THE DILEMMA OF SLOT CONCENTRATION AT NETWORK HUBS

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1. INTRODUCTION

A number of the worlds' major airports have a high proportion of their capacity utilised by a single airline, or alliance of airlines. At major US airports, for example, it is common for the leading carrier to account for three-quarters or more of the flights; at European airports the proportions are generally smaller but often exceed 50 per cent (see **Annex 1**). This has lead to concerns that such high levels of capacity utilisation ('slot concentration') will impact adversely on competition and prices and, in turn, has inclined policy makers and regulatory bodies towards pro-active competition measures. In the US, for example, the General Accounting Office (GAO, 1996) judged that the buy-sell market in slots established at certain US airports in 1985, had failed because it was argued to have done little to reduce slot concentration and introduce competition into the market. It went on to recommend that slots should be re-distributed. In Europe, the current slot allocation regulation (Regulation 95/93, Article 10) requires that at slot co-ordinated airports preference be given to new entrant carriers in the allocation of unused, returned or new slots (that together constitute the slot pool)[1]; there is also a reluctance on the part of the European Commission to accept unrestricted slot trading because of the fear that it will reinforce dominant positions; and approval of proposed alliances between carriers has often been accompanied by conditions requiring slot divestiture.

In this chapter, I suggest that these positions require re-examination; it develops a number of issues raised in Starkie (2003a). The effects of slot concentration are complex and there are a number of economic efficiency considerations that suggest that a (high) degree of concentration of slots at an airport might be beneficial. On the other hand, there are the understandable concerns that concentration, (that could come about by trading slots for example), could lead to reduced competition at the route level leading to a reduction in welfare. This tension between the advantages and disadvantages of slot concentration at airports has long been recognised and commented upon in previous papers[2]. Where this paper is different is that it incorporates recent developments in the theory of congestion pricing that, it is suggested, have an important bearing on the balance of the argument. It also argues that higher fares at slot constrained airports do not constitute a *prime facie* case that a dominant position is being exploited and that there are a number of possible reasons apart from market power why we might expect higher air ticket prices at major hubs. Consequently, because the balance between the costs and benefits of concentration are difficult to determine, there should be a presumption against intervention in the market.

The next two sections outline the economic factors favouring slot concentration. This is followed by a consideration of the possible effects of concentration on consumer prices. A concluding section considers the implications for policy.

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[1] The European Commission has commented that "new entrants [should be given] the possibility to grow [at co-ordinated airports] so as to reach a critical mass to be considered as viable competitors against the 'big' carriers"

[2]See, for example, Kahn (1993) and Borenstein (1989). Borenstein comments: "Though the link between airport dominance and high fares seems clear, a welfare analysis of increased airport concentration must also include the benefits that may accrue from hub operations…These possible benefits… should be weighed against the higher prices that seem likely to result"(page 362).

2. NETWORKS AND NATURAL MONOPOLY

2.1 *Characteristics of Hub Networks*

Most major and, as a consequence, often congested airports are hubs for an interconnecting network of air services and it is well known that (two-way) service networks connected through hubs produce powerful connectivity externalities (Oum and Tretheway, 1995). In the case of two-way networks, as the number of nodes attached to the network increases so do the number of possible connections and thus its value to the consumer: the number of possible connections increases by the square of the number of connections (minus one). There is, therefore, the potential for a significant scaling effect so that the consumer benefits from an exponential growth in the number of possible destinations (s)he can fly to[3].

In addition to increasing connectivity between nodes, the other important effect of a hub network is to increases the traffic density across the connecting flows and this also benefits the passenger by allowing for increased service frequencies. On the supply-side, an increase in traffic density is also associated with empirically established economies (Caves, Christensen and Tretheway, 1984). Increasing the flow of traffic on a particular route for example, allows fixed station costs associated with the node to be spread over more passengers thereby reducing unit costs.

On the other hand, there are offsetting factors. For those passengers who, in the absence of a hub network, would have had the opportunity of a direct service to some of their preferred destinations (and no services to others), there is a price to be paid; longer journey times (but probably less schedule delay) and the inconvenience of having to change flights. Overall, however, there is a presumption that both passengers and airlines benefit from a business model based on hub networks. The issue here, however, is not the size of the overall net benefit; it is whether the characteristics of the hub network impart a degree of natural monopoly so that single firm delivery is more efficient. If this is the case, *ceteris paribus*, greater slot concentration at the hub is also more efficient.

2.2 *Hub Networks as Natural Monopolies*

The connectivity externality associated with hub networks is not in itself an argument in favour of service delivery by the single firm. To gain the connectivity externality the passenger does not require each connecting service to be operated by a single airline or alliance; the connectivity of the network could in theory be established with each hub connecting service operated by a different airline with slots allocated accordingly[4]. Equally, there is no obvious gain if the station costs of all the network *nodes* feeding through a hub are the responsibility of the single airline because there are no evident economies from combining these station costs. Consequently, the traffic density effect at route level would be captured equally well if each separate route in the hub network was operated by a different carrier.

Nevertheless, there is a demand and supply side gain to be achieved by single firm delivery across the whole of the network servicing a hub. In the case of the former, the benefit is from an improved quality of service. This improvement in service quality is the result of two factors. First, passengers have a preference for making *on*line connections rather than interlining between carriers, so that as the proportion of possible online connections grows, service quality increases (Bailey and Liu, 1995). Second, service quality also improves if connecting times between services are minimised. Arguably, such times are more likely to be minimised for the maximum number of passengers, the larger the proportion of services provided by the singular airline. This is because of information asymmetries: to minimise total connection times in a non-concentrated network requires each airline to be fully informed of the flow dynamics on other parts of the network that it does not operate and also to act co-operatively on the basis of such information[5].

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3 This is qualified when the nodes differ in their traffic generation potential. As Krugman (1999) has pointed out (referenced in Miller, 2003), connections are usually made to the larger cities (nodes) first so that in practice, as more nodes are connected to the hub, the scaling effect decreases.

[4] This is facilitated by the IATA interlining system.

[5] An interesting example of this problem and attempts to address it, has arisen in relation to the forthcoming opening of Terminal 5 at London Heathrow airport. The movement of British Airways into T5 will release space in two of the existing four terminals leading to an opportunity for a general reallocation of airlines to terminals. To assist in this task, the airport operator, BAA, commissioned work to assess what allocation would minimise connect times, taking into account flows of interlining passengers and the preferences of alliance partners to be co-located (Economics-Plus, 1995). The analysis was based on the interlining data then available but inevitably failed to capture the dynamics of interlining.

On the supply-side, until recently empirical studies had suggested that there were no evident production economies from increasing the size of networks so that there were no efficiency gains if a singular airline providing services across all the routes in a particular hub-based network[6]. However, the more recent empirical literature on airline economics has indicated that, in addition to economies of traffic density, there are economies of network scale possibly associated with the better utilisation of aircraft fleets (Ng and Seabright, 2001; Brueckner and Zhang, 2001)[7]. In addition, Jara-Diaz, Cortes and Ponce (2001) have suggested that previous approaches to measuring the effects of scale were confounded because an increase in network size adds more products (points) to the network; measurement, therefore, should take into account economies of spatial scope. Initial analysis on these lines using Canadian airline data suggests that there might be pronounced spatial scope economies, especially for the expansion of smaller networks (Basso and Jara-Diaz, 2005). With finite slot capacity at a hub this cost advantage can be obtained only by slot concentration.

Thus, to summarise, there are considered to be net gains to passengers from networking services through an airport hub. Although these connecting services could be provided by as many airlines as there are routes serving the hub, the quality of the network is improved if it is possible for passengers to make online connections and, if these connections are organised within the firm, they are more likely to be optimised. This, in turn, suggests that service quality increases the greater the proportion of nodes linked by one carrier (or, but to a lesser degree of quality, an alliance of carriers); in turn, with finite airport capacity, this implies slot concentration can increase consumer welfare. Larger networks operated by the single carrier from a hub are also likely to introduce supply-side economies of scale or scope (possibly associated with improved equipment utilisation and with better utilisation of fixed establishment costs associated with the hub itself), again suggesting a degree of natural monopoly and thus efficiency gains from slot concentration.

3. CONGESTION EXTERNALITIES

3.1 No quantity controls

At airports that act as network hubs, peak period congestion is a common feature so that an additional service imposes at the margin costs of delay on existing flight operations. The traditional prescription in these circumstances is to achieve an efficient level of use (and allocation of slots) by introducing (short run) marginal cost pricing to internalise the delay externality. Recent economics literature on the cost of airport congestion has, however, led to a major revision in thinking about the airport marginal cost issue and this new approach also has interesting connotations for how we might view slot concentration.

The new literature argues that the traditional approach to congestion externalities at airports has the effect of overstating the marginal costs of delay (Brueckner, 2002, 2005 and Mayer and Sinai, 2003). This is because the traditional approach does not take into account the fact that the delay costs that an airline imposes (by choice) on its own operations when it adds an additional flight to the peak at a particular airport are, in effect, internalised and therefore do not constitute an externality. The process of internalisation takes into account the impact of rescheduling on the operating costs of all other flights that the airline operates at the airport and, through adjustments to its peak/off-peak fares, the impact on the travel times of its passengers. (The latter are longer in the peak because of the added delay and, as a consequence, the airline has to adjust its fares to get the marginal passenger to switch to the peak; this required fare reduction affects all peak passengers thus reduces peak revenues as the airline adds flights. Equilibrium is reached when the gains and losses from shifting flights to the peak cancel each other). It is only with respect to the costs added to the flight operations of other airlines that the externality arises and therefore the marginal cost charge should reflect only this latter.

There are a number of consequences that follow from this insight.

- The traditional measure of marginal delay costs only applies to the airport case where, in the extreme, each service is operated by a different airline (the ‘atomistic’ case).

- Where, in the opposing polar case, all services are provided by a monopoly airline, there are no delay externalities, even when the airport appears to be congested; the efficient congestion charge is zero.

[6]See, for example, Gillen, Oum and Tretheway (1990) and Caves, Christensen, Tretheway and Windle (1987)
[7] There might also be scale effects associated with establishment costs at the hub.

- If, as is typically the case, the airport has a mix of carriers operating different peak period quantities, different carriers should pay different levels of congestion charge; generally carriers with a larger number of flights will pay less.

- The different levels of congestion charge will encourage slot concentration.

- More slot concentrated outcomes will have the effect of reducing total congestion externalities; more slot concentrated airports will have on average lower delay externalities (Starkie, 2003a).

With Quantity Controls

This revised view of congestion externalities was developed in the context of airports where there are no administered slot controls and airlines are free to add peak capacity by scheduling extra flights; the context is essentially that of a queuing model (see Daniel 1995). However, at a few US airports, together with most of the significant airports in Europe, the number of slots that can be used on an hourly basis is subject to a restriction, so that airlines have, in effect, to pre-book access; the object is to reduce the congestion externality by administrative means (see Forsyth and Niemeier in this volume). This raises the issue of whether the revised conceptual approach to congestion externalities requires modification, or ceases to apply at all, at such slot controlled airports. This would clearly be the case, for example, if the administrative rules had the effect of eliminating congestion.

Generally, this is not the case; the controlled number of flight operations per hour is usually fixed at a level which is expected to result in some delay and it would be inefficient not to do so[8]. Of course, with the quantity of slots now fixed, an airline is no longer free to add to the *total* number of flights in the peak and therefore the equilibrium mechanism outlined above no longer applies in the same way, but some of the essential features of the new approach still remain. For example, if all peak flights at the quantity controlled airport were operated by the singular airline, the (residual) externalities associated with the expected delay allowed for in the slot control limit would be eliminated. Thus, the size of the externality is now a function of the distribution of the fixed number of slots and the more concentrated the distribution the smaller the overall externality. Consequently, at slot controlled airports rules that prevent the consolidation of slots, such as disallowing slot trading, might have the effect of increasing the total size of the delay externality.

4. CONCENTRATION AND PRICES

The objective of regulators interventions in the allocation of slots at major airports is to enable competitive entry and, in the case of the EU, this object is reflected in the preferences that must be given to entrants when allocating new slots. But in exercising this preference there is an opportunity cost involved; the benefit foregone by not allowing the incumbent network carriers access to the prescribed slots (unless potential new entrants decline their option). These benefits, as suggested above, include reduced congestion externalities, the higher quality of service to passengers associated with online transfers and the potential for lower costs as a result of density, scale and scope economies at the level of the firm. The repost would be, however, that the potentially lower costs of the larger and more densely used network do not translate into a *reduction* in prices paid by airline passengers; in spite of potential economies of density, scale and scope, a number of studies have shown that fare yields on average are higher rather than lower, at airports where there are large incumbent carriers, with the implication that large carriers are exploiting their dominance[9].

There are, however, a number of points to consider before it can be concluded that the higher fare yields at hubs do indicate an exploitation of market power. First, providing for transfer passengers including their baggage adds complexity and thus costs to airline operations and with more transfer passengers there is a greater incentive to use expensive air-bridges rather than non-contact stands in order to speed up transfers. Second, hubs are usually large airports and larger airports are generally more costly to operate from because of the spatial separation of activities. For example, taxiing distances can be greater. Third, the organisation structure of a hub can add to airline costs because of the ground staff requirements associated with bunching arrival and departure flights to minimise connecting times. Fourth, the temporal concentration of on-line transfer opportunities also

[8] At London Heathrow, for example, the agreed average delay is 5 minutes but, in practice, the variance around this mean is considerable.
[9] The GAO (1999), for example, pointed out that there were 13 airports serving large communities where passengers in 1998 paid, on average, over 8 per cent more than the national average fare. Seven of these airports were hubs for major airlines (page 10).

adds to demands for extra (peak) capacity which might, and should, be reflected in higher airport charges or in terminal lease fees if, as seems likely with major airports, there are diseconomies of scale in capacity[10].

A number of factors, therefore, suggest that there are some operational costs that might be higher for airlines operating network hubs from major airports. Whether the factors pushing up operating costs offset the economies of density/scale/scope associated with a connected network is a moot point. If fares are higher from concentrated hubs, a basic issue is whether and to what extent this is a cost reflective outcome so that passengers are, in effect, paying higher prices for a differentiated and, ultimately, more costly quality of service, one that is associated with higher service frequencies and on-line connections.

There is a further important consideration. Many hub airports are increasingly operating at or near capacity, either operational capacity or declared capacity, particularly during peak periods. In these circumstances, prices (or quality deterioration) will have to be used to limit demand to capacity available. If the airport is pricing efficiently such rationing prices will be reflected in higher (peak) period charges, hence in higher costs to the airlines and, in turn, in higher fares charged to passengers for travel at peak periods. But for various reasons congested airports often charge airlines inefficiently low prices[11]. Nevertheless, it does not make sense for the airlines to pass on sub-optimally low airport charges in the form of lower fares. If they were to do so, service quality would deteriorate (a growing number of frustrated customers would be unable to obtain a booking at posted prices). The sensible airline will maintain its fares at market clearing levels. This will result in high fare yields[12]; but these high yields will reflect scarcity and not monopoly rents.

There are, therefore, a number of good reasons why we might expect higher fare yields at airports dominated by hub carriers. The existence of higher yields *per se* does not indicate that dominant carriers are exploiting their market power. On the contrary, for airlines to extract true monopoly rents there has to be evidence that output (as reflected either in the inefficient use of slots or in low aircraft load factors) is being deliberately restrained below capacity and the analytical work done so far on this point does not support such a conclusion (Kleit and Kobayashi, 1996)[13].

Conversely, if you cannot increase output because of capacity limits, the proclivities of regulators to (re)allocate slots to potential competitors should make little difference to the overall level of fares at the hub; some fares may go down as capacity is shifted to allow competition on particular routes but, generally, this will be at the expense of other routes from which capacity is withdrawn and which as a consequence experience lower frequencies or the loss of a service. The effect of a reallocation of capacity in these circumstances is not to introduce competition across the network but, in large measure, to reassign the scarcity rents[14].

5. CONCLUSIONS

This chapter has suggested that high levels of capacity utilisation by a single airline at major hub airports might constitute an efficient outcome and that recent developments in the theory of congestion pricing applied to airports has made this outcome more likely. The efficiency gains from concentration appear to have been largely ignored by policy makers who, instead, have focussed on the negative aspects of slot concentration, particularly on the reduced opportunities for potential service competition at the *route* level from a particular airport. In doing so, they have neglected competitive pressures arising in many regional markets from parallel or substitute routes facilitated by the use of secondary airports with spare capacity. These generally less crowded airports have been used by airlines with a business model different from that used by the typical network carrier. It is based on simplified low cost operations and, in Europe especially, point-to-point-services[15]. Low cost airlines

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[10] Starkie and Thompson, (1985) argued from first principles that there were diseconomies of scale at major airports. Pels`s (2000) empirical work supports this view with respect to terminal development.
[11] See Starkie (2003b) for a discussion why airports seem reluctant to use efficient charging schemes.
[12] For example, the GAO (1999) found that: “Airfares at six gate constrained and four slot constrained airports were consistently higher than airfares at non-constrained airports that serve similar sized communities… ” (page 20) but it tended to draw the conclusion that this must be due to exploitation of market power.
[13] Use-it or lose-it clauses in EU regulations and regulations governing the use of slots at high density airports in the US are also intended to guard against this practice
[14] At major congested airports there is rent-seeking behaviour. At the time of writing, the *Financial Times* (US edition, November 3rd, 2005) reports on the prospect of a deal between the EU and the US which could remove restrictions on further US carriers accessing London Heathrow. It comments: “A deal would open London Heathrow to more competition (*sic*)…”
[15] Although the low cost airlines have developed operational hubs, usually these do not provide for network traffic. Ryanair and easyJet for example, the two largest European low-cost carriers, provide for no connecting traffic at their respective hubs. Passengers can transfer between flights but have to purchase separate sector tickets. Ryanair has concentrated exclusively on what were, at the time of entry,

using this business model have had a major impact on local competition in the US domestic[16] and intra-European markets[17] and, in the process, they have made rules such as that in the current EU slot Regulation giving preferential allocation of pooled slots to new entrants, unnecessary for the purpose of achieving competitive outcomes.

Thus, in judging an appropriate level of slot concentration there is an important balance to be struck between the benefits of concentration and the disbenefits associated with an increase in market power (increasingly tempered in short-haul markets by entry from low cost carriers using secondary airports). It is not at all clear where the optimal balance lies and this suggests a presumption against regulatory intervention especially interventions making use of *per se* rules. As matters stand it is by no means evident that the level of slot concentration to be found, for example, at major European network hubs (between 40 and 60 per cent of slots in the hands of the leading carrier), is inefficiently high once account has been taken of the inherent economies of density, scale and scope of network hubs, the reduction in congestion externalities of increased concentration and the growing competitive threat from low-cost carriers using secondary airports. The prevailing, often moderate, degree of slot concentration might, in fact, prove to be too low if efficiency and, thus, welfare is to be maximised.

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secondary airports (although Dublin was an exception) and has made no use of the major network hubs, but easyJet has made some use of them (see for example Paris Orly in Annex 1).

[16] See, for example, Morrison (2001).

[17] See, for example, Davies *et. al.* (2004).

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ANNEX 1:
CONCENTRATION AT SELECTED EUROPEAN AND US NETWORK HUBS

	Airport		Proportion of flights by 3 leading carriers						One firm HHI
Europe	Munich	MUC	64.0	Lufthansa	7.8	dba	1.8	Air France	4096
	Paris	ORY	61.3	Air France	7.5	Iberia	5.6	easyJet	3758
	Frankfurt	FRA	60.1	Lufthansa	3.2	BA	2.3	Condor	3612
	Milan	MXP	59.1	Alitalia	7.1	Lufthansa	3.6	Air France	3493
	Paris	CDG	57.9	Air France	5.2	Lufthansa	4.0	BA	3352
	Madrid	MAD	56.7	Iberia	13.7	Spanair	6.8	Air Europa	3215
	Amsterdam	AMS	50.7	KLM	5.3	Transavia	3.5	easyJet	2570
	London	LHR	42.3	BA	11.5	BMI	4.5	Lufthansa	1789
US	Houston	IAH	85.7	Continental	2.4	AA	2.1	Delta	7344
	Charlotte	CLT	84.0	US Airways	3.5	Delta	3.2	AA	7056
	Dallas	DFW	83.2	AA	2.3	Delta	2.0	United	6922
	Detroit	DTW	80.3	NW	3.3	Delta	2.5	AA	6448
	Atlanta	ALT	74.8	Delta	13.4	Air Tran	2.3	AA	5595
	Newark	EWR	66.2	Continental	7.2	AA	4.1	Delta	4382
	Denver	DEN	54.9	United	18.0	Frontier	8.6	Gt. Lakes	3014
	Chicago	ORD	47.5	United	38.7	AA	1.9	Delta	2256

Source: Adapted from *Airline Business*, June 2005