Annex 1: Methodology

A1.1 This annex describes the data and methodology employed by the Department of Environment, Transport and the Regions in the 1997 forecast of air traffic. The basic procedure consists of regressing traffic on its determinants, such as GDP, prices, exchange rates and trade, to obtain the relationship between these variables. This relationship is then used, by inserting forecast values of the explanatory variables, to obtain future values of air traffic.

Data Sources

A1.2 For the purpose of forecasting air traffic is broken up into several markets cross-tabulating long and short haul travel, UK and foreign residency and business and leisure. The traffic data for the international market sectors was obtained from the International Passenger Survey (IPS) carried out by the Department of National Heritage (published by HMSO in the Business Monitor M6). The IPS provides data on tourist traffic at UK airports according to trip purpose, nationality and origin and destination. This allows the forecast of traffic of individual market sectors which may have differing relationships with the explanatory variables. The data for the domestic market sectors was obtained from the CAA Annual Statistics.

A1.3 Non-tourist traffic such as diplomats and airline and military personnel are excluded from the IPS traffic figures, as are passengers to North Sea oil rigs and airside interlining passengers. Growth rates are applied to the 1995 values of these air traffic categories (obtained from the CAA Annual Statistics) to forecast total international traffic (Table 3.1). A residual is then added to this total to ensure that the final figure is consistent with the CAA total figure. Channel Tunnel diversion rates have been applied to all short haul market sectors.

A1.4 IPS 'tourist' traffic data is split into different market sectors according to destination, nationality of traveller and purpose of visit. Sixteen international traffic forecasting models are estimated. For the 1994 forecasts long haul data was split between OECD destinations and non-OECD destinations. For the Department's 1997 forecasts however it was decided to split non-OECD destinations into Newly Industrialised (Asian) Countries (NIC's) and Less Developed Countries (LDC's). This was thought to be appropriate due to the different economic situations in these countries, resulting in different relationships between air traffic and its determinants. The split of non-OECD data into NIC's and LDC's should result in more accurate traffic forecasts for long haul markets.

A1.5 UK GDP, consumer expenditure and the Retail Price Index were taken from issues of "Economic Trends". Overseas trade data was obtained from the "Monthly review of External Trade Statistics". Foreign GDP, exchange rates and foreign consumer price indices were taken from IMF Annual Yearbooks of "International Financial Statistics". Fares data was obtained from the CAA and IPS yearbooks.

A1.6 Data on fares actually paid by air passengers from the IPS was used in estimating all UK residency models. This provides a more accurate reflection of the effect of fares on air travel, as using published fares data is increasingly misleading due to the volume and variety of discount air fares on offer. This data is not as yet available for foreign passengers.

A1.7 For all sixteen international market sectors, indices were constructed for fares, exchange rates, foreign GDP and trade volumes using a weighting procedure, with the weight attached to any country depending on the traffic flow by type and trip purpose to/from that country relative to the total traffic for that market sector.

Channel Tunnel diversion forecasts

A1.8 The Channel Tunnel diversion forecasts are based on estimated diversion rates of passengers from air to rail for particular routes. These diversion rates have been revised considerably since the (former) DOT 1994 forecasts, based on recent developments in the Channel Tunnel rail and relevant air markets.

A1.9 As actual short haul air traffic in 1995 reflected the effects of diversion an estimate of diversion in 1995 was added to this figure to obtain a base year total to which forecast growth rates could be applied. Diversion rates were then applied to forecast air traffic in the absence of Channel Tunnel rail services and forecast numbers of air passengers diverting to rail services obtained.

A1.10 A study of the market indicated diversion to rail services on the London-Paris route has been substantial and some diversion has also taken place on the London-Brussels route. The market share of rail on the London-Brussels and London-Paris routes has been steadily increasing since services initially began towards the end of 1994. By October 1996, two years after services were introduced, rail travel accounted for 63% of the combined (rail-air) London-Paris market and 53% of the London-Brussels market. It appears that as yet diversion on routes to other destinations and from regional points of origin in the UK has not taken place to any significant extent.

A1.11 The relationship between rail journey times and rail/air market shares used to derive Channel Tunnel diversion rates for the 1994 forecasts was modified using experience to date, and new diversion rates derived. These diversion rates were applied to routes likely to experience significant diversion over the forecast period due to the introduction of new high speed links reducing journey times considerably. These were London-Brussels, Paris, Amsterdam, Cologne, Dusseldorf and 'Other', consisting primarily of traffic between London-Antwerp and London-Rotterdam. The diversion rates and the routes to which they were applied are similar to those used by other organisations.

A1.12 Analysis of experience on other routes where air and rail compete suggest that there is likely to be some further diversion, even in the absence of rail journey time reductions, as public awareness of services increases to its ceiling. This has been taken into account in estimating diversion rates for 2000 on the London-Paris and London-Brussels routes.

A1.13 Diversion rates, for leisure and business markets, are applied to routes where diversion is likely to be significant. This is currently the London-Paris and London-Brussels routes. With the introduction of further high speed links, notably the Brussels link and the CTRL, by 2000 and 2005 respectively, it is likely that, for leisure traffic at least, diversion on the London-Amsterdam and London-Cologne and Dusseldorf routes will also be significant. Diversion from Manchester and Birmingham to Brussels, Paris, Amsterdam, Cologne and Dusseldorf was also forecast.

A1.14 As further high speed rail links are introduced throughout Europe, particularly the Channel Tunnel Rail Link between London and Folkestone, and journey times decrease, diversion is likely to increase on existing routes and become evident on some new routes, for example London-Frankfurt, where diversion is at present insignificant. Without more detailed information on these links however it is not possible to estimate diversion rates.

A1.15 Leisure air traffic on all routes is expected to be affected more than business traffic, as the former is less time sensitive. A number of other factors in addition to journey times are also likely to affect future diversion rates such as relative convenience and ease of access and egress from stations. The impact of these has not been taken account of in calculating diversion rates for these forecasts.

A1.16 Due to the longer rail journey times and therefore relatively smaller journey time reductions as a result of high speed rail links, diversion on routes from regional points of origin in the UK is expected to be less than diversion on routes to/from London, although still significant. In calculating diversion rates from the regions it was assumed that there would be some reduction in rail journey times to and from London due mainly to improvements on the West Coast Main Line. It must be noted that there may be further service improvements and rail journey time reductions that have not been foreseen and therefore not modelled in deriving these diversion estimates. Such improvements would increase diversion from air to rail.

A1.17 It is important when calculating diversion rates, actual and forecast, to take account of airside interlining traffic which is effectively 'non-divertable' traffic i.e. airside transfer passengers are far less likely to consider rail travel than 'point to point' passengers as to do so would lengthen journey times considerably. Airside interlining traffic on particularly the London-Paris and London-Amsterdam routes accounts for a significant proportion of total air traffic. In calculating future diversion rates, airside interlining traffic (assumed to grow at the same rate as foreign traffic) has been deducted from the forecast of air traffic in the hypothetical 'no Channel Tunnel' scenario.

A1.18 The relationship between rail journey times and rail air market shares used to calculate the diversion rates is based on rail fares 95-100% the level of air fares. This has broadly been the case since Channel Tunnel rail services began operation and is assumed to remain so over the forecast period. This results in one set of diversion rates being applied to the high and low economic growth scenarios used to provide the range for forecast air traffic. This range should prove adequate to incorporate uncertainty about consumer preferences, frequency of services, marketing strategies, networks etc.

Econometric analysis and forecasting procedure

A1.19 Econometric analysis forms the basis of the forecasting equations used by the Department. The models used to calculate the 1997 forecasts took as their starting point the specifications used in the 1994 forecasts

A1.20 Individual models were specified for each of the sixteen international market sectors and three domestic market sectors. The models included a number of variables as determinants of air traffic such as GDP, trade, air fares, and exchange rates. All econometric analysis involves a number of judgements on such issues as the functional form of the equations and the period over which relationships are to be estimated. Such judgements were based on economic theory, research into specific issues such as market maturity and the statistical performance of the models estimated. For example, research into air travel market maturity indicates that a constant elasticity log-log model best represents business markets while many leisure markets, particularly those for UK residents, are consistent with declining elasticities and exponential models.

A1.21 Recent developments in econometric theory include using the Hendry approach to model specification/estimation and dealing with the problem of non-stationary variables (variables that display a deterministic or stochastic trend). Hendry methodology advocates a more thorough and precise approach to model specification/estimation and removing trends in variables is necessary for Ordinary Least Squares (OLS) estimation to be valid. Both of these principles were applied in estimating the equations used to produce these forecasts.

A1.22 The models estimated were error correction models that allow the short run dynamics and long run solutions to be estimated at the same time. These models use the difference between the previous periods traffic and its determinants (the 'error' term) as one of the determinants of current traffic. Examples of the models used are given below. Equation (1) is a basic example of the log-log form of model used to forecast business traffic. This functional form produces income elasticities that are constant over time, implying that the market for travel for business purposes is not approaching saturation or maturity. While this is broadly consistent with past experience it was felt that there would be some decline in growth rates towards the end of the forecast period. This decline was allowed for by adjusting the forecasts using the ratio $1/(Pax_t/Pax_{1995})^{0.15}$.

$\Delta\ln(Pax)_{t-1} + \alpha_3\Delta\ln(GDP)_t + \alpha_4\ln(Pax)_{t-1} + \alpha_5\ln(GDP)_{t-1} + \varepsilon t$

Δ is the difference operator i.e. $\Delta\ln(Pax)_t = \ln(Pax)_t - \ln(Pax)_{t-1}$. This is done to remove the stochastic trend to make the variable stationary.

The long run solution to the above equation is given by: $\ln(Pax) = \alpha_1 + \alpha_5/-\alpha_4\ln(GDP)$

The long run (constant) income elasticity is given by $\alpha_4/-\alpha_5$

$Ln(Pax)_t$ = natural logarithm of passengers at UK airports by market segment in period t

GDP_t = Gross Domestic Product

εt = error term in period t

A1.23 Equation (2) is an example of an exponential transformation model incorporating declining income elasticities (to reflect market maturity) that was used to estimate most leisure markets. The exponent k determines the degree of decline of income elasticity. The higher the value of k the greater the decline in income elasticity over time and the more mature the market.

(2) $\Delta Pax^k_t = \beta_1 + \beta_2 \Delta \ln(GDP)_t + \beta_3 Pax^k_t{-1} + \beta_4 \ln(GDP)_{t-1} + \varepsilon t$

The long run solution is given by: $Pax^k = \beta_1 + \beta_4/{-\beta_3}\ln(GDP)$

The long run (declining) income elasticity is given by $(\beta_4/{-\beta_3})/k{*}Pax^k$

A1.24 For OLS estimation to be valid it is necessary that all variables in the equation are stationary. First differencing is usually required to make variables (with a stochastic trend) stationary and this was tested for using Augmented Dickey-Fuller tests. The difference between the previous periods air traffic and, in the simple example given above, GDP (the error term) is stationary if these variables are cointegrated i.e. there exists a long run equilibrium relationship between them. This was tested for using the Johansen Maximum Likelihood test.

A1.25 Broadly following the Hendry approach to econometric modelling, all possible determinants of air traffic, such as those mentioned above, were included in the initial estimation and omitted systematically if they proved to be insignificant.

A1.26 Dummy variables were used where necessary and coincided with international events such as the bombing of Libya and the Gulf War that had significant 'one off' effects on air travel in those years. A dummy variable for 1992 was used in some equations as the relationship between GDP and air traffic was temporarily disturbed in that year. This was because high levels of air traffic, due to 'catch up' following the previous years very low levels of air traffic (the result of the Gulf War), coincided with negative growth in UK GDP.

A1.27 As mentioned above the models were estimated using OLS estimation and were subjected to a range of tests for statistical adequacy such as serial correlation, heteroscedasticity, normality and functional form. The models also passed Chow and Predictive Failure tests for structural stability. All models used to obtain the 1997 Air Traffic Forecasts were statistically adequate and consistent with economic theory.

A1.28 Results were consistent with what one would expect to observe - GDP was a significant determinant of all air traffic, trade and exchange rates were mostly significant in business market models and air fares were a significant determinant of most leisure traffic. Long run income and price elasticities calculated from the model specifications were consistent with economic theory. Income elasticities were approximately 2 and price elasticities, where relevant, were between -0.5 and -1.0.

Miscellaneous traffic categories

A1.29 The IPS air traffic data on which most of the information included in these Air Traffic Forecasts is based, excludes three categories of air traffic and a residual difference between CAA and IPS figures. The three categories are: North Sea oil rig traffic; non tourist traffic; and airside interliners. Growth rates were applied to these categories and a residual added to obtain a figure comparable to CAA figures.

The growth rates applied to the categories listed above were as follows:

1. In the 'high growth' scenario there was assumed to be no growth in oil rig traffic over the entire forecast period. In the 'low growth' scenario traffic was assumed to decline by 1.5% p.a. between 1996 and 2001, by 1.08% between 2001 and 2006 and zero growth/decline was assumed between 2006 and 2015. These growth rates are based on estimates of employment in the oil sector prepared by Aberdeen City Council and Aberdeenshire Council.

2. Airside interliners were assumed to grow at the same rate as total foreign traffic.

3. Non-tourist traffic (diplomatic, military and airline personnel) was assumed to grow at the same rate as tourist traffic.

The residual term was assumed to remain constant in absolute terms throughout the forecast period, in line with past experience.

Domestic traffic

A1.30 Domestic traffic is divided into three market sectors: traffic between London and regional airports, traffic between the regional airports and traffic to the Channel Islands. The regression analysis and forecast procedure adopted followed that applied to the international markets, described above.

A1.31 All domestic traffic markets were modelled using declining elasticity exponential models as it was assumed these markets were approaching maturity. The degree of market maturity/income elasticity decline was judged to be greater in the case of Channel Islands traffic and was modelled accordingly. Significant determinants of domestic traffic were UK GDP and air fares.

Summary of differences between methodologies used in the 1994 and 1997 forecasts

A1.32 The econometric methodology employed by the Department in calculating the 1997 Air Traffic Forecasts is very similar to that used to calculate the 1994 forecasts. However, air traffic in 1995 was used as the base year to which forecast growth rates were applied for the 1997 forecasts while 1992 was used as the base year for the 1994 forecasts.

A1.33 The availability of an extra three years' data in the estimation of the models used to produce the 1997 Air Traffic Forecasts inevitably results in slightly different forecasting models to those used for the 1994 forecasts. However none of the models were altered significantly. This is indicative of the robustness of the models used to forecast air traffic in 1994. The same model specifications were used to forecast the individual markets but in some cases some modification was required, such as a slight change in the value of the exponent (see equation (2) above) used to forecast some leisure markets.

A1.34 For the estimation of forecasting models, total air traffic from UK airports is disaggregated into individual markets by destination region. For the 1997 Air Traffic Forecasts it was decided to split the non-OECD traffic category used previously into Newly Industrialised Countries (NIC's) and Less Developed Countries (LDC's). Due to the different economic situations in these countries it is very likely that the relationship between GDP and air travel is different. Separating these regions for model estimation allows a more accurate reflection of the individual markets' characteristics.

A1.35 As mentioned above, the relationship between rail journey times and rail/air market shares used to calculate Channel Tunnel diversion was revised. The routes on which diversion was considered to take place were also amended. Higher diversion *rates* were assumed for the 1997 Air Traffic Forecasts but less routes were considered likely to be affected by Eurostar services.

A1.36 In the 1994 forecasts the higher estimate of diversion was deducted from air traffic in the 'Low' demand scenario and vice versa. For the 1997 forecasts however high diversion was associated with the 'High' demand scenario as diversion was assumed to occur in proportion to air traffic growth.