to October, 1999, holiday flight traffic increased by 10.2% rising to 688,670. Also the percentage of long-haul flights to holiday destinations is growing- 92,000 passengers traveled to holiday destinations via the EuroAirport.

Business Operations

With an increase in turnover of almost 15%, the EuroAirport boosted its own resources by 30% compared to 1998, to 157 million French francs. Despite investments rising from FRF 163 to 307 million, indebtedness remained stable at 705 million French francs.

Capital Program

Construction work progressing as planned in 1999 and as noted below:
Apron and taxiing area- after completing construction of the base and level 2 of the new Y-shaped finger dock, construction work on levels 3 and 4 began at the end of December, 1999.
Arrival area- car park P1 and the northern access ramps demolished so that new multi-story car park could be started.
Technical centre developed and this houses technical services, airport fire service, emergency services, weather services and IT.
Gates South III- new south terminal, Gate South III with 8 additional departure gates has been operational since December 1999.

Tower- according to guidelines of DGAC, ATC room and radar control room needed to be adapted due to increase in flight movements. Work began on this in 1999.

Bristol, UK (BRS)

Bristol Airport is owned and operated by Bristol Airport plc. The airport was privatized in 1987, and continues to build up a strong presence for services in southwestern England.

Market Growth

The airport has experienced increasing volumes of passengers over the past decade. The number of total passengers increased by 8% from 1998 to 1999, reaching over 2 million passengers in 1999. The number of aircraft movements remained fairly stable from 1998 to 1999, reflecting the use of larger aircraft on some routes. Cargo volume grew slightly (by 4.7%).

The airport serves 27 direct destinations through scheduled flights, including Cork, Belfast, Manchester, Dublin, Munich, and London (LGW). Dublin serves as a strong hub for Bristol passengers connecting to transatlantic routes. The airport serves over 300 destinations worldwide through extensive connection services.

Capital Program

Bristol Airport opened a new £27 million terminal in March 2000. The new terminal has five baggage reclaims and a total of 31 check-in desks. The airport offers a total of 4,200 parking spaces.

Cardiff (CWL), Wales

Cardiff International Airport is operated, controlled and managed by Cardiff International Airport Limited. The parent company is TBI plc Group. The airport was privatized in 1995.

The airport is situated 12 miles from Cardiff city center and 10 miles from the M4 motorway. It handles 1.5 million passengers per year and purports to be one of the UK's most successful regional airports.

Market Growth

During the financial year 1998-'99, there was a 10% increase in passenger numbers. The route to Amsterdam continued to grow, attributed to passengers taking advantage of the convenience and cost savings associated with traveling to Amsterdam as an international gateway, rather than taking the journey to Heathrow (presumably by surface transport). Services to other European capitals remain popular and jet services are planned for 3 times daily flights to Paris and Brussels

During 1999-'00, there was a 5% increase in passenger numbers. Again, the route to Amsterdam (as opposed to surface journey to Heathrow) increased in popularity. There are now 5 flights per day on this route. Daily scheduled services operate direct from Cardiff to thirteen key destinations across the UK and Europe. Scheduled services were enhanced by the introduction of jets in place of turboprop aircraft on the Paris, Brussels and Belfast/Aberdeen routes.

Business Operations

During the financial year 1998-'99, there was a 17% increase in its operating profitability, which was attributed to the 10% increase in passenger numbers and improved commercial revenues.

The airport offers tax-free goods to all passengers regardless of destination.

Capital Program
During 1998-'99, Stg£3m was invested across the entire airport, resulting in new airfield ground lighting and replacement radar displays. Inside the terminal building, landside bar and catering areas were refurbished and security improvements made to the car park.

During 1999-'00, the international pier, check-in area and catering area have all been significantly upgraded. The departure gates have been reorganized with the addition of one new gate. There were also improvements in the baggage screening process (with new conveyors and X-ray equipment), improving security and speeding up check-in.

Leeds Bradford International Airport (LBA), United Kingdom

Leeds Bradford is a regional airport serving the middle portions of England in the United Kingdom. The following applies to the year ended 31 March 2000.

Market Growth
Passenger throughput increased by 5% on the previous year. The highest rate of growth was on international scheduled services, which represented 34% of the airport's total traffic. Sebena's Brussels service showed year and year growth of 23% in the number of passengers using it, while British Midland's Paris service showed an increase in the number of passengers of 9%. Domestic traffic showed a decrease of 1%, and represented 28% of the airport's total traffic.

Charter traffic increased by 5%, with little, if any, growth in the overall UK market. There is, according to annual report 99/00, still scope for further growth given that 2 million charter passengers that originate in Yorkshire currently fly out of Manchester airport.

Business Operations
Approximately £1 million of duty free revenues were lost in 1999/00. Some of this was recouped by way of a price increase, the first to its airline customers in five years. The overall result is that the airport has come close

to maintaining the same level of profitability in 1999/'00 as it achieved in the previous year.

Capital Program
Consisted of a series of extensions to the terminal building (which began four years previously). The annual report predicted that this would have been finished by the end of 2000, effectively rebuilding the terminal building and doubling its capacity. The airport now has the capacity to handle up to 3 million passengers.

July 1999 saw the start on site of the scheme to provide new arrivals facilities, offices and the covered walkway linking the airbridge to the new arrivals area. The annual report predicted that this work would have been completed in November 2000.

Towards the end of 1999, proposals were submitted by Multiflight Limited for a major development of hangers and other facilities for corporate and general aviation on the south side of the airfield. This development was expected to begin towards the end of 2000.

London Luton (LTN), United Kingdom

London Luton (LTN) is located about 32 miles north of central London. The airport serves London, the South East, the Midlands, and the East of England.

Market Growth

LTN is the seventh largest airport in the UK, serving over 6.2 million passengers in the calendar year 2000 (a 17.5% growth from 1999). Over 72% of passengers are on international flights, with 28% on domestic flights within the UK. Dublin was the 9th most popular destination for LTN passengers in 2000. About 78% of passengers fly on scheduled services, the remaining on charter services. The most popular destinations include

Glasgow, Edinburgh, Amsterdam, Nice, Malaga, Geneva, Belfast City, Barcelona, Dublin and Palma.

LTN has seen a significant transition from its role as a charter hub to increased levels of scheduled service. In 1992, only 23% of passengers were on scheduled services. This number increased to 68% in 1998 and 78% in 1999. This has been combined with tremendous growth in overall passenger numbers since that time. Passenger numbers have increased from 1.9 million in 1995/96 to 5.5 million in 1999/00, and 6.2 million in the past calendar year.

Business Operations

In a unique public/private partnership, the airport remains publicly owned by Luton Borough Council. But it is operated, managed and developed by a private consortium, London Luton Airport Operations Ltd (for a period of 30 years). TBI plc Group (the specialist airport management company) became the majority shareholder in London Luton Airport Operations Ltd in March 2001, when they increased their shareholding by buying shares from Barclays Private Equity and Barclays UK Infrastructure Fund. The new structure of London Luton Airport Operations Limited is TBI plc with a 71.4 percent share and Bechtel Enterprises Ltd holding a 28.6 percent share.

London Luton Airport Operations is responsible for major operations at the airport, including retail development, concessions, and facility maintenance. The airport is responsible for generating about 8,000 jobs at its site (many of which are outside the operating company).

Capital Program

A new terminal was opened at LTN in the fall of 1999 as part of a £80 million development program. The terminal, which cost £40 million, includes 60 check-in desks, a new baggage handling system, and a new passenger information system. The terminal also included expanded retail and catering outlets. The existing terminal building was refurbished and provides a larger airside departures and arrivals area, 12 shops, and a food court.

Other improvements include extension of the taxiway, construction of six new aircraft stands (able to accommodate up to a Boeing 767), and upgrading of car park facilities. The current configuration of the runway can handle up to 29 aircraft on take off and landings every hour.

The airport has a dedicated cargo terminal. In 1999, a new railway station opened by the airport (a shuttle bus provides service to the terminal which is located 1.8km away). This station provides service to the City of London via King's Cross station in less than 30 minutes.

Southampton, UK (SOU)

Southampton International Airport (SOU) is owned and operated by the British Airports Authority (BAA). BAA is working to position SOU as the major business airport for central southern England.

Market Growth

Southampton Airport has experienced significant growth in the past few years. The airport now serves 22 direct destinations throughout the UK and Europe. Airlines also offer services to over 200 long-haul destinations through six key hubs, including Amsterdam, Brussels, Paris, Frankfurt, Manchester and Dublin.

Passenger numbers increased by 13.9 percent from 1999 to 2000, reaching 855,000 passengers. The airport experienced new and additional frequencies on new routes to Frankfurt and added services to Dublin, Paris, and Amsterdam.

Business Operations

Southampton Airport is recognized as a strong regional player within the UK airport system. The airport was named *Regional Airport of the Year* by Regional Airline Magazine in 2000. BAA is focusing on increasing the number of long-haul passengers by adding the number of flights to major hubs. British Regional Airways is a significant presence at the airport, and uses Southampton as an operating base. BRA carries over 500,000 passengers through the SOU airport.

Capital Program

Southampton opened a new terminal in 1994, which has helped to support growth of service and capacity. Since that time, BAA has invested £30 million to make Southampton Airport a more modern regional airport. BAA has recently opened a new duty free and tax-free shop, increasing retail capacity by three times its original size. The airport also developed a business lounge for British Airways.

The airport has direct connection to a dedicated railway station. Hi-speed trains run three times each hour from London's Waterloo station.

APPENDIX VIII TO CP8

Off-Peak Charges in Respect of the Landing and Take-Off of Aircraft at Dublin Airport

Report on the Calculation of the Associated Marginal Costs

Oliver Hogan and Dr. David Starkie

OFF-PEAK CHARGES IN RESPECT OF THE LANDING AND TAKE-OFF OF AIRCRAFT AT DUBLIN AIRPORT

REPORT ON THE CALCULATION OF THE ASSOCIATED MARGINAL COSTS

26TH AUGUST 2001

PREPARED BY OLIVER HOGAN AND DAVID STARKIE

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1. Introduction

Aircraft movements (take-off and landings) at Dublin Airport are not uniform throughout the day. Although existing off-peak traffic, as well as much of the foreseeable growth in that traffic, could continue to be handled by the existing runway infrastructure[1], there are periods when the limitations of available runway capacity become evident. It is important, therefore, to encourage the efficient use of existing capacity.

Efficient use requires a charging structure that reflects the marginal cost associated with an additional runway movement. At peak times, this marginal cost comprises the costs of damage, or wear and tear, to the runways, taxiways and aprons, together with the costs of delay that the additional aircraft movement imposes on other flights. It is these latter congestion costs that, in the longer term, inform the case for a new runway. At off-peak times, congestion costs are absent, so that the damage costs alone become the marginal cost of use[2]. An efficient charging structure should ensure that these damage costs are covered.

Consistency with the Commission's statutory objective, which is "… to facilitate the development and operation of cost-effective airports which meet the requirements of users", requires that the difference between peak and off-peak costs of runway use at Dublin should be reflected in the structure of charges. It also requires that charges should be cost-reflective. Consequently, to further these objectives, the Commission has decided to place a sub-cap on charges in respect of aircraft movements at Dublin airport during daily off-peak periods.

The Commission does not intend to place any specific cap on peak charges, which will be constrained only to the extent that revenues from charges must be such as to satisfy the Commission's overall

[1] The exception would be those periods that do not have enough spare capacity to accommodate all the expected traffic growth without some congestion occurring.

[2] Fixed costs (such as staff costs) that do not change with a marginal increase (or decrease) in output during the off-peak are not included. Inclusion of such overheads would amount to a fully distributed, or average cost approach, which would not be an economically efficient method of charging. This is because charges based on average costs might deter some potential users willing to pay the off-peak marginal costs. Equally, an average cost approach might encourage excessive use at busy times leading to inaccurate signals concerning the need for future expansion.

Determination specifying the maximum levels of airport charges. The Commission expects that the charges levied by Aer Rianta in respect of aircraft movements during peak periods will exceed the specified maximum off-peak (damage-related) charges.

2. Costs[3]

2.1 "Routine" Repair and Maintenance of Pavements

Runway, taxiway and apron pavements sustain damage from the pressure imposed by the combined weight and speed of an aircraft when landing or taking off and from the weight of the aircraft when taxiing and when parked on the apron. The resulting potholes, cracks and damage to the sealing of joints require "routine" repair and maintenance.[4]

Aer Rianta does not record the costs attributable to each individual aircraft movement and, therefore, the starting point is the total annual operating expenditures on repair and maintenance of the pavements of the runways, taxiways and aprons.

Table 1 shows the sources of expenditures on external services and materials associated with "routine" pavement repair and maintenance. Aer Rianta does not allocate costs on an activity basis, but rather collects them at the cost centre level. There might be other costs associated with pavement maintenance that have been collected in other cost centres. However, such costs are not considered to be material by Aer Rianta.

Table 1: expenditures on external services and materials associated with "routine" pavement repair and maintenance.

Cost Centre (number)	Cost Centre (name)	Cost	Adjusted for inflation up to 30 September 2001 (4.5%)	Adjusted for inflation for period 1 October 2001 to 30 September 2002
11-399	Airside Services Manager	[redacted]	[redacted]	[redacted]
11-400	Apron Manager	[redacted]	[redacted]	[redacted]
11-385	Airfield Manager	[redacted]	[redacted]	[redacted]
11-390	Airside Electricians	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]

Source: Aer Rianta

[3] All costs have been blanked out in the enclosed tables to respect Aer Rianta's designation of this information as confidential and commercially sensitive.

[4] Note that it is appropriate to consider the costs of repair and maintenance of all runway, taxiway and apron pavements in order to capture the damage caused by all aircraft movements at Dublin airport.

Table 2 shows Aer Rianta's sources of internal labour costs associated with the repair and maintenance of pavements.

Table 2: Aer Rianta labour costs associated with "routine" pavement repair and maintenance.

Cost Centre (number)	Cost Centre (name)	Total	Adjusted for inflation up to 30 September 2001 (4.5%)	Adjusted for inflation for period 1 October 2001 to 30 September 2002
11-399	Airside Services Manager	[redacted]	[redacted]	[redacted]
11-385	Airfield Manager	[redacted]	[redacted]	[redacted]
11-390	Airside Electricians	[redacted]	[redacted]	[redacted]
11-391	Airside Operatives	[redacted]	[redacted]	[redacted]
11-392	Landisde Operatives	[redacted]	[redacted]	[redacted]
11-393	Outdoor Cleaners	[redacted]	[redacted]	[redacted]
11-400	Apron Manager	[redacted]	[redacted]	[redacted]
11-320	Maintenance Manager	[redacted]	[redacted]	[redacted]
11-330	Maintenance Facilities	[redacted]	[redacted]	[redacted]
11-332	Plumbing	[redacted]	[redacted]	[redacted]
11-338	Painting	[redacted]	[redacted]	[redacted]
11-348	Maintenance Stores	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]

Source: Aer Rianta

Consistency with the Commission's Determination specifying the maximum levels of airport charges requires there to be two inflation adjustments to the costs extracted from Aer Rianta's General Ledger for 2000. The first was for actual inflation between January and September 2001 (which required some estimation to take account of the period July-September) and the second for the first regulatory year, October 2001 to September 2002.

2.2 Structural Damage Costs

Routine maintenance and repair expenditures do not, however, capture all of the damage costs caused by an additional aircraft movement. There is also damage caused to the basic structure of the runways, taxiways and aprons that leads eventually to their reconstruction. To represent the structural damage costs, we have used as a basis the annualised cost of Aer Rianta's planned airfield upgrade projects over the next ten years at

Dublin Airport, which include apron reconstruction and runway and taxiway overlays.

Aer Rianta has distinguished between airfield upgrade projects that are planned to take place between 2001 and 2006 and those that are planned to take place between 2001 and 2010. Therefore, the excess of the 2001-2010 costs over the 2001-2006 costs represents the costs of projects planned for 2007-2010.

Table 3: Aer Rianta planned airfield upgrade projects for Dublin Airport, 2001-2006.

Project	**2001-2006**	**2001-2010**	**2006-2010**
Apron Reconstruction Runway/Taxiway Overlay	[redacted]	[redacted]	[redacted]
Totals	[redacted]	[redacted]	[redacted]

Source: Aer Rianta

For projects planned for the period 2001-06, the present value of the estimated costs was found by assuming that the capital expenditure will be averaged over the period (in other words, expenditure occurs in 2004 such that n = 3) and that the rate of interest of 7% is equal to Aer Rianta's pre-tax cost of capital. The relevant annuity factor was then divided into this sum to give an annualised cost (over five years such that n = 5) of airfield upgrade projects planned for the period 2001 to 2006.

Table 4: annualised cost of Aer Rianta airfield upgrade projects planned for 2001-06.

For present value: **r = cost of capital = 7%** **n = number of years = 3** **Present value of 1 = 0.816**	***For Annuity Factor:*** **r = Cost of Capital = 7%** **n = number of years = 5** **Annuity factor = 4.1**		
Project	**2001-2006**	**Present Value**	**Annualised Cost**
Apron Reconstruction Runway/Taxiway Overlay	[redacted]	[redacted]	[redacted]
Totals	[redacted]	[redacted]	[redacted]

For projects planned for the period 2007-2010, the present value of the estimated costs was found by assuming that the expenditure will be averaged over the period 2007-10 (in other words, that the expenditure occurs in 2008 such that n = 7), again with the rate of interest equal to Aer Rianta's pre-tax cost of capital. The relevant annuity factor was divided into this sum to give the annualised cost (over 9 years such that n = 9) of airfield upgrade projects planned for the period 2007-10. Note that this capital expenditure component was used only for the purposes of calculating the marginal cost associated with off-peak aircraft movements at Dublin Airport, but is without prejudice to the Commission's future consideration of projects falling outside the period of the current Determination.

Table 5: annualised cost of Aer Rianta airfield upgrade projects planned for 2007-10.

For present value:	***For Annuity Factor:***		
r = cost of capital = 7%	**r = cost of capital = 7%**		
n = number of years = 7	**n = number of years = 9**		
Present value of 1 = 0.623	**Annuity factor = 6.515**		
Project	**2006-2010**	**Present Value**	**Annualised Cost**
Apron Reconstruction	[redacted]	[redacted]	[redacted]
Runway/Taxiway Overlay	[redacted]	[redacted]	[redacted]
Totals	[redacted]	[redacted]	[redacted]

The sum of the annualised cost of projects planned for 2001-06 and the annualised cost of projects planned for 2007-10 is used to represent the annual structural damage costs to runways, taxiways and aprons.

2.3 Damage Allocation

Allocating this total across the movements of different aircraft types required estimates of the proportion of the total damage attributed to each type. Using data provided by Aer Rianta on the number of landings by aircraft type in 2000, Dr. Kieran Feighan (of PMS[5]) calculated, for the Commission, the average damage caused by different categories of these aircraft types.

Every aircraft has an Aircraft Classification Number (ACN), which is an ICAO rating based on the equivalent damage caused by, among other things, different weights, landing gear and tyre pressures of aircraft. A higher ACN indicates a more damaging aircraft and, for the same load, more wheels and lower tyre pressures imply a lower ACN.

The ACN value varies depending upon whether the runway pavement is rigid (concrete) or flexible (bitumen). The value also varies according to ground conditions. Dr. Feighan made the following assumptions for the calculations:

1. The appropriate representative subgrade classification to use for Dublin Airport is C (low strength). The subgrade classification at Dublin airport varies between B (medium) and D (very low). Runway 10/28, associated taxiways and new

[5] Pavement Management Services Ltd., Dublin

aprons would generally be B, most other taxiways have a C classification, while older runways have a D classification;

2. Calculations were done for both rigid and flexible pavements: newer pavements such as runway 10/28, its associated taxiways and aprons are rigid. Most of the other pavements are termed composite (originally rigid, subsequently overlaid with bituminous layers). Dr. Feighan has recommended that, if the Commission wishes only to use one allocation, it should be the rigid damage allocation, as this is representative of the majority of pavements at Dublin Airport.
3. The aircraft categorisation is based on Maximum Take-off Weight (MTOW) and ACN number.

The results of the allocation of damage to aircraft types, based on these assumptions, are detailed in the table 6 below.

Table 6: Dublin Airport Damage allocation.

Aircraft Damage Category	Actual Landings 2000	% Damage to rigid pavements
< 10T	[redacted]	0.001
10-20T	[redacted]	0.038
20-30T	[redacted]	0.019
FK70, BAe146, BA11, RJ85	[redacted]	2.097
FK100, RJ100, TU134, B717	[redacted]	0.957
B737-200,-300,-500,-600; DC9	[redacted]	12.238
A319, A320, B737-400,-700,-800;MD80 Series	[redacted]	18.302
B757, TU154	[redacted]	1.093
A300, A310, DC8	[redacted]	1.005
B727	[redacted]	2.376
A321, MD90	[redacted]	36.716
B767	[redacted]	4.703
L1011, A330	[redacted]	17.810
B747, B777, A340, MD11, DC10	[redacted]	2.645
	72822	**100**

Source: Pavement Management Services Limited (Dr. Kieran Feighan)

2.4 SRMC per Landing/Movement by Aircraft Category

Using the damage allocation in table 6 to allocate the total costs associated with aircraft movements on the runways, taxiways and aprons gave an estimate of the marginal cost associated with a landing aircraft within the aircraft damage categories in table 6.

Using data on the number of landings by individual aircraft type and their Maximum Take-off Weights (MTOWs), it was possible to calculate the total landed weight (in tonnes) for those aircraft types. Dividing the total marginal cost associated with each type by the total weight of landings gave a marginal cost *per tonne* per landing for each aircraft type. (See Appendix I.)

To develop an appropriate charging schedule it was necessary to make a trade-off between simplicity and practicality on the one hand, and complexity and accuracy on the other, by grouping together aircraft types incurring a similar marginal cost per tonne. The following bands were used:

< IR£0.99
IR£1.00 - IR£1.99
IR£2.00 - IR£2.99
IR£3.00 - IR£3.99
> IR£4.00

The calculated (weighted) marginal cost for each band is shown in Table 7. (See Appendix II for details of the calculations and Appendix III for the list of aircraft within each category)

Table 7: weighted marginal cost per tonne per landing by aircraft category

	Weighted marginal cost per tonne per landing
Aircraft Category 1	IR£0.41
Aircraft Category 2	IR£1.71
Aircraft Category 3	IR£2.13
Aircraft Category 4	IR£3.04
Aircraft Category 5	IR£4.33

In view of Aer Rianta's proposal to charge on an aircraft movement basis, we have also expressed the calculations accordingly. The results are shown in table 8.

Table 8: weighted marginal cost per tonne per aircraft movement by aircraft category

	Weighted marginal cost per tonne per aircraft movement
Aircraft Category 1	IR£0.21
Aircraft Category 2	IR£0.86
Aircraft Category 3	IR£1.06
Aircraft Category 4	IR£1.52
Aircraft Category 5	IR£2.16

Making charges reflect these marginal costs of damage should encourage the use of aircraft that cause less pavement damage, at the expense of those that cause more. Over time, Aer Rianta should benefit from a reduction in its annual maintenance and repair expenditure and from an extension to the lives of runway, taxiway and apron pavements.

2.5 The Sub-Cap

The weighted marginal cost per tonne per movement of aircraft within each of the five categories above are the maximum that Aer Rianta can levy by way of charges in respect of the landing and take-off of aircraft during off-peak times at Dublin Airport during the regulatory year beginning on 24 September 2001. These charges will be subject to an annual adjustment as specified in the Commission’s Determination.

3. Defining the Off-Peak Period

3.1 The Approach

In a situation where further capacity expansions are possible, one approach is to define the off-peak period(s) as the inverse of the peak period(s) and to define the latter as those hours for which their forecasted output exceeds the capacity of the existing infrastructure by the time an expansion of capacity is expected to be operational.[6] However, applying this approach strictly would not necessarily allow for the "shifting peak" phenomenon, whereby demand responds to differential pricing leading to changes in the pattern of peak and off-peak periods. In other words, those aircraft currently operating in a peak hour might respond to a lower off-peak charge by shifting into an off-peak hour. This could, in turn, result in the off-peak hour becoming a peak hour, or the hour from which traffic is shifting losing its status as a peak hour.

Aer Rianta suggests that a second parallel runway (to 10/28) will be required by 2007. Therefore, in order to take account of the possibility of "peak shifting", a period has been defined as off-peak if, in 2007, the forecasted number of aircraft movements per 15-minute interval during the period does not exceed an average of 6. Only periods fulfilling this criterion and which are at least of one hour's duration are counted as off-peak periods. Peak shifting would be unlikely to result in these periods becoming peak periods. Choosing forecasted demand for 2007 will, in effect, test the case for a second runway and should send correct signals about the timing of such an investment.

3.2 Capacity

The movements limit at Dublin airport is 40 per hour and 38 per hour in a two-hour period, which, according to a report for the Department of Public Enterprise by the consultants SH&E, is lower than some 'best practice' single runway airports.[7] "SH&E believes that, with the adoption of 'best practice' runway management, the limit might be raised to 44 movements

[6] See First Affidavit of David Starkie sworn on 11 June 1993 on behalf of the Applicants (First Applicant was Air New Zealand) in New Zealand High Court Case CP829/92 and the Defendants (Air New Zealand) in New Zealand High Court Case CP13/93.

[7] See SH&E Limited (April 2001), "Assessment of Capacity of Dublin Airport for Irish Department of Public Enterprise." This report is available from the Commission's website, www.aviationreg.ie

per hour."[8] It is reasonable to assume that Aer Rianta, prior to building a new parallel runway on the scale of 10/28, will take measures to ensure that the existing capacity is being utilised at maximum efficiency. Therefore, we adopt SH&E's 'best practice' capacity as the capacity of the existing runway system at Dublin airport in 2007.

3.3 Total Aircraft Movement Forecasts

The total number of aircraft movements at Dublin Airport was 180,245 in 2000. Based on Aer Rianta's forecasting methodology, there are three forecasts for the total number of aircraft movements in 2007. Given that the number of movements in 2000 exceeded expectations, a revised forecast for 2007 would also result in a higher expected number of aircraft movements than in the original forecast. Therefore, for the sake of consistency, the proportional increase in the expected number of aircraft movements between 2000 and 2007 was calculated on the basis of the expected number of aircraft movements in 2000 from Aer Rianta's original forecast.

Table 9: forecasted percentage increase in the number of aircraft movements between 2000 and 2007

ART Forecasts of Aircraft Operations (Movements) - Dublin			
	2000	2007	% Change
Centreline	[redacted]	[redacted]	24%
High	[redacted]	[redacted]	39%
Low	[redacted]	[redacted]	12%

Source: Aer Rianta

The centreline forecast was used for the purposes of the Commission's Determination and, therefore, we assume that the increase in the number of daily aircraft movements is 24% by 2007.

3.4 Choosing the Representative Busy Day

Capacity expansions are driven by traffic growth during peak periods and determination of those periods requires analysis of aircraft movements

[8] See page 3 of that report.

during a day that is representative of the peak.[9] We adopted the approach of choosing the 30th busiest day. The economic rationale for the standard 30th busiest day is to avoid choosing the peak of the peak because an efficient system will still sometimes experience excess demand and consequent congestion; it is not economically efficient to eliminate congestion entirely.

3.4.1 Application to Dublin Airport

Annual traffic patterns at Dublin airport would appear to be such as to justify a seasonal approach, whereby different peak periods are defined for the summer months (1st May to 31st October) and the winter months (1st November to 30 April). This is consistent with Aer Rianta's proposed new structure of airport charges. Applying the above methodology to this seasonal approach required choice of the 15th busiest of the busy days in each of the six-month periods.

The busiest day of the week throughout the year is predominantly Friday. Of the Fridays during the summer months (1st May to 31st October), September 15th is the 15th busiest. Of the Fridays during the winter months (1st November to 30th April), December 8th is the 15th busiest. These two days are, therefore, considered to be the 15th busiest days of the winter and summer periods respectively. Separate sets of peak periods have been determined on this basis.

3.4.2 Aircraft Movement Distribution on Representative Days

The aircraft movement distributions for each of the representative days show the number of passenger movements (both take-offs and landings) for each 15-minute interval.

Data on non-passenger flights (freight/mail and positioning flights) were insufficiently detailed to allow their direct inclusion in the traffic distributions for the representative days. However, Airport Co-ordination Limited, the airport co-ordinator at Dublin airport, provided the Commission with an hourly non-passenger distribution for a typical busy week during summer 2001 (see Appendix IV). Assuming that the pattern of non-passenger movements on the Friday of that week roughly corresponds to the pattern of non-passenger traffic on each of the

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9 See International Civil Aviation Organisation (ICAO), "Airport Planning Manual, Part 1: Master Planning," Second Edition, 1987, Doc 9184-AN/902 Part 1.

representative days chosen above, we added the forecasted distribution of non-passenger movements in 2007 to the distribution of passenger movements. The results are shown in Appendix V.[10]

It is assumed that general aviation (GA)[11] (for which separate data was not available) has negligible impact. This would seem to be consistent with general aviation's use of runway 11/29, which can (according to ACL) be used simultaneously with the longer runways so that GA does not interfere with the commercial operation of the airport.

3.5 The Daily Off-peak Periods

Section 3.1 outlined the approach to be adopted in defining the off-peak periods, which, when applied to the representative busy days, yields the following:

Table 9: winter and summer daily off-peak periods

Winter	Summer
0000-0744	0000-0559
1545-1744	0800-0859
2115-2359	1500-1629
	1915-2059*
	2130-2359

*The total number of movements during this one-and-a-half hour period exceeds the threshold by just one and, therefore, it has been defined as an off-peak.

3.6 Off-peak Movements Summary

Tables 10 and 11 summarise the numbers and proportions of movements that fall within the defined off-peak periods on the basis of the preceding analysis.[12]

[10] For the purposes of these distributions, where the number of movements in a 15-minute period in the raw distribution exceeded the 15-minute capacity of the system (i.e., eleven movements), that excess was spread across adjacent periods with spare capacity.

[11] General Aviation is defined as 'an aircraft operation other than a commercial air transport operation or an aerial work operation, where commercial air transport refers to the transport of passengers, cargo or mail for remuneration or hire, and where an aerial work operation refers to aircraft operations in which an aircraft is used for specialised services such as agriculture, construction, photography, surveying, observation and patrol, search and rescue, aerial advertisements etc.'

[12] Note that the forecast increase in the number of aircraft movements during off-peak periods between 2000 and 2007 deviates from the centreline forecast of 24%. The centreline forecast was calculated on the basis of the total number of aircraft movements at Dublin Airport, and was then applied to each 15-minute interval during the representative days. Rounding the forecast number of aircraft movements for the 15-minute intervals to the nearest whole number can lead to deviations from the original forecast of 24% during short periods.

Table 10: summary of numbers of movements during winter off-peak periods

Winter: summary of total movements during off-peak periods			
2000		**2007**	
Period	**Movements**	**Period**	**Movements**
0000-0744	31	0000-0744	36
1545-1744	31	1545-1744	46
2100-2359	49	2100-2359	60
Total off-peak	**111**	**Total off-peak**	**142**
Total day	**415**	**Total day**	**508**
Proportion	**26.75%**	**Proportion**	**27.95%**

Table 11: summary of numbers of movements during summer off-peak periods

Summer: summary of total movements during off-peak periods			
2000		**2007**	
Period	**Movements**	**Period**	**Movements**
0000-0559	15	0000-0559	17
0800-0859	17	0800-0859	20
1500-1629	28	1500-1629	34
1915-2059	36	1915-2059	43
2130-2359	25	2130-2359	31
Total off-peak	**106**	**Total off-peak**	**128**
Total day	**477**	**Total day**	**585**
Proportion	**22.22%**	**Proportion**	**21.88%**

4. Conclusion

The airport authority shall ensure that, for the regulatory year beginning on 24 September 2001, the charges in respect of the landing and take-off of aircraft during daily off-peak times at Dublin Airport shall, in respect of the five different aircraft categories referred to in the table below, not exceed the maxima stipulated therein.

	Weighted marginal cost per tonne per aircraft movement
Aircraft Category 1	IR£0.21
Aircraft Category 2	IR£0.86
Aircraft Category 3	IR£1.06
Aircraft Category 4	IR£1.52
Aircraft Category 5	IR£2.16

The aircraft in each category are listed in Appendix III.

The off-peak times are defined as follows:

Winter	**Summer**
0000-0744	0000-0559
1545-1744	0800-0859
2115-2359	1500-1629
	1915-2059
	2130-2359

"Winter" months are from the 1st November to the 30th of April and "summer" months are from the 1st May to the 31st of October.

Appendix I – Calculation of the Marginal Cost per Tonne by Aircraft Type

Aircraft Type	Max take-off Weight (tons)	Landings	Marginal Cost per Landing	Total Marginal Cost by Aircraft Type	MTOW x Landings	Marginal Cost per Tonne by Aircraft Type
A300	142	[redacted]	IR£202.91	[redacted]	[redacted]	IR£1.43
A300203	142	[redacted]	IR£202.91	[redacted]	[redacted]	IR£1.43
A300600	142	[redacted]	IR£202.91	[redacted]	[redacted]	IR£1.43
A300B4	142	[redacted]	IR£202.91	[redacted]	[redacted]	IR£1.43
A310	150	[redacted]	IR£202.91	[redacted]	[redacted]	IR£1.35
A310300	150	[redacted]	IR£202.91	[redacted]	[redacted]	IR£1.35
A310304	150	[redacted]	IR£202.91	[redacted]	[redacted]	IR£1.35
A319	64	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.93
A319100	64	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.93
A319111	64	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.93
A319112	64	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.93
A319114	64	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.93
A320	73.5	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.68
A320200	73.5	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.68
A320211	73.5	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.68
A320212	73.5	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.68
A320214	73.5	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.68
A320231	73.5	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.68
A320232	73.5	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.68
A321	83	[redacted]	IR£251.64	[redacted]	[redacted]	IR£3.03
A321131	83	[redacted]	IR£251.64	[redacted]	[redacted]	IR£3.03
A321132	83	[redacted]	IR£251.64	[redacted]	[redacted]	IR£3.03
A321200	83	[redacted]	IR£251.64	[redacted]	[redacted]	IR£3.03
A321211	83	[redacted]	IR£251.64	[redacted]	[redacted]	IR£3.03
A321231	83	[redacted]	IR£251.64	[redacted]	[redacted]	IR£3.03
A330	212	[redacted]	IR£457.29	[redacted]	[redacted]	IR£2.16
A330200	212	[redacted]	IR£457.29	[redacted]	[redacted]	IR£2.16
A330243	212	[redacted]	IR£457.29	[redacted]	[redacted]	IR£2.16
A330301	212	[redacted]	IR£457.29	[redacted]	[redacted]	IR£2.16
A340312	260	[redacted]	IR£839.74	[redacted]	[redacted]	IR£3.23
AN12	61	[redacted]	IR£123.83	[redacted]	[redacted]	IR£2.03
AN24	21.8	[redacted]	IR£0.53	[redacted]	[redacted]	IR£0.02
ARJ		[redacted]	IR£0.53	[redacted]	[redacted]	
ATP	23.7	[redacted]	IR£0.53	[redacted]	[redacted]	IR£0.02
ATR42	16.7	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.02
ATR42300	16.7	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.02
ATR72	21.5	[redacted]	IR£0.53	[redacted]	[redacted]	IR£0.02
B717	51.71	[redacted]	IR£23.17	[redacted]	[redacted]	IR£0.45
B727	72.57	[redacted]	IR£403.17	[redacted]	[redacted]	IR£5.56
B727256	95.04	[redacted]	IR£403.17	[redacted]	[redacted]	IR£4.24
B727276	95.04	[redacted]	IR£403.17	[redacted]	[redacted]	IR£4.24
B737	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B737200	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B737222	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B737229	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54

B7372YF	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B737300	56.74	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.50
B737329	56.74	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.50
B737330	56.74	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.50
B73733A	56.74	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.50
B73736	56.74	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.50
B737382	56.74	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.50
B7373S3	56.74	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.50
B7373Y5	56.74	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.50
B7373YO	56.74	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.50
B737400	68.04	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.41
B737429	68.04	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.41
B737448	68.04	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.41
B73746B	68.04	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.41
B7374Q8	68.04	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.41
B7374YO	68.04	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.41
B737500	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B737505	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B737529	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B737530	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B737548	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B73755S	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B7375K5	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B7375L9	52.39	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.54
B737600	56.24	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.50
B737683	56.24	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.50
B737700	70.08	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.40
B7377AK	70.08	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.40
B7377L9	70.08	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.40
B737800	70.53	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.40
B73785H	70.53	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.40
B73785P	70.53	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.40
B73786N	70.53	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.40
B737883	70.53	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.40
B7378K2	70.53	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.40
B7378Q8	70.53	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.40
B747	340.195	[redacted]	IR£839.74	[redacted]	[redacted]	IR£2.47
B747128	340.195	[redacted]	IR£839.74	[redacted]	[redacted]	IR£2.47
B747200	377.84	[redacted]	IR£839.74	[redacted]	[redacted]	IR£2.22
B747400	362.875	[redacted]	IR£839.74	[redacted]	[redacted]	IR£2.31
B757	108.86	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.48
B757200	108.86	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.48
B757217	108.86	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.48
B757224	108.86	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.48
B757236	108.86	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.48
B75723A	108.86	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.48
B75723N	108.86	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.48
B75727B	108.86	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.48
B75728A	108.86	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.48
B7572Q8	108.86	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.48
B7572T7	108.86	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.48

B767	175.54	[redacted]	IR£354.36	[redacted]	[redacted]	IR£2.02
B767200	175.54	[redacted]	IR£354.36	[redacted]	[redacted]	IR£2.02
B767204	175.54	[redacted]	IR£354.36	[redacted]	[redacted]	IR£2.02
B767300	175.54	[redacted]	IR£354.36	[redacted]	[redacted]	IR£2.02
B767304E	175.54	[redacted]	IR£354.36	[redacted]	[redacted]	IR£2.02
B767332	175.54	[redacted]	IR£354.36	[redacted]	[redacted]	IR£2.02
B7673Q8	175.54	[redacted]	IR£354.36	[redacted]	[redacted]	IR£2.02
B777	233.6	[redacted]	IR£839.74	[redacted]	[redacted]	IR£3.59
BA11	40.153	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.24
BA11501	40.153	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.24
BA11510	40.153	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.24
BA11523	40.153	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.24
BA11530	40.153	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.24
BA146300	38.1	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.25
BA41	10.895	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.02
BA46200	42.185	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.23
BA46300	44.225	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.21
BAE146	42.185	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.23
BAE14610	38.1	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.25
BAE14620	42.185	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.23
BAE14630	44.225	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.21
BAE146RJ	44.225	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.21
BAEATP	23.678	[redacted]	IR£0.53	[redacted]	[redacted]	IR£0.02
BAEJ41	10.895	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.02
BAERJ85	43.998	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.22
CL60	18.201	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.01
CL600	18.201	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.01
CL6002B	18.201	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.01
CL65	18.201	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.01
CRJ	34.02	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.28
DO82		[redacted]		[redacted]	[redacted]	
D328	13.99	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.02
D328110	14.99	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.02
DC10	263.085	[redacted]	IR£839.74	[redacted]	[redacted]	IR£3.19
DC1030	263.085	[redacted]	IR£839.74	[redacted]	[redacted]	IR£3.19
DC862F	151.95	[redacted]	IR£202.91	[redacted]	[redacted]	IR£1.34
DC9	54.885	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.51
DC941	54.885	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.51
DC951	54.885	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.51
DC980	54.885	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.51
DC982	54.885	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.51
DC983	54.885	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.51
DC987	54.885	[redacted]	IR£28.11	[redacted]	[redacted]	IR£0.51
DH8	21.32	[redacted]	IR£0.53	[redacted]	[redacted]	IR£0.02
DHC7	21.32	[redacted]	IR£0.53	[redacted]	[redacted]	IR£0.02
DHC8	21.32	[redacted]	IR£0.53	[redacted]	[redacted]	IR£0.02
E110	5.9	[redacted]	IR£0.04	[redacted]	[redacted]	IR£0.01
EMB110	5.9	[redacted]	IR£0.04	[redacted]	[redacted]	IR£0.01
EMB145	22	[redacted]	IR£0.53	[redacted]	[redacted]	IR£0.02
F100	45.81	[redacted]	IR£23.17	[redacted]	[redacted]	IR£0.51
F50	19.5	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.01

F70	36.47	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.26
FK100	45.81	[redacted]	IR£23.17	[redacted]	[redacted]	IR£0.51
FK50	19.5	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.01
FK70	36.47	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.26
L1011	211.375	[redacted]	IR£457.29	[redacted]	[redacted]	IR£2.16
L10111	211.375	[redacted]	IR£457.29	[redacted]	[redacted]	IR£2.16
L101114	211.375	[redacted]	IR£457.29	[redacted]	[redacted]	IR£2.16
L1011385	211.375	[redacted]	IR£457.29	[redacted]	[redacted]	IR£2.16
L610	14.4	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.02
MD11	273.314	[redacted]	IR£839.74	[redacted]	[redacted]	IR£3.07
MD80	67.81	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.83
MD81	67.81	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.83
MD82	67.81	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.83
MD83	67.81	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.83
MD87	67.81	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.83
MD87H	67.81	[redacted]	IR£123.83	[redacted]	[redacted]	IR£1.83
MD90	78.245	[redacted]	IR£251.64	[redacted]	[redacted]	IR£3.22
MD9030	78.245	[redacted]	IR£251.64	[redacted]	[redacted]	IR£3.22
PA23	2.36	[redacted]	IR£0.04	[redacted]	[redacted]	IR£0.02
PA31	1.633	[redacted]	IR£0.04	[redacted]	[redacted]	IR£0.02
RJ100	46.039	[redacted]	IR£23.17	[redacted]	[redacted]	IR£0.50
RJ85	43.998	[redacted]	IR£9.49	[redacted]	[redacted]	IR£0.22
SAAB2000	22.8	[redacted]	IR£0.53	[redacted]	[redacted]	IR£0.02
SB20		[redacted]	IR£0.53	[redacted]	[redacted]	
SD360		[redacted]	IR£0.27	[redacted]	[redacted]	
SF34	13.155	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.02
SH36	12.292	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.02
SH360	12.292	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.02
SH360100	12.292	[redacted]	IR£0.27	[redacted]	[redacted]	IR£0.02
TU134	47	[redacted]	IR£23.17	[redacted]	[redacted]	IR£0.49
TU154	100	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.52
TU154B	100	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.52
TU154M	100	[redacted]	IR£52.44	[redacted]	[redacted]	IR£0.52
Totals		**72,822**		[redacted]	[redacted]	

Appendix II - Calculation of the Weighted Marginal Cost per Tonne per Movement by Aircraft Category

Aircraft Category 1

Marginal Cost per Tonne by Aircraft Type	Aircraft Type	Maximum take-off Weight (tons)	Landings	MTOW x Landings	Total Marginal Cost by Aircraft Type
IR£0.01	E110	5.9	[redacted]	[redacted]	[redacted]
IR£0.01	EMB110	5.9	[redacted]	[redacted]	[redacted]
IR£0.01	F50	19.5	[redacted]	[redacted]	[redacted]
IR£0.01	FK50	19.5	[redacted]	[redacted]	[redacted]
IR£0.01	CL65	18.201	[redacted]	[redacted]	[redacted]
IR£0.01	CL60	18.201	[redacted]	[redacted]	[redacted]
IR£0.01	CL600	18.201	[redacted]	[redacted]	[redacted]
IR£0.01	CL6002B	18.201	[redacted]	[redacted]	[redacted]
IR£0.02	PA23	2.36	[redacted]	[redacted]	[redacted]
IR£0.02	ATR42	16.7	[redacted]	[redacted]	[redacted]
IR£0.02	ATR42300	16.7	[redacted]	[redacted]	[redacted]
IR£0.02	D328110	14.99	[redacted]	[redacted]	[redacted]
IR£0.02	L610	14.4	[redacted]	[redacted]	[redacted]
IR£0.02	D328	13.99	[redacted]	[redacted]	[redacted]
IR£0.02	SF34	13.155	[redacted]	[redacted]	[redacted]
IR£0.02	SH360	12.292	[redacted]	[redacted]	[redacted]
IR£0.02	SH36	12.292	[redacted]	[redacted]	[redacted]
IR£0.02	SH360100	12.292	[redacted]	[redacted]	[redacted]
IR£0.02	PA31	1.633	[redacted]	[redacted]	[redacted]
IR£0.02	ATP	23.7	[redacted]	[redacted]	[redacted]
IR£0.02	BAEATP	23.678	[redacted]	[redacted]	[redacted]
IR£0.02	SAAB2000	22.8	[redacted]	[redacted]	[redacted]
IR£0.02	EMB145	22	[redacted]	[redacted]	[redacted]
IR£0.02	AN24	21.8	[redacted]	[redacted]	[redacted]
IR£0.02	ATR72	21.5	[redacted]	[redacted]	[redacted]
IR£0.02	DH8	21.32	[redacted]	[redacted]	[redacted]
IR£0.02	DHC7	21.32	[redacted]	[redacted]	[redacted]
IR£0.02	DHC8	21.32	[redacted]	[redacted]	[redacted]
IR£0.02	BA41	10.895	[redacted]	[redacted]	[redacted]
IR£0.02	BAEJ41	10.895	[redacted]	[redacted]	[redacted]
IR£0.21	BAE14630	44.225	[redacted]	[redacted]	[redacted]
IR£0.21	BA46300	44.225	[redacted]	[redacted]	[redacted]
IR£0.21	BAE146RJ	44.225	[redacted]	[redacted]	[redacted]
IR£0.22	RJ85	43.998	[redacted]	[redacted]	[redacted]
IR£0.22	BAERJ85	43.998	[redacted]	[redacted]	[redacted]
IR£0.23	BA46200	42.185	[redacted]	[redacted]	[redacted]
IR£0.23	BAE14620	42.185	[redacted]	[redacted]	[redacted]
IR£0.23	BAE146	42.185	[redacted]	[redacted]	[redacted]
IR£0.24	BA11	40.153	[redacted]	[redacted]	[redacted]
IR£0.24	BA11523	40.153	[redacted]	[redacted]	[redacted]
IR£0.24	BA11530	40.153	[redacted]	[redacted]	[redacted]
IR£0.24	BA11501	40.153	[redacted]	[redacted]	[redacted]
IR£0.24	BA11510	40.153	[redacted]	[redacted]	[redacted]

IR£0.25	BA146300	38.1	[redacted]
IR£0.25	BAE14610	38.1	[redacted]
IR£0.26	FK70	36.47	[redacted]
IR£0.26	F70	36.47	[redacted]
IR£0.28	CRJ	34.02	[redacted]
IR£0.40	B73785H	70.53	[redacted]
IR£0.40	B73786N	70.53	[redacted]
IR£0.40	B7378Q8	70.53	[redacted]
IR£0.40	B737800	70.53	[redacted]
IR£0.40	B73785P	70.53	[redacted]
IR£0.40	B737883	70.53	[redacted]
IR£0.40	B7378K2	70.53	[redacted]
IR£0.40	B7377L9	70.08	[redacted]
IR£0.40	B737700	70.08	[redacted]
IR£0.40	B7377AK	70.08	[redacted]
IR£0.41	B737448	68.04	[redacted]
IR£0.41	B737400	68.04	[redacted]
IR£0.41	B737429	68.04	[redacted]
IR£0.41	B73746B	68.04	[redacted]
IR£0.41	B7374Q8	68.04	[redacted]
IR£0.41	B7374YO	68.04	[redacted]
IR£0.45	B717	51.71	[redacted]
IR£0.48	B757200	108.86	[redacted]
IR£0.48	B757217	108.86	[redacted]
IR£0.48	B757236	108.86	[redacted]
IR£0.48	B75727B	108.86	[redacted]
IR£0.48	B75728A	108.86	[redacted]
IR£0.48	B7572Q8	108.86	[redacted]
IR£0.48	B7572T7	108.86	[redacted]
IR£0.48	B757224	108.86	[redacted]
IR£0.48	B75723A	108.86	[redacted]
IR£0.48	B75723N	108.86	[redacted]
IR£0.48	B757	108.86	[redacted]
IR£0.49	TU134	47	[redacted]
IR£0.50	B737300	56.74	[redacted]
IR£0.50	B737329	56.74	[redacted]
IR£0.50	B737330	56.74	[redacted]
IR£0.50	B73733A	56.74	[redacted]
IR£0.50	B73736	56.74	[redacted]
IR£0.50	B737382	56.74	[redacted]
IR£0.50	B7373S3	56.74	[redacted]
IR£0.50	B7373Y5	56.74	[redacted]
IR£0.50	B7373YO	56.74	[redacted]
IR£0.50	B737683	56.24	[redacted]
IR£0.50	B737600	56.24	[redacted]
IR£0.50	RJ100	46.039	[redacted]
IR£0.51	F100	45.81	[redacted]
IR£0.51	FK100	45.81	[redacted]
IR£0.51	DC941	54.885	[redacted]
IR£0.51	DC951	54.885	[redacted]
IR£0.51	DC980	54.885	[redacted]

IR£0.51	DC982	54.885	[redacted]	[redacted]	[redacted]
IR£0.51	DC983	54.885	[redacted]	[redacted]	[redacted]
IR£0.51	DC987	54.885	[redacted]	[redacted]	[redacted]
IR£0.51	DC9	54.885	[redacted]	[redacted]	[redacted]
IR£0.52	TU154M	100	[redacted]	[redacted]	[redacted]
IR£0.52	TU154	100	[redacted]	[redacted]	[redacted]
IR£0.52	TU154B	100	[redacted]	[redacted]	[redacted]
IR£0.54	B737	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B737200	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B737229	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B7372YF	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B737500	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B737505	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B737529	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B737530	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B737548	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B73755S	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B7375K5	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B737222	52.39	[redacted]	[redacted]	[redacted]
IR£0.54	B7375L9	52.39	[redacted]	[redacted]	[redacted]
				[redacted]	[redacted]

Charge per Tonne per Landing	**IR£0.41**
Charge per Tonne per Movement	**IR£0.21**

Aircraft Category 2

Marginal Cost per Tonne by Aircraft Type	Aircraft Type	Maximum take-off Weight (tons)	Landings	MTOW x Landings	Total Marginal Cost by Aircraft Type
IR£1.34	DC862F	151.95	[redacted]	[redacted]	[redacted]
IR£1.35	A310	150	[redacted]	[redacted]	[redacted]
IR£1.35	A310300	150	[redacted]	[redacted]	[redacted]
IR£1.35	A310304	150	[redacted]	[redacted]	[redacted]
IR£1.43	A300	142	[redacted]	[redacted]	[redacted]
IR£1.43	A300203	142	[redacted]	[redacted]	[redacted]
IR£1.43	A300600	142	[redacted]	[redacted]	[redacted]
IR£1.43	A300B4	142	[redacted]	[redacted]	[redacted]
IR£1.68	A320	73.5	[redacted]	[redacted]	[redacted]
IR£1.68	A320200	73.5	[redacted]	[redacted]	[redacted]
IR£1.68	A320212	73.5	[redacted]	[redacted]	[redacted]
IR£1.68	A320231	73.5	[redacted]	[redacted]	[redacted]
IR£1.68	A320211	73.5	[redacted]	[redacted]	[redacted]
IR£1.68	A320214	73.5	[redacted]	[redacted]	[redacted]
IR£1.68	A320232	73.5	[redacted]	[redacted]	[redacted]
IR£1.83	MD80	67.81	[redacted]	[redacted]	[redacted]
IR£1.83	MD81	67.81	[redacted]	[redacted]	[redacted]
IR£1.83	MD83	67.81	[redacted]	[redacted]	[redacted]
IR£1.83	MD87	67.81	[redacted]	[redacted]	[redacted]
IR£1.83	MD82	67.81	[redacted]	[redacted]	[redacted]
IR£1.83	MD87H	67.81	[redacted]	[redacted]	[redacted]

IR£1.93	A319	64	[redacted]	[redacted]	[redacted]
IR£1.93	A319100	64	[redacted]	[redacted]	[redacted]
IR£1.93	A319111	64	[redacted]	[redacted]	[redacted]
IR£1.93	A319112	64	[redacted]	[redacted]	[redacted]
IR£1.93	A319114	64	[redacted]	[redacted]	[redacted]
				[redacted]	[redacted]

Charge per Tonne per Landing **IR£1.71**
Charge per Tonne per Movement **IR£0.86**

Aircraft Category 3

Marginal Cost per Tonne by Aircraft Type	Aircraft Type	Maximum take-off Weight (tons)	Landings	MTOW x Landings	Total Marginal Cost by Aircraft Type
IR£2.02	B767	175.54	[redacted]	[redacted]	[redacted]
IR£2.02	B767200	175.54	[redacted]	[redacted]	[redacted]
IR£2.02	B767204	175.54	[redacted]	[redacted]	[redacted]
IR£2.02	B767300	175.54	[redacted]	[redacted]	[redacted]
IR£2.02	B767304E	175.54	[redacted]	[redacted]	[redacted]
IR£2.02	B767332	175.54	[redacted]	[redacted]	[redacted]
IR£2.02	B7673Q8	175.54	[redacted]	[redacted]	[redacted]
IR£2.03	AN12	61	[redacted]	[redacted]	[redacted]
IR£2.16	A330200	212	[redacted]	[redacted]	[redacted]
IR£2.16	A330	212	[redacted]	[redacted]	[redacted]
IR£2.16	A330243	212	[redacted]	[redacted]	[redacted]
IR£2.16	A330301	212	[redacted]	[redacted]	[redacted]
IR£2.16	L1011	211.375	[redacted]	[redacted]	[redacted]
IR£2.16	L10111	211.375	[redacted]	[redacted]	[redacted]
IR£2.16	L101114	211.375	[redacted]	[redacted]	[redacted]
IR£2.16	L1011385	211.375	[redacted]	[redacted]	[redacted]
IR£2.22	B747200	377.84	[redacted]	[redacted]	[redacted]
IR£2.31	B747400	362.875	[redacted]	[redacted]	[redacted]
IR£2.47	B747	340.195	[redacted]	[redacted]	[redacted]
IR£2.47	B747128	340.195	[redacted]	[redacted]	[redacted]
				[redacted]	[redacted]

Charge per Tonne per Landing **IR£2.13**
Charge per Tonne per Movement **IR£1.06**

Aircraft Category 4

Marginal Cost per Tonne by Aircraft Type	Aircraft Type	Maximum take-off Weight (tons)	Landings	MTOW x Landings	Total Marginal Cost by Aircraft Type
IR£3.03	A321200	83	[redacted]	[redacted]	[redacted]
IR£3.03	A321231	83	[redacted]	[redacted]	[redacted]
IR£3.03	A321	83	[redacted]	[redacted]	[redacted]
IR£3.03	A321131	83	[redacted]	[redacted]	[redacted]
IR£3.03	A321132	83	[redacted]	[redacted]	[redacted]
IR£3.03	A321211	83	[redacted]	[redacted]	[redacted]

IR£3.07	MD11	273.314	[redacted]	[redacted]	[redacted]
IR£3.19	DC1030	263.085	[redacted]	[redacted]	[redacted]
IR£3.19	DC10	263.085	[redacted]	[redacted]	[redacted]
IR£3.22	MD90	78.245	[redacted]	[redacted]	[redacted]
IR£3.22	MD9030	78.245	[redacted]	[redacted]	[redacted]
IR£3.23	A340312	260	[redacted]	[redacted]	[redacted]
IR£3.59	B777	233.6	[redacted]	[redacted]	[redacted]
				[redacted]	[redacted]
Charge per Tonne per Landing					**IR£3.04**
Charge per Tonne per Movement					**IR£1.52**

Aircraft Category 5

Marginal Cost per Tonne by Aircraft Type	Aircraft Type	Maximum take-off Weight (tons)	Landings	MTOW x Landings	Total Marginal Cost by Aircraft Type
IR£4.24	B727256	95.04	[redacted]	[redacted]	[redacted]
IR£4.24	B727276	95.04	[redacted]	[redacted]	[redacted]
IR£5.56	B727	72.57	[redacted]	[redacted]	[redacted]
				[redacted]	[redacted]
Charge per Tonne per Landing					**IR£4.33**
Charge per Tonne per Movement					**IR£2.16**

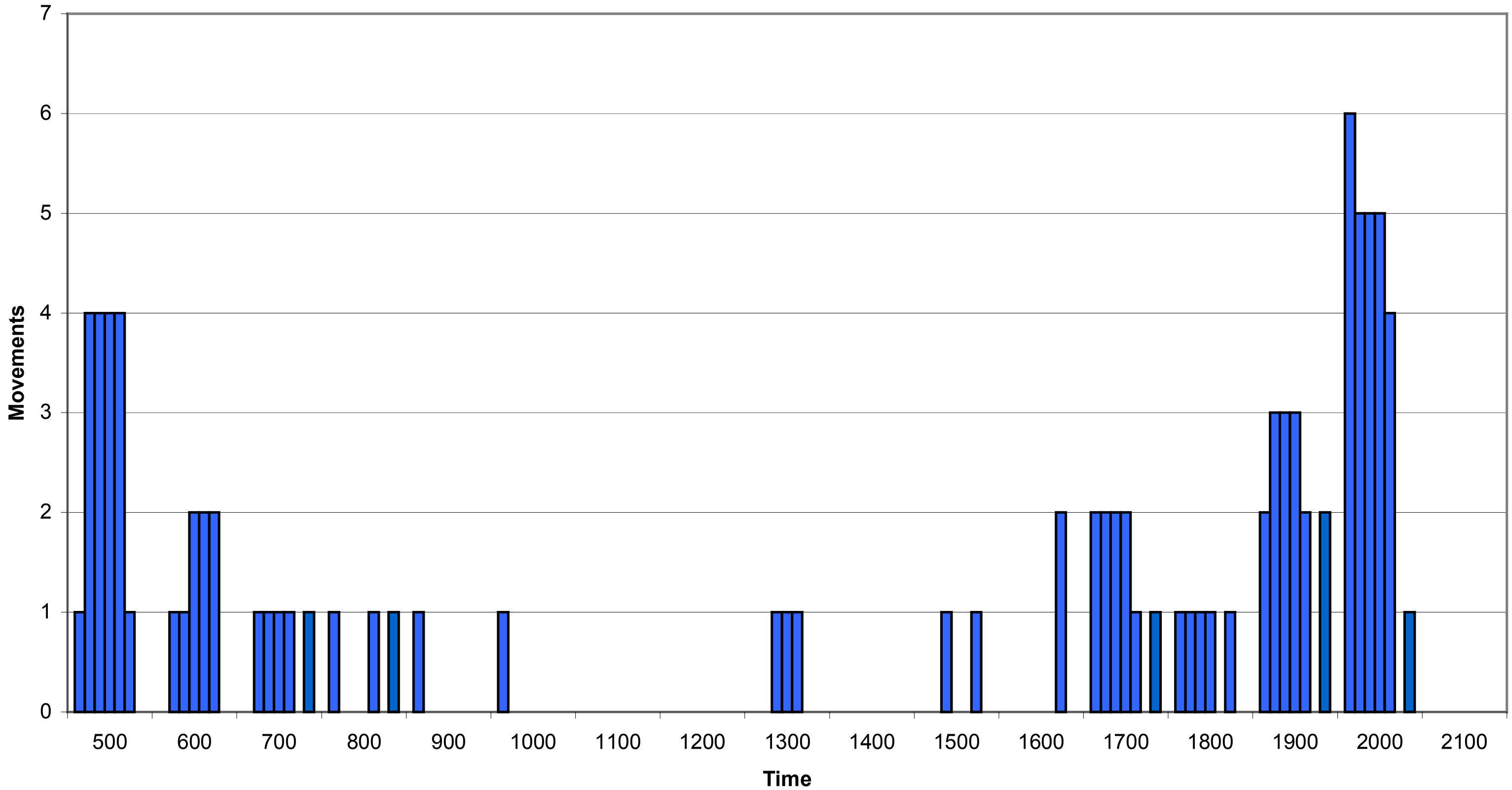
Appendix III – Aircraft Categories

Aircraft Category 1				
AN24	B737500	B75723N	CRJ	RJ85
ATP	B737505	B75727B	D328	SAAB2000
ATR42	B737529	B75728A	D328110	SF34
ATR42300	B737530	B7572Q8	DC9	SH36
ATR72	B737548	B7572T7	DC941	SH360
B717	B73755S	BA11	DC951	SH360100
B737	B7375K5	BA11501	DC980	TU134
B737200	B7375L9	BA11510	DC982	TU154
B737222	B737600	BA11523	DC983	TU154B
B737229	B737683	BA11530	DC987	TU154M
B7372YF	B737700	BA146300	DH8	
B737300	B7377AK	BA41	DHC7	
B737329	B7377L9	BA46200	DHC8	
B737330	B737800	BA46300	E110	
B73733A	B73785H	BAE146	EMB110	
B73736	B73785P	BAE14610	EMB145	
B737382	B73786N	BAE14620	F100	
B7373S3	B737883	BAE14630	F50	
B7373Y5	B7378K2	BAE146RJ	F70	
B7373YO	B7378Q8	BAEATP	FK100	
B737400	B757	BAEJ41	FK50	
B737429	B757200	BAERJ85	FK70	
B737448	B757217	CL60	L610	
B73746B	B757224	CL600	PA23	
B7374Q8	B757236	CL6002B	PA31	
B7374YO	B75723A	CL65	RJ100	

Aircraft Category 2		Aircraft Category 3		Aircraft Category 4	Aircraft Category 5
A300	A320200	A330	B767200	A321	B727
A300203	A320211	A330200	B767204	A321131	B727256
A300600	A320212	A330243	B767300	A321132	B727276
A300B4	A320214	A330301	B767304E	A321200	
A310	A320231	AN12	B767332	A321211	
A310300	A320232	B747	B7673Q8	A321231	
A310304	DC862F	B747128	L1011	A340312	
A319	MD80	B747200	L10111	B777	
A319100	MD81	B747400	L101114	DC10	
A319111	MD82	B767	L1011385	DC1030	
A319112	MD83			MD11	
A319114	MD87			MD90	
A320	MD87H			MD9030	

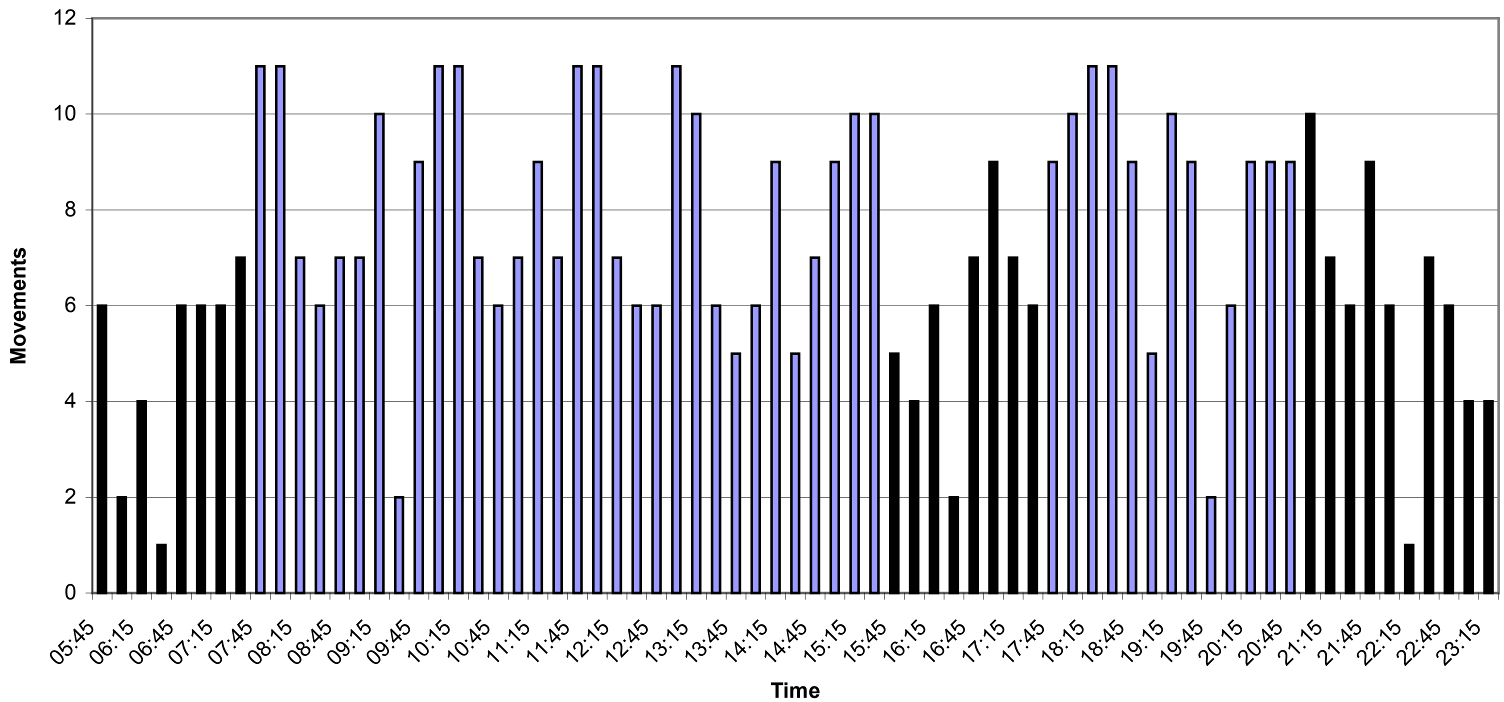
Appendix IV – Non-passenger Movements Distribution by Hourly Intervals

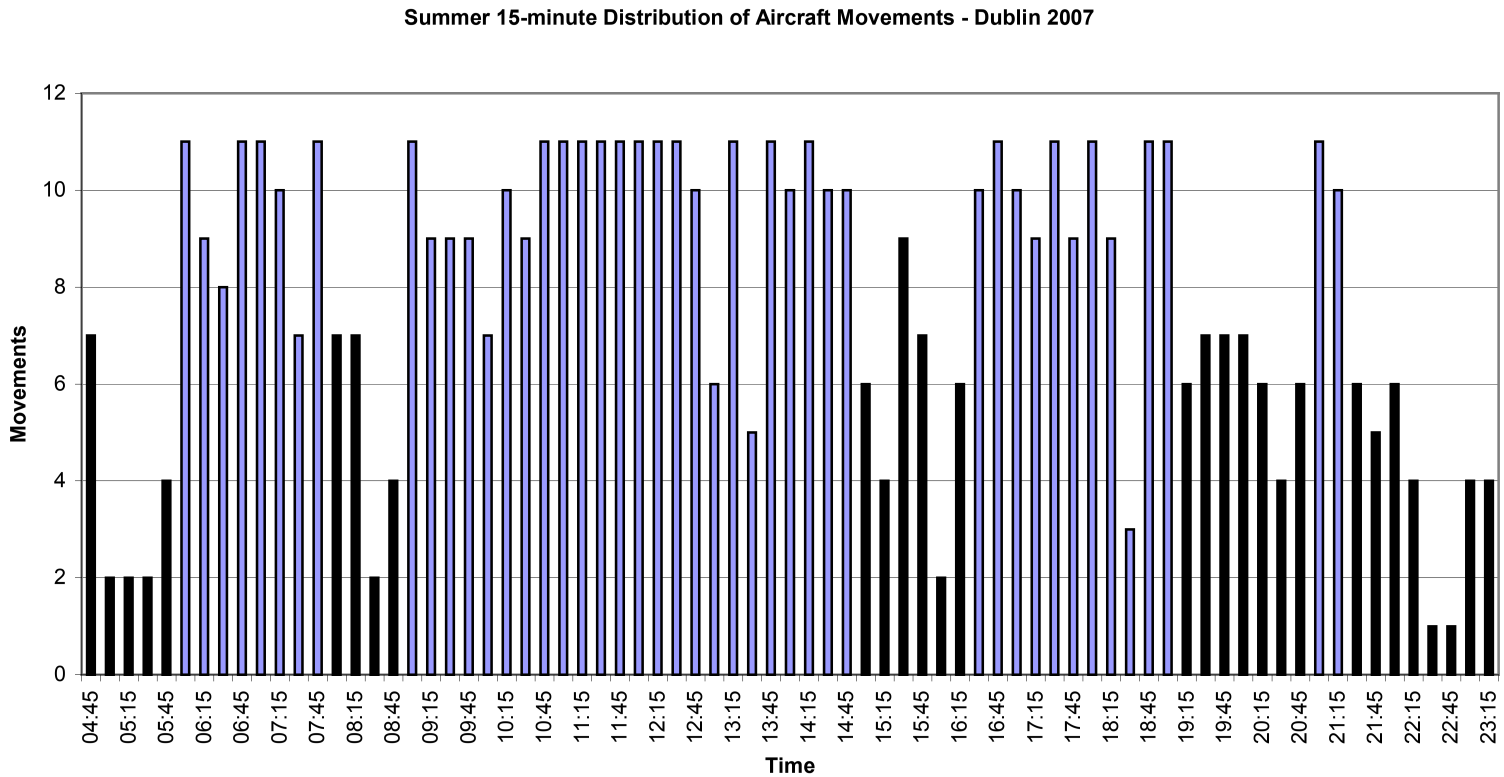
DUBLIN SUMMER 2001
Non-Passenger Flights (Freight/Mail and Positioning flights)
Source: Airport Co-ordination Limited (ACL)



Appendix V – Total Aircraft Movement Distributions by 15-minute Intervals

Winter 15-minute Distribution of Aircraft Movements - Dublin 2007




Summer 15-minute Distribution of Aircraft Movements - Dublin 2007
Movements
0
2
4
6
8
10
12
Time
04:45
05:15
05:45
06:15
06:45
07:15
07:45
08:15
08:45
09:15
09:45
10:15
10:45
11:15
11:45
12:15
12:45
13:15
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19:45
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20:45
21:15
21:45
22:15
22:45
23:15