The effects of increases in airport charges at congested airports on airline fares

A briefing note for the CC prepared by NERA

Introduction

1. The CAA's proposals for changing to a dual-till basis for economic regulation, and, in the case of Heathrow, for linking airport charges to the incremental cost of increasing airport capacity, will eventually lead to substantial real increases in airport charges, especially at Heathrow. However, the CAA contend that higher airport charges will not result in any overall increase in airline fares, at least on services to and from Heathrow. The CAA argue that, to the extent that the increased charges force some airlines to withdraw services from marginally profitable routes, leading to fare increases on these routes, the vacated slots will be taken up by airlines who are currently unable to obtain access to the congested airports because of the prevalent grandfathering arrangements. This, in turn, will lead to fare reductions on routes where capacity has been increased as a result of market entry. Overall, the CAA argue, the effects on a basket of fares will therefore be broadly neutral.[1]

2. Airlines take a different view. For example, BA has told the CC that:

> in an industry with very low margins, or even experiencing losses, increases in costs from any source will have to be passed on to consumers in the long term. Whilst some costs may be absorbed in the short term as a result of competitive pressures and an ever present focus among companies in competition to find efficiencies, any rise in airport charges, that affects all users at an airport, would eventually be passed through to passengers in the form of higher fares or lower service levels.

3. This note attempts to evaluate these arguments. It begins by considering what is the price-relevant marginal cost facing an airline operating from an airport where there is excess demand for access given the existing airport charges. The analysis helps to clarify the circumstances under which an increase in airport charges might affect airline fares, given airline price setting behaviour in imperfectly competitive airline markets. We then examine evidence on demand-supply balances in airport and airline markets, and its implications for the possible effects on airline prices of increases in airport charges.

Airline Marginal Costs and Pricing

Introduction

4. BAA levies charges on airlines using the south-east airports that vary according to the number of passengers carried, the number of landings and the use of aircraft parking or stand facilities. The majority of the charges are differentiated by peak and off-peak periods, and the per passenger charge varies according to whether the flight is domestic or international.

5. Each element of the tariff is directly variable with demand for airport facilities. An increase in any element of airport charges would thus directly affect airline variable or marginal costs, and this, in turn, would generally be passed through fully or partially into airline fares, the extent of pass-through varying according to competitive conditions in airline markets. To see why this normal transmission mechanism might not apply at congested airports, and, in particular, to throw light on the nature of price relevant marginal costs at a congested airport, we develop a simplified model of airline behaviour, and use this model to analyse the impact of airport charges at congested and uncongested airports.

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[1]See, CAA, *Heathrow, Gatwick, Stansted and Manchester Airports' Price Caps, 2003–2008, CAA Preliminary Proposals*, Consultation Paper, November 2001, paragraph 4.49. See also, BAA 23, p60, 11–38.

A Model of Airline Behaviour

6. We consider the following, highly simplified model of airline behaviour. An airline operates on n routes from the congested airport. It seeks to maximise profitability across the n routes (equal to [Π(i) + Π(j)….+ Π(n)]), through determining prices (p), and the number of flights offered (x) on each route. It does so given route demand functions, d(p,x), which we assume are independent,[1] and operating costs, c(d,x), including airport charges. It is helpful to distinguish between decisions on pricing, and frequency, first, because each is a key airline commercial planning variable, second, because demand reflects both aspects of the airline's offer, and, finally, because the existence of a binding constraint on one dimension of output may not imply that there is also a binding constraint on the other. Our analysis also distinguishes between peak and off-peak demand periods.[2]

7. This approach implies that airline decisions will be subject to separate constraints, on flight frequencies and passenger numbers, and for peak and off-peak periods. The constraints on frequencies take the form:

$$\Sigma_i x_i \le X_t$$

where X_t is determined by the airlines grandfathered allocation of slots.

8. The constraints on passengers are route specific, and take the form:

$$d_{it} \le D_{it}(x_{it})$$

etc for all n routes, where the D_{it} values represent the capacity available, given the x_{it}.

9. The first order conditions, which are derived in full at Annex A, imply the following:

(a) That if the constraint on passenger numbers binds, prices are set such that marginal revenue per passenger is equated to the passenger related marginal cost (including passenger-related airport charges) plus a factor reflecting the opportunity cost, or scarcity rent accruing to the airline, associated with a marginal passenger on the route. If the constraint does not bind, prices are set to equate marginal revenue with passenger-related marginal costs, including passenger-related airport and other charges.

(b) If the constraint on flight frequency binds, the marginal revenue with respect to frequency, plus a further route-specific element reflecting the additional economic rent accruing to the airline per passenger carried from relaxing the constraint on each route, will be equated to the marginal cost of the flight, plus a factor, common to all routes, reflecting the opportunity cost or scarcity rent on the airline's current slot portfolio. If neither constraint binds, marginal revenue would be equated to the marginal cost of the flight, including any airport charges varying directly with the number of flights.[3]

10. This analysis of airline behaviour therefore indicates that the price relevant marginal cost, which is equated to marginal revenue, is greater than or equal to the marginal operating cost, which includes any variable airport charges, depending upon whether or not the constraints on passengers numbers on any particular route are binding.

The Direct Effects of Airport Cost Changes in Theory

11. The implications of this model of airline behaviour for the relationship between airport charges and the level of airline fares are shown in Figures 1 and 2, where MC(0) and MC(1) are the marginal passenger-related airline operating costs before (0) and after (1) the increase in airport charges. In Figure 1, the post-increase marginal operating cost still lies below the initial price-relevant marginal cost (equal to MC(0) + λ), where λ is the shadow price, or scarcity rent on passengers or slots, implying that

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[1] In the sense that $\partial p(i) / \partial d(j) = 0$.

[2] The analysis abstracts from the possibilities that airlines can price discriminate. Airlines can and do price discriminate, but the policies fall well short of perfect price discrimination. Introducing limited price discrimination, for example between business and leisure travel, would further complicate the analysis, without adding significant insights.

[3] Such as landing and parking charges.

the increase in charges results in a transfer of rents from the airline to the airport. In Figure 2, however, the post-increase marginal operating cost lies above (MC(0) + λ), implying that there would be some increase in airline fares in the short run, although the short run increase in fares would be less than the increase in airport charges, both because of the familiar reason that the relevant demand function is downward sloping, and because some of the increase in charges is absorbed as a reduction in the scarcity rent enjoyed initially by the airline.

FIGURE 1

The effect of an increase in airport charges on marginal costs and fares (constraint binds before and after increase in charges)

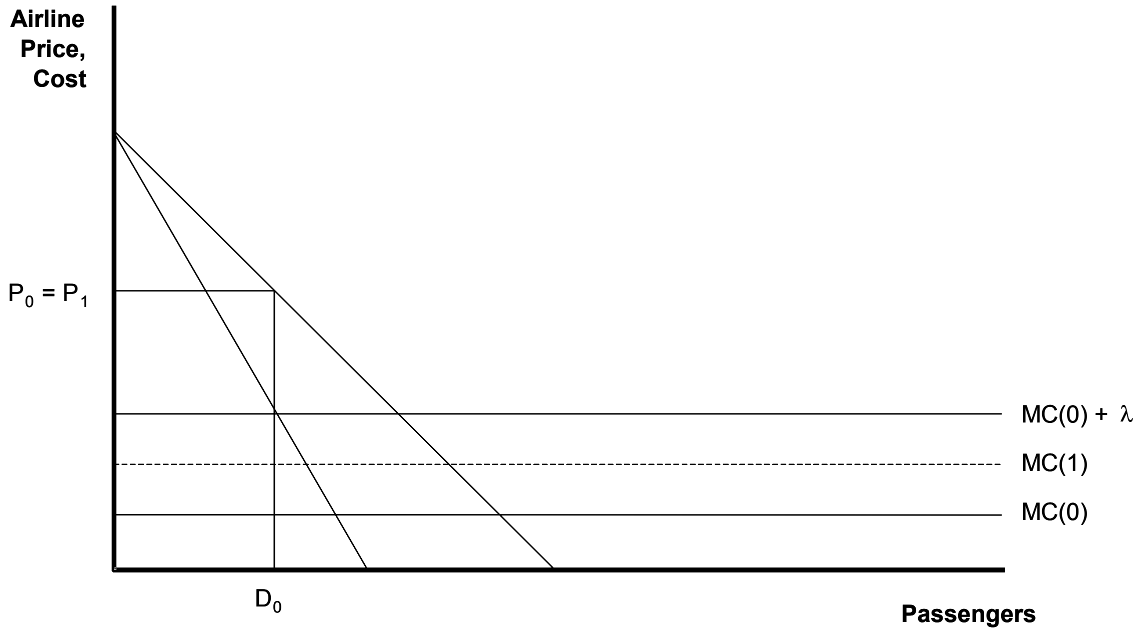
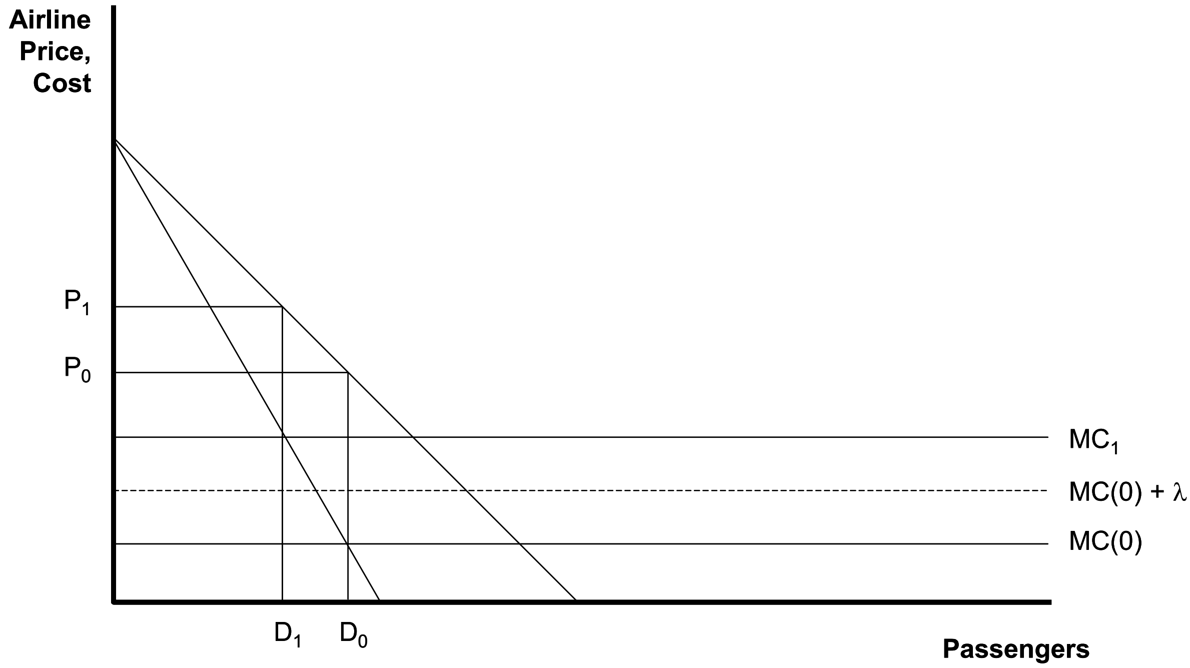


FIGURE 2

The effect of an increase in airport charges on marginal costs and fares (constraint binds before but not after increase in charges)

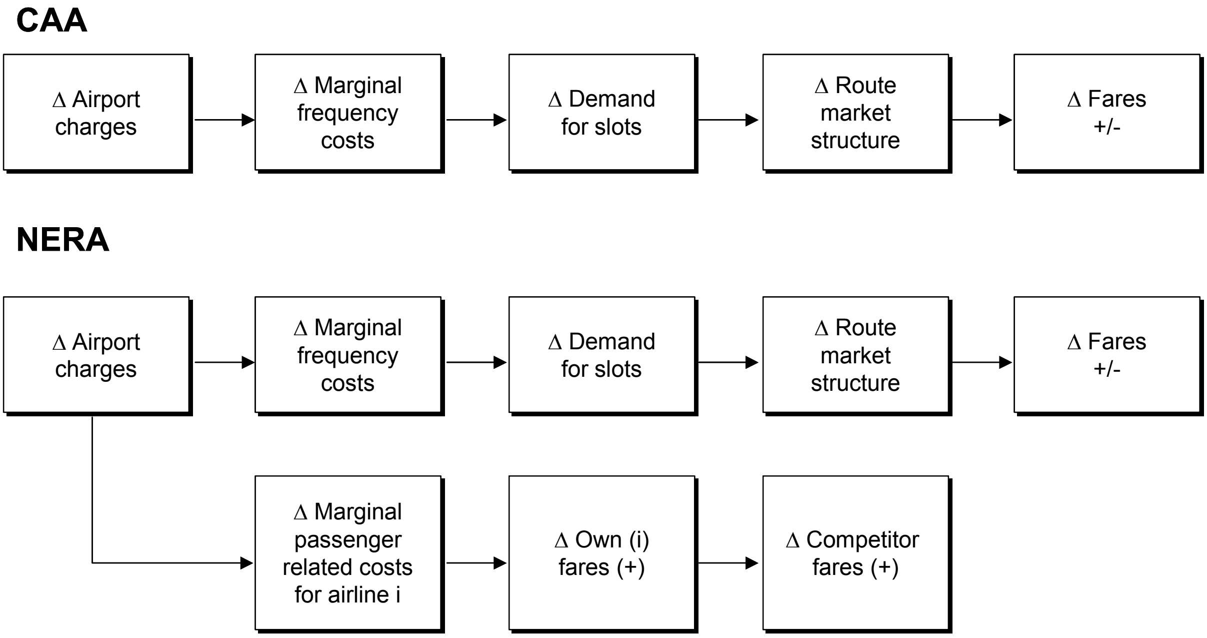


Transmission Mechanisms

12. Our analysis suggests a more complex linkage between changes in airport charges and airline fares to that proposed by the CAA, as shown in Figure 3. According to the CAA, changes in airport charges affect airline costs *indirectly*, by causing changes in airline market structures. An initial increase in charges may cause a reduction in airline demand for slots on routes where the marginal revenue falls short of the increased marginal costs (see Figure 2). This could result in an increase in market concentration on the route, and the increase in market concentration would lead directly to an increase in prices, given Cournot price setting behaviour.[1] However, this effect would be offset on routes where service frequency increased, as new services were added using slots released from lower value routes.[2]

FIGURE 3

Transmission mechanisms



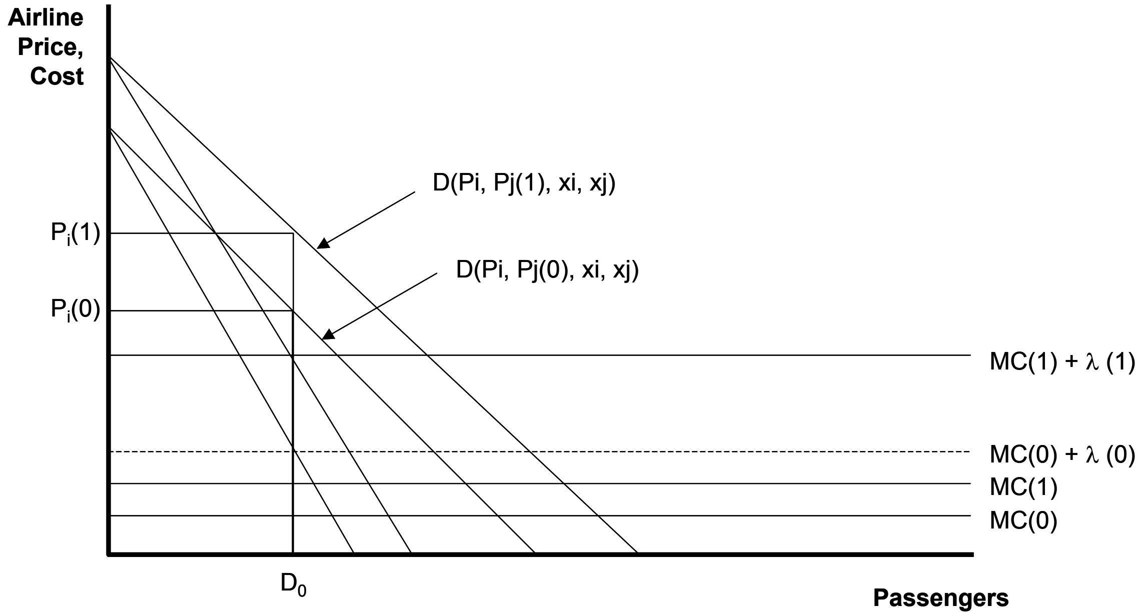
13. The analysis in paragraphs 6 to 10, which predicts changes in service frequencies when the price relevant marginal cost of service frequency increases as a result of an increase in airport charges, would be consistent with the mechanism proposed by the CAA. However, our analysis also suggests that changes in airport charges may directly affect airline fares by altering price relevant marginal costs. It should be noted, moreover, that this direct effect leads unambiguously to increases in fares, unlike the mechanism proposed by the CAA, which predicts a mixture of fare increases and fare reductions. Moreover, although the direct price effect would be limited to airlines that were not capacity constrained, it may well affect price setting more widely. Airlines for which the price relevant marginal costs were not affected by the increase in airport charges, but which competed with airlines that had increased fares, would have an incentive to increase fares, as shown in Figure 4. The initial increase in the competitor's fares would cause the demand curve for the capacity-constrained airline to shift outwards, and this, in turn, would mean that the rationing price increased from P0 to P1.

14. The scale of fare increases resulting from competitive interaction of this kind would depend upon the expectations, or conjectures of the market participants. Price increases would be stronger the more closely non-constrained airlines expected their competitors to match any price increases they imposed following an increase in airport charges.

[1]The remaining players would set prices on the basis of increased residual demand.
[2]We note that the CAA's analysis, which links changes in fares to changes in market structure, is radically different from that proposed by Professor Alfred Kahn, in his testimony in the AA–BA merger litigation. Kahn suggested that fares from congested airports would be unaffected by a merger-induced change in market structure.

FIGURE 4

Competitive effects on fares of airline i, given a fare increase by airline j



Empirical Evidence and Evaluation

15. Although our model indicates the possibility of a fairly direct link from changes in airport charges to airline fares, the important issue is whether, as a matter of fact, market conditions at Heathrow more closely resemble the outcome shown in Figure 1 or in Figure 2 above.

16. There is clear evidence of excess demand for access to the airport from airlines. Airlines are willing to pay premia for obtaining additional slots in grey market trading. ACL also regularly receives more requests for slots than it is able to schedule, especially during peak periods, as shown in Figure 5. Indeed the imbalance between the demand for and supply of slots is almost certainly greater than the ACL data indicate, because many potential entrants may simply not attempt to secure slots because the likelihood of success is so small.

17. However, determining whether there is also pervasive excess demand from passengers, given the flight frequencies and profit maximising fares set by airlines is not so straightforward. To assess this issue, we consider evidence on the relationship between passenger volumes and passenger handling capacity at Heathrow, and on airline load factors.

Passenger volumes and terminal capacities at Heathrow

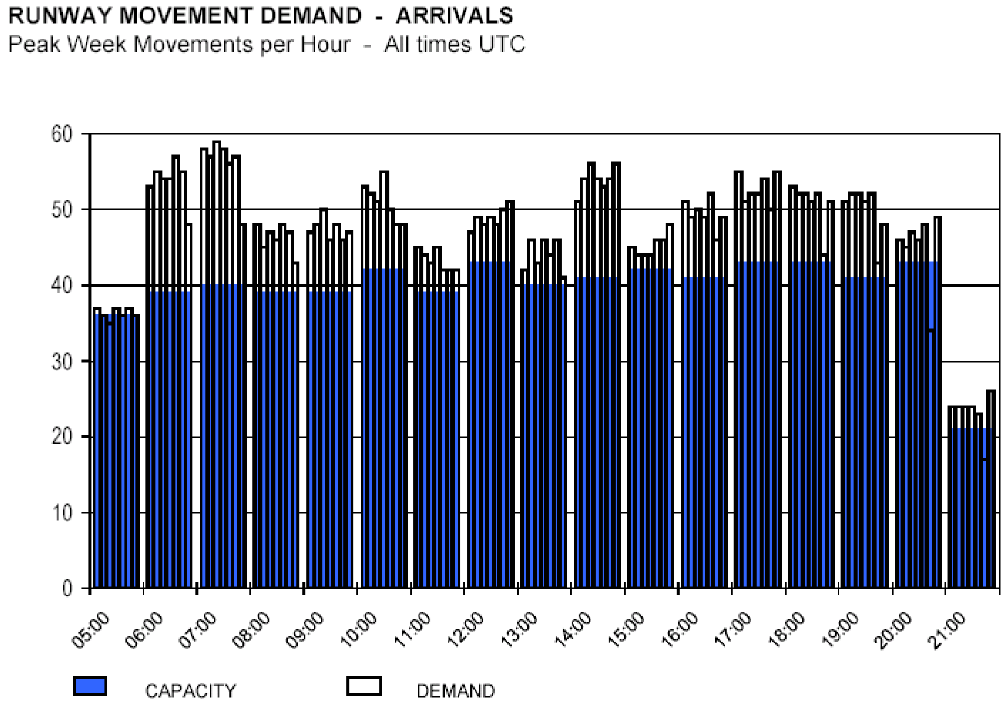
18. Figures 6 to 10, which are taken from a recent ACL report[1] show the projected relationship between passenger volumes and the declared capacity by quarter hour periods at each of the four terminals and across the central terminal area at Heathrow for the Summer 2002 scheduling season. We see that the declared capacity, shown by the thick black lines in each diagram, is exceeded by projected volume for only a very few periods in each terminal, and that there is generally very substantial spare capacity in all of the terminals.

19. This does not appear to indicate a situation where airlines would consciously have to engage in price rationing in order to meet terminal passenger handling constraints on any significant scale. Of course, demand will increase over the quinquennium, but BAA may also be able to make incremental investments to relieve capacity pinch points if required.

[1]ACL, Heathrow Summer 2002. Start of Season Report, May 2002. The report can be accessed on the ACL web site at www.acl-uk.org/library/library.asp.

FIGURE 5

Demand for Heathrow Slots



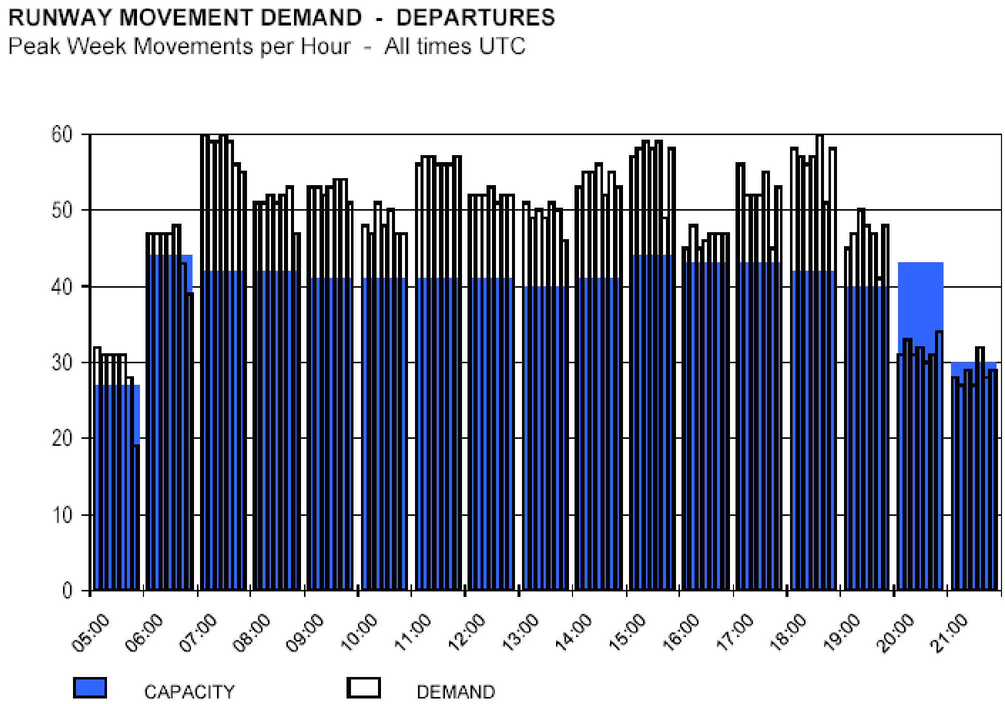
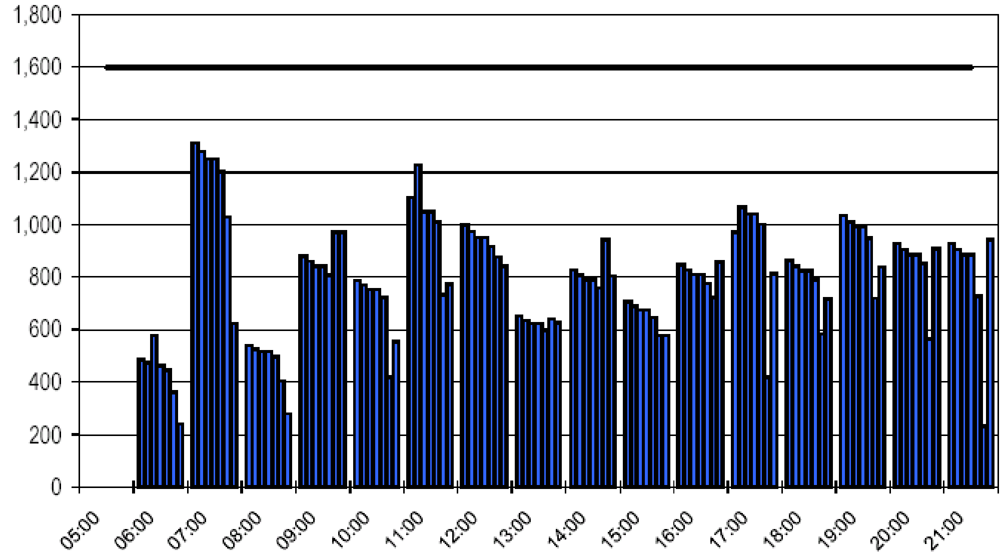


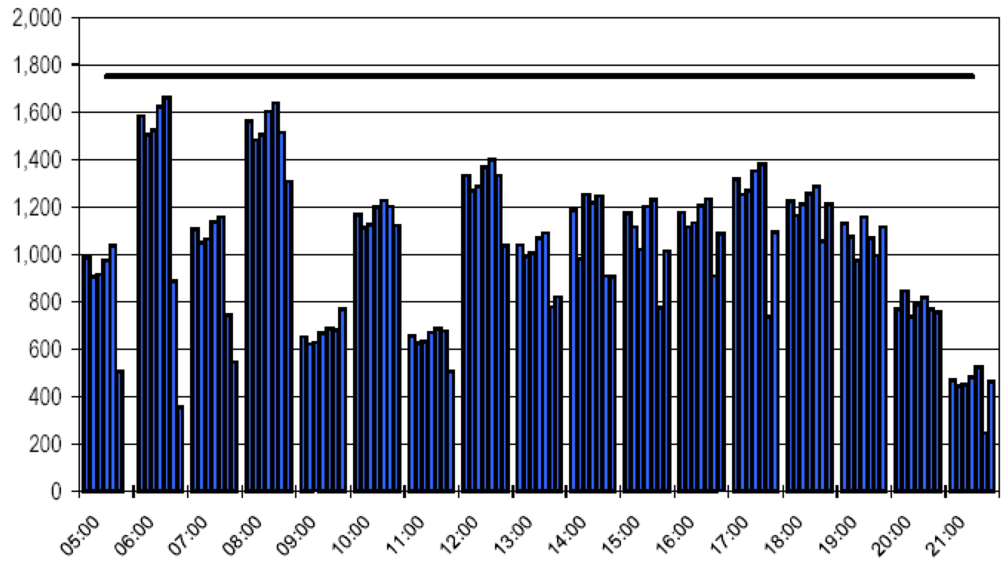
FIGURE 6

Terminal 1: demand and capacity

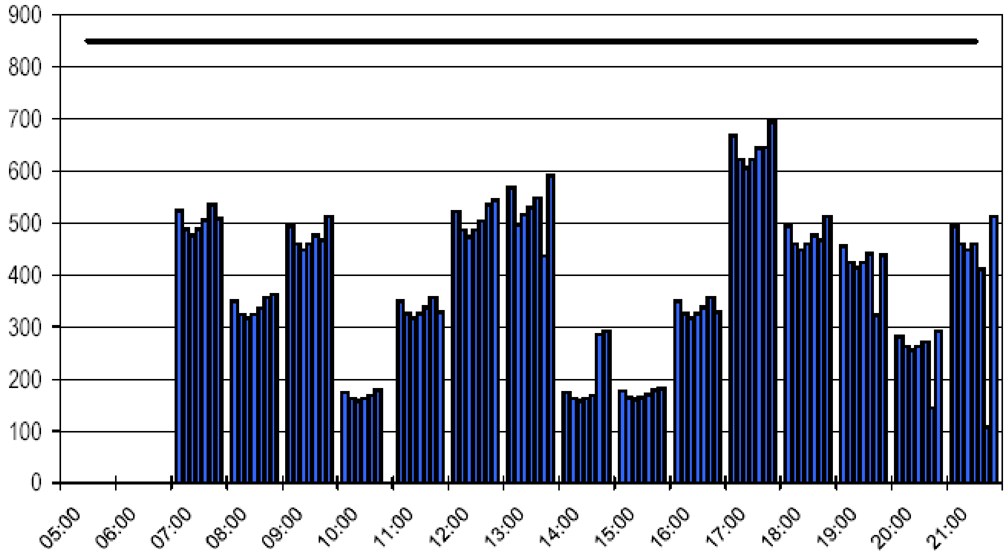
TERMINAL 1 DOMESTIC - ARRIVALS
Passengers per Hour - All times UTC



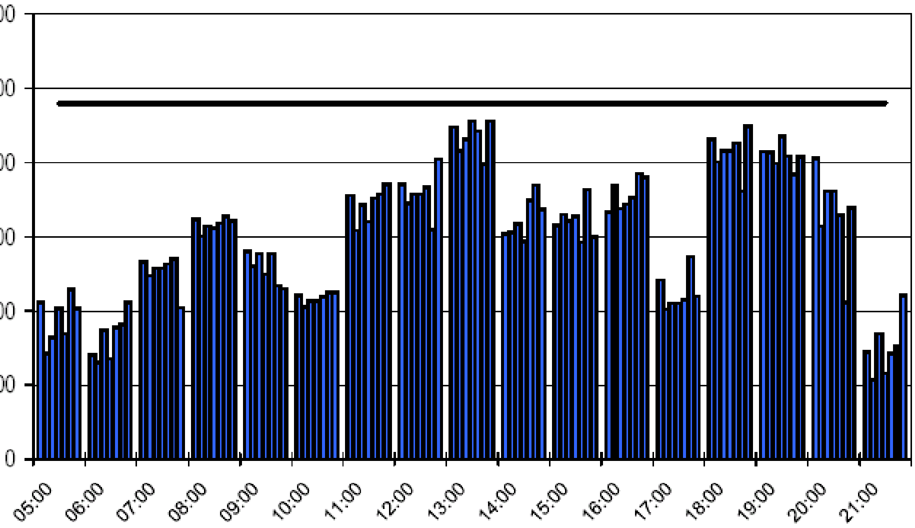
TERMINAL 1 DOMESTIC - DEPARTURES
Passengers per Hour - All times UTC



TERMINAL 1 COMMON TRAVEL AREA - ARRIVALS
Passengers per Hour - All times UTC



TERMINAL 1 INTERNATIONAL - ARRIVALS
Passengers per Hour - All times UTC



TERMINAL 1 INTERNATIONAL - DEPARTURES
Passengers per Hour - All times UTC

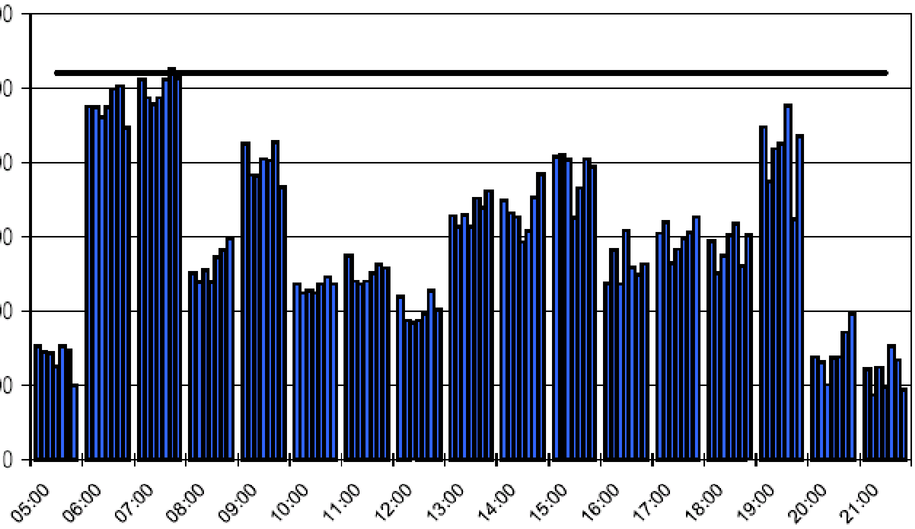
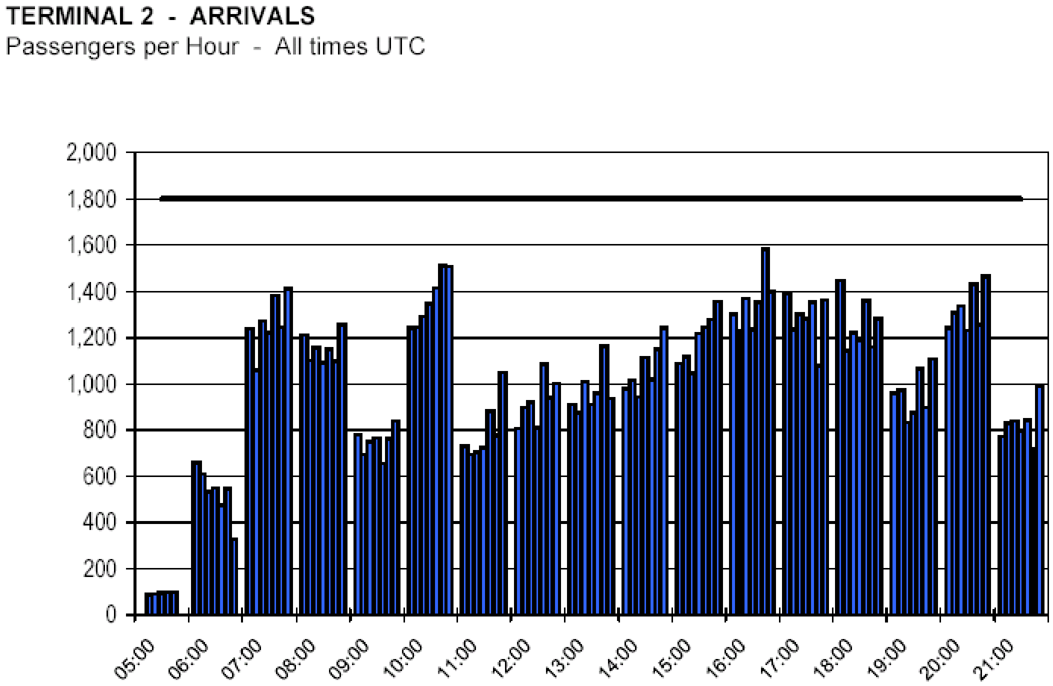


FIGURE 7

Terminal 2: demand and capacity



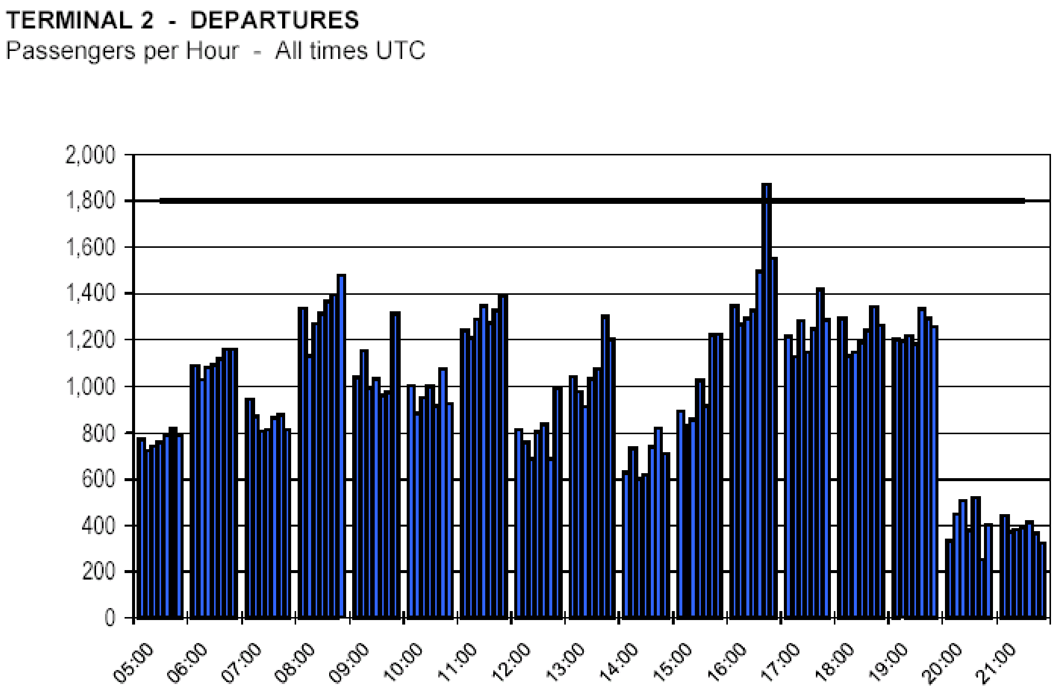
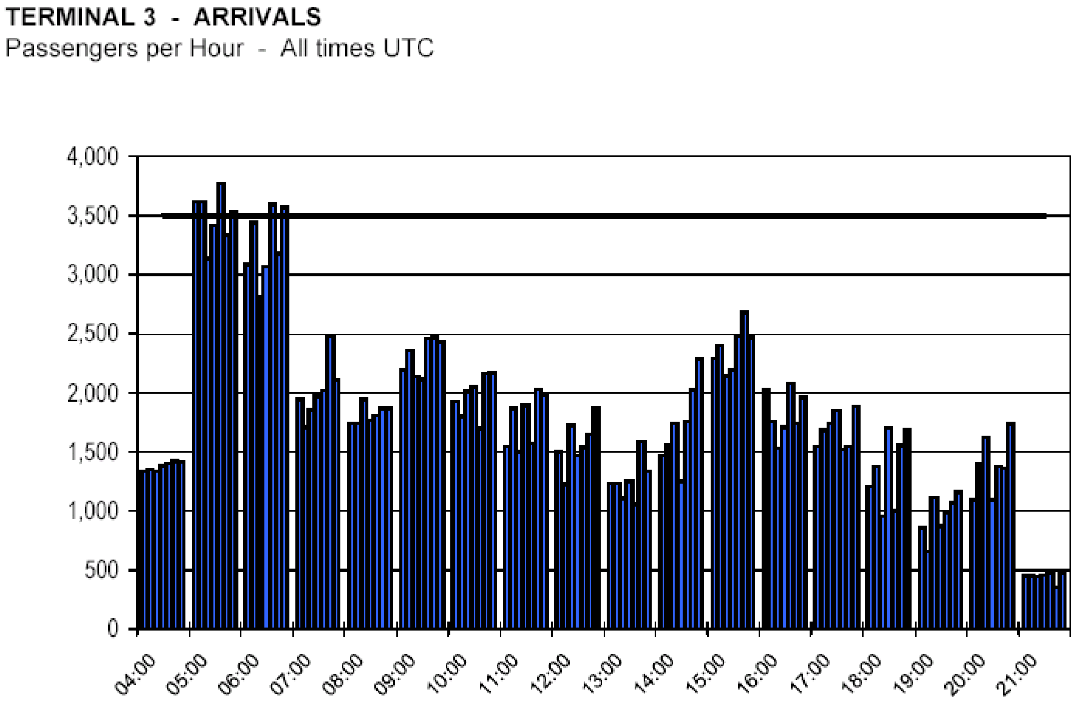


FIGURE 8

Terminal 3: demand and capacity



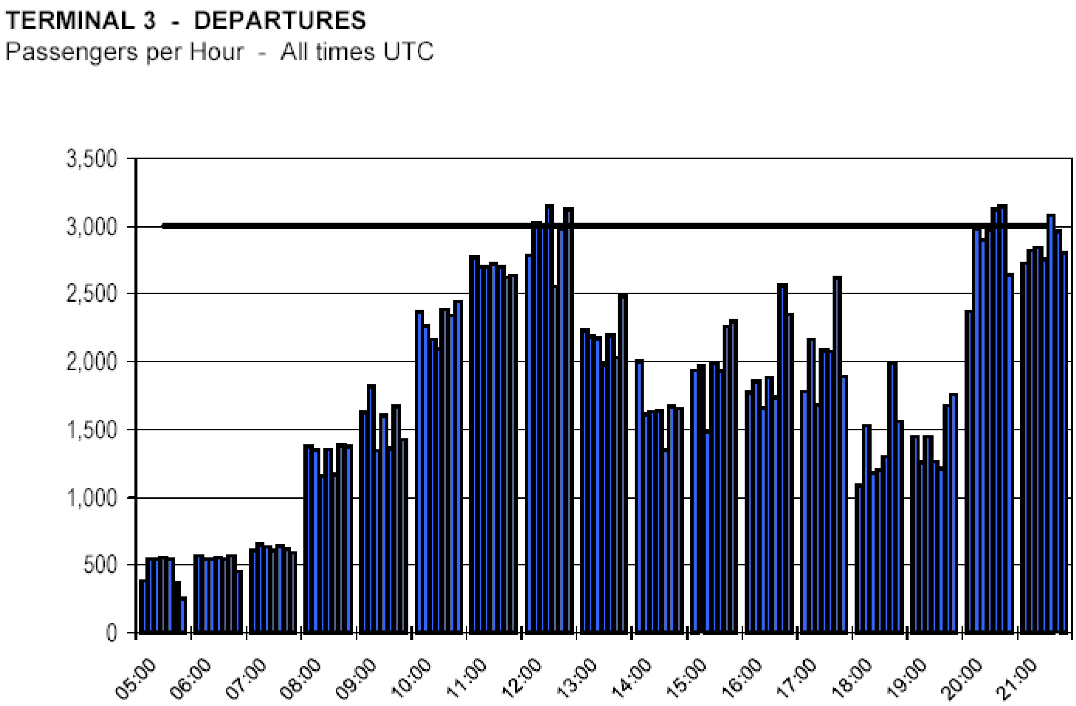
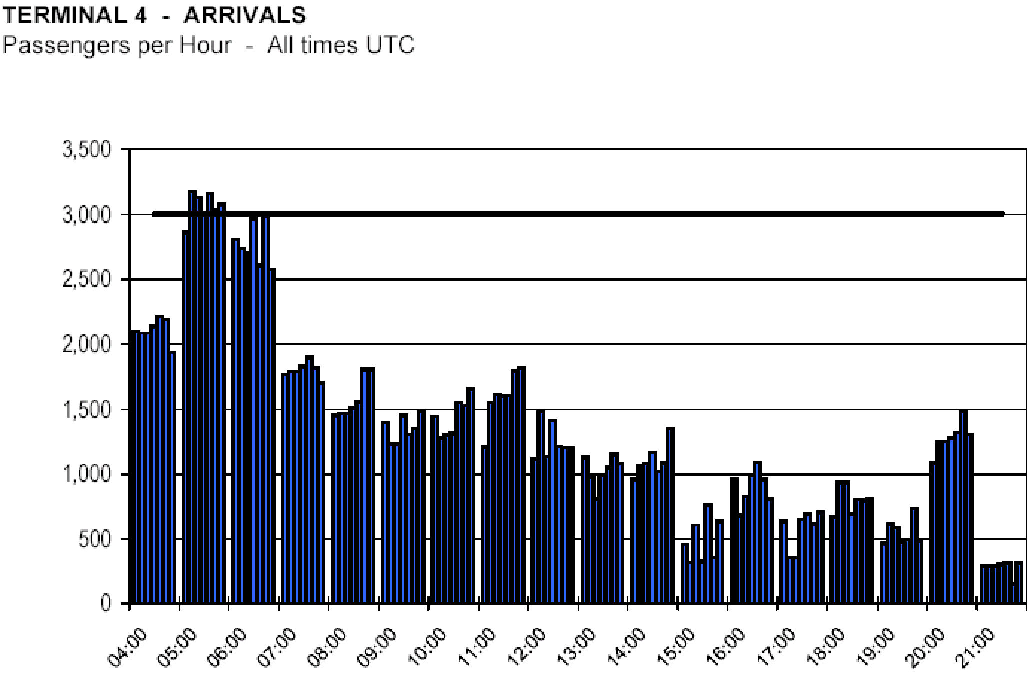


FIGURE 9

Terminal 4: demand and capacity



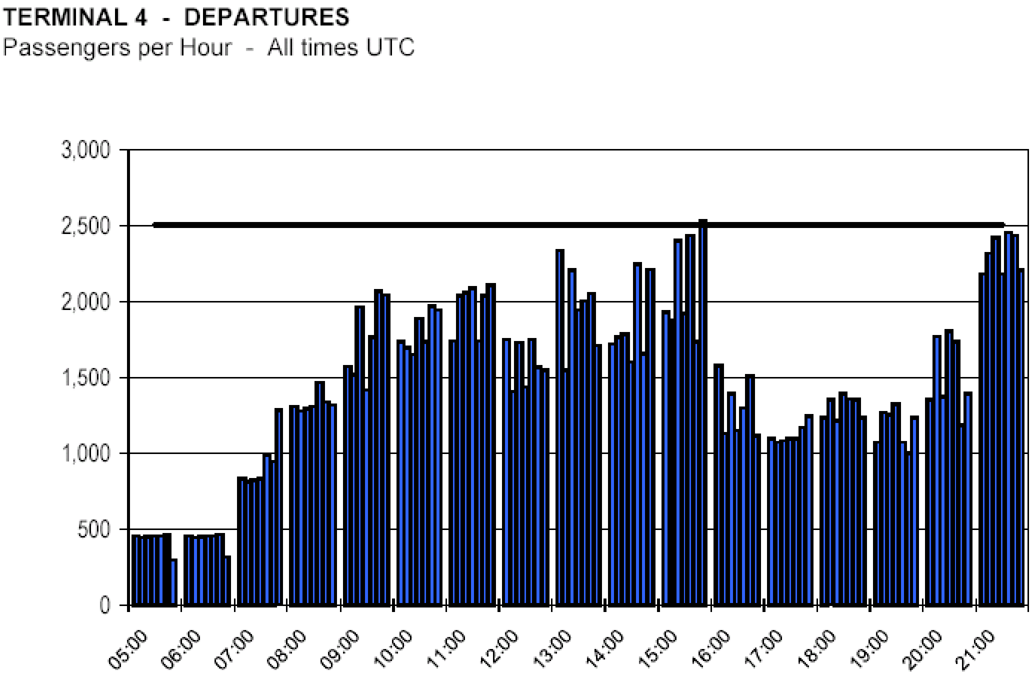
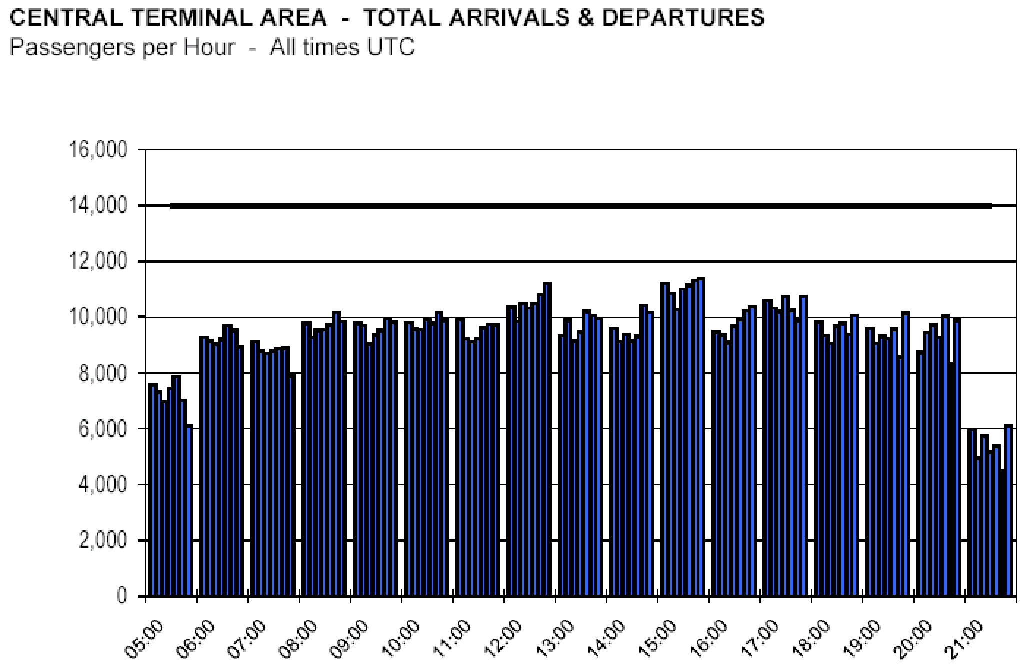


FIGURE 10

Central terminal area: demand and capacity



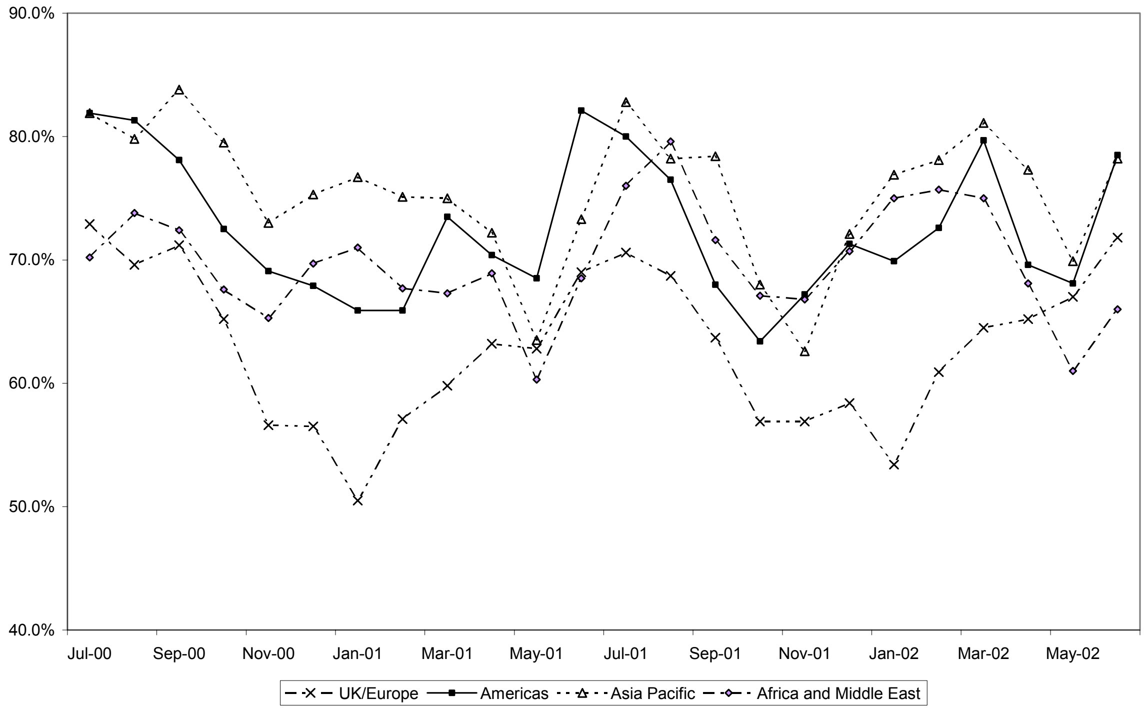
Airline load factors

20. Figure 11 shows monthly average passenger load factors for all BA routes disaggregated by market sector (UK/Europe, Americas, Asia Pacific, and Africa/Middle East) for the most recent two-year period, including a significant period prior to the 11 September attacks. Although the data do not refer exclusively to Heathrow-based services, the Heathrow hub operations dominate BA's operations overall, and so the aggregate data are unlikely significantly to misrepresent the position with respect to Heathrow. These disaggregated data show clearly that load factors vary widely between market segments, with load factors on long-haul routes, at around 70 per cent, generally very much higher than on the short-haul routes, where the monthly load factor appears to vary between around 50 per cent and 70 per cent, averaging around 60 to 65 per cent. They also vary widely by season within each market segment.

21. There is clearly no simple read across from a particular level of load factor to the existence or non-existence of excess demand. However, it seems difficult to characterise a situation where average load factors across all services are around 70 per cent as being one of pervasive excess demand, with substantial scarcity rents accruing to airlines. Although there may well be particular flights, or services, which routinely achieve very high load factors, such that a degree of price rationing would be applied to restrict demand to available capacity, these may be the exceptions. The overall picture appears to more consistent with a situation where demand levels are such that an airline would attempt to maximise contribution to fixed and overhead costs by applying the same pricing and yield management techniques as would be applied by full service carriers (as opposed to no-frills operators) on services to and from less congested airports. This is especially likely to be the case on short-haul services, which are characterised by quite high levels of excess capacity.

FIGURE 11

BA load factors by market segment July 2000–June 2002



22. If the price-relevant marginal cost in some of BA's markets was the airline marginal operating cost, this would have important consequences for the effects of increases in airport charges in the markets concerned, given BA's position as the major operator on routes to and from Heathrow. Even if its competitors' price relevant marginal costs post the increase in airport charges were above their marginal operating costs, the fact that BA was under pressure to increase fares could encourage some degree of price following, leading to more general fares increases. This would be especially likely on routes where competitive pressures from services operating from other airports were relatively unimportant factors in airline pricing decisions. Price increases would be relatively modest if carriers faced significant competition either from other modes, such as rail, or from no-frills carriers whose response to price increases by full service carriers would be especially difficult to predict.

Summary and Conclusions

23. The main findings from this analysis can be summarised as follows.

- BAA's airport charges at Heathrow and Gatwick include some elements that vary directly with passengers, and others that vary with flight frequency.

- Whether increases in either passenger or frequency related charges affect airline price and output (frequency) setting behaviour depends upon whether airlines' marginal costs increase as a result. Increases in marginal costs are less likely if the marginal cost includes a significant element of scarcity rent. However, the incidence of such scarcity rents, even at a congested airport such as Heathrow, may vary widely between airlines, and between peak demand and off-peak periods, especially in the absence of an efficient secondary market in slots. As the CAA has acknowledged, the prospects for the development of such a market in the short-medium term are not promising.

- If an increase in passenger related charges led to an increase in an airline's price relevant marginal cost, this would lead directly to an increase in fares by the airline concerned, given imperfectly competitive airline markets. Such increases may be matched by competitor airlines whose price relevant marginal costs would not have been affected by the increase in airport charges. The scale of increases would depend primarily on expectations concerning competitor behaviour in response to an initial, cost-induced increase.

- As the CAA has proposed, changes in service frequencies in response to increases in frequency related airport charges would result in a mixture of price increases (in airline markets where frequencies had been reduced) and price reductions (in markets where frequencies had increased).

24. To the extent that the model presented above captures important aspects of airline pricing and output decisions, it suggests that the transmission mechanism linking changes in airport charges and airline fares should explicitly recognise the possibility of both price and output adjustments in response to airport cost changes.

25. Whether this is anything more than a theoretical possibility depends on market conditions. There is strong evidence of excess demand for slots at Heathrow. However, data on supply/demand balances does not appear to offer strong evidence of any widespread excess passenger demand. There is currently substantial spare passenger handling capacity at Heathrow. In airline markets, we have noted that BA's load factors vary widely between market segments, and by season, but average only around 60 to 65 per cent in short-haul markets, and around 70 to 75 per cent in long-haul markets.

26. To the extent that the load factor data do signal differences in the supply-demand balance between short and long haul markets, they would suggest that the risk of some price increases in response to airport cost increases is somewhat higher in the former than in the latter. However, we also recognise that competitive pressures in this sector of the market, both from other transport modes and from no-frills carriers, are also stronger, inhibiting Heathrow-based carriers' ability to pass through cost increases into prices.

Annex A: A model of airline behaviour

1. We consider the following model of airline behaviour. The airline operates on routes from a congested airport and seeks to maximise profitability (π) by choosing prices, p, and service frequency, x, subject to constraints on passengers carried on each route and service frequencies on all routes in the relevant time period t(where t = 1 is peak, and t = 2 is off-peak).

2. Thus

$$\pi = \sum_i \sum_t d_{it}(p_{it}, x_{it}) \cdot p_{it} - \sum_i \sum_t c_{it}(d_{it}(p_{it}, x_{it}), x_{it}) - F$$

where

p_{it} = fare on route i in period t

d_{it} = demand on route i in period t

x_{it} = frequency on route i in period t

c_{it} = airline variable cost on route i in period t

F = airline fixed costs

π is maximised subject to the following constraints.

Frequencies

For each t:

$$\sum_i x_{it} \leq X_t$$

X_t reflects the airlines grandfathered slot allocation.

Passengers

For each route, i, and each t:

$d_{it} \leq D_{it}(x_{it})$

where D_{it} is the capacity available, given x_{it}.

The Lagrangian for this problem is then:

$$L = \sum_i \sum_t d_{it}(p_{it}, x_{it}) \cdot p_{it} - \sum_i \sum_t c_{it}(d_{it}(p_{it}, x_{it}), x_{it}) - F$$

$$- \sum_i \sum_t \lambda_{it}(d_{it}(p_{it}, x_{it}) - D_{it}(x_{it})) - \sum_t \lambda_t \left(\sum x_{it} - X_t\right)$$

3. For each route–time period combination and assuring that services are provided on each route in each time period (so that $d_{it} > 0$ and $x_{it} > 0$), Kuhn-Tucker first order conditions are as follows:

$$p_{it}\frac{\partial L}{\partial p_{it}} = p_{it}\,\partial d_{it}/\partial p_{it} + d_{it} - \partial c_{it}/\partial d_{it}\,.\,\partial d_{it}/\partial p_{it} - \lambda_{it}\,\partial d_{it}/\partial p_{it} = 0 \qquad \text{- (1)}$$

$$x_{it}\frac{\partial L}{\partial x_{it}} = p_{it}\,\partial d_{it}/\partial x_{it} - \partial c_{it}/\partial d_{it}\,.\,\partial d_{it}/\partial x_{it}$$

$$-\partial c_{it}/\partial x_{it} - \lambda_{it}\left(\partial d_{it}/\partial x_{it} - \partial D_{it}/\partial x_{it}\right) - \lambda_t = 0 \qquad \text{- (2)}$$

$$\frac{\partial L}{\partial \lambda_{it}} \geq 0 \quad \lambda_{it}\frac{\partial L}{\partial \lambda_{it}} = 0$$

$$\frac{\partial L}{\partial x_t} \geq 0 \quad \lambda_t\frac{\partial L}{\partial \lambda_t} = 0$$

Dividing (1) by $\partial d_{it}/\partial p_{it}$, we obtain the condition that:

$$MR_{it} = MC(d)_{it} + \lambda_{it}$$

Where

MR_{it} = marginal revenue

$MC(d)_{it}$ = passenger related marginal cost

From (2) we obtain:-

$$\text{MR}(\text{x}_{\text{it}}) + \lambda_{it}\left(\partial D_{it}/\partial x_{it} - \partial d_{it}/\partial x_{it}\right) = \text{MC}(\text{x}_{\text{it}}) + \lambda_t$$

where

MR (x_{it}) = marginal revenue within respect to frequency

MC (x_{it}) = marginal cost of frequency

4. When constraints bind, $\lambda > 0$. Under these conditions the first order condition on prices implies that the airline optimises by equating route marginal revenue (with respect to passengers) with marginal passenger related costs, plus a route specific factor reflecting the shadow price or economic rent of an additional passenger.

5. The condition on frequencies implies that the airline optimises frequencies by equating the marginal revenue with respect to frequency, plus a further route/time period specific factor representing the additional economic rent gained by relaxing the constraint on passengers carried on route i in time period t, with the marginal cost of frequency plus a factor, λ_t, common to all routes reflecting the shadow price or scarcity rent on frequencies (slots).

6. When either or both constraints do not bind, the usual marginal conditions apply. In these circumstances, any increase in airport charges would cause changes in prices or service frequencies, the latter causing consequential changes to route market structures and prices.