Competition Act 1998

No Grounds for Action Decision

No. MPINF-PSWA001 – 04

Alleged abuse of a dominant position by Flybe Limited

Annexe A – Market Definition Catchment Profile Analysis and Event Study

(Case MPINF-PSWA001)

OFT1286

Please note that [...] indicates figures or text which have been deleted or replaced in ranges at the request of the parties or third parties for reasons of commercial confidentiality.

ANNEXE A - MARKET DEFINITION CATCHMENT PROFILE ANALYSIS AND EVENT STUDY

CATCHMENT PROFILES

A.1 The OFT observes that the majority of the catchment area for the Flybe Focal routes is in Devon, with a minority of passengers coming from the counties of Somerset, Dorset, Cornwall and Avon. Table A1 below shows the proportions of passengers travelling on the Flybe Focal routes from Exeter Airport who originate in each county.

Table A.1: Exeter Airport catchment on the Flybe Focal routes

County	Number of Exeter Airport passengers	Proportion of Exeter Airport passengers
Avon	4,506	1.9%
Cornwall	17,933	7.4%
Devon	199,796	82.9%
Dorset	6,274	2.6%
Somerset	12,478	5.1%

Source: CAA 2008 survey data

A.2 For major airports, the CAA collects survey data from passengers.[1] The OFT has used some of this data to analyse the overlap in catchment areas between Bristol Airport and Exeter Airport for the Focal routes. In the OFT's view, the degree of catchment area overlap[2] is not a direct measure of market power as it does not directly provide information on the sensitivity of passengers to price. However, in accordance with the reasoning set out by the Competition Commission in its BAA Airports

[1] The CAA publishes reports based on its passenger surveys and can provide bespoke information on request. See www.caa.co.uk

[2] Catchment overlap refers to the degree to which an airline at one airport draws passengers from the catchment of an airline at another airport.

market investigation,[3] the OFT considers that it can be used to identify approximately the passengers who are likely to be marginal (likely to switch airports in response to a price rise at either airport). If everyone in a given area uses one airport exclusively, the OFT considers that it is probable that these passengers will be less likely to switch in response to a price change than if a large proportion of the passengers in that area make use of another airport. Consequently, in the OFT's view, the significance of the overlap between the two airports' catchment areas can be informative of the likely degree of competition between flights from the two airports.

A.3 The OFT has analysed the overlap in the catchment areas of Bristol Airport and Exeter Airport on the Focal routes following a similar approach to that used by the Competition Commission in the BAA Airports market investigation. In its analysis, the Competition Commission identified the proportion of passengers of a certain airport that were 'exposed' to competition from another airport, as those that came from districts where the other airport had an overall share of passengers above a certain threshold (the district share threshold). This proportion gives a measure of the degree of catchment area overlap (termed 'inter-airport exposure' in the Competition Commission BAA Airports market investigation).[4]

A.4 The OFT considers that the interpretation that the overlap in catchment areas is a reasonable indicator of 'marginal passengers' is predicated on the assumption that there is significant geographic differentiation between the two airports (that is, passengers' choice of airport is significantly determined by their point of origin). The OFT considers that this assumption is reasonable based on the particular facts of this case. The airports are approximately one hour and 15 minutes' drive time

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[3] Competition Commission report, *BAA airports market investigation - A report on the supply of airport services by BAA in the UK*, dated 19 March 2009, paragraph 3.39 - see www.competition-commission.org.uk/rep_pub/reports/2009/fulltext/545.pdf

[4] Ibid, paragraph 3.43.

apart with no large centres of population in between. As a result of this, most passengers are likely to face a significant difference in costs, in terms of time taken to get to the airport and/or the cost of fares on public transport, to travel to either airport. In the OFT's view, this difference in costs is likely to have a significant impact on passenger preferences and consequently their choice of airport.

A.5 Given that the vast majority of the catchment for Exeter Airport originates in the counties of Devon and Cornwall (see Table A1), the OFT considers that the large difference in travel times and costs between the airports from these counties suggests that the constraint of flights from Bristol Airport is likely to be weak, all other matters being equal. In the OFT's view, this is particularly so relative to a one-hour flight time to domestic destinations. That said, this observation on its own does not take into account other factors, such as the relative frequency of flights offered on the routes, which may cause passengers to travel to Bristol Airport despite the greater travel time and cost.

A.6 To analyse the extent of the catchment overlap in the results that follow, the OFT has used the Competition Commission 'exposure' methodology with a district share threshold of 20 per cent. The reported 'catchment exposure' is therefore the proportion of all passengers travelling from Exeter Airport (on the route in question) who come from districts where the airline at Bristol Airport has a greater than 20 per cent share.

A.7 The OFT acknowledges that this choice of threshold is somewhat arbitrary, but considers that the methodology serves to give an indication of the likely extent of competition, rather than to provide an absolute test. Therefore, the OFT has interpreted cautiously the calculated catchment exposures, and has made additional detailed reference to the location of the 'exposed' districts and to the county-level passengers shares for each airport. Consequently, the OFT's conclusions are not sensitive to the choice of threshold used.

A.8 The following table reports the catchment area exposure for the aggregated Focal routes. The OFT has also identified the districts which are 'exposed', and the passenger shares of the airlines at the two airports at a county level.[5]

Table A.2: Catchment exposure for aggregated Focal routes

20% Catchment exposure	'Exposed' districts (Bristol Airport has a greater than 20% share)	Flybe (Exeter Airport) passenger numbers and shares				
		Avon	Cornwall	Devon	Dorset	Somerset
46%	• Avon - all districts • Cornwall - all districts except North Cornwall • Devon - North Devon, Plymouth, Torbay, Torridge, West Devon • Dorset - all districts • Somerset - all districts	4,506 (1%)	17,933 (75%)	199,796 (80%)	6,274 (40%)	12,478 (12%)
		Aggregated Bristol Airport passenger numbers and shares				
		487,603 (99%)	6,147 (25%)	48,772 (20%)	9,417 (60%)	94,553 (88%)

Source: CAA passenger survey, OFT calculations

A.9 In the OFT's view, the results show a large degree of overlap between the two catchment areas. Using the 20 per cent threshold, a significant proportion of passengers at Exeter Airport appear to be 'exposed to competition' from Bristol Airport (marginal passengers). Based on this evidence, the OFT considers there seems likely to be competition between airlines at both airports on these routes, when considered in aggregate.

A.10 The tables below report the catchment area exposure for each individual route. The OFT notes that a danger in disaggregating the catchment area analysis by route and by district is that some districts may have low samples of passengers lowering the statistical significance of the results. That said, with the exceptions of Leeds Bradford and

[5] These shares only consider passengers from Exeter Airport and Bristol Airport, not Plymouth Airport and Newquay Airport.

Manchester, the overall survey samples for each route have more than 50 passengers for both Bristol Airport and Exeter Airport[6] and the variation in results across the routes is, in the OFT's view, striking. The OFT considers that the share of passengers at a county level can be employed as a useful sense check to verify these results.

Table A.3: Catchment exposure and passenger shares for Dublin

20% Catchment exposure	'Exposed' districts (Bristol Airport has a greater than 20% share)	Flybe (Exeter Airport) passenger numbers and shares				
		Avon	Cornwall	Devon	Dorset	Somerset
98%	All districts except: • Mid Devon • Cornwall - Karrier, Carrick, North Cornwall	0 (0%)	1,983 (54%)	24,018 (48%)	653 (25%)	1,686 (4%)
		Aggregated Bristol Airport passenger numbers and shares				
		149,659 (100%)	1,676 (46%)	26,363 (52%)	1,974 (75%)	39,165 (96%)

Source: CAA passenger survey, OFT calculations

A.11 For the Dublin route, the catchment area exposure is very high (98 per cent) with large numbers of Bristol Airport passengers travelling from Devon. The OFT considers that this suggests that a large proportion of the passengers are likely to be responsive to relative price changes at the two airports. Therefore, the OFT considers that flights from Bristol Airport are extremely likely to constrain flights from Exeter Airport on this route.

[6] Except for Leeds Bradford (31 Bristol passengers and 91 Exeter passengers surveyed) and Manchester (only 40 Bristol Airport passengers and 299 Exeter Airport passengers surveyed).

Table A.4: Catchment exposure and passenger shares for Guernsey

20% Catchment exposure	'Exposed' districts (Bristol Airport has a greater than 20% share)	Flybe (Exeter Airport) passenger numbers and shares				
		Avon	Cornwall	Devon	Dorset	Somerset
15%	• Avon - all districts • Mid Devon • Somerset - all districts • Cornwall - Carrick	1,359 (9%)	3,091 (95%)	14,964 (96%)	1,480 (100%)	1,329 (31%)
		Aggregated Bristol Airport passenger numbers and shares				
		13,465 (91%)	136 (5%)	631 (4%)	0 (0%)	2,938 (69%)

Source: CAA passenger survey, OFT calculations

A.12 For the Guernsey route, the catchment area exposure is 15 per cent. The OFT considers that, from this figure alone, it would be difficult to infer that flights from Bristol Airport are not a constraint. However, the OFT notes that the vast majority of this exposure arises from a sizeable proportion (10 per cent) of Exeter Airport passengers originating in Avon and Somerset. On the other routes the OFT observes that the proportion of Exeter Airport passengers coming from these counties is negligible. Further, the OFT notes that Bristol Airport has a negligible share of Devon passengers (four per cent). The OFT considers the fact that Exeter Airport's catchment area is larger and encroaches into Avon on this route suggests that flights from Bristol Airport are likely to be a weak constraint.

Table A.5: Catchment exposure and passenger shares for Glasgow

20% Catchment exposure	'Exposed' districts (Bristol Airport has a greater than 20% share)	Flybe (Exeter Airport) passenger numbers and shares				
		Avon	Cornwall	Devon	Dorset	Somerset
26%	• Avon - all districts • Cornwall - Carrick, Carradon • Devon - Mid Devon, North Devon, West Devon, Torbay • Dorset - all districts • Somerset - all districts	127 (0%)	3,995 (56%)	30,495 (74%)	349 (20%)	1,576 (8%)
		Aggregated Bristol Airport passenger numbers and shares				
		142,044 (100%)	3,201 (44%)	10,887 (26%)	1,357 (80%)	17,143 (92%)

Source: CAA passenger survey, OFT calculations

A.13 For the Glasgow route, the catchment area exposure is 26 per cent, which is higher than for Guernsey. However, apropos the Glasgow route, the OFT notes this is largely because of significant numbers of Bristol Airport passengers originating in Devon. The OFT considers that this evidence suggests that flights from Bristol Airport are likely to be a constraint. However, in the OFT's view, this evidence, considered alone, is not strong enough to draw a clear-cut conclusion.

Table A.6: Catchment exposure and passenger shares for Jersey

20% Catchment exposure	'Exposed' districts (Bristol Airport has a greater than 20% share)	Flybe (Exeter Airport) passenger numbers and shares				
		Avon	Cornwall	Devon	Dorset	Somerset
13%	• Avon - all districts • Devon - N Devon • Somerset - Sedgemore	2,665 (11%)	2,164 (94%)	24,673 (98%)	731 (100%)	3,747 (62%)
		Aggregated Bristol Airport passenger numbers and shares				
		22,305 (89%)	140 (6%)	523 (2%)	0 (0%)	2,282 (38%)

Source: CAA passenger survey, OFT calculations

A.14 In the OFT's view, the catchment analysis for the Jersey route should be treated with some caution, as both Flybe and ASW operate flights to Jersey from Bristol Airport. However, the OFT considers that such analysis still serves to show the level of competition between airlines at the two airports. The catchment area exposure is 13 per cent. As for Guernsey the exposure has arisen from a sizeable proportion of Exeter Airport passengers originating in Avon (eight per cent), although Bristol Airport has a very small share of Somerset passengers travelling to Jersey. In the OFT's view, Exeter Airport's larger catchment size suggests, as it did for flights to Guernsey, that flights to Jersey from Bristol Airport are likely to be a weak constraint.

Table A.7: Catchment exposure and passenger shares for Leeds Bradford

20% Catchment exposure	'Exposed' districts (Bristol Airport has a greater than 20% share)	Flybe (Exeter Airport) passenger numbers and shares				
		Avon	Cornwall	Devon	Dorset	Somerset
3%	• Somerset - Taunton Deane	0 (0%)	8,610 (100%)	16,950 (100%)	341 (100%)	761 (14%)
		Aggregated Bristol Airport passenger numbers and shares				
		25,789 (100%)	0 (0%)	0 (0%)	0 (0%)	4,794 (86%)

Source: CAA passenger survey, OFT calculations

A.15 For the Leeds Bradford route the sample size is small (only 31 passengers travelling from Bristol Airport and 91 from Exeter Airport). However, the OFT considers that the lack of overlap between the catchment areas of the two airports is striking - the catchment areas only overlap very marginally in Taunton Deane in Somerset. Elsewhere, Bristol Airport serves Avon and Exeter Airport serves Devon and Cornwall. In the OFT's view, this quite strongly suggests that there is no constraint from flights at Bristol Airport on this route.

Table A.8: Catchment exposure and passenger shares for Manchester

20% Catchment exposure	'Exposed' districts (Bristol Airport has a greater than 20% share)	Flybe (Exeter Airport) passenger numbers and shares				
		Avon	Cornwall	Devon	Dorset	Somerset
0%	None	0 (0%)	1,398 (58%)	47,759 (98%)	1,718 (100%)	1,643 (28%)
		Aggregated Bristol Airport passenger numbers and shares				
		21,245 (100%)	994 (42%)	894 (2%)	0 (0%)	4,280 (72%)

Source: CAA passenger survey, OFT calculations

A.16 For the Manchester route, the sample size is similarly small (only 40 passengers travelling from Bristol Airport and 299 from Exeter Airport). As with the Leeds Bradford route, however, the OFT notes there is no overlap between the catchment areas of the two airports. In the OFT's view, this suggests that flights from Bristol Airport are unlikely to be a competitive constraint.

Table A.9: Catchment exposure and passenger shares for Newcastle

20% Catchment exposure	'Exposed' districts (Bristol Airport has a greater than 20% share)	Flybe (Exeter Airport) passenger numbers and shares				
		Avon	Cornwall	Devon	Dorset	Somerset
26%	• Avon - all districts • Devon - M Devon, South Hams, Torbay, Torridge • Dorset - all districts • Somerset - all districts	353 (0%)	4,443 (100%)	40,936 (81%)	1,001 (18%)	1,733 (7%)
		Aggregated Bristol Airport passenger numbers and shares				
		113,096 (100%)	0 (0%)	9,475 (19%)	6,086 (82%)	23,951 (93%)

Source: CAA passenger survey, OFT calculations

A.17 For the Newcastle route, the OFT considers that the 26 per cent exposure is fairly significant. It arises from significant numbers of passengers travelling from Bristol Airport originating in Devon. As with the Glasgow route, the OFT interprets this as suggesting that flights from Bristol Airport are likely to be a constraint.

EVENT STUDY

Methodology

A.18 The OFT has sought to further assess the constraint imposed by flights from Bristol Airport on the Focal routes by conducting an econometric 'event study'.[7] This event study analyses competitive interaction between the airlines on the routes in question. It looks at the impact of changes in capacity at Bristol Airport on competitive parameters at Exeter Airport such as passenger numbers, yields and revenue per flight. An increase in capacity on a route at Bristol Airport leading to lower passenger numbers, yields or revenue per flight at Exeter Airport is an indicator of competitive interaction between the airlines at either airport.[8]

A.19 Similar methodologies to analyse airline competition have previously been applied by other competition authorities. In the Competition Commission's market investigation of BAA airports,[9] an econometric analysis was conducted to see whether yields across a range of routes fell at one airport when there was an increase in capacity[10] at a

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[7] Econometric studies have been used to assess competitiveness between airports. For example Commission Decision of 27 June 2007, *Ryanair/Aer Lingus* [2008] OJ C 47/05.

[8] Competition Commission, BAA Airlines Market Investigation, *Working paper on analysis of airline yield data* (May 2008), paragraph 2.8 - see www.competition-commission.org.uk/inquiries/ref2007/airports/pdf/working_paper_airline_yield_data.pdf

[9] Ibid.

[10] Capacity in this context refers to the frequency of flights offered by an airline on a particular route for a period of time

potentially substitutable airport. The analysis here differs from that of the Competition Commission in the following ways:

- The Competition Commission's analysis only focused on the impact of changes in capacity at one airport on the yield at the potentially substitutable airport. This study considers the impact of changes in capacity in one airport (in this case Bristol Airport) not only on yield but also on the passenger numbers and the revenue per flight at the potentially substitutable airport (in this case Exeter Airport).

- The Competition Commission's analysis was conducted by using panel data analysis that allowed the treatment of route specific effects. This enabled the Competition Commission to make an inference of the substitutability of the airports overall. In this analysis, the OFT is interested in the evidence of competition on specific routes. Therefore, it has conducted time series analyses on each individual route.

A.20 The OFT has considered in further detail how, if the airlines at the two airports are in competition with one another, competitive parameters at Exeter Airport should be affected by the capacity at Bristol Airport. These competitive parameters are passenger numbers, revenue per flight and average fares.

A.21 With regard to passenger numbers at Exeter Airport, the OFT considers that an increase in capacity at Bristol Airport will have a negative impact on the number of passengers at Exeter Airport, if the airlines at the two airports are competing. This is both because passengers will have a greater choice in flight times at Bristol Airport and because an increase in capacity at Bristol Airport may lead to a reduction in fares offered at Bristol Airport.

A.22 With regard to the revenue per flight at Exeter Airport, the OFT considers that an increase in capacity at Bristol Airport will have a negative impact on the revenue per flight at Exeter Airport if both airports are competing. The reason is that an increase in capacity at

Bristol Airport should lead to reduced passenger numbers at Exeter Airport, which should in turn directly lead to reduced revenue per flight.

A.23 With regard to the average fares at Exeter Airport, the OFT considers that the effect of changes in capacity at Bristol Airport may be both more indirect and potentially may be of an indeterminate direction in the short term. Following a similar logic to the previous competitive indicators, the OFT considers that if both airports are competing, an increase in capacity at Bristol Airport will lead to fewer passengers at Exeter Airport. In a competitive equilibrium, fares at Exeter Airport would be expected to fall to meet the reduced demand. However, both Flybe and its competitors at Bristol Airport price discriminate by charging higher fares to passengers who book later using revenue management models.[11] In the short term, the OFT considers that it is possible that increased capacity at one airport could cause more price sensitive passengers to switch. This may raise the average fare but lower the number of passengers per flight (the load factor), and the revenue per flight. While the overall effect of increasing capacity at one airport should be put downwards pressure on fares at the other airport if airlines at either airport are competing, the timing and immediate direction of the effect on average fares is somewhat unclear.

A.24 These hypotheses can be tested econometrically for each route using reduced form equations of the form:

$$YieldExt_t = \alpha + \beta_1(CapBristol)_t + \beta_2(CapExeter)_t + cT + \varepsilon_t,$$

[11] Airlines do not set one price for each flight but may price discriminate across fare classes and across time. The marginal costs of putting an extra passenger on a flight are small, so revenue management systems are used to ensure that prices are set to extract the maximum possible revenue for each flight. Demand is uncertain beforehand, and as the flight is filled up the airlines will tend to raise prices and reserve capacity for more price insensitive customers, for example, business passengers who tend to book later and be inflexible about time. Similarly airlines may reallocate seats to more expensive categories depending on how quickly the capacity is booked. Information on Flybe's revenue management models can be found at the Flybe's response to section 26 dated on 11 January 2010.

$$PaxExt_t = \alpha + \beta_1(CapBristol)_t + \beta_2(CapExeter)_t + cT + \varepsilon_t,$$
$$RvExtFly_t = \alpha + \beta_1(CapBristol)_t + \beta_2(CapExeter)_t + cT + \varepsilon_t,$$

A.25 Subscripts 't' denote the time period for each observation. 'YieldExt' is the average price charged at Exeter Airport. 'PaxExt' is the number of passengers flying from Exeter Airport on that route. 'RvExtFly' is the Flybe's revenue at Exeter Airport for each route. 'CapBristol' is the capacity at Bristol Airport. 'CapExeter' is the capacity at Exeter Airport. T is a trend and a dummy variable for the summer season. The error is given by ε.

A.26 A negative and statistically significant coefficient on the capacity at Bristol Airport indicates that routes from the two airports are competing.[12] The capacity term at Exeter Airport will control for changes in market demand that are predicted by Flybe.[13]

Data

A.27 To carry out its analysis, the OFT has used monthly information from the CAA on frequencies of flights, seating capacity and passenger numbers on the routes at Exeter Airport and Bristol Airport since 1996. In addition to this, Flybe has provided monthly information on revenues, passengers and capacities on its routes from Exeter Airport.[14] From the monthly revenues and passenger numbers the OFT has calculated average prices (yields).

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[12] Competition Commission, BAA Airlines Market Investigation, *Working paper on analysis of airline yield data* (May 2008) available at www.competition-commission.org.uk/inquiries/ref2007/airports/pdf/working_paper_airline_yield_data.pdf

[13] Ibid, paragraph 6.10.

[14] Annex 1 - 7 of Flybe's response to OFT's, section 26, notice dated 30 September 2009.

Results and interpretation

A.28 Ordinary least squares (OLS) regressions have been carried out for six out of the seven focal routes. For Jersey, this part of the analysis was not carried out as Flybe is the principal airline operating on this route at Bristol Airport, triangulating its service via Exeter Airport, and as such would be expected to make its capacity and pricing decisions at the two airports jointly, rather than in competition.

A.29 Before estimating the regressions, the OFT has checked that the variables are stationary.[15] Running regressions using non-stationary variables may find a statistical relationship that is significant when in reality it might not be. This is known as spurious regression.[16]

A.30 The Augmented Dickey Fuller (ADF) test is used to test for stationarity.[17] The data are all logarithmically transformed to enable interpretation of the coefficients as proportional effects. Table A10 below summarises the results of the ADF tests. It shows that some of the variables are non stationary.

[15] A stationary variable is a weakly dependent time series process that, when used in regression analysis, satisfies the law of large numbers and the central limit theorem. Source: Wooldridge, J. M., 2002, 'Econometric Analysis of Cross Section and Panel Data' page 797

[16] Granger C., 1981, 'Some Properties of Time Series Data and Their Use in Econometric Model Specification', Journal of Econometrics 16: page 121 - 130

[17] For further reference of the ADF test see Wooldridge, J. M. 2002, 'Econometric Analysis of Cross Section and Panel Data' page 578.

Table A.10 Augmented Dickey Fuller (ADF) unit root test for stationarity

Route Variable	Dublin	Glasgow	Guernsey	Leeds Bradford	Manchester	Newcastle
Yield at Exeter	Stationary	Stationary	Non-stationary	Non-Stationary	Stationary	Non-Stationary
t Statistic	-3.89	-4.76	-2.31	-3.10	-3.71	-3.19
P value	0.01	0.00	0.42	0.10	0.02	0.09
Pax at Exeter	Stationary	Non-stationary	Non-stationary	Stationary	Stationary	Non-Stationary
t Statistic	-3.63	-2.27	-3.06	-3.42	-3.44	-2.63
P value	0.03	0.45	0.12	0.05	0.05	0.26
Flybe revenue at Exeter	Stationary	Stationary	Stationary	Stationary	Stationary	Non-stationary
t Statistic	-4.37	-3.50	-4.94	-3.90	-4.62	-2.33
P value	0.00	0.04	0.00	0.01	0.00	0.42
Capacity at Bristol	Stationary	Non-stationary	Stationary	Stationary	Stationary	Non-stationary
t Statistic	-3.78	-1.86	-11.61	-3.82	-4.80	-3.28
P value	0.02	0.68	0.00	0.01	0.00	0.07
Capacity at Exeter	Stationary	Non-stationary	Stationary	Stationary	Stationary	Non-stationary
t Statistic	-3.65	-1.98	-3.94	-3.97	-6.08	-2.30
P value	0.03	0.61	0.01	0.01	0.00	0.43

Notes - A trend is included in all the ADF tests. The null hypothesis (Ho) is that a variable is non-stationary. A 'P value' larger than 0.05 means that we reject the null hypothesis. For instance, the P value of the ADF test for the number of passengers at Exeter Airport for Dublin is 0.02. This means the null hypothesis of non-stationarity is rejected.

A.31 An additional feature of the data is that it exhibits a large degree of seasonality. That is, capacities and revenues fluctuate according to the

time of the year. This is because the demand for air travel on certain routes may be greater during particular periods, such as summer and Christmas.

A.32 In order to transform non-stationary variables into stationary variables and to control for seasonality, the observations for each variable have been transformed to give the year on year change ('seasonal difference'). The ADF tests suggest that all the transformed data (that is, seasonally differenced) are stationary.[18]

A.33 When estimating a regression using time-series data, it is important to check for the presence of autocorrelation in the errors. Autocorrelation occurs when the errors in one time period are correlated with errors in subsequent periods. While autocorrelation does not bias the OLS coefficient estimates, the standard errors tend to be underestimated. Incorrectly estimated standard errors may suggest that the variable associated with the parameter is more significant that it actually is.

A.34 In certain cases, one way to clear up the autocorrelation in the errors is by including the lagged dependent variable as another explanatory variable. The equations to estimate become:

$$YieldExt_t = \alpha + \beta_1 (YieldExt)_{t-1} + \beta_2 (CapBristol)_t + \beta_3 (CapExeter)_t + \varepsilon_t,$$
$$PaxExt_t = \alpha + \beta_1 (PaxExt)_{t-1} + \beta_2 (CapBristol)_t + \beta_3 (CapExeter)_t + \varepsilon_t,$$
$$RvExtFly_t = \alpha + \beta_1 (RvExtFly)_{t-1} + \beta_2 (CapBristol)_t + \beta_3 (CapExeter)_t + \varepsilon_t,$$

A.35 Both the equations excluding a lagged dependent variable, shown in paragraph A.24, and the equations including a lagged dependent variable have been estimated using OLS. The Durbin Watson tests were conducted on all equations to detect the presence of autocorrelation.[19]

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[18] Results available on request.

[19] One way to test for autocorrelation in these equations is by using the Durbin Watson (DW) statistic. The DW statistic is given by: 2(1-p), where p is the autocorrelation coefficient for the errors. As the correlation coefficient approaches to zero, that means that we do not have

All the estimated regressions excluding lagged dependent variables had autocorrelated errors, with the exception of the equation estimating revenue per flight on the Guernsey route. None of the equations estimated with a lagged dependent variable tested positively for autocorrelation.[20]

A.36 Table A.11 below reports the summary statistics and Table A12 reports the estimated regressions for the equations with the number of passengers at Exeter Airport as the dependent variable and including a lagged dependent variable. The estimated regressions for the OLS estimations excluding a lagged dependent variable are not reported here. The results of these regressions are qualitatively the same as for the estimations including a lagged dependent variable.

A.37 Equations using yield and Flybe's revenues at Exeter Airport were also estimated but are not reported here. The coefficient of the capacity at Bristol was not statistically significant in any of the equations. For the equations using Flybe's revenue as a dependent variable, the coefficient of the capacity at Bristol was statistically significant at the 10 per cent level for Glasgow.

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autocorrelation in the model (the DW statistic would be equal to two). If the DW statistic is substantially less than two, this means that there is positive autocorrelation. If the DW statistic is substantially larger than two, there is negative autocorrelation. In the regressions that include the lagged values of the dependent variable, the Durbin-Watson test is not applicable. We use the Durbin h alternative test to test for autocorrelation in the residuals. For further reference of the autocorrelation test see Greene, 'Econometric Analysis, fifth edition' page 270.

[20] We take five per cent as our confidence interval.

Table A.11: Summary statistics for Focal routes

Manchester					
Variable	**Number of observations**	**Mean**	**Standard deviation**	**Min**	**Max**
Number of pax at Exeter Airport	40	4454.9	460.6	3515.0	5411.0
Number of seats at Exeter Airport	40	7928.1	487.7	7100.0	9012.0
Number of seats at Bristol airport	40	6752.4	1218.0	4300.0	8000.0
Leeds Bradford					
Variable	**Number of observations**	**Mean**	**Standard deviation**	**Min**	**Max**
Number of pax at Exeter Airport	48	2827.0	705.4	**1739.0**	**4507.0**
Number of seats at Exeter Airport	48	4666.7	1098.3	2808.0	6784.0
Number of seats at Bristol airport	48	5679.0	1010.6	4300.0	7700.0
Guernsey					
Variable	**Number of observations**	**Mean**	**Standard deviation**	**Min**	**Max**
Number of pax at Exeter Airport	63	2696.7	565.0	**1668.0**	**4188.0**
Number of seats at Exeter Airport	63	4378.5	519.2	3510.0	5433.0
Number of seats at Bristol airport	63	3691.3	655.7	2048.0	5940.0
Glasgow					
Variable	**Number of observations**	**Mean**	**Standard deviation**	**Min**	**Max**
Number of pax at Exeter Airport	63	3823.7	952.3	1965.0	5761.0
Number of seats at Exeter Airport	63	6114.1	1566.7	3824.0	8878.0
Number of seats at Bristol airport	63	30883.3	6131.6	20124.0	43835.0

Dublin					
Variable	**Number of observations**	**Mean**	**Standard deviation**	**Min**	**Max**
Number of pax at Exeter Airport	63	2776.2	639.2	1150.0	4067.0
Number of seats at Exeter Airport	63	4751.7	705.9	2656.0	6258.0
Number of seats at Bristol airport	63	38212.9	6825.9	27960.0	60407.0
Newcastle					
Variable	**Number of observations**	**Mean**	**Standard deviation**	**Min**	**Max**
Number of pax at Exeter Airport	56	4124.2	827.5	2188.0	5976.0
Number of seats at Exeter Airport	56	6569.1	1396.1	4368.0	8800.0
Number of seats at Bristol airport	56	25714.7	2940.8	18228.0	33972.0

Source: CAA data and OFT calculations

Table A.12 OLS regressions with the lagged dependent variable; dependent variable: number of passengers at Exeter

Equation	Dublin	Glasgow	Guernsey	Leeds Bradford	Manchester	Newcastle
Lagged PaxExt	0.226**	0.411**	0.696**	0.680**	0.385**	0.435**
	(0.114)	(0.064)	(0.109)	(0.138)	(0.154)	(0.098)
CapBristol	-0.198**	-0.284**	0.129	0.149	0.120*	-0.131
	(0.084)	(0.071)	(0.070)	(0.123)	(0.062)	(0.087)
Cap Exeter	0.599**	0.522**	0.413*	0.084	0.552***	0.516**
	(0.120)	(0.055)	(0.190)	(0.192)	(0.183)	(0.091)
Number of observations	50	50	50	35	27	43
R^2	0.50	0.92	0.61	0.47	0.58	0.85
Alternative Durbin Watson statistic	3.72	0.17	0.10	2.96	0.16	0.09
Ho: No serial correlation						
P value	0.054	0.68	0.75	0.09	0.69	0.77

Notes: Numbers reported in parentheses are the standard errors; * and ** indicates a significance at the five per cent and one per cent level respectively. YieldExt, CapBristol and CapExeter are expressed in logs. Because the revised model includes lagged values of the dependent variable, the Durbin-Watson test is not applicable. We use the Durbin h alternative test to test for autocorrelation in the residuals.

A.38 The inclusion of a lagged dependent variable changes the interpretation of the coefficients. The reason is that anything that has a significant impact on the dependent variable today will also affect the dependent variable in the subsequent periods indirectly. To compute the long run

effect, time subscripts are dropped and the resulting equation solved for the coefficients of interest. The table below illustrates the long run effect of a 10 per cent increase in capacity at Bristol Airport on Flybe's passenger numbers at Exeter Airport on the Dublin and Glasgow routes. Results for the other routes are not statistically significant and so are omitted from the table.

Table A1.3 Long run effects of a 10 per cent increase in capacity at Bristol Airport

	Dublin	Glasgow
Change in Flybe's passenger numbers	-2.5%	-4.8%

A.39 The results of these estimations are qualitatively the same as for the OLS regressions without a lagged dependent variable, namely that capacity changes at Bristol Airport have a statistically significant impact on passenger numbers on the Dublin and Glasgow routes, and additionally on revenue per flight on the Glasgow route.

A.40 The OFT considers that these results indicate that there is likely to be competitive interaction between Flybe at Exeter Airport and its competitors on the Glasgow and Dublin routes, but provide no evidence of competition on the Guernsey, Leeds Bradford, Newcastle and Manchester routes.

Estimation bias

A.41 The OFT has considered possible sources of bias in the above estimates. The estimates will be biased if one of the explanatory variables is correlated with the error term. This is known as endogeneity. In the OFT's view, the estimates will be biased if the capacity at Bristol Airport is correlated with the error term.

A.42 As the Competition Commission considered in its analysis,[21] the OFT considers that the most likely omitted variable is a demand shock. A positive demand shock would be likely to drive up average fares, passenger numbers and revenue per flight at Exeter Airport, whilst at the same time, if the shock is predicted, may cause competitors at Bristol Airport to increase capacity. The resulting direction of bias from such demand shocks is positive and would lead to a finding of less competition than there actually is. The capacity at Exeter Airport should control in part for demand shocks that are also predicted by Flybe.

A.43 The OFT considers that the significance of this source of bias may be further limited a) to the extent that airlines can accurately predict fluctuations in demand at the time that capacities are set; and b) as the decision to set capacity on a route is a joint decision of how to allocate a fleet of relatively fixed size across a number of routes in order to maximise profits, subject to constraint of slot availability and potentially a myriad of other strategic considerations. As such the capacity setting decision is likely to depend on many factors other than just the demand predicted on the route.

A.44 While the OFT considers demand shocks to be the most significant omitted variable, it recognises that there may be other omitted variables that may cause bias in either direction, but considers the bias from these to be likely to be minimal in comparison. As a consequence, the OFT considers that if the results are biased this bias is most likely to be positive, that is towards a finding of less competition.

A.45 The OFT has also considered whether there may be problems of simultaneity bias, in particular because of the likely feedback between capacity choice and passenger numbers, revenue per flight or average fares. This may result in bias in an indeterminate direction. Because the

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[21] Competition Commission, BAA Airlines Market Investigation, *Updated working paper on analysis of airline yield data* (March 2009) paragraph 3.14 at www.competition-commission.org.uk/inquiries/ref2007/airports/pdf/working_paper_airports_yield_analysis.pdf

operation of these feedback channels is related to the airline's ability to accurately predict demand, the OFT considers these problems to be similar to omitted demand shocks in this case. However, the OFT is unable to rule out simultaneity bias and so treats the results with some caution.

Conclusion on the event study

A.46 For the Dublin and Glasgow routes the results are mixed depending on the dependent variable used.[22] In particular, while the regressions show significant effects of capacity changes at Bristol Airport on passenger numbers at Exeter Airport on these routes, there is no significant effect of capacity changes on yield. The OFT is unable to rule out that the lack of effect on yield is not due to the particular nature of the revenue management systems employed by the airlines rather than providing evidence of a lack of competitive interaction.

A.47 The OFT treats these results with some caution because of possible sources of bias from omitted variables and simultaneity. However it considers that they provide some evidence of competition between Flybe at Exeter Airport and its competitor at Bristol Airport on the Dublin and Glasgow routes.

A.48 The results show no evidence of competition between Flybe at Exeter Airport and its competitor at Bristol Airport on the Guernsey, Leeds Bradford, Manchester and Newcastle routes. The OFT considers that the possibility of bias, particularly positive omitted variable bias from anticipated demand shocks, means that it is not possible to draw a strong inference from these results. However, the OFT does not consider there to be reason that any bias would differ systematically on these routes to the Dublin and Glasgow routes.

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[22] For the Dublin and Newcastle routes, the results show a significant impact of changes in capacity at Bristol on passenger numbers at Exeter. For the Glasgow route, the results also show a significant impact of changes in capacity at Bristol on revenue per flight at Exeter.

A.49 With the exception of the Newcastle route, these results are consistent with both the relative flight frequencies and passenger volumes at Bristol Airport and Exeter Airport and with the catchment area profile analysis.