UNOAI Report 97-6

# The Conference Proceedings of the 1997 Air Transport Research Group (ATRG) of the WCTR Society

Volume 2, Number 2

Editors
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September 1997

# UNO

Aviation Institute
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The Conference Proceedings
of the 1997 Air Transport Research Group of the WCTR Society


June 25-27, 1997: University of British Columbia, Vancouver, Canada


Published on behalf of the Air Transport Research Group (ATRG)

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**ATRG first Conference**

Vancouver, June 1997

Title of paper: Airport Pricing Systems

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**Abstract**

Because of their continued importance airport charges and the pricing philosophies underlying them merit particular attention. On the one hand, it should be borne in mind that from the airlines' point of view airport charges are an important issue since they impinge directly upon their own costs. For most european charter airlines airport charges represent around 15 per cent of total operating cost (see Doganis 1992). On the other hand, the airport pricing policy must provide a sound guide for future investments. This must be so because if prices reflect cost then demand levels will represent the true demand fot that facility and will thus provide an indication of whether additional units of that facility are needed at that price. Due to indivisibility investments in airport infrastructure pricing system becomes a critical issue. In this paper we describe the pricing policy which is being adopted in most of european airports. Additionaly we'll describe any alternative pricing systems and finally we calculate the structure of landing fees at uncongested airports as an application of Ramsey Pricing with data from european airports.

**Airport Pricing Systems**

## 1. -Introduction

The basic pricing structure for several airports from differents continents is a weight-based landing fee plus a passenger charge on departing passenger. The similiarity in charging structure around the world occurs because most countries have adopted the recommendations made by ICAO and IATA. Both organizations have tried to achieve standardization of airport charges. However, weight-related charges may lead to poor utilization of resources, over-investment in facilities and users gaining at the expense of producers. For instances, the case where users who impose high costs by operating at night or at peak periods or by requiring special facilities are not charged accordingly.

An efficient allocation of airport resource require that the price paid by any user reflects the costs which they impose on the airport. If prices reflect cost then demand level will represent the true demand, but if price below cost may estimulate extra demand and induce investment in facilities which do not cover their full costs. A key question, therefore, in assessing the suitability of airport pricing structures in a more commercially oriented environment is the degree to which they reflect costs.The shortcoming of traditional pricing structures pushe one inevitably towards alternative pricing structures like cost-related pricing: marginal cost pricing or Ramsey pricing.

This paper is organised as follows. Section 2 describe the differents charges on european airports and the traditional pricing policy (average-cost pricing). Next, some alternative pricing strategies, as marginal cost pricing, Ramsey pricing and two part tariff are analysed. Section 4 presents a structure of landing fees at uncongested airport as an application of Ramsey Pricing. Finally, section 5, extracts some results.

## 2.-European Airports Charges

A commercial aircraft landing at an airport faces a number of possible charges. The most common charges at European Aiports are :

A)Aiport Related Charges: landing and take-off fees, passenger charges for terminal passengers and transfer passenger, parking charges, state imposed departure taxes, airbridge charges, security charges, terminal navigation charges, noise charges, night operation or lighting charges.

B)Handling Charges: passenger handling, ramp handling, aircraft cleaning, supervision of handling services, bus, special assistance, executive lounge access, air start for engines, assistance to special needs for passengers.

The major single source of revenue for most european airports has traditionally been revenue derived from landing fees charged to aircraft. Since the early days landing fees have been based on the weight of the aircraft usually the maximum take-off weight (MTOW). There is a charge per unit weight (e.g. per tonne, 1000 lbs or Kgs.). Additionaly, a complex and diverse systems of surcharges and rebates on the basic landing fee are operated at different airports. These are usually of three kinds. They may be related to the distance or type of flight to noise levels of the aircraft or to night landings. In recent years several airports, especially in Europe, have introduced noise-related rebates or surcharges to encourage the use of quieter aircraft. For instance, Amsterdam and the larger French airports have quite complex noise surcharges for different aircraft types while most German airports have simpler surcharges. At airports not operating on a twenty-four-hours basis there is frequently an extra surcharge on those aircraft wishing to land and take-off during the shut-down period. Even when the airport is open for twenty-four hours there may be a special fee during night hours to cover the cost of runway lights, as happens at Athens and Italian airports.

Beyond the free- parking period covered by the landing fee, which is generally two to

six hours, aircraft must pay a charge if parked on the airport's apron, taxiways ramp or hangars. The parking fee is normally an hourly charge. This charge is calculated usually on the basis of the aircraft's weight or less often on its area.

The charges per passenger are an second very important source of airport revenue. The common practice among european airports is that this charges be levied directly by the airport on the airlines who incorporase the charge within the fare. However, this way to do is a major source of conflict between airlines and airports authorities. Airlines argue that including this charge in the ticket has adverse consequences. It entails the passenger paying more than the airport charge because the ticket price has to be increased by a greater amount both to cover increased commission paid to travel agents on the higher ticket price and to absorb the airlines'own administrative cost of handling the airports' passenger charges. The level of the passenger charge varies widely. There is a differential between domestic and internacional fees which may be justified on cost grounds because internacional passenger are more costly to handle in terms both of facilities and the space they require.

Additional to the types of charge outlined above, there are a variety of charges which are lived by some airports. Among other, we point out a fuel throughput charge. This is in essence a royalty for the fuel concession granted in addition to the rental for space occupied by the fuel companies. Airports, also, are beginning to impose separate charges for specific facilities like fee for airbridges, buses or mobile lounges. Finally airport security charges are also be comming more widespread.

We pointed out above that the passenger charges were the second very important source of airport revenue after aircraft landing fee, however, for some european airports, they are the most important. Below (see table 1), we compare the most important charges per turnaround (4 hours between landing and take-off ) for Boeing 737-200 (passenger: 114, range : 2518 Kms and cruising speed: 793 Km/h). The case of London airports is a significant one. It is noticeable that at many airports the passenger-related charge has now become much more important than aircraft-related

landing fee based on weight. For about half the airports surveyed the passenger charge generated between 45 and 50 per cent of the total aeronautical charges.

**Table 1: Weight comparison of most important charges (Boeing 737- 200)**

| Country | Airport | Landing fees (%) | parking charges (%) | passenger charges (%) | terminal navigation charges(%) |
|---------|---------|------------------|---------------------|----------------------|-------------------------------|
| Netherlands | Amsterdam (Schipol) | 41.0 | 0.0 | 49.6 | 9.4 |
| Germany | Berlin | 59.0 | 0.0 | 32.9 | 8.0 |
| Germany | Frankfurt | 46.6 | 2.5 | 42.5 | 8.4 |
| Germany | Munich (new) | 48.0 | 0.0 | 43.0 | 9.0 |
| Belgium | Brussels | 43.1 | 0.0 | 56.9 | 0.0 |
| Portugal | Lisbon | 34.5 | 4.5 | 46.3 | 14.7 |
| United Kingdom | London (Gatwick) | 15.3 | 16.9 | 52.0 | 15.8 |
| United Kingdom | London (Heathrow) | 22.5 | 9.7 | 54.2 | 13.6 |
| Spain | Madrid | 57.7 | 3.1 | 39.3 | 0.0 |
| Italy | Milan (Linate) | 32.5 | 0.6 | 52.9 | 13.9 |
| Norway | Oslo | 53.2 | 0.0 | 46.8 | 0.0 |
| France | Paris (CGD) | 38.8 | 3.0 | 41.7 | 16.5 |
| Austria | Vienna (Schwechat) | 55.5 | 0.0 | 44.5 | 0.0 |
| Denmark | Copenhagen | 50.5 | 0.0 | 49.5 | 0.0 |
| Finland | Helsinki | 49.6 | 4.3 | 46.2 | 0.0 |

Source:TM Economics Ltd, 1992 (adapted).

Most airports needs to geneate more revenue in response to rising cost often brought about by new investments or to reduce existing losses. The recommendation made by International Civil Aviation Organizations (ICAO) of recovering costs led to the use of the average cost as basic price. Dividing the costs incurred by the airport by the number of traffic units processed, provides a unitary tariff. This procedure can be applied separating the different components of the total cost in order to obtain tariffs for the different services provided. For example, the costs originated in the landing área, such as runways maintenance, fire service, safety and use of control equipment, are divided by the number of tons processed to obtain the tariff corresponding to the landing rights, or the costs of the terminal building are divided by the number of passengers in order to derive the tariff applied to them. In this last case, the process must be made in a separate way for the different classes of traffic. This methodology constitutes the traditional pricing policy.

Air companies argue that this procedure is objective and fair, since all the users pay the same for using the same services. However, in fact the different operators impose different costs and, because of this, they have to pay different tariffs. For example, a company that operates in peak periods imposes a higher cost (capacity cost) than others that operate in off-peak periods. On the other hand it can happen that the tariff based on the average cost leads to an inefficient use of the available resources. Suppose that, for a certain airport, the tariff for the peak period is lower than the costs in that period[5] and that it happens exactly the opposite for the off-peak period, which is perfectly possible in this procedure. Then, air companies would be stimulated to operate in peak periods, thus increasing congestion levels. If the situation is extreme, for example, the airport is operating at a level which is very close to its installed maximum capacity, this would lead to the need of widening that capacity. The final consequence would be the under-utilization of the installed capacity during most of the day, with the consequent increase in the average costs in those periods (see Toms, 1994).

The efficient allocation of airports limited resources requires that users pay a price for the services provided which reflects the costs they impose. This principle is not verified in the traditional pricing policy. Economic literature suggests a series of alternative procedures that allow the approach to the efficiency principles. Below we will make a short description of these methodologies.

## 3.-Alternative Pricing Strategies

*Relating costs and prices: marginal-cost pricing*

Airports are production units whose capacities can only be increased by large and indivisible units that demand a high investment. For example, if the capacity of a given airport means handling a traffic of *"n"* aircrafts, to handle *"n+1"* aircraft would imply to

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[5] For example due to externalities generated by congestion.

widen its capacity, in that case, to build a new runway. In that context, an important point to take into account is the existing relationship between the rates charged to users and the need of amplification of the installed capacity.

The cost of handling an additional passenger or aircraft unit in an airport that operates below its installed capacity at any time of the day is almost zero. In these conditions, an extra passenger or aircraft would produce a very small impact on the airport´s operating costs. The costs associated with the terminal building and runways maintenance would be increased in a marginal way. The rates applied to passengers or aircrafts based on these costs would result very low and anyone who could afford them should have access to the airport´s facilities. In this way the utilization of such facilities would be maximized. Figure 3 shows this situation[6] (see Doganis, 1992):

**Figure 1: Marginal Cost (short and long term):**
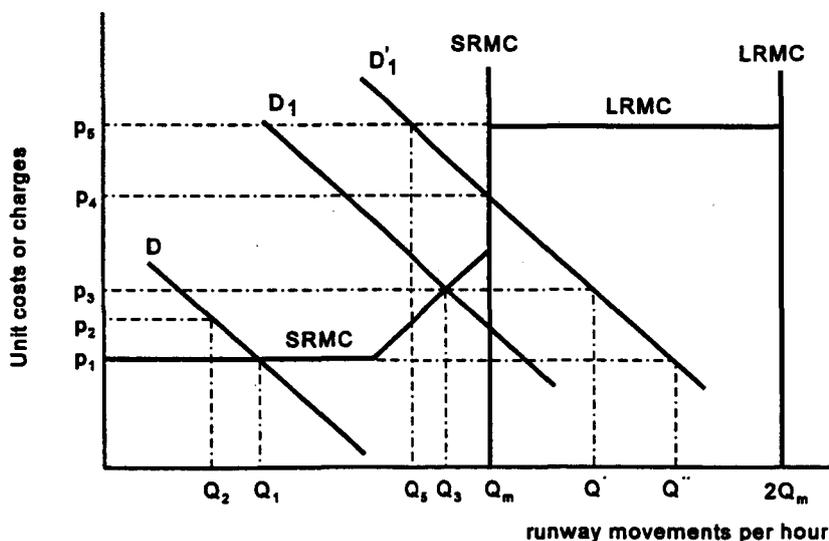


In the figure above, *D* is the present demand function, *SRMC* is the cost of an additional passenger or aircraft unit and $Q_m$ is the maximum number of movements per hour

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[6] The graphic reasoning is made in terms of runways capacity. However, it can be made about any other service.

allowed by the installed capacity. The solution $p_1$ = SRMC would imply a traffic volume of $Q_1$. To cover the costs of the capital invested it would be necessary to set a price equal to $p_2$, but this would make the demand hold back to $Q_2$ and the installed capacity would be under-utilized. Consequently, once the facilities are already built, and since the possibility of alternative uses does not exist in the short run, the solution $p_1$ = SRMC would maximize the infrastructure utilization and the consumer benefit. The resulting losses would be[7]:

$$p_1Q_1 - [p_1Q_1 + capital\ cost] = -capital\ cost$$

The rationale for this policy bases in the fact that setting a price over $p_1$ would imply a capacity excess of $Q_m - Q_2$. On the other hand, according to the demand function $D$, the marginal cost is inferior to the value that the users would be willing to pay for an additional service unit. That means that the social benefit could increase (the consumer surplus would increase) if we do not consider the capital cost and establish a price equal to $p_1$.

If we change the initial situation and admit a greater traffic concentration in peak hours, the costs of operating during these periods are increased by the need of more staff and, furthermore, due to the intensive use of facilities. If the marginal cost of operating in peak hours and in off-peak hours shows large differences, then there is a reason to introduce separate charges for the two periods, which can be based on the short run marginal cost. According to Figure 1, the charge for peak hours would be equal to $p_3$, and the one for off-peak hours would be $p_1$. Nevertheless, if the situation evolves in such a way that in peak periods traffic increases considerably, or what is the same, if demand function $D_1$ shifts to the right ($D_1'$), an excess of demand would appear for both prices. These excesses of demand are represented by $Q_m - Q^*$ and $Q_m - Q'$, and it would be necessary to charge $p_4$ to avoid them. Any intermediate price between $p_4$ and $p_1$ would not modify the total traffic level, which can not exceed the quantity $Q_m$. However,

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[7] $CMa = dCV/dQ \rightarrow \int dCV = \int CMa\ dQ \rightarrow CV = CMa \int dQ = CMa\ Q = p_1\ Q$

at $p_4$ services would be used by those who value them the most. Once here it is possible to try to satisfy demand $D_1'$ widening the facilities or building another runway, for example. In this case, users would have to pay a price equal to the long run marginal cost ($p_5$ in figure1), which appears as a consequence of building and operating the new installation. The application of the price $p_5$ contracts demand to $Q_5$. If at this price the demand in the top hours continues growing, this would be a clear indication of the need of amplification of the installed capacity.

Due to the own nature of the solution "price equal to marginal cost", this is unable to generate enough income to cover the generated costs. If airports are companies operated from a commercial point of view, they should be financially self-sufficient. However, if charges are based on the short run marginal cost, these do not generate enough income to cover capital costs. Consequently, the strict application of the rule "price equal to marginal cost" leads to losses, and this is unacceptable from the commercial point of view.

The conclusion from above is that there is a need of finding a methodology that permits recovering costs and that, at the same time, does not produce any distortion in the allocation of resources. The technique commonly used to reach both objectives is known as "Ramsey pricing policy".

*Ramsey pricing*

Ramsey pricing policy suggests that, where the solution price equal to marginal cost does not generate enough income to cover costs, it would be economically more efficient to generate an extra income, appraising the different users in inverse relationship to the elasticity of the service demand. In other words, to appraise on the base of the willingness to pay of users.

Morrison (1982) derived a Ramsey pricing structure for landing rights at uncongested airport. The objective is the maximization of the difference between social benefits and

costs subject to the obtainment of a certain quantity of income. The solution of the resulting Lagrangean provides a standard Ramsey solution which indicates that the percentual margin of price (landing rights) on the marginal cost must be inversely proportional to the price-elasticity of landing demand:

$$\frac{p_i - \partial(TC)/\partial Q_i}{p_i} = \left(\frac{\lambda}{1 + \lambda}\right) \cdot \frac{1}{\varepsilon_i} \quad (i=1,...n)$$

Ramsey pricing structure is a quasi-optimum solution, since it permits covering costs without forgetting the principle of efficient allocation of the airport's available capacity. It is, therefore, an alternative way of reducing the deficit incurred in the aeronautical operations of the airport, avoiding the need of any kind of subsidies. On the other hand, it permits to include in the tariffs structure the costs generated by externalities such as congestion, noise and pollution (see Oum and Tretheway, 1988).

*Two Parts Tariff*

Another alternative would be the establishment of a two parts tariff. This tax would try to cover fixed costs as well as the variable ones incurred in the production of the service. Concretely, the fixed costs (construction costs and capital costs) would be recovered through the establishment of a fixed charge independent of the level of utilization of the service, and the variable costs (maintenance costs and other costs caused by the utilization of the service) would be covered with a price that reflected the marginal value of the service. The principal problem of this system is shaded in the following question: Who must pay the fixed costs?. Suppose that all air companies must pay that cost (each one of them pays the same quantity). Since, normally, each company operates with different aircraft type, there would not be incentive to use those whose needs of runways design and construction were minimum (see Levine 1969).

In summary, for uncongested airports marginal-cost pricing will result in deficits which are often unacceptable. The pricing problem is thus one of covering the deficit with as

small a deviation as posible from the optimal pattern of use. Ramsey pricing permits recovering cost without distorting too much the allocation of resources. Following Morrison (1982) we'll try to develop a Ramsey pricing model for uncongested hypothetical airport.

## 4.-The structure of landing fees at uncongested airport: An application of Ramsey Pricing

This section derives an example of Ramsey pricing model for spanish airport data. We'll estimate an estructure of landing rights using the same formulation as in Morrison's work. First of all, the results presented are an first approximation. The values used for elasticity of demand for passenger trips related to distance of trip and the equation that estimate the total operating cost as a function of distance were not updated. The standard Ramsey pricing presented in Morrison's work is as follows:

$$p_i = \frac{\partial(TC)/\partial Q_i + (K/\eta_i) \cdot TC_i}{1 - K/\eta_i} \quad (i=1,...n)$$

$$K = \lambda/(1 + \lambda)$$

The landing right depends on the resulting marginal cost, on the price-elasticity of the passengers demand ($\eta_i$ in absolute value) and on the total cost of the flight. This last one, at the same time, depends on the aircraft size, as well as on the flight distance. The price-elasticity of the passengers demand indicates that it increases, in absolute value, with the distance of the trip[8]. To sum up, the key to reflect the true value of service lies in the aircraft size and distance[9].

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[8] We can assume two hypothesis about $\eta_i$: 1) it is a weighted average of the price-elasticity of the passengers demand with different flight distances, aboard the same aircraft or 2) the flight distance of all the passengers is identical to the flight distance of the aircraft.

[9] Users´willingness to pay depends on the flight distance.

The above equation can be solved for landing fees for different aircraft types and distance for a hypothetical airport. The values used for the elasticity of demand for passenger trips related to distance was:

**Table 2: Elasticity of demand for passenger trips related to distance**

| Distance | 500 | 1000 | 1500 | 2000 | 2500 | 3000 | 3500 |
|----------|------|------|------|-------|-------|------|-------|
| $\eta_i$ | 1.04 | 1.10 | 1.14 | 1.152 | 1.162 | 1.17 | 1.174 |

The operating cost for a given aircraft type and distance can be estimated by multiplying the operating cost per block hour for that aircraft type by the number of block hours for the flight. The result can be multiplied by two to obtain total flight cost. Morrison used block hours as a function of distance:

*Total operating cost per block hour* . $(0.5263 + 0.0019\ D_i)$

Operating cost per block hours in 1992 for different types of aircraft and other information to be used subsequently are presented in table 3.

**Table 3: Aircraft Characteristics (1992)**

| Aircraft characteristics | Aircraft type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DC-9 | MD-87 | A-320 | B-727 | B-757 | A-300 | DC-10 | B-747 |
| $/block hour* | 3748 | 3953 | 4445 | 4595 | 5846 | 6142 | 6603 | 8002 |
| Seats | 105 | 109 | 147 | 153/164 | 200 | 256/260 | 268 | 418 |
| MTOW (ton)* | 48.9 | 61.6 | 71.5 | 83.5 | 99.8 | 162.1 | 251.7 | 371.94 |
| MLW (ton)* | 44.9 | 58.06 | 64.5 | 70.08 | 89.8 | 134 | 182.8 | 265.35 |

*USA $ per block hour.
*Maximum takeoff weight and maximum landing weight respectively.
Source: Compiled by the author from Association of European Airlines (AEA) data.

There was no available data to estimate marginal cost to the spanish airport of an air carrier landing. The analysis was carried out for different values of marginal cost, with no significant change in the pattern of results. According to engineers of AENA[10] the recommended value for marginal cost to be used in this study was $79.

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[10]Aeropuertos Españoles y Navegación Española.

The value of K depends on the extent to which the revenue constraint is binding. The analysis which follows used a value for K of 0.088. This value was used because the fees generated were of the same order of magnitude as weight based fees actually charged in spanish airports. A variety of values of K were used, and the general pattern of results remains the same. Given the values of the parameters for Ramsey pricing equation the structure of landing fees for different aircraft types and distances are presented in table 4:

## Table 4: Ramsey Pricing (USA $ 1992)

| Distance (Km) | Aircraft type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DC-9 | MD-87 | A-320 | B-727 | B-757 | A-300 | DC-10 | B-747 |
| 500 | 594 | 622 | 689 | 709 | 879 | 919 | 982 | 1172 |
| 1000 | 866 | 909 | 1012 | 1043 | 1304 | 1365 | 1461 | 1753 |
| 1500 | 1142 | 1200 | 1339 | 1381 | 1734 | 1818 | 1948 | 2342 |
| 2000 | 1419 | 1492 | 1668 | 1721 | 2166 | 2272 | 2436 | 2934 |
| 2500 | 1697 | 1785 | 1997 | 2061 | 2599 | 2727 | 2925 | 3527 |
| 3000 | 1975 | 2078 | 2326 | 2402 | 3033 | 3182 | 3415 | 4120 |
| 3500 | 2253 | 2371 | 2656 | 2743 | 3466 | 3638 | 3904 | 4717 |

As Morrison found, two basic patterns can be pointed out:

First, landing fees for each aircraft type increase with distance, because the derived demand for landings for longer flights is more inelastic than for shorter ones. Second, landing fees increase as aircraft size increases. This is due entirely to the flight-cost effect.

The ratio of Ramsey prices in table 4 to current weight-based fees will be used to analyse the relative structure of the Ramsey prices. It is thus necessary to choose a level of weight-based fees (i.e. a normalisation criterion) as basis for comparison. The normalisation criterion was chosen so that the ratio of fees for the DC-9 at 500 kilometres equals one. Given the weight of the DC-9, this implies a level of weight-based fees of $12.147 per ton takeoff or landing weight. These ratios are shown in table 5 and 6.

**Table 5: Normalized ratio of Ramsey price to prices based on landing weight**

| Distance (Km) | Aircraft type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DC-9 | MD-87 | A-320 | B-727 | B-757 | A-300 | DC-10 | B-747 |
| 500 | 1.00 | 0.88 | 0.88 | 0.83 | 0.80 | 0.56 | 0.44 | 0.36 |
| 1000 | 1.45 | 1.29 | 1.29 | 1.22 | 1.20 | 0.84 | 0.66 | 0.54 |
| 1500 | 1.92 | 1.70 | 1.71 | 1.62 | 1.59 | 1.12 | 0.88 | 0.73 |
| 2000 | 2.38 | 2.11 | 2.13 | 2.02 | 1.99 | 1.40 | 1.10 | 0.91 |
| 2500 | 2.85 | 2.53 | 2.55 | 2.42 | 2.38 | 1.68 | 1.32 | 1.09 |
| 3000 | 3.32 | 2.95 | 2.97 | 2.82 | 2.78 | 1.95 | 1.54 | 1.28 |
| 3500 | 3.79 | 3.36 | 3.39 | 3.22 | 3.18 | 2.24 | 1.76 | 1.46 |

**Table 6: Normalized ratio of Ramsey price to prices based on takeoff weight**

| Distance (Km) | Aircraft type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DC-9 | MD-87 | A-320 | B-727 | B-757 | A-300 | DC-10 | B-747 |
| 500 | 1.00 | 0.83 | 0.79 | 0.70 | 0.72 | 0.47 | 0.32 | 0.26 |
| 1000 | 1.45 | 1.21 | 1.16 | 1.03 | 1.07 | 0.69 | 0.48 | 0.39 |
| 1500 | 1.92 | 1.60 | 1.54 | 1.36 | 1.43 | 0.92 | 0.64 | 0.52 |
| 2000 | 2.38 | 1.99 | 1.92 | 1.70 | 1.79 | 1.15 | 0.80 | 0.65 |
| 2500 | 2.85 | 2.38 | 2.30 | 2.03 | 2.14 | 1.38 | 0.96 | 0.78 |
| 3000 | 3.32 | 2.77 | 2.68 | 2.37 | 2.50 | 1.61 | 1.12 | 0.91 |
| 3500 | 3.79 | 3.16 | 3.05 | 2.70 | 2.86 | 1.85 | 1.28 | 1.04 |

The results have shown the same trends as found by Morrison:

Two consistent trends are apparent in the tables. First, for any given aircraft type, the ratios increase with distance. This indicates that the Ramsey prices increase with distance faster than the weight-based fees. (Indeed, the weight-based fees do not increase with distance). Second, for any given distance, the ratios decrease as aircraft size increase. This indicates that weight-based fees rise too rapidly with size (weight). Imposition of Ramsey pricing would result in increased fees for "small" planes on "long" flights and decreased fees for "large" planes on "short" flights. However, on average, small planes do not make long flights and large planes do not make short flights. At the average, then, the weight-based fees is not as distorted as the table suggests. But, of course, any flight which deviates from the average will be mispriced under the weight-based fees system. If, for some reason, airport have to use weight-based prices, since that the difference between takeoff weight and landing weight is fuel, takeoff

weight is, on average, better because incorporates the relevant dimensions of Ramsey prices (size and range).

## 5.-Summary

Strict application of marginal-cost pricing w'll lead to accounting losses at many airports, even though there may be improved efficiency in resource allocation respect to traditional price policy (average-cost pricing). Where marginal-cost pricing is unable to generate revenues to cover some required revenue target, then it is economically most efficient to raise the extra revenue required from different users in inverse relation to their elasticity of demand for airport services, in other words by charging on the basis of ability to pay. In combining marginal-cost pricing and the concept of ability to pay airport authorities have the possibility to close the gap between their income from marginal-cost charges and their targeted total revenue charging a more high price where demand is inelastic. Ramsey pricing reflects the true value of service; size of aircraft (weight) and distance of flight whitout distorting too much the allocative efficiency of marginal-cost pricing.

we have to say that the results of Ramsey pricing exercise presented for spanish airports datas need a more detailed research because the equations of the elasticities and total operating cost related to distance used in this study, was taken from DeVany's work, and this formulation have to be updated. However, although the results are only a first approximation, they shown the same trend as found in Morrison's work. Finally, as pointed out Oum and Tretheway (1988), a possible extension of this work is to consider the externalities (congestion, noise and air pollution) that impose aircraft movements on others.

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# Airport Services and Airport Charging Systems: A Critical Review of

# The EU Common Framework

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## I. INTRODUCTION

Airport charging practices in recent years have been based on a principal of cost-recovery rather than on the principal of cost-relatedness for facilities used and services provided. In Europe, a wide range of services and facilities are jointly provided by the publicly owned airport authorities. Several key studies have highlighted the capacity constraints currently existing at European airports and the additional constraints likely to develop as traffic growth continues at average rates of 5-6% per annum. With the liberalisation of inter-community air transport in 18 states of Europe by the end of 1997, the issues of airport capacity allocation and efficient airport capacity management are critically important in determining the development of a truly competitive airline market for passenger and freight services. In this arena, a move towards a more market based procedure is welcome for all users and for those involved in the long term planning of air transport infrastructure requirements. There is a large body of literature proposing and supporting a more market-based approach towards charging systems, arguing that it will lead to greater efficiency in airport use and in long term capacity investments[1]. However there are many difficulties associated with operationalising such charging mechanisms, some legal, some practical and some political.

In this paper, these issues are discussed in relation to the CEC Consultation Paper on Airport Charges. This set of proposals was put forward by the Commission in 1995 and is expected to be agreed by the Council of Ministers and European Parliament during 1997. The proposals contained in the Consultation Paper are critically reviewed here, particularly in relation to (i) whether the proposals will make any difference to current charging practices and rates; (ii) the way in which individual European airport services and facilities are viewed as well as the view of the airport system as a whole; (iii) the possible role of the private sector in the provision and funding of components of the suite of airport services and functions.

In the next section of this paper, a framework for examining the nature of airport services is presented and the general issue of competition and privatisation in airport service provision is addressed. The

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[1] See for example Doganis (1992); TRB (1991; 1990); Levine (1969); Carlin and Park (1970); Morrison (1982; 1987). Jones. Viehoff and Marks (1993).

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section concludes by summarising the economic arguments surrounding the imposition of a marginal cost pricing scheme. In section III, the CEC paper and the proposals are briefly reviewed. In section IV, problems associated with the CEC proposals are highlighted. Many of these issues came to light in the US, where a similar cost-based, non-discriminatory charging framework has been in place for some time. The main conclusions from this review are that the CEC proposals will be difficult to enforce because they are vague, implementation is left to the individual member states, and because they allow for a variety of approaches to charging systems which can include substantial cross-subsidisation across aeronautical and non aeronautical uses. The fact that the Commission will not have significant powers of enforcement reduce the impact which the proposals can have.

## II. THE NATURE OF AIRPORT SERVICES

*Functions and ownership of civil airports:*
The basic functions of an airport are to provide access for aircraft to the national airspace, to permit easy interchange between aircraft and to facilitate the consolidation of traffic. In order to perform these functions, the airport must have several basic infrastructure elements present[2] such as runway, taxiways, aprons ('airside infrastructure') and airport ground resources for passengers or cargo. The ground resource elements as well as airside infrastructure capacity dictate the airport's air traffic capacity.

Traditionally, European and US airports have been in public ownership by local, regional or national governments or some combination of government tiers. Approximately 160 airports received scheduled international air services in the EU in 1991. This number has been expanding recently with the growth in services to regional airports encouraged by air transport liberalisation. With the exception of the London airports, the largest EU airports are owned by a combination of city, regional and national governments. The London airports are privately owned and operated by BAA plc. In the US, the airports which are used by scheduled air carriers are virtually all publicly-owned facilities run by an agency on behalf of the state or local government. There are a small number of publicly-owned airports which are managed and run by private companies who receive a management fee for their services. No US airports have been privatised to date.

The EU has taken substantial steps towards liberalising the air transport sector, particularly with the provisions in the so-called 'Third Package' of liberalisation measures. One of the cornerstones of these regulations is that there be free entry to international markets, and since April 1997, domestic markets for all EU registered carriers. As Hardaway (1991) noted, access to airport gates and terminals is critical in permitting effective competition to take place and "Denial of access serves as an absolute barrier to entry". The constraints on existing airport capacity have been identified in several studies as one of the main elements which will determine the extent to which competition actually

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[2] In the US Document "Policy Regarding Airport Rates and Charges" [Federal Register: June 21, 1996 (Volume 61, Number 121)] [Notices], the following distinction between aeronautical and non aeronautical uses is made: "The [US] Department [of Transportation] considers the aeronautical use of an airport to be any activity that involves, makes possible, is required for the safety of, or is otherwise directly related to, the operation of aircraft. Aeronautical use includes services provided by air carriers related directly and substantially to the movement of passengers, baggage. mail and cargo on the airport. Persons, whether individuals or businesses, engaged in aeronautical uses involving the operation of aircraft, or providing flight support directly related to the operation of aircraft, are considered to be aeronautical users. Conversely, the Department considers that the operation by U.S. or foreign air carriers of facilities such as a reservations center, headquarters office, or flight kitchen on an airport does not constitute an aeronautical use......Such facilities need not be located on an airport. A carrier's decision to locate such facilities is based on the negotiation of a lease or sale of property. Accordingly, the Department relies on the normal forces of competition for non aeronautical commercial or industrial property to assure that fees for such property are not excessive."

develops in the liberalised EU market (Balfour (1995), Comite des Sages (1994), Doganis (1995), AEA (1996)).

It can be argued that the larger European and US airports have a monopoly position in relation to terminating or originating traffic (i.e. hinterland traffic) but face competition for connecting or transferring traffics from other airports. In many large cities, there are two or more airports supporting air transportation and thus competing for the hinterland traffic as well as transferring traffics. The economic rationale for public ownership and operation is usually that some type of market failure exists and government regulation or direct involvement is required. The main types of market failure and other arguments for public ownership of airports (adapted from Button (1993) and Kahn (1988)) are as follows:

- The containment of monopoly power
- The control of excessive competition
- The regulation of externalities
- The provision of public goods
- The provision of high costs infrastructure
- The integration of transport into wider economic policies
- The improvement in transport co-ordination
- The importance of the facility nationally
- The facilities may be natural monopolies
- Competition simply does not work well.

It can be argued that many of these factors continue to be relevant and substantive in relation to continued public ownership and provision of airports. The key points of concern are (i) whether these issues are relevant to all of the services provided at airports, or if it is the case that users would benefit and efficiency would be improved if some airport services were competitively provided and (ii) for services which remain in public ownership, what forms of economic regulation will optimise efficiency and capital investment ?

Concerns in the US about privatisation have highlighted two main issues:
1. That privatised airports may not be able to fund long term maintenance and capacity expansion programmes
2. The issue of access (for certain carriers as well as for general aviation users) may be problematic under a privatised system of operation, particularly if capacity constraints exist or are likely to exist in the future.
An extensive study undertaken by the World Bank in 1995 (Juan, 1995) suggested that, on the basis of relatively small scale private sector participation in airport ownership so far, the available data indicates that both the quality of service and investment commitments have significantly improved. This is the situation in which the private sector has a significant participation in management and ownership. The effect of airport privatisation on airport pricing policies is difficult to measure, but the following general patterns are noted: (i) airside charges are not lower, nor have they increased substantially than under the previous public ownership, but the charges pricing mechanisms have become more complex (ii) airside charges are subject to price-cap economic regulation (iii) there has been intense development of non-aeronautical commercial airport revenues at relatively high prices. We note that non aeronautical users of airport facilities have alternatives in terms of locational choice and property fees[3].

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[3] At present, there are few constraints on a private developer building car parks or hotels on lands adjacent to a large number of European airports and competing with the airport authority in the provision of these services. If air side

## The nature and range of airport services:

Table 1 gives a schematic representation of the categories of airport services typically found at European and US airports. The services are grouped according to (a) whether the airport service is an 'aeronautical use' or non-aeronautical use (b) whether there is general public access or access only for those travelling by air (c) whether or not there is direct airside access. For airside facilities, it is argued that duplication of runway, taxiway and apron facilities is not advisable for the following reasons: (i) these infrastructural items require substantial capital investments and should generate fees sufficient only to cover replacement costs. (ii) these facilities have significant planning requirements in terms of zoning of adjacent lands, and surface transport access. (iii) these facilities have merit good characteristics and have non-economic potential benefits or insurance aspects. For reasons of defence or growth and development, it may be necessary to provide excess capacity or facilities of a higher technical standard than are actually required to meet current demand with current technology.

Groundside facilities can be provided in a number of ways (a) through continued public ownership by a single airport company (b) through franchised arrangements with public or private management/operator companies (c) through mixed public/private ownership by multiple companies (d) through privately owned terminal companies, which have airside access (see Juan, (1995) for lengthy discussion of these options). From an economics standpoint, the main issue is whether competition in the provision of these services is necessary, feasible and if it can be justified in terms of keeping rates and costs low and producing a reasonable standard of service quality. While the costs and benefits of each alternative approach need to be assessed for particular facilities, it is clear that European airports offer an increasing range of services and facilities to their different customer groups. Retail franchising and duty free sales for example are very lucrative areas for the airports and have allowed for investment and expansion of the airport's suite of services and facilities. The airports have maintained a dominant or monopoly position for this suite of services and facilities. In many instances, landing fees have been kept low because cross-subsidisation has taken place.

Many companies doing business at an airport pay both rental for the space which they occupy and a gross receipts fee based on their turnover at the airport. In computing carrier fees, some airports may take these concessionaire revenues fees into account. There are two methods used for the computation of air carrier fees, the residual method and the compensatory method. With the former, the airport deducts all revenue earned from non-airline sources from its total annual budget. The airlines then pay the residual. With the latter approach, the airport is divided into various cost centres and the airlines pay their fees based on the measures of airport services or facilities which they use (for example, parking, terminals etc.) [ATAA, (1995)]. If competition is permitted in the provision of terminal and groundside services, then this cross-subsidisation is unlikely to continue. With competition in groundside services, revenues for infrastructure use can be collected either by billing carriers separately for each service or by imposing collection requirements on a single agent.

The provision of basic airside infrastructure requires significant capital investment as well as having substantial planning requirements. In addition, the merit good characteristics and insurance aspects provide strong argument for continued public sector ownership and involvement. However in relation to the other types of airport services, a wide range of possibilities exist for raising the level of private sector involvement and imposing competitive or efficiency conditions on the production of services. The World Bank report (Juan, 1995) gives examples of a variety of circumstances and contexts. Generally speaking, the US airport offer a narrower range of services and facilities to airlines and passengers and have exercised greater flexibility in permitting private sector development and use of publicly owned airport lands.

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capacity is required however. constraints exist because of the airport authority's ownership of most of the land tracts adjacent to the runways and taxiways.

The optimum pricing mechanisms for the use of these services and facilities will be briefly discussed before the CEC document is introduced.

### *Optimal Pricing for Regulated Monopoly and public utilities:*

The basic economic principles of marginal cost pricing suggest that welfare is maximised where prices are set equal to long run marginal cost. As with economies of scale, under economies of scope, price will be below average costs with this marginal cost pricing prescription. As Kahn (1988) points out, the traditional legal criteria of proper public utility rates have always borne a strong resemblance to the criteria of the competitive market in long run equilibrium. The principal benchmark for 'just and reasonable' rate levels has been the cost of producing including the necessary return on capital. The rule that individual rates not be unduly discriminatory similarly has been defined in terms of the respective costs of the various services. However, it is short run marginal cost to which price should be equated because it is the short run marginal cost which reflects the social opportunity cost of providing the additional unit that buyers are at any time trying to decide to buy. Marginal costs look to the future not the past since it is only future costs that can be saved if production is not undertaken. In the presence of competition, it is long run and not short run costs which should set the floor. If capital costs are to be included in price, then it should be clear that those capital costs are those that will have to be covered over time in the future if service is to continue to be rendered.

The issue then arises as to whether all users should pay the price which includes the capacity costs. Kahn argues that the off-peak users should not pay these costs since they do not impose these costs on society once their demand is sufficiently slight and inelastic that even at a zero cost, no congestion occurs at the time when they use the facility. The necessity for expansion is imposed by the customers at the peak hours. If the same type of capacity serves all users, capacity costs should be levied only on utilisation at the peak. This peak responsibility pricing is not discriminatory between peak and off-peak users (that (discrimination) implies that the price differences are not based on cost differences), rather it reflects the fact that there is a genuine increase in the costs of supplying users at the peak compared with the off-peak. The proposal then is to reflect the cost difference in respective prices.

When infrastructure capacity or plant is built far in advance of total need (because for example of economies of scale), charging depreciation in equal instalments imposes a disproportionately heavy burden on customers in earlier years, when much of the capacity lies idle. This idle capacity is of benefit to future not present customers. Economic efficiency suggests concentrating capital charges in the later years.

Finally, in situations of economies of scale or scope, where price set equal to marginal cost will yield a loss, Ramsey prices eliminate the deficit while minimising the loss in welfare that results. Ramsey prices maximise social welfare but also require revenues to cover costs: the resulting prices achieves as great a level of social welfare as possible in the presence of realities that prevent the use of marginal cost prices.

## III. CEC COMMON FRAMEWORK FOR AIRPORT CHARGING SYSTEMS

The CEC consultation paper considers the introduction of a common framework for airport charging systems in the Community. The paper proposes that CEC airport charges should reflect the real cost of providing the facilities and services to users, with no discrimination between intra-community air services. The results of a recent study by the Commission included in the consultation document,

indicate very substantial differentials in landing and other charges applied to domestic as opposed to international services. The paper further proposes that users should only be charged for facilities used and services provided and only on a cost-related basis, with information on airport charging systems being made available to users to ensure transparency. The paper envisages that airport charging systems should provide airports with a means to efficiently manage available capacity and contain impacts on the environment. Willingness-to-pay or Ramsey pricing mechanisms can be applied once they are operated in a consistent and non-discriminatory manner. Finally the paper provides for modulations in the charging system in the cases of air links to peripheral, remote or less developed regions. In summary, the paper suggests that airport charging systems should meet the criteria of non-discrimination, cost-relatedness and transparency. The consultation paper is a short and very general statement of aspiration, which is vague about the airport services which are to be covered by the framework. The framework does not outline any penalties associated with non-adherence, nor does it provide for arbitration in the case of disputes. The time frame for implementation of the proposals is unclear.

The proposals contained in the CEC consultation document are supported in principle by the ICAO states. From the viewpoint of economic efficiency, the proposals make sense in trying to ensure efficient allocation and use of existing airport capacity as well as allowing for superior planning of additional capacity investments. Currently EU airports are funded through local, regional and or national government funding and more recently from EU funds. The airport facilities have been provided as public utilities and as Doganis (1992) points out, current charges are typically based on a cost-recovery process and averaged for different categories of users based on weight of aircraft. The literature in economics has shown that when demand for transport infrastructure exceeds available capacity at different times of the day or in different seasons, then social marginal cost pricing which includes external congestion costs offers the first-best solution to the pricing of such congested infrastructure [Oum & Zhang (1990); Morrison (1983); Doganis (1992)]. The literature has then looked at the issue of cost recovery from capacity investments using revenues from congestion tolls. In this regard, it is argued that when capacity expansion is divisible (i.e. it can be incrementally and continuously expanded to meet growing demand), then under constant returns to scale (in relation to construction of the infrastructure capacity) revenue from congestion tolls will exactly equal the capital cost of the capacity investment, assuming that the average variable cost function is homogenous of degree zero in traffic volumes and capacity. With increasing (decreasing) returns to scale in capacity construction, there will be a shortfall (surplus) in the capital costs from the congestion tolls. When the lumpy nature of capacity expansion is considered and the nature of demand is such that it is changing over time, then the airport authority may go through alternating periods of surplus and deficit before and after capacity expansion [Oum & Zhang (1990)]. In fact, the financial condition of the airport authority depends on the time path of the traffic growth over the investment cycle, which will of course affect the flow of congestion tolls. In cases where capacity cannot be expanded, then a rationing process based on 'willing-to-pay' is most efficient in terms of allocating the scarce facility to those who most value it. However economic rents then accrue to the facility owner, who has a monopoly or quasi-monopoly position on supply. Airports do not exist in isolation and can offer complementary or substitute services particularly for connecting traffic. The airports should be viewed as a network or system, since there is a significant proportion of traffic which can be redistributed to uncongested facilities.

The analysis of optimal congestion charges and capital recovery constraints needs to be expanded to consider the case of a system of airports, some of which are operating at peak capacity for several periods of the day and others operating consistently below capacity, and where redistributing traffic through system pricing mechanisms may yield more efficient system capacity utilisation and more efficient costs for users and those effected by external costs. In relation to a road network, the

economics and regional science literature has shown the kinds of pricing decisions which may result (McDonald (1995); Johanson & Mattson (1995)).

The current weight based landing and other airport charges system has been criticised because it does not relate directly to the costs which users impose on the airport facilities or other users. In terms of the actual physical wear and tear caused by different classes of users, the ICAO procedures for the calculation of an Aircraft Classification Number (ACN) and a Pavement Classification Number (PCN) take into account the combined effects of weight, gear configuration and tyre pressures in assessing the damage by aircraft to airport pavements. The integration of these technical measures with other indicators of airport usage, such as the amount of time required of glide paths/approach and runway space, spacing of aircraft based on Instrument Flight Rules (IFR) versus Visual Flight Rules (VFR), spacing of aircraft based on broad category of user (with greater vertical separation and temporal separation required in the case of light general aviation (GA) aircraft compared with jet aircraft) would certainly allow for more efficient pricing and allocation of airport capacity [see for example Alexander and Hall (1991); Small, Winston & Evans (1989)]. Morrison (1987) suggests that there may be small welfare gains associated with shifting from weight based fees to marginal cost pricing procedures when airports are uncongested. Indeed such fees are reasonably consistent with net benefit maximisation. At congested airports however, the use of weight based fees is economically inefficient since "aircraft weight is a reasonable proxy for demand elasticity...(*but*)..a poor proxy for congestion costs" [Morrison, (1987)]. For congested airports, the weight based fee structure favours commuter airlines over other classes of airline.

When congestion charges are not imposed in peak periods and there is excess demand for airport capacity, that capacity is allocated by a queuing system. Bishop and Thompson (1992) argue in relation to ATC that these arrangements lead to an increase in airlines' costs in serving peak periods but also to a reduction in passenger demand because of a deterioration in service quality.

The CEC consultation paper requiring a cost-based charging system, if properly enforced, should lead to an improvement in the efficiency and allocation of airport capacity. The framework addresses the need for cost-related charges, including external costs. However there are several broad issues related to such charging procedures which need to be considered before adoption of this framework. These issues will be raised in the next section.


# IV. PROBLEMS WITH THE PROPOSED COMMON FRAMEWORK

In this section of the paper, the practical and legal difficulties associated with the proposals set out in the consultation paper will be presented and discussed. Some proposals for dealing with the difficulties are given and in other cases the need for assessments of current practices is highlighted. It should be stressed that many of the issues raised below are interrelated and point to the need for a EU-wide evaluation of difficulties and solutions.

*System View of EU Airports Needed:*
The broad aim of the common framework is given as the "efficient operation of airports and fair and equal treatment of users". Throughout the consultation paper, the focus of attention seems to be on individual airports and the pricing of airport services and facilities in isolation. The possibility of a 'system view' of EU airports does not receive any attention. In the extensive literature assessing capacity and capacity constraints at US airports, the 'system approach' to managing existing capacity and planning for future capacity needs is consistently viewed as a series of Federal issues. The airports in a large domestic system like the US or the European internal market serve a whole variety of

different users, requiring different types of services. Some of these services are not location specific and at the congested airports, using pricing and other mechanisms to redistribute traffic to under-utilised airports is becoming a key strategy for coping with congestion delays in the short to medium term. In the longer term, many of the larger airports will not be able to expand their capacity for reasons of adequate space availability, environmental restrictions or legal or planning restrictions. Under these circumstances, the imposition of congestion fees based on peak demand is problematic, if dealt with at the individual airport level. Legal cases in the US[4] and in France[5] have outlawed the imposition of such charges when they are not related to services actually provided by the airport for its customers. When such congestion charges are to be used to extend capacity through new investments, the charges are reasonable and can be upheld legally. Where airport capacity cannot be expanded and where the capacity is rationed, significant rents will accrue to the airport owners. If airport capacity is viewed at the system level (or as a series of regional subsystems - which may be politically more palatable), then funds gathered through congestion charges may be allocated towards new airports projects or extensions at other airports in order to alleviate congestion in the system. In the US, this view was proposed as a means of avoiding legal difficulties with the charges[6]. This issue of the efficient management and operation of EU system capacity, and long term planning of system investment is a Union-wide issue. In some instances this system view of the airports has been accepted. For example, the definition and strategic European view of the transport networks which make up the Trans-European Networks (TENs) reflect such an approach towards managing and developing key infrastructural networks which serve a variety of users at different spatial scales. This system view needs to be assessed in the context of charging/pricing mechanisms.

## *Airport services covered by the framework:*
### *(i) Need to specify what services & facilities are to be covered by this framework.*
In the introduction, the consultation paper provides a listing of typical airport services. It is unclear whether this cost-related pricing scheme is to be applied to ATC services, Immigration and customs services, security services etc., all or most of which are provided by government staff, rather than airport staff. In the area of ATC, with the move towards harmonisation and standardisation as well as central flow management (a system approach), the investment requirements for this program should be examined and linked to elements of airport charges. In section 2 of this paper, a broad categorisation of airport services was presented in order to define more precisely the types of services which were likely to remain as regulated monopolies and those which could be subjected to competition, thus allowing market mechanisms to determine pricing policies.

### *(ii) Administration/collection costs:*
Passenger charges are levied at the majority of European airports, with the onus on the airline to collect the charge on behalf of the airport. Doganis (1992) argues that this results in European carriers having the highest set of airport charges when compared with other major international aviation markets. Passenger charges (as opposed to taxes) should also be cost-related and non-discriminatory, with rates being made publicly available. In the UK for example, BAA plc. has calculated the terminal and ground costs associated with different classes of passengers (i.e. domestic/short-haul, intra-community/medium haul, long haul international and transit passengers) [Toms, (1991), Doganis (1992)]. As with landing fees however, the imposition of congestion fees for use of terminal facilities during peak periods can be problematic depending on how passenger congestion tolls are utilised. In the US until recently, passenger charges were prohibited under the 1973 Anti-Head Tax Act (see

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[4] See Chapter 6 of _Winds of Change Domestic Air Transport Since Deregulation_ Transportation Research Board Special Report 230., TRB. Washington D.C. 1991.

[5] November 1987 French High Court case involving Aerport De Paris (see Doganis (1992)).

[6] *Op. Cit.* TRB. 1991.

Peters (1994)). Since 1990, 'Passenger Facility Charges' (PFCs) have been permitted[7], with the funds being used for a defined set of purposes (for example, enhancing airport capacity, safety, security and competition, or to reduce noise). The GAO (1990) outlined several clauses in the authorisation Act aimed at safeguarding the goals of the PFCs. In a European context, these are worth considering in relation to the passenger charges imposed by airports. In summary the safeguard provisions aim to (i) ensure that the revenues generated are used for a narrowly defined set of possible projects, directly related to airport activities (ii) ensure that there is competitive access to new facilities, so that leasing of PFC-funded facilities is done on a preferential lease basis. This means that where incumbent carriers can block entry to pre-existing facilities (for a variety of reasons), competitive access to new facilities will be ensured. Without this clause, the possibility of incumbent carriers with exclusive-use lease of existing facilities could lease new PFC-funded facilities and continue to block entry by new carriers. (iii) the amount and number of passenger fees should be noted on a passenger's ticket and limited in the case of a multiple-segment trip.

*(iii) Bundling of airport services and cross-subsidisation/cross-crediting:*
Airport revenues accrue from several sources where a wide variety of services and facilities are provided to users. For example (i) airlines pay landing fees and passenger fees covering runway and terminal usage; (ii) Other users (general aviation users) pay fuel flowage fees and (iii) concessionaires bid on rental rates or pay negotiated market rates for terminal space. The fact that airports are spatial monopolies or quasi-monopolies for certain categories of users would indicate a need to have some regulatory control over total revenues, while at the same time ensuring that the fees charged make the "airport as self-sustaining as possible under the circumstances existing at that particular airport" in the words of the US Airport and Airway Development Act of 1970. The generation of surplus revenues in the US and in the UK recently has raised issues relating to cross-crediting or cross-subsidisation among groups of revenue generators for the airports.

The main issues relates to whether it is reasonable that airlines can pay reduced landing and other charges if significant revenues are being raised by the airport on concessionaires. If such a discounting scheme is acceptable, then the implications once again for the long term funding of airport capacity need to be investigated. Peters (1994) gives a very detailed discussion of the key US legal cases in this area. To summarise the two arguments: (1) Since concessions are frequented for the most part by airline passengers, then the charges for the wares sold by concessionaires are unavoidable by passengers[8]. The conclusion was then that when the airport charges a rental fee to concessionaires, it is equivalent to imposing a landing fee on an airline or imposing a head tax on a passenger. So since concession rentals are unavoidable costs of travel, either the passenger or airline should be entitled to offset concession revenues against the operating costs of the airport as a whole. (2) Passengers at airports are not captive audiences for concessionaires and accordingly the high concession prices are an inescapable add-on to the cost of travel. The fact that airports generate significant revenue from concessionaires should not require them to cross-credit these revenues when establishing rates for airlines.[9] Gillen (1990) proposes that privatisation of airports would be a preferable option for achieving an economically efficient outcome.

Recently in the UK, because of the provisions in the 1986 Airports Act (which privatised BAA), a system of price regulation was introduced, determined by the retail price index minus an x-factor, borrowed from the previous privatisations of state monopolies. The x-factor is assessed by taking

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[7] These charges were authorised under Section 9110 of the Aviation Safety and Capacity Expansion Act of 1990.

[8] Indianapolis Airport Authority v. American Airlines. 733 f.2d 1262 (1984). see Peters (1994).

[9] City and County of Denver v. Continental Air Lines Inc.. 712 F.Supp.834 (1989). see Peters(1994). Indeed in this case the federal district court upheld the right of Denver City and County to use Stapleton concession revenues for the costs of a replacement airport.

account of the profits earned from the airports unregulated businesses (i.e. concessionaires). The more that BAA earns on concessions, the more they have to reduce their landing fees to airlines. The result has been a lowering of landing fees at the congested Heathrow airport (stg£550 for a B747) and an increase of fees at under-utilised Stansted Airport (stg£715 for a B747)[10]. Essentially the issues here are how the overall revenue generated by airports is used and whether rebates or cross-crediting on landing and/or passenger fees is economically justified. The consultation document does not address these issues, despite the fact that permitting modulations in the charging system (to facilitate for example a 'willingness-to-pay' criterion) could generate significant rents for airports.

*Legal issues prohibiting short-term implementation of this framework:*

When air carriers have contributed to airport capital investments and have agreements with airports relating to among other things, fixed charges and voting rights in relation to capacity expansions, these types of agreements may limit the extent to which airport charges or airport charging systems may be changed, at least in the short to medium term, as was the case in the US [GAO (1990; 1991)]. In many instances there are also international agreements with non-EU countries which may have explicit limits on airport charges or changes to charging schemes. The extent to which such agreements exist should be investigated by the CEC and possible legal issues involved in imposing new charges or new charging systems. In the US, such agreements had a significant impact in preventing new entrants and in blocking airport plans to expand capacity [TRB (1990; 1991); Reilly (1990)]. If such agreements are in operation in Europe, then these agreements need to be considered in the context of long term capacity provision. To assess a feasible time frame for the implementation of this common framework and, the extent to which lead time is necessary and reasonable for airports to shift from the current system to new cost-related system, the CEC needs to establish the extent of exclusive-use or long term lease clauses or any other legally binding agreements where changing charges or charging systems cannot be introduced immediately.

*Time-varying marginal social cost pricing*

Social marginal cost pricing calls for a pricing schedule which is time varying so that the user charges increase as the volume/capacity ratio increases and are reduced after capacity has been expanded. In practical terms, airport managers and indeed some economists argue that landing charges should not vary over time. Park (1989) however has shown that the welfare loss associated with charging a constant optimal price is high relative to the social marginal cost pricing scheme which is time-varying. Such a time-varying pricing system is difficult to implement, given that such charges for a given traffic mix on a given day may vary to reflect reduced capacity. The capacity of some airport facilities (for example, the runway) is variable depending on such factors as weather conditions and traffic mix.

*Social Air Services:*

Since social air services are currently designated and provided on a national basis, it is reasonable that individual governments specify quotas for allocation of slots and any modulation in airport charges for these services[11]. However with the liberalisation of domestic air services scheduled for 1997, the provision of social air services within the EU and the allocation of slots and pricing of airport services at large and/or congested airports will become an inter-community matter. An assessment of the extent of these types of services would help to assess the need for guidelines on quotas and modulations in airport charges required under current and fully-liberalised circumstances. In the US,

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[10] See Economist (September 1995)

[11] Some economists would argue that a strict market-based pricing mechanism would result in a decline in services to small communities (USDOT, 1990).

slot-controlled airports have specified numbers of commuter/regional carrier slots per hour laid down by the FAA (GAO, 1994).

# V. CONCLUSIONS

This paper has critically reviewed the CEC Consultation document on airport charging systems. While the aims to introduce a non-discriminatory, transparent and cost-related framework for airport charging is welcome, there are many practical and legal difficulties which need to be addressed in the wake of such a framework being implemented.

In this review it was argued that the CEC needs to view the pricing issue from a system perspective, since the identification and planning of the strategically important Trans-European Network is already a 'Union' as well as a regional concern. The fact that several of Europe's largest airports face or will face capacity constraints in the short to medium term, coupled with the increasingly significant environmental and physical constraints on infrastructure facility expansion, highlights the need to plan for the efficient distribution of current and new traffics. The airport system capacity needs to be planned and allocated in an economically efficient manner and the union-role in pricing and allocation of revenues must be considered.

It is unclear which charges are to be covered by the new framework: while landing and parking charges are certainly included, passenger charges, security, immigration and air traffic control for example, are not referred to directly. Airports earn revenue from a variety of sources, some regulated, some unregulated, such as concessionaires. The issue of cross-crediting or cross-subsidising landing and other charges needs to be addressed directly.

The CEC paper proposes to introduce a framework for airport charging systems which is vague in terms of the charges covered. In addition, an assessment of the potential legal and other obstacles which may hinder its full implementation should have been completed before the framework is implemented.

Airport capacity problems are recognised as a major constraint to entry in the airline industry in Europe. European carriers in an international context face a competitive disadvantage because of their relatively high costs, and will need to reduce these as much as possible in the medium to long run. The industry forecasts suggest significant growth in European air traffic and also significant capacity problems. The CEC document does not contain specific proposals or mechanisms to address several important issues in the funding and operation of airport services and infrastructure.

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# Airport Services



Car Park
Hotel
Warehouse
Services

Pax Check-in
Pax Loading/Unloading
Aircraft Parking
Baggage Claim
Pax Holding
Terminal Gates
Loading Bays

Apron
Taxiway
Runway

Airspace

General Public Access

Travelling Pax/Cargo Only

Groundside

Airside
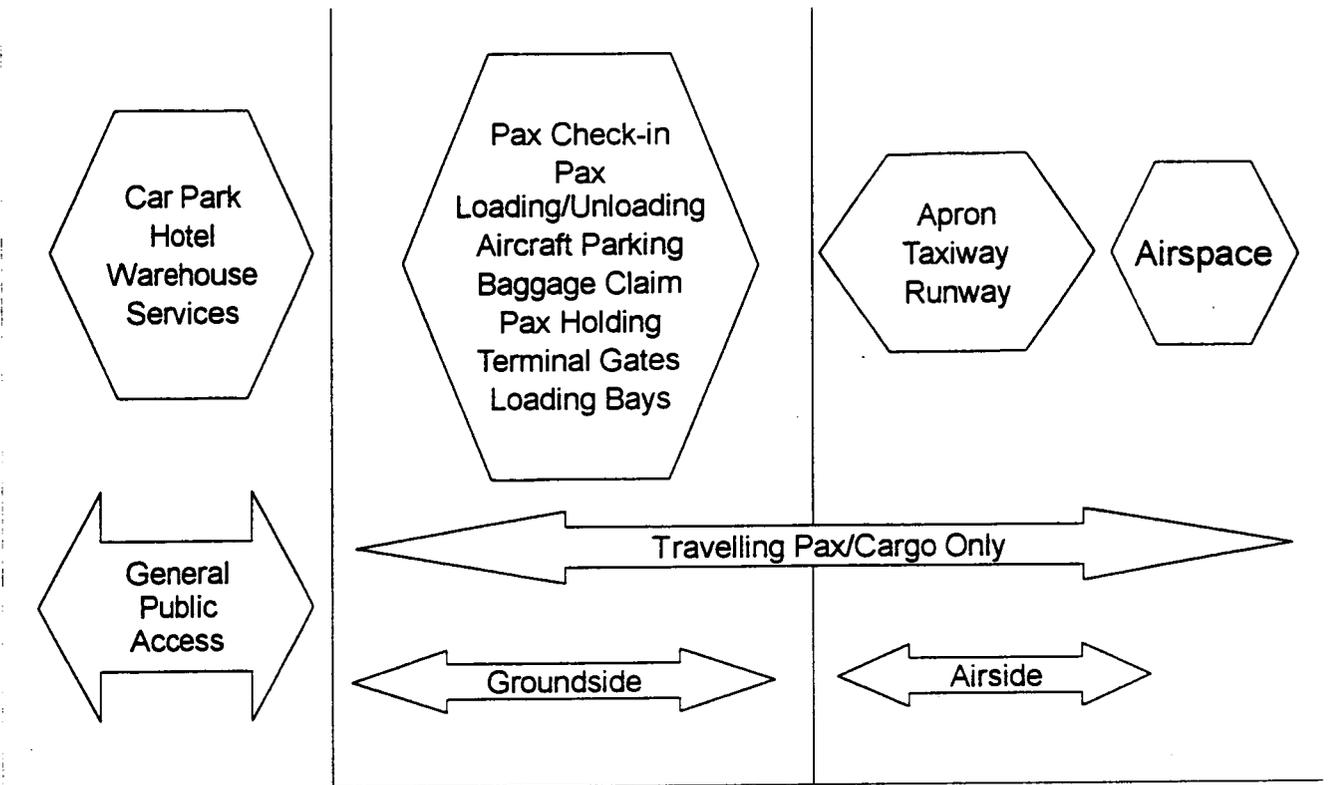
# I. INTRODUCTION

1. The key function of an airport is to take charge of the aircraft from its approach to the airport through to its take-off in order to enable the air carriers to fulfil under the best possible conditions their air transport activities.

To that effect airports provide a number of airport facilities and services, such as landing and take-off facilities as well as aircraft and passenger services, which are essential to the activity of air transport. Users are charged for the use of these facilities and the provision of these services.

Airport charges cover those airport facilities and services, which are related to the operation of aircraft and which by their nature can only be provided by the airport itself. These facilities and services differ from activities which are not related to the operation of aircraft and which include commercial activities, such as terminal catering services, as well as airline-related activities, such as groundhandling services, which can be provided by parties other than the airport.

2. Airport charges serve to cover the cost of providing airport facilities and services. They represent a source of revenue for the airport.

Thus, airport charges must be distinguished from airport taxes which are imposed by the national authorities and do not represent revenue for the airport, but are usually collected by the airport on behalf of the treasury.

Taxes or so-called charges levied for facilities or services not used by or not provided for the users should not be assimilated with airport charges.

Concession and rental fees represent additional sources of revenue for the airport which should be identified as such and be distinguished from airport charges.

3. Airport charges are usually established and levied in accordance with a set of principles and criteria which make up the airport charging system.

Charging systems are in most instances imposed and governed by the national authorities. Existing systems in the Community differ widely from one Member State to another and sometimes from one airport to another in a single Member State.

4. Charging systems also function as management tools. By modulating certain charges airports can seek to enhance the use of airport infrastructure as well as seek to reduce the impact of air transport on the environment.

5. The adoption of the third civil aviation package[1] by the Council in June 1992 represents the final stage in the liberalisation process of the aviation sector within the framework of the Internal Market. The new market organisation makes it essential that adequate aspects of air transport, such as groundhandling services, computer reservation systems and slot allocation, meet the requirements of the Single Market. This is also the case of airport charging systems.

6. An analysis of airport charging systems in the Community reveals that

Airport charges often do not reflect the real cost of providing airport facilities and services to users.

The charging criteria often allow for differences in treatment between national and international flights, including intra-Community flights.

Charging systems are often highly sophisticated and complicated and information concerning the charging principles and criteria is not always available to users and where available is often inadequate.

7. For the purpose of the Single Market it is essential that air carriers can operate under fair and equal market conditions. Consequently,

there should be no discrimination between intra-Community air services

users should be charged only for the facilities used and services provided and only on a cost-related basis

At the same time information concerning airport charging systems should be made available by the airports to users so as to ensure transparency about the different aspects of charging. Regular exchanges of information between airports and users should contribute to transparency and appropriate and adequate consultations should enable airports and users to overcome points of dissension.

Such requirements would be in line with the basic principles laid down by the International Civil Aviation Organization (ICAO), more particularly in Article 15 of the International Civil Aviation Convention signed on 7 December 1944 in Chicago, as well as in the Declaration of the Council on Aircraft Charges (ICAO Doc 9082) and included in the "Airport Economics Manual" (ICAO Doc 9562).

8. Finally it is essential that air transport should contribute to "sustainable mobility" and remain environmentally compatible.

Airport charging systems should therefore provide airports with the means to manage airport capacity efficiently as well as contain the impact of air transport on the environment, particularly in the vicinity of the airport.

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[1] Council Regulations (EEC) N° 2407/92, 2408/92, 2409/92, 2410/92 and 2411/92 of 23.07.1992 (OJEC of 24 August 1992).

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Air transport should also contribute to economic and social cohesion in the Union. Airport charging systems should therefore take account of the need for air links which are vital for the accessibility or economic development of landlocked, remote and less developed regions of the Community.

# II. THE CURRENT SITUATION IN THE COMMUNITY

## a. Charging systems

9. Airport charging systems in the Community differ considerably from one Member State to another and sometimes even within a single Member State. They nevertheless in general include the following basic elements:

a description of the airport facilities and services covered by each type of airport charge

the cost basis of the individual charges

the method of calculation

Airport charging systems also include the decision-making procedures for modifying the system as well as the mechanisms for levying the charges.

Differences between the charging systems relate to all these elements.

10. Airport charging systems cover a wide variety of charges related to different airport facilities and services. These include landing, lighting, parking, fuel and storage facilities as well as aircraft, passenger and freight services.

These different types of airport charges are not found in all the Member States. Also there is no standard use for the different charges so that airport charges do not always cover identical facilities or services.

Landing, parking and passenger charges are in general use, whereas lighting, storage and fuel charges are less common. Freight charges are only levied at a small number of airports.

11. Airport charges are based on a number of criteria, which vary from one charging system to another. There are, however, a number of criteria in common use.

These include

the origin or destination of the flight, often differentiated between national and international flights, for landing, passenger and lighting charges.

the mass of the aircraft, often the maximum take-off mass, for landing and parking charges.

the acoustic category of the aircraft for the noise charge or, if no such charge exists, for the landing charge when modulated according to the noise emissions of the aircraft.

the parking stay and sometimes in addition the flight schedule for the parking charge.

the number of passengers, the age group and sometimes the flight distance for the passenger charge.

the freight tonnage loaded or unloaded for the freight charge

Some of these criteria can give rise to discriminations, as is the case of the criterion of origin or destination of the flight.

12. Airport charging systems sometimes provide for the possibility of modulating certain charges.

Thus, in some Member States charges are reduced for certain categories of users or for certain users within a particular category, as for example in the case of reduced passenger charges for children.

13. Airport charging systems also often include the possibility of exempting certain users from payment of all or several charges.

Thus, aircraft which fall within a particular noise category, military aircraft, aircraft used for the transport of Heads of State, aircraft on humanitarian missions, aircraft piloted by members of the aviation authorities, aircraft forced to return to their point of departure, flights operated at the request of the authorities, test flights and flights carried out for the obtention or renewal of flight certificates are often exempted.

Such exemptions may also cover passengers, such as transit passengers, children and crew members servicing the aircraft.

14. The level of airport charges varies significantly from one Member State to another and often even from one airport to another within a single Member State.

A study of 22 major airports in the Community has revealed the following differences[2]

i) 25 to 1.81 (and even 2.21 during peak periods) for landing charges applicable to a 45 tonne aircraft (FOKKER 100, international rate)

ii) 33 to 1.70 for a 70 tonne aircraft (Airbus 300)

iii) 21 to 1.73 for a 365 tonne aircraft (Boeing 747)

iv) 25 to 2.29 (and even 2.31 during peak periods) for passenger charges on national flights

v) 14 to 2.55 for passenger charges on international flights

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[2] These differences are based on a Community average equal to one and on figures expressed in ECU at the 1993 exchange rate.

Even when taking account of the exchange rate variations and the wage level differences between Member States as well as additional factors, such as demand and environmental performance, it is questionable that these differences justify a cost variation for these facilities and services between 1 and 19 for international traffic and 1 and 9 for national traffic.

These variations, thus, appear to indicate that airport charges do not at present always reflect the real cost of facilities or services provided by the airport to users. They appear to be too significant to be merely the reflection of local economic conditions or the result of airport investments.

15 In the case of landing and passenger charges there are significant differences according to the origin or destination of the flight. In most cases charges for international flights, including intra-Union flights, are higher than for national flights.

For the 22 major Community airports studied, the ratio between the charges applied to international and national flights varies from:

2.46 to 1.16 for landing charges of a 45 tonne aircraft
2.31 to 1.19 for landing charges of a 130 tonne aircraft
2.27 to 1.21 for landing charges of a 365 tonne aircraft
3.62 to 1 (down to 0.41 during peak periods) for passenger fees

Passenger charges record the highest differences between international and national flights, except during peak periods.

Only a few airports do not differentiate between national and international traffic. This is the case of Dublin, London-Heathrow (except during peak periods), Brussels, Luxemburg and Amsterdam. However, for the last three airports national traffic is virtually non-existent.

**b.    Exchange of information and consultations between airports and users**

16 Even if in some Member States the airport charging system(s) provide for exchange of information between airports and users, very often this information is restricted to certain users. In addition it is often not appropriately detailed or sufficiently transparent.

The lack of adequate information makes it difficult for users to check the cost-relatedness of airport charges as well as the possible existence of differential treatment.

Also, the absence of regular exchange of information between users and airports may make it difficult for airports to plan their future financial requirements in function of traffic forecasts.

17 Some charging systems provide for consultation procedures between airports and users. These procedures vary throughout the Union.

Thus, in some instances consultation of users is mandatory prior to a change in the level of charges, the introduction of a new charge or a modification of the charging system. Often only certain users are consulted.

This means that it is difficult for users to prevail upon their rights when major or unforeseen increases of airport charges, new charges or changes in the charging system are introduced.

These procedures hardly ever compel the parties to reach consensus on the issues under consideration.

**III.  A COMMON FRAMEWORK**

**a.    Objectives**

18 In 1990 the Commission adopted a Proposal for a Regulation concerning the consultation procedure between airports and airport users and airport charging principles' This proposal has not yet been adopted by the Council.

Since the completion of the Internal Market on 1 January 1993 and the entry into force of the Treaty on European Union on 1 November 1993 this proposal no longer meets existing requirements.

19 The liberalisation process of the aviation sector has gradually highlighted the need to ensure the efficient operation of Community airports. This can only be achieved within a framework which ensures fair and equal treatment of users, while allowing airports the possibility of adapting the use of the charging system to the needs of optimal management of airport capacity which remains compatible with environmental requirements.

20 Such a framework must also remain compatible with the global approach outlined in the Commission White Paper "The Future Development of the Common Transport Policy - A global approach to the construction of a Community framework for sustainable mobility"[4] in order to ensure its contribution to the efficiency of the transport system as well as economic and social cohesion.

The efficient operation of airports as well as fair and equal treatment of users thus represent the key objectives of such a framework.

**b.    The means**

21 Not all differences in the charging systems and airport charges are incompatible with the objectives of a common framework. Harmonization of existing regulations in the Member States would be virtually impossible to achieve and in addition is not essential to achieve these objectives.

However, it will be necessary for airport charging systems to meet a number of requirements, which should ensure that charges are non-discriminatory, that they reflect costs and that users are provided with adequate information.

Such requirements will make it necessary to introduce three basic principles : the principles of non-discrimination, cost-relatedness and transparency.

22 These principles constitute the key elements of the common framework and should be applied in a manner that allows for the appropriate flexibility for the purposes of efficient airport capacity management and environmental compatibility as well as economic and social cohesion.

*The principles*

*The principle of non-discrimination*

23 The completion of the Single Market makes it necessary to eliminate all discriminations between intra-Community air services, since such discriminations are not compatible with the principles of the Internal Market.

Thus, charging systems should not discriminate between equivalent intra-Community services. Discriminations in terms of the type and nature of airport charges, the criteria, the conditions for levying and collecting charges should thus be abolished.

Differentiated treatment between intra-Community air services would not be justified unless such a difference is related to the actual cost of the airport facilities and services provided. In such cases the airport authority would have to provide evidence of a significant cost difference.

*The principle of cost-relatedness*

24 The Commission services feel that airport charging systems should ensure a relation between the level of the charges and the cost of providing airport facilities and services.

The principle of cost-relatedness complies with existing Community law, in particular Article 86 concerning abuse of dominant position, as well as with the provisions of the Chicago Convention and the recommendations of ICAO.

25 Cost-relatedness implies that

.   Airport charging systems should ensure that the level of airport charges reflect the cost of the airport facilities and services covered by the charges, including a reasonable return on invested capital and a reasonable depreciation of assets as well as efficient management of capacity.

Users should not have to pay for facilities which they do not use or services from which they do not benefit. However, in order to avoid abrupt increases in the level of charges the gradual inclusion of the cost of infrastructure and facilities to be built or not yet completed but actually programmed would not be excluded.

26 Scrutiny of the different charging criteria according to these two principles means that the criterion of origin or destination of the flight should no longer be given the weight it currently has in airport charging systems.

This criterion is in effect difficult to reconcile with the principles of cost-relatedness and non-discrimination, since it results in differential charging which is not related to significant differences in cost and can lead to discrimination between national and other intra-Community services.

The origin/destination criterion would only be justified in so far as it differentiates between extra and intra-Community services.

*The principle of transparency*

27 In order to ensure that both the principles of non-discrimination and cost-relatedness are properly implemented and complied with, transparency requirements will be essential to complete the common framework.

The principle of transparency should enable users to check whether they are being charged for the facilities and services provided in a non-discriminatory manner and at the appropriate cost-relatedness.

The availability of precise, transparent and comparable information should enable users to prevail upon their rights, if necessary, when airport charges are significantly increased or the charging system is modified. Transparency should also contribute to forward planning of airport development by linking new investment requirements to charging increases.

The principle of transparency implies a regular exchange of precise and transparent information between airports and users.

28 The Commission services believe it is necessary to introduce minimal requirements covering the nature and the scope of the information.

Thus, airports should provide information on

the cost basis for the charges

the relevant criteria for the different types of airport charges

the description of the services and facilities covered by each type of charge

the accounting data and relevant financial information as well as the traffic volume of the airport.

Presentation of the financial information should be done in accordance with currently practised accountancy methods.

The Commission services feel that as part of the exchange of information the air carriers should provide the airports with information on traffic and fleet developments as well as on the facilities and services necessary to meet their forecasts.

The principle of transparency should be introduced and implemented in such a way as to take account of practices and procedures already in use at airports.

29. The principle of transparency also requires the introduction of consultation procedures between airports and airport users.

Such consultations should involve the airport, the carriers and the relevant authorities of the Member States

Consultations should be mandatory in the case of modifications of the charging system or significant increases of the charges and should take place within a specified period of time prior to the introduction of the modifications or increases.

The scope of the consultations should not be limited to a simple exchange of information, but should encourage the participants to reach consensus on the issues concerned.

**Modulations**

30. In order to ensure that airports can operate efficiently and meet the requirements of "sustainable mobility" in the context of the future development of the common transport policy, it will be essential to ensure efficient management of airport capacity as well as environmental compatibility.

In order to enable airports to meet these objectives the principle of cost-relatedness should allow for sufficient flexibility so as to allow for the modulation of certain airport charges under specific conditions.

*Modulation in function of demand and available airport capacity*

31. A large number of airports are faced with capacity problems due to physical and environmental constraints. This phenomenon is likely to spread due to the continuous growth of air traffic. In order to ensure efficient operation airports should be encouraged to make optimal use of existing capacity as well as plan future capacity development.

The possibility of modulating certain charges, such as landing, parking and passenger charges, in relation to the number of movements would make the price of the service a function of the level of demand. This should enable the airport to respond more efficiently to capacity demand and to manage more effectively scarce capacity ressources

Modulations could also be used as an incentive to reduce the number of aircraft movements by encouraging the operation of larger aircraft during periods of high demand

*Modulation in function of the impact on the environment*

32. The cost of aircraft operations in the airport does not only include the cost of providing facilities and services to the users. It also includes external costs caused by environmental disturbances, such as noise and gaseous emissions. At present these external costs are not always borne by those who cause them.

In accordance with the approach advocated in the Commission Green Paper on the Impact of Transport on the Environment[1] and the White Paper on the Future Development of The Common Transport Policy, the internalisation of such costs should contribute to "sustainable mobility" since those who are at the origin of such costs will be made financially responsible for them.

The possibility of modulating the level of landing charges in function of the noise emissions produced by an aircraft or of introducing a specific noise charge can contribute to the enhancement of environmental compatibility.

The possibility of increasing the rate of the landing charges during specific periods of the day or introducing a specific noise charge for night flights could serve as a deterrent and reduce the overall impact of noise emissions in the vicinity of the airport. This practice is already in force at a large number of Community airports.

An acoustic classification of aircraft types in accordance with the criteria of Annex 16 to the Chicago Convention could make the introduction of such modulations easier in practice and contribute to the overall transparency of charging systems.

However, such modulations should remain in line with the provisions of existing Community legislation, in particular Council Directive 92/14 EEC on the operation of noisy aircraft.

*Requirements for modulations*

33. The possibility of modulating airport charges should meet certain requirements, in particular the principle of non-discrimination. Modulations should not give rise to distortions of competition between users and should not be used to increase revenue.

Since modulations represent a change in the charging system, they should comply with the principle of transparency.

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[1] [COM(92)46 final] of February 1992

**Discounts**

34. A number of Community airports grant discounts or exemptions to certain users. Such practices have a number of consequences.

Firstly, they can result in a differentiated treatment between users which is not justified by a cost difference. This would be the case of a discount granted in relation to traffic volume, since the cost of an operation for the airport is only marginally affected by the number of operations of a particular air carrier during a given period.

Discounts or exemptions which are not justified by cost differences can give rise to distortions of competition. They can have discriminatory effects, particularly if they favour the national carrier to the detriment of its competitors established in other Member States.

Since in many instances airports are still directly or indirectly controlled by the public authorities, such practices could constitute indirect state subsidies which are contrary to Community law when they affect or threaten to affect competition.

These discriminatory aspects are exacerbated by the fact that discount systems are often applied in a progressive manner and/or operated on the basis of thresholds below which no discount or exemption is available. The advantage which arises to the beneficiaries of such discounts can be considerable and consequently affect competition.

The Commission services thus feel it is essential that discount systems should meet the requirements of non-discrimination and transparency.

**Exemptions**

*Public service obligations*

35. Some airports are located in less developed, isolated or landlocked regions, where air transport often represents the only rapid link with the rest of the Union.

Air links are vital in overcoming the remoteness of the region as well as for their economic development. In such cases the Member State may in accordance with Community legislation impose a public service obligation on the national carrier(s) and allow for financial compensation as provided in the Council Regulation 2408/92 on market access in order to safeguard financially the operation of these services

Such derogations to the principles of cost-relatedness and non-discrimination would be justified, if they contribute to the economic and social cohesion in the Union. It is, however, essential that they do not give rise to distortions of competition between users and do not affect the objectives of the common framework. They should also comply with the principle of transparency

e. **The legal base and scope of the common framework**

36. The common framework represents an integral part of the liberalisation process of the aviation sector and should therefore be defined for the Community as a whole. The appropriate legal base for a legislative initiative in this area of air transport policy is therefore Article 84(2) of the Treaty.

In view of the inherent differences between the systems in existence in the Member States it is essential to take full account of the principle of subsidiarity and allow Member States to implement the contents of the common framework. Member States will thus be able to determine the type and nature of the charges as well as the level of the charges, provided they comply with the basic principles of the common framework. The possibility of modulating the charges in function of demand, available capacity as well as the impact on the environment will enable Member States to adapt the common framework to existing constraints and specific requirements. To that effect a Council Directive would be the most appropriate legal instrument.

37. Since the purpose of the common framework is to ensure fair and equal treatment of users, it should include

all airports which are situated in the Community and are open to commercial aviation

all charges related to airport facilities and services which are intrinsic to the activity of air transport

all air carriers in the Community and all types of traffic.

Non-Community air-carriers should also be able to benefit from the common framework on the basis of reciprocity. However, it should be possible to suspend fully or in part the advantages of the common framework when a third country does not act on a reciprocal basis.

# Multiple Hub Network Choice

# in the Liberalized European Market

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## 1. Air transport liberalization: the consequences for airports.

A key question that so far has received relatively little attention in the germane literature is that of the changes at various airports as a result of the EU liberalization policies. That is, presently, most major European airports still benefit from the so-called home-carrier phenomenon where the country's publicly or semi-publicly owned carrier uses the country's main airport as its gateway hub and, consequently, the home-carrier is also the principal user of this airport (in terms of proportion of total aircraft movements, number of passengers transported, connections, slots ownership, etc.). The country's main airport has substantially benefited from these monopoly conditions of airline captivity, strongly determined by the bilateral system of international air transport regulation. Therefore European major airports were used to operate in essentially different markets, compared to the increasingly competitive markets of their home based carriers. This partly explains relative stability of transport volumes and financial results of European major airports compared to the relatively volatile financial results of most European national airlines.

However the liberalization of European aviation is likely to change this situation. Market access is open now to all community carriers, i.e. carriers with majority ownership and effective control in the hands of EU citizens. Ticket prices are free, governments can only intervene in case of dumping or excessive pricing. A community airline can choose its seat in any of the 15 member states. Licensing procedures are harmonized between member states. Since a few months community carriers have unrestricted route access within the EU.
Most probably this development will be extended to countries inside and outside Europe. Last year the European Commission got the mandate to start negotiations with 10 other European countries. In the meantime the EC has also started negotiations with the USA on so-called soft rights. In the meantime open skies agreements have been concluded between the USA and most of the EU member states to facilitate strategic alliances between airlines of the states involved.

As a result of this on-going liberalization the model of the single 'national' carrier using the national home base as its single hub for the designated third, fourth and sixth freedom operations will stepwise disappear. Within the EU the concept of the national carrier has already been replaced by that of the community carrier. State ownership in more and more European carriers is reduced. On the longer run mergers or even bankruptcy will further undermine the 'single national carrier - single national hub' model in Europe. In the meantime strategic alliances between national carriers in Europe will already reduce the airlines' loyalty to a single airport. Profit maximization and accountability to share holders will supersede the loyalty of these newly emerging alliances, probably looking for the opportunities of a multiple hub network to adequately cover the whole European market.

As a consequence some European airports might see a substantial decline in arriving, departing and transfer traffic, thus in revenues and financial solvency, as well as in their connection to other inter-continental and intra-European destinations. At the same time other airports might realize a significant increase in traffic as they will be sought after by the profit maximizing airlines as their major gateway hubs. Which will be the loosing airports and which will be the winning ones? Can airports anticipate the actions of airlines in deregulated markets and utilize policies which will improve their relative position? If so, what should be

these anticipatory policies? These questions become the more urgent, since an increasing number of major European airports will be privatized in the near future. Although increasing airport congestion in Europe will also be reflected in a growing demand pressure for airport slots, this is not a guarantee for a stable transport volume growth of individual airports. The more volatile the market is, the more vulnerable privatized airports become.

Therefore the main issue of this study is the analysis of the opportunities of major European airports to become a central hub as a result of the network choices made by the new European airlines in a completely liberalized market.
In a previous study (Berechman and de Wit, 1996), we already explored the potential of Amsterdam Airport Schiphol of becoming the major West-European hub, once European aviation markets are deregulated. A major hindrance of that study was the use of a single hub-and-spoke network. For example that model could not analyze the viability of different combinations of European hubs within a multiple hub network of alternative airline alliances.

In this study we have formulated *the model of a multi-hub network where two West-European airports are used for inter-continental and intra-European travel to enable a more realistic analysis of hub choice.*
Like the previous one also this multi-hub model is primarily used to assess the potential ability of Amsterdam Airport Schiphol for becoming a major West-European hub. Thus in particular the policy tests focus on this airport in a double hub network.

## 2. The Economic Model and Mathematical Program

In this section we first describe the microeconomic model on which the mathematical program is based.

### 2.1 The Economic Model

The observed phenomenon of increased hubbing, following the USA aviation market deregulation, has long been the subject of in-depth analysis in the germane literature. In general, the question is under what conditions will an airline's profit be greater when it uses a Hub and Spoke (HS) network vs. a Fully Connected (FC) network. The advantages of the HS network structure can be divided into three main branches (see Berechman and de Wit, 1996, for a detailed analysis):

*Cost Economies:* A number of authors have argued that cost considerations, mainly economies of aircraft size coupled with scope economies, underlie the intensified use of HS networks.
*Demand-Side Effects:* Demand-side effects are another argument to explain the intensified use of HS network following deregulation. Two types of explanation fall under this approach: (a) demand elasticities relative to airfare and travel time; and (b) product differentiation in departure times.
*Market Dominance:* analysis shows that given the proper conditions the incumbent airline will operate a HS network when faced with the threat of entry, thus successfully obstructing entry.

In this study we adopt all three types of explanation by considering a hypothetical airline, which operates in a deregulated market, and which strives to maximize profits and gain market dominance by structuring its network as a hub-and-spoke. In doing so it takes advantage of demand and network cost economies. On each route it sets airfare, output level (number of passengers and frequency), and employs aircraft capacity in a way that deters entry by potential rival airlines. In structuring its HS network, the airline chooses as main hubs those airports which best contribute to its profits. The analytical model, which is embedded in the simulation model, explicitly contains all these elements.

It should be re-emphasized however, that in this study we do not regard a pure HS network. Instead, we consider two main hubs that can serve as intercontinental gateway hubs, intra-European hubs, or both. (See for example figure 1 and 2).

On the demand side, the utility of a business or non-business passenger traveling on the route from node i to node j is based on the airfare, frequency of flights and whether or not the flight is direct or indirect. If a passenger is flying indirectly, he or she must fly from node i to node j via one or two hubs because no direct link exists in the network configuration chosen. The utility is then measured according to the lowest frequency along any one of the maximal three legs of the route required ($i \xrightarrow{1} hub_1 \xrightarrow{2} hub_2 \xrightarrow{3} j$). As can be seen from the theoretical model (Berechman et al, 1995), this ensures non-entry of airlines that may consider providing a direct service between two nodes, at present unconnected, since the airfare paid will be low enough to render entry uneconomical.

It is assumed that the airline's operating cost function can be defined as a standard CES function. This class of function is general enough to capture the cost of operating different types of networks with a varying number of routes and layout patterns. It is monotonically increasing and exhibits increasing returns. This ensures scale economies in that as output (frequency, or ACM per week) increases, the cost per flight decreases. Therefore it is worthwhile increasing frequency in a HS system in order to deter entry into the marketplace by carriers attempting to provide a direct service from i to j, where this route does not presently exist.

Additional costs result from payments made by the airline to the airports in the form of landing and passenger charges. The landing charges (LC) are paid to the arrival airport and are based on the maximum take-off weight of the aircraft size. The LC per route is computed by multiplying the Maximum Take-Off Weight of the aircraft size chosen, by the cost per ton of landing at the specific airport, by the frequency per week. The passenger charges (PC) are paid to the departure airport for each passenger carried. Two passenger charges have been included: the full tariff paid at the first departure airport and a transfer charge paid at subsequent hubs, when the passenger is carried on two or more legs to reach her destination. This pricing system is in line with the present rules of most international airports. Since there are many different types of charges, the LC and PC have been modified to include other relevant charges such as night charges and noise charges etc. and will be referred to as landing related and passenger related charges.

***The Airline's Objective Function:*** Given a particular hub airport, the airline's objective function consists of the revenue the airline earns from passengers that travel directly to their destination and are therefore willing to pay an additional charge, and those that travel via the hub. The costs defined in the objective function include the operational cost function and landing and passenger related charges at this hub. The profit function is thus defined as:

Profit Function =     Revenue Function
                      - Operating Costs Function
                      - Landing Charges
                      - Passenger Charges

Recall that in this analysis we consider networks with two primary hubs. Therefore, the optimization model produces a solution to the profit function in terms of the potential profitability of the network with these hubs. By repeating the analysis for all possible networks the model sets the one with the highest level of profits to equal 100 and subsequently, ranks all other networks accordingly. [1]

### 2.2.    Mathematical Program

The mathematical program consists of the above-mentioned objective function and four types of constraints that have been included in the program as follows:

***Type 1: Aircraft Capacity Constraint***
This restricts the size of the aircraft to a minimum and a maximum number of seats.

***Type 2: Airport Capacity***
Airport capacity in terms of aircraft movements per unit of time (e.g. ACM per week) is affected by three components; runway, terminal and apron capacity. Runway capacity proved to be the most binding restriction in all cases, consequently other constraint types were redundant.

***Type 3: Load Factor Minimal Capacity***
This constraint requires a minimum percentage of seats filled (load factor) at all times, since the industry has an accepted minimal level, below which the airline will not break even.

***Type 4: Network Constraint***
The last set of constraints requires all frequency levels to be positive, ensuring that all nodes are connected in the network configuration specified.

The algorithm that solves the mathematical program searches for a solution using a modification of Goldfarb's conjugate-gradient projection algorithm for a non-linear objective function with linear constraints. The algorithm has been modified to deal with a set of non-

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[1] The choice of a network (thus hubs) is also based on the quality level of these hubs to indicate additional costs associated with the use of these airports (e.g., costs due to delays, congestion and handling).. Therefore, schematically the ranking of a network is:

Network Ranking = Profitability Rank + Quality Score of Hub 1 and of Hub 2

Analysis of this subject is beyond the scope of this study and is the main theme of a follow-up study.

linear constraints that require the load factor to be above a certain percentage in a feasible solution. (Adler et al., 1996).

## 3. Network Structure

In this study two intermodal demand matrices, one for business and one for non-business, have been composed for 18 major European airports [2] (resulting in 16 routes to be assigned to the two airports selected as hubs), a U.S. airport JFK and a Far-East airport NRT. We assume that all North-Atlantic traffic is aggregated into one international route (i.e. all North-American departures first fly to New York and then to a West-European hub). Similarly all Far-East routes are first connected to Tokyo and then to a West-European hub. In the simulation model it is possible to distribute the 2 inter-continental and the 16 European routes in any order (e.g. the two international routes to one hub and the 16 European airports evenly distributed between the two hubs), though a geographical distribution seems most sensible (see Figures 1 and 2).

So the structure of the network is determined by three factors: a) the location of the major hubs; b) the number of intra-European routes and inter-continental routes that are connected to each hub; c) the allocation of European routes between the hubs. In this analysis we distinguish between two types of hub: a gateway-hub and a Euro-hub. A gateway hub is a point of transfer between inter-continental routes and intra-European routes. In this regard, a gateway hub has a feeder function by feeding the intra-European network with inter-continental passengers (e.g. long-haul: New York $\Rightarrow$ Amsterdam $\Rightarrow$ Zurich), vice versa. A Euro-hub, is a transfer point connecting short-haul to short-haul routes inside Europe. The same airport can, of course, serve the two functions but what counts is the *proportion* of trips that are long- or short-haul.

Figure 1 shows a base case where all 16 European routes are distributed between an intercontinental hub (e.g. London) and an intra-European hub (e.g. Milan) whereby all North-Atlantic and Far-East international routes go to London. The division of the European routes is geographically based, i.e., all airports east of Milan are linked to Milan whereas all airports west of Milan with London. A shuttle service links the main two hubs.
Figure 2 shows a case where each hub connects with one international route (North-Atlantic with London and Far-East with Milan).

## 4. Base Run Simulation

Above we have defined a network by its main hubs and by the distribution of international and intra-European routes between these hubs. It should be understood that the simulation model is flexible enough to handle any assumed network configuration. The ones described below serve mainly as examples.

We begin by presenting the results from, what we call, the "base run simulation". The choice of the following 13 networks in this base run simulation was made on the grounds that airlines

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[2] AMS, ARN, ATH, BCN, BRU, CDG, CPH, FBU, FCO, FRA, GVA, LHR, LIN, MAD, MAN, MUC, VIE, ZRH.

that use these hubs are potential alliances and that from geographical and demand considerations it is useful to distribute the intra-European routes as in the networks below. In each case, the 16 European routes have been split evenly between the two designated hubs, based on geographical considerations (distance to nearest hub). The two international routes are allocated to one hub which represents the international gateway (the one chosen provides the airline with the highest profits)[3]. The key parameters to notice are the potential profits of the (hypothetical) airline from using a particular network and the relative ranking of this network. Profits or losses to an airport are also noted. In some cases, however, these profits are from ACM and PAX related income and costs only as no information is available on the fixed income and costs of a particular airport. It is important to emphasize that it is not possible to attribute any "real-world" meaning to the numerical results from the simulations which stem from theoretical conditions of network choice and market structure under complete deregulation.

In this section we report only principal results from the base-run simulation. Two main conclusions can be derived from the results of table 1. First, the networks which contain London (Heathrow) as one of their hubs rank the highest in terms of airline's potential profits. In this base run simulation, the choice of London (LHR) and Rome (FCO) as the main hubs proves to be potentially the most profitable one (potential profit rank = 100). Amsterdam receives second ranking only when it is part of the network that includes London (potential profit rank = 86).

A second conclusion is that when an airline designs a profitable network, the hubs in this network do not necessarily earn positive profits. For example, in the case of the London (LHR) and Rome (FCO) network, which earn the airline the highest potential profits, Rome airport suffers a loss. Apparently, what is good for the airline is not necessarily good for the airports. The question, what can an airport do in order to increase its use without suffering a loss, will be further explored in policy analysis section.

## 5. Policy Tests

### 5.1. Objectives of Policy Tests

There are two main objectives for the policy tests. The first is to examine the network choice and performance of airlines and of airports under varying external conditions. The second objective is to determine optimal policy for Amsterdam airport Schiphol with respect to traffic and financial performance.

In terms of the simulation model, attainment of the first objective requires that we introduce into the program changes in basic demand and operating conditions and, subsequently, a comparison of the model's results with those obtained from the base run. Attainment of the second objective requires a search process by which the best combination of policy means available to Schiphol (e.g. change in ACM and PAX charges) is identified.

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[3] One might expect that the gateway hub will serve all 16 European routes due to inter Gateway-European transfer flows. We have thus run these networks on the basis of demand considerations alone. The results were quite similar in terms of profit to the airline.

Table 1. Summary of the Results from the Base Run Simulation

| hub 1<br>hub 2 | Potential Profit in $'s<br>- to airline<br>- to hub 1<br>- to hub 2 | routes assigned<br><br>- to hub 1<br>- to hub 2 | Relative Position<br>Network |
|---|---|---|---|
| airline<br>ZRH<br>AMS | 22524964<br>4120282<br>826803 | <br>Euro: 9 Interc'l: 0<br>Euro: 9 Interc'l: 2 | 24 |
| airline<br>FRA<br>MAD | 30740134<br>-11436754<br>1865857 | <br>Euro: 9 Interc'l: 2<br>Euro: 9 Interc'l: 0 | 33 |
| airline<br>MAD<br>AMS | 38417272<br>1760099<br>896383 | <br>Euro: 9 Interc'l: 0<br>Euro: 9 Interc'l: 2 | 41 |
| airline<br>LHR<br>FCO | 92710360<br>3361255<br>-13523035 | <br>Euro: 9 Interc'l: 2<br>Euro: 9 Interc'l: 0 | 100 |
| airline<br>FCO<br>AMS | 48660468<br>-9109776<br>1933525 | <br>Euro: 9 Interc'l: 0<br>Euro: 9 Interc'l: 2 | 52 |
| Airline<br>BRU<br>ZRH | 9087265<br>4328177<br>3494701 | <br>Euro: 9 Interc'l: 2<br>Euro: 9 Interc'l: 0 | 10 |
| Airline<br>CPH<br>CDG | 40734660<br>1541480<br>-1829261 | <br>Euro: 9 Interc'l: 0<br>Euro: 9 Interc'l: 2 | 44 |
| Airline<br>CPH<br>FRA | 11021846<br>3117824<br>-14378592 | <br>Euro: 9 Interc'l: 0<br>Euro: 9 Interc'l: 2 | 12 |
| Airline<br>CPH<br>MAD | 33637388<br>1876608<br>2359777 | <br>Euro: 9 Interc'l: 0<br>Euro: 9 Interc'l: 2 | 36 |
| Airline<br>LHR<br>BRU | 61958164<br>1924944<br>1684258 | <br>Euro: 9 Interc'l: 2<br>Euro: 9 Interc'l: 0 | 67 |
| Airline<br>LHR<br>FRA | 69006952<br>1895986<br>-15216546 | <br>Euro: 9 Interc'l: 2<br>Euro: 9 Interc'l: 0 | 74 |
| Airline<br>CDG<br>FCO | 66057220<br>-1982632<br>-15034719 | <br>Euro: 9 Interc'l: 2<br>Euro: 9 Interc'l: 0 | 71 |
| Airline<br>LHR<br>AMS | 79428896<br>3047660<br>-1294053 | <br>Euro: 9 Interc'l: 2<br>Euro: 9 Interc'l: 0 | 86 |

The following policy tests were performed:

(A) effect of doubling demand;
(B) effect of doubling demand and increasing airport capacity;

(C) effect of decreasing landing charges (at Schiphol);
(D) effect of decreasing passenger charges (at Schiphol);
(E) effect of a change in a mix of policies on Schiphol's position;

Two additional policy tests focused on the effects of changes in network structure on Schiphol's position.

(F) effect of splitting international routes;
(G) effect of changing intra-European routes;

In many of these tests the introduction of an exogenous change is also likely to affect the quality of airports from the point of view of airlines which, in turn, could affect their choice of a primary hub. Since in this study we did not model airlines' reaction to changes in airport quality attributes, we disregard airports' quality effects arising from these policy changes. As mentioned above, such an analysis is the subject of a follow-up study. Below we report the major findings from these policy tests.

### 5.2.  Policy Test Results

A. <u>Effect of Doubling Demand</u>: the demand data used here represents approximately 45% of actual demand. The reason being that in Europe non-scheduled and charter operations constitute a very large proportion of total demand. In addition, in this study we have used only 18 European airports (albeit the major ones), thereby not considering trips from smaller airports. To account for this discrepancy and to assess the effect of future growing demand we have doubled both the business and non-business demand matrices. Compared with the base-run the results show that while the network with London (LHR) - Rome (FCO) as its hubs still ranks the highest, other networks become a viable option. Thus, for example, whereas in the base- run London (LHR) - Brussels (BRU) ranked fifth after London (LHR) - Rome (FCO), now it ranks second. On the other hand, the network London (LHR) - Amsterdam (AMS) which ranked second in the base-run is now down to fifth position. Apparently, as demand increases the strategic position of other airports (such as Brussels in combination with London) becomes an attractive option for airlines. This conclusion should be qualified, however, as we did not consider the effect of greater demand on congestion and delays, thus on the attractiveness of airports from airlines' viewpoint.

B. <u>Effect of Doubling Demand and Increasing Airport Capacity</u>: It can be seen from the doubled demand test results that certain airports are used to their full capacity. One solution is to expand runway capacity. Of the 5 major airports in our study, London (LHR) and Frankfurt are unlikely to see any increase in runway capacity. Amsterdam, Paris (CDG) and possibly Brussels, can expect such a development[4]. Thus, in this policy test the runway capacity of these 3 airports is increased according to their projected capacity per week in the year 2000 (SRI, 1991) as follows:

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[4] In cases where it is not possible to increase capacity the solutions to congestion will be either decline in service level (e.g. longer delays) or higher charges, or both.

| Hub Airport | Original Runway Capacity | Runway Capacity for the year 2000 |
|---|---|---|
| Amsterdam | 11,424 | 15,120 |
| Brussels | 7,392 | 10,080 |
| Charles de Gaulle | 12,096 | 12,600 |

The main conclusion from this analysis is that compared with the previous test (A) the position of Amsterdam will not improve while that of Paris (CDG) will (compare, for example the positions of CDG - FCO and LHR - AMS in tests A and B). The profit level of different networks might change as well but in evaluating these results it should be point out that we did not account for the capital costs of these capacity development projects and their possible effect on airlines' costs.

C. Effect of Decreasing Landing Charges (at Schiphol): In this study we have lumped all charges into two main categories: landing or Aircraft Movement (ACM) and Passengers (PAX) charges. In general, all charges need to be approved by governmental authorities thus, except for inflation adjustments, the margins for a change are rather limited. However, as explained above, our objective is to examine the effect of charges on network structure and the choice of a particular hub, independent of how applicable is this policy at present. To that end, in this test we reduce ACM charges at Schiphol by 15 percent. Compared with the base-run the results from this test indicate no effect on Schiphol's ranking (LHR - AMS is second place in both cases) with a slight improvement in potential profits for airlines (due to the drop in charge costs).

D. Effect of Decreasing Passenger Charges (at Schiphol): In the following policy test we have decreased Schiphol's passenger related (PAX) charges, for both transfer and non-transfer passengers, by 15%. The results show that decreasing PAX charges has little to no effect on the outcomes (Schiphol's ranking and airlines' profits). Compared with the results of test C, decreasing Schiphol's landing charges by 15% has a greater impact on the airlines' profits than a decrease of PAX charges of a similar magnitude. In either case, decreasing charges has no effect on the ranking of preferable networks.

E. Effect of a Change in a Mix of Policies on Schiphol's Position: In this test we examined the combined effect of completely eliminating all charges at Schiphol (i.e., ACM and PAX charges are set to zero) while concurrently doubling demand everywhere. The main conclusion from this test is that demand has a much greater impact on network ranking and profitability than charges have. Compared with the results of test A, the decline in Schiphol's charges has improved the airline's level of potential profits but did not affect its relative ranking.

F. Effect of Splitting International Routes: In the base case analysis the two international routes (New York (JFK) and Tokyo (NRT)) are connected to one hub (the European gateway hub, e.g., London) while the other airport serves as an intra-European main hub. In this case each of the two hubs is connected to one of the two international hubs in order to determine the effect on potential profits and network ranking. The results (shown in Appendix F) imply that, based on potential profits, the splitting of the international routes reduces overall

profitability, compared with the base-run's results. Hence, from this perspective this is not a preferable approach. From network ranking point of view the network London (LHR) connected to JFK and Amsterdam (AMS) connected to NRT is superior (in terms of potential profits) to the network London (LHR) connected to JFK and Rome (FCO) connected to NRT which seems, from geographical viewpoint, to be the more logical one (than LHR connected to Tokyo and FCO connected to New York).

G. Effect of Changing Intra-European Routes: In the base case analysis each of the two main hubs is connected to 9 intra-European routes. The objective of this test is to ascertain whether a different split of these routes will affect potential profitability and ranking. Hence, in this run, the European domestic routes are alternately split 7 to 11 between the two European hubs (as well as between the two international routes). Compared with the base-run results, in general, profit level has been increased after this split. For example LHR - FCO weekly potential profit level has risen from $92.7 million in the base-run to $100.5 million. In this regard this policy is a preferable one. From network ranking viewpoint, Schiphol's position is not improved as another network, London (LHR) - Frankfurt (FRA) has a higher ranking. It is possible, of course, to test for any other routes' split to find out whether Schiphol's position can indeed be considerably improved.

Table 2. Summary of Policy Tests: Selected Results [a]

| Test Type | | Airline's Best Network Choice | | Schiphol' Best Position | | |
|---|---|---|---|---|---|---|
| | | Hubs | Rank | Hubs | Rank | Position |
| | Base Run | LHR FCO | 100 | LHR AMS | 86 | 2 |
| A | Doubling Demand | LHR FCO | 100 | FCO AMS | 77 | 4 |
| B | Doubling Demand *and* Increasing Airport Capacity | LHR FCO | 100 | FCO AMS | 76 | 5 |
| C | Decreasing Schiphol's Landing Charges | LHR FCO | 100 | LHR AMS | 87 | 2 |
| D | Decreasing Schiphol's Passengers Charges | LHR FCO | 100 | LHR AMS | 86 | 2 |
| E | Mix of Policies | LHR FCO | 100 | FCO AMS | 91 | 4 |
| F | Splitting International Routes [b] | LHR FCO | 97 | LHR AMS | 97 | 2 |
| G | Changing Intra-European Routes | LHR FCO | 100 | LHR AMS | 80 | 3 |

Note: [a] These results do not take into account possible changes in the quality level of airports resulting from these policies; [b] The combination LHR-FCO while ranking first, is somewhat doubtful from geographical viewpoint as it requires LHR to be connected to Tokyo (NRT) and FCO to be connected to New York (JFK)

*5.3.    Summary of The Policy Tests*

As the focus of this study is on the effect of alternative policies on airlines' choice of best network (in terms of primary hubs) and on the position of Amsterdam (Schiphol) airport, the following table summarizes the main results from the above policy analyses.

Several conclusions can be drawn from these results. **First**, the combination of London (LHR) and Rome (FCO) airports appears to be superior, in terms of its potential ability to generate profits for airlines, under all policy test conditions (save for the implausible case of test F). This is mainly due to the very strong position of London's Heathrow airport in Europe and the effective geographical division of European routes between London and Rome.

The **second** conclusion is that the dominant factor affecting potential profitability and ranking of airports are actual demand patterns. Given demand elasticities, when more passengers use an airport as their origin or destination airport, the greater is the propensity of airlines to use this airport as their primary hub. It further seems that the demand factor supersedes many possible policy options like reducing landing and passenger charges. As suggested by the results of test A, if demand for air travel will indeed grow, (e.g., due to reduction in airfare following the European aviation deregulation), Schiphol's position is likely to decline as other airports, like Brussels and Paris (CDG), are more likely to be selected by airlines as their primary European hubs. This tendency will be further intensified if these other airports will also increase their runway capacity (see results of test B). A plausible corollary to this conclusion is that if Schiphol airport wishes to improve its relative position it needs to increase demand for its services relative to other airports. One sensible way of doing so is by expanding its catchment area, for example, by improving rail and bus link services to it.

A **third** conclusion is that the intercontinental linkages of an airport play an important role in determining its relative position. This can be seen from the results of test F which indicate that the combination of London (linked to New York (JFK)) and Amsterdam (linked to Tokyo (NRT)) is a viable alternative to the London-Rome combination. In general, it is the airlines which decide on the structure of their network and connectivity to international hubs.

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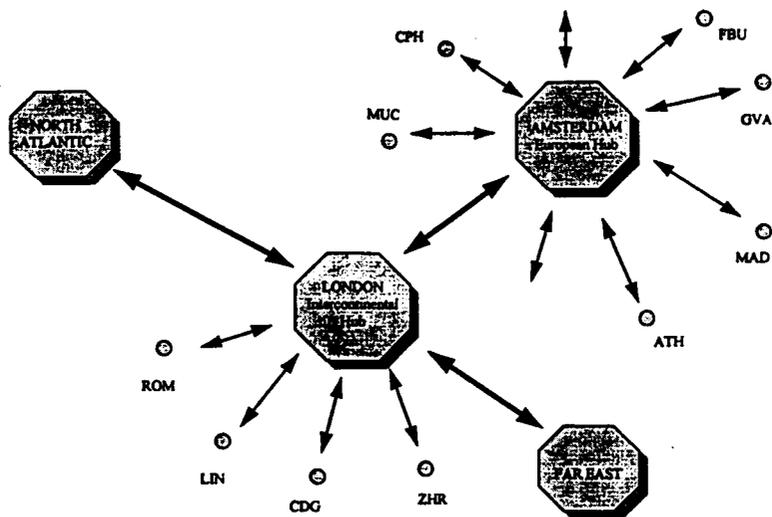
Figure 1: A network with London as the intercontinental hub and Amsterdam as the Intra-European hub
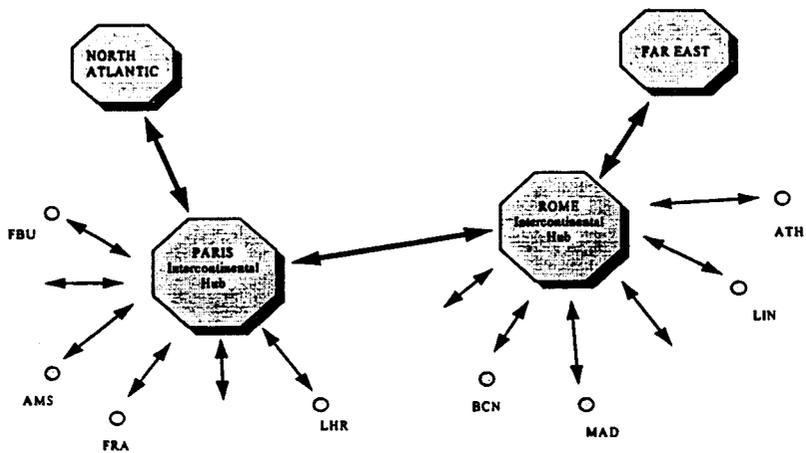


Figure 2. A network with both Paris and Rome as intercontinental hubs

# HOW BIG IS TOO BIG FOR HUBS:

## MARGINAL PROFITABILITY IN HUB-AND-SPOKE NETWORKS

by

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(Preliminary Draft - Please Do Not Quote)

ABSTRACT Increasing the scale of hub operations at major airports has led to concerns about congestion at excessively large hubs. In this paper we estimate the marginal cost of adding spokes to an existing hub network. We observe entry/non-entry decisions on potential spokes from existing hubs, and estimate both a variable profit function for providing service in markets using that spoke as well as the fixed costs of providing service to the spoke. We let the fixed costs depend upon the scale of operations at the hub, and find the hub size at which spoke service costs are minimized.

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## 1. INTRODUCTION

One legacy of airline deregulation has been an increased reliance upon hub-and-spoke networks among national carriers. By drastically reducing the number of flights required to accommodate a set of endpoints, hubs have been the source of massive scale and scope economies. A benefit of the hub-and-spoke system is service to smaller markets where direct service to a variety of destinations is cost prohibitive, yet exclusive service to a nearby hub is not; this service enables travelers from small markets to access a carrier's entire network. While consumers benefit from spacial accessibility resulting from large networks, most national carriers reported excessive losses during the early 1990s. These losses threaten service to numerous small markets. Given the proliferation of hubs and the recent losses incurred within the airline industry, it is timely and appropriate to identify the minimum and maximum efficiency scales of both hubs and their associated networks.

We focus on identifying the incremental costs of increasing the number of spokes served by a single hub. This structure may be determined by examining the additional profits gained from offering service to smaller airports and connecting those airports to an entire network via a central hub. We do not measure profits explicitly. Rather, we use entry and exit decisions as a signal of profitability. Our approach is innovative in inferring spoke-level fixed costs from entry and exit decisions.

The optimal structure for an air carrier depends on both the incremental costs associated with each spoke and the fixed costs of operating a hub. Two extreme cases may be considered. If carrying traffic over long spokes is costly, or if the average "cost-minimizing" hub contains only a small number of spokes, then the efficient network structure involves many small hubs. This type of network would more likely evolve when congestion costs are high. Conversely, if the fixed costs associated with hubs are high, or if carrying spoke traffic is inexpensive, then an efficient network will involve a few large hubs with numerous spokes. Some anecdotal evidence suggests that moving toward larger hubs is the more efficient network structure for airline markets.[1] However, a fundamental issue in building an assessment of the relative efficiency of large and small hubs lies in the determination of costs.

We use entry and exit decisions as a signal of profitability, since it is not straightforward to measure operating costs with cost data.[2] First, we infer both the profits earned by carrying traffic along the network as well as the fixed costs associated with providing the entire network. The use of entry decisions to infer fixed costs was pioneered by Bresnahan and Reiss (1987) and has been applied to airlines by Reiss and Spiller (1989),

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[1] This conclusion is based upon the recent consolidation of American Airlines.

[2] An entire literature has evolved with respect to allocating costs among routes, spokes, etc. For details see Caves, Christianson and Tretheway (1984), Cornwell, Schmidt and Sickles, (1990) etc.

Berry (1992), and Brueckner and Spiller (1994). Second, we combine the use of entry as a signal of costs and profitability with the cost disaggregation of Brueckner and Spiller, to directly measure the costs associated with adding a spoke to an existing hub-and-spoke network. This second innovative step is crucial in identifying the optimal network structure.

Our model of entry, unlike previous models, recognizes that demand is based on city-pair markets, not on service along spokes. We incorporate the many four-segment markets (or routes) a carrier simultaneously enters when adding a spoke. Adding a flight along a spoke between two cities enables the carrier to enter any four segment city-pair market that is accessible from either endpoint. Demand for any route depends upon the total distance, competition, and demographic factors. Costs depend on both the variable costs associated with providing service in the relevant city-pair markets, plus the fixed costs of adding the additional spoke to the hub airport. Thus choice of entry or exit depends on the variable profits for the change in a network versus the associated fixed costs of operating that particular spoke.

Like Brueckner and Spiller (1994) we measure costs as a function of flights between city pairs. Because the choice of entry or exit depends upon the incremental revenue of entry versus the associated incremental cost of offering service on a particular spoke, we measure the total effect of entry or exit on the carrier's network-wide profits. We combine three data sets (route variables, route-carrier variables, and spoke variables) into a maximum likelihood specification where entry/non-entry is the dependent variable. From our model, we recover a cost specification for operating spokes through hub cities, and test that specification for scale economies.

The remainder of paper is organized as follows: The next section contains a description of the hub-and-spoke system and provides motivation for our research. Our methodology, including a description of our technique and our data, comprises the third section. Results from our model and concluding remarks are included in the fourth and fifth sections, respectively.

## 2. THE HUB-AND-SPOKE SYSTEM

During airline economic regulation, tight government control over route entry resulted in a "linear" structure for national carriers. Airlines were required to petition the Civil Aeronautics Board (CAB) if they desired entry into a given route and often had to justify the need for additional service to gain such entry. Conversely, carriers were required to provide service to many smaller, less lucrative markets. While the CAB was effective in providing service to small markets, travel to and from these airports often involved numerous stops and inter-line connections.[3] Proponents of regulation expected small airports to suffer a loss of

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[3] When making an inter-line connection, the passenger changes airlines at some point during the trip and recheck in himself and his luggage.

service without government protection. This prediction was based on the linear route structure imposed by regulation.

Since deregulation, we have observed a curiously different outcome. The linear route structure imposed by the CAB was quickly abandoned by national carriers in favor of a hub-and-spoke (H&S) system.[4] The H&S system has been used in other modes of transportation, such as busing, rail, and subway; it was a natural progression for airlines. A noted advantage in H&S is the cost savings generated from more efficient aircraft utilization. These savings generally offset the cost increases that are associated with additional ascents and descents, and circuitous routing. These cost savings have allowed many small markets to maintain a profitable niche in airline networks and driven carriers to extend their networks even further.[5]

The dominance of the H&S system has revolutionized the way carriers offer service. Two key aspects of this revolution are in flight composition and frequency of service. Because H&S systems allow passengers, from a variety of origins, travel to the entire network of destinations via a hub, a spoke is used by all passengers originating at the spoke regardless of their intended destination.[6] Given this increased spoke usage, airlines offer more frequent service to accommodate passengers requiring connecting service at various times. Increased frequency implies a greater dependence on smaller aircraft and better utilization of larger aircraft between hubs and other large markets. The end result is larger, non-uniform fleets of aircraft.

The economic consequences of H&S paradoxically include both heightened competition and the market power associated with hub dominance. Competition has increased on a network scale. Prior to deregulation, carriers were restricted in the markets they could enter; since deregulation, entry is easier, although not free, and carriers are able to use their H&S networks to link all entered markets to all others. Given the increased variety in routes offered by all carriers, it is inevitable that carriers will begin to compete for customers on previously monopolized routes. Conversely, Borenstein (1989) has shown significant market power associated with hub dominance. A case in point is the Charlotte, NC hub dominated by USAir. USAir uses its USAir express service to provide spoke service to several dozen small markets within a few hundred miles of Charlotte. For most

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[4] Under H&S airplanes from several points of origin arrive at a central hub where passengers change planes to travel to their intended destinations.

[5] For extensive details on the transition from linear to hub-and-spoke systems in the airline industry, see Oum and Tretheway (1990).

[6] This implies an absolute increase in spacial accessibility due to the availability of network service from their local airports.

of these markets, USAir express is the only local link to a national network.[7] American Airlines attempted to introduce competition from a "mini-hub" at Raleigh/Durham (RDU). However, after several years of poor response American left these smaller markets and sold much of its RDU business to Midway Airlines. Therefore, although the H&S system has led to intense competition among national carriers for heavily traveled routes, monopolized pockets have become an important factor in maintaining profitable service to smaller markets and the entire network.[8]

## 3. METHODOLOGY

In the following subsection, we use various terms to describe network configurations for supply and demand purposes. A hub is a centrally located airport serving as an intermediate point between numerous outlying cities. A spoke is a connection between a hub city and an endpoint city. Airlines fly along spokes, connected to their hubs, to feed traffic into their networks. A route is a connection between one outlying city and another reached via a hub; that is, each route contains two spokes attached to the same hub. Passengers fly along routes; the routes an airline can serve depend on the spokes it flies. A market is a pair of endpoint cities; each market contains one route for each possible hub by which a passenger can travel between the outlying cities.

### 3.1. Model

In order to provide service to a market, an airline must operate two spokes connecting the origin city and destination city to its network via one of its hub cities. We specifically define a route as two endpoints connected by a hub. Following Brueckner and Spiller (1994), we disaggregate the costs into two components--the fixed costs of providing the hub, and the incremental cost of providing service along each spoke. We then break down the incremental costs of serving each spoke into a fixed cost of serving the spoke, and the variable costs of carrying passengers along that spoke. Brueckner and Spiller examine the marginal costs of carrying passengers to test for economies of density; in contrast, we focus on the fixed (with regard to network traffic) costs of adding the spoke into the hub. We define spoke costs between an outlying city and the hub as

$$C_i = X_i * \beta, \tag{1}$$

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[7] Access to other national networks would require travel to other mid-sized airports such as Raleigh/Durham, Nashville, or Norfolk.

[8] An alternative representation of this point may be found in Hayes and Ross (1996). Hayes and Ross note that the financially viable national carriers tend to offer an extensive network of service, but carefully protect dominated routes.

where $C_i$ represents the cost of operating spoke $i$, $X$ is a set of exogenous variables describing cost conditions at the outlying city and at the hub, and $\beta$ is a vector of parameters. If a carrier does not provide spoke service to some outlying city, it cannot provide route service between that city and any other city on the airline's network. However, providing spoke service, allows service on any four-leg routes in the network (as well as the two-leg route between the outlying city and the hub).

When the airline incurs the fixed costs of providing the sppoke, it gains the ability to provide service to four-segment routes that connect to the network along that spoke. In serving the network of routes, the airline will incur traffic costs but will also earn revenue from additional traffic. Profits earned by serving a given route are

$$\Pi_{ij} = Z_{ij}{}^{*}\gamma + \varepsilon_{ij}, \tag{2}$$

where $\Pi$ is the airline's profitability from route $j$ via spoke $i$. $Z_{ij}$ is a set of exogenous variables describing cost conditions and demand for tickets between the two endpoints; $\gamma$ is a vector of parameters; and $\varepsilon$ is an error term whose distribution is described below. The airline will choose to serve those routes for which profits are positive. For any spoke $i$, let $S_i$ be the set of all routes for which such profits are positive. Then the airline's incremental profits for serving spoke $i$ are given by

$$\Pi_i = \Sigma_{Si}\,\Pi_{ij} - C_i.\,{}^{9} \tag{3}$$

If incremental spoke profits are positive, then the airline will choose to provide service in spoke $i$ and will serve those routes in the set $S_i$. The carrier will not serve those routes for which incremental route profits are negative, even after the costs of providing spoke $i$ are paid; that is, the routes outside the set $S_i$. If incremental spoke profits are negative, then the carrier will not provide service on the spoke nor any of the routes which include that spoke.

The incremental profit from serving a route depends upon the extent of competition from other airlines serving the same market, and on the level of product differentiation between them. This issue was addressed by Berry (1992). Following his approach, we decompose the error term in the profit equation (2).

$$\varepsilon_{ij} = h(N, W, \alpha)_{ij} + \upsilon_{ij} \tag{4}$$

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[9] This is similar to Brueckner and Spiller, p. 396.

$N$ is the number of airlines serving the market; $W$ is a set of variables describing the product differentiation between those airlines which affect this airline's share of the market; $\alpha$ is a vector of parameters; and the error $\upsilon$ is independent of $N$ and distributed Normal(0,1).[10]

After substituting, the final form of the incremental route profit function is

$$\Pi_{ij} = Z_{ij}\text{*}\gamma + h_{ij}(N,W,\alpha) + \upsilon_{ij}. \tag{5}$$

After rearranging to collect error terms, the incremental spoke profit function is given by

$$\Pi_i = (\Sigma_{Si} Z_{ij}\text{*}\gamma + h_{ij}(N,W,\alpha)) - X_i\text{*}\beta + (\Sigma_{Si} \upsilon_{ij}). \tag{6}$$

The airline enters the spoke if $\Pi_i$ is positive and does not enter if it is negative.[11]

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[10] Berry allows for the possibility that there is product differentiation which is observed by airlines and customers, but unobserved by econometricians. He thus allows the $h()$ function to contain a second, carrier-specific error term whose distribution may be firm-specific and may be correlated with $\varepsilon$. The identification of the model is made complicated by the presence of two error terms, possibly correlated, whose joint distribution depends on the number of carriers already serving the market. Berry suggests four different strategies for identifying the model.

1) Assume that profits are constant with respect to N, thus removing the correlation between e and N from the model.

2) Berry himself restricts consideration to markets served by two or fewer carriers, and reduces the problem of the joint distribution of error terms to one which is computationally tractable. This solution is not suitable to our problem. In order to consider the effect of spoke costs on entry we must consider all routes served along that spoke, regardless of the number of carriers which serve the relevant markets.

3) Suppress the carrier-specific error requiring the addition of sufficient $W$ variables to explicitly account for product differentiation. While airlines are product differentiated in many ways, we believe that the variables we include in W are sufficient to measure the effect of product differentiation on profitability. We adopt this method. As a result, the entry game between the carriers serving this market uniquely determines the number of firms serving the market, but not their identities (see Berry for details). We therefore condition our draws for $\varepsilon$ on the equilbrium having the proper number of firms, since that is what can be inferred from the distribution of $\varepsilon$, not whether any specific firm enters or not.

4) Assume that firms enter in order of decreasing profitability, and that entry decisions are binding. Then one need consider the firm-specific error of the last firm, rather than one for every potential entrant. An alternative representation of this point may be found in Hayes and Ross (1996). Hayes and Ross note that the financially viable national carriers tend to offer an extensive network of service, but carefully protect dominated routes.

[11] The above description may not apply to some markets where alternate hubs are available for serving the markets in question. In that case, the airline serving the spoke may be able to make some profits in some of the affected markets even if it chooses not to serve the spoke in question; adding service to the spoke in question may cause the airline to forego profits on passengers that are currently flying between the

### 3.2. Estimation Strategy

As in a probit model, we maximize the likelihood of observed entry and non-entry decisions as a function of our parameters. However, our estimation is complicated by two distinguishing features. First, the distribution depends of $\varepsilon$ upon the number of competitors in each of the markets served by a particular spoke. Second, when an airline does enter a spoke, we know which routes it chooses to serve and which routes it chooses not to serve. This entry decision provides useful information regarding the $\gamma$ parameters.

To address the peculiarities of our model, we use numerical integration to estimate its parameters. For every spoke in the data set, we estimate the likelihood that the airline chooses the entry/no entry decision we observe by the following procedure:

1) In each route served by that spoke, we draw a value, $e_{ij}$, for $\varepsilon_{ij}$ which is consistent with the known information about how many other carriers serve the market, and with the airline's actual decision to serve that route if we observe it (that is, if the airline did enter the spoke in question).

2) Based upon $e_{ij}$, we calculate the airline's profit on that route from equation (5). If the airline did enter the spoke, we know for which routes the airline chose to provide service. Our calculated route profits will be positive if they did and negative if they did not (due to the conditioning in step 1). If the route profit is negative, we set it to zero, since the airline will not enter this route even if they do enter the spoke. If the airline did not enter the spoke, then our random draws can produce either positive route variable profits (route entry) or negative route variable profits (route non-entry), since we do not observe whether the airline chooses to serve that route or not if it had entered the spoke. Since the airline would not serve a route predicted to offer negative variable profits, we set zero profits in that case also.

3) We add the profits on each route together and subtract the additional costs of serving the spoke. We predict entry if the total spoke profits are positive, and non-entry if they are negative.

4) We repeat steps 1 to 3 a large number of times for each spoke, and take the fraction in which we predict entry as the probability of entry in that spoke.

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endpoint cities by means of a different hub. In such case the entry decision should be conditioned on marginal profit earned by serving the spoke, rather than the total. For the current version of the paper we have restricted ourselves to airlines and spokes where no alternative hub is available and therefore the profits the airline will earn, in the relevant markets, by not entering the given spoke is known to be zero. We may expand the data sample to include other markets in which the marginal profit characterization will be relevant in a future version of this paper.

When entry is not observed, we do not know which routes the airline would serve if it chose to serve the spoke. However, we surmise profits for the whole spoke to be negative, and accordingly, the likelihood for the spoke is $\Pr(\Pi_i < 0)$. Conversely, when a spoke is served, we do know which routes the airline serves and which it does not serve. In the case of entry, the likelihood for the spoke is $\Pr(\Pi_i > 0, \Pi_i > 0 \text{ over } S_i, \Pi_{ij} < 0 \text{ over } \sim S_i)$. We calculate the former likelihood by numeric integration without complication. Since the probability of any one trial having the correct pattern of routes served and not served is low, the latter likelihood is computationally intensive; therefore, numerous draws are required to accurately estimate the probability. A more efficient procedure is to decompose the probability of entry into $\Pr(\Pi_i > 0 \mid \Pi_{ij} > 0 \text{ over } S_i, \Pi_{ij} < 0 \text{ over } \sim S_i) * \Pr(\Pi_{ij} > 0 \text{ over } S_i, \Pi_{ij} < 0 \text{ over } \sim S_i)$. The first term, a conditional probability of the decomposition, is computed numerically by drawing values of $\varepsilon_{ij}$ that are conditioned on $\Pi_{ij} > 0$ for routes where entry is observed, and on $\Pi_{ij} < 0$ for routes where entry is not observed, as discussed above. The second term, a marginal probability, is computed using the normal distribution function. We multiply these two probabilities together to condition properly the likelihood estimates.

### 3.3. Airline Data

Adapting our empirical model to available airline data presents many challenges. We use airline presence data from the Department of Transportation's Origin and Destination Survey (DB1A) and the T100 Domestic Segment Data for 1992 (T100).[12] The DB1A provides revenue and number of passengers flying from ticket sales, leg by leg itinerary records for each ticket, and hub utilization information. The T100 provides plane usage, frequency of service, and fleet composition information. In addition to the data from the Department of Transportation, we incorporate gate information and demographics to describe hub dominance and demand, respectively.[13]

We chose the entire year of 1992 for several reasons. First, 1978 through 1988 was a period of massive restructuring in the airline industry with some 41 mergers (27 alone occurring between 1985 and 1988) and numerous bankruptcies. Such activity could easily complicate the identification of entry, non-entry, and competition. Therefore, we want to be (chronologically) as far away from this activity as our available data allow. Second, the T100 is a valuable source of information which began in 1990.[14] Third, we chose to utilize

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[12] The former data comprises a 10% sample of all domestic passenger itineraries and provides us with detailed information on routes of travel, hub utilization and revenue. The latter data source includes data from all non-stop flights and provides information on plane size and utilization, and flight frequency.

[13] We are indebted to Robin C. Sickles for demand characteristics and to Richard Butler for gate information. The demand characteristics are not included in this draft.

[14] Another data source (Service Segment Data) provides similar information for earlier years.

an entire year to avoid seasonal fluctuations. Finally, much of the financial distress that rocked the airline industry in the very early 1990s led carriers to abandon unprofitable routes and discontinue service to small markets. By catching the tail end of this era, we hope to correctly label these abandoned routes as non-entry.

A central issue to our estimation procedure is a comparison between entry and non-entry spokes. While collecting revenue and flight information about entry spokes is a straightforward process, the same is not true for the non-entry spokes. A non-entry spoke is the combination of a hub and an outlying airport that is not served through the hub. Our task is to find the potentially fruitful outlying airport. We find the fruitful airports by watching the behavior of (a) other carriers hubbing at the same hub, (b) other carriers hubbing near by, or (c) the same carrier hubbing near by. Table 1 contains a list of our carrier/hub combinations and the alternative carrier/hubs we utilize to identify and infer revenue and flight information for non-entry routes. Table 2, showing summary statistics, exhibits an average value of .87 to the entry indicator. The low percentage of non-entry routes demonstrates that airline carriers have a tendency to "blanket the market" and, therefore, non-entry spokes are rare.

The set of independent variables is composed of three subsets. The first subset of variables is spoke-carrier based. We include the total revenue associated with entry into a spoke, spoke distance, flight frequency and enplanement data, and the number of endpoints accessible from the hub. The second subset of variables is route-carrier based and provides information regarding overall flight distance, route revenue, and market share. The third subset is composed of route information focusing on endpoint demographics and the competitive environment of the route. Summary statistics for these variables are contained in Table 2 and detailed descriptions may be found in the Data Appendix.

## 4. RESULTS

Our preliminary results are based upon a limited number of variables and a 10% sample of our data set. In the spoke fixed costs $X_i*\beta$ (equation 1) we use two independent variables, TOTGATES, the total number of gates at the hub, and CARRGATES, the number of gates under the control of the carrier in question. In the route profits $Z_{ij}*\gamma$ ( equation 6) we use ROUTDIST, the distance along the route; we hope to add demographic information on demand in the near future. In the $h_{ij}(N,W,a)$ function, we include log N, the number of carriers serving the route, NDEST, the number of destinations each carrier may reach from a spoke, and DISTRATIO, the ratio of distance of each carrier on the route to the distance of the competitor with the shortest path between the two endpoints.[15] The latter two variables capture heterogeneity in service between airlines. Airlines which serve more destinations are more attractive for frequent flyer programs, and should be more profitable;

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[15] We include observations for all carriers flying a route in question.

airlines which take passengers far out of their way will have longer travel times and should be less demanded, hence less profitable.

The results of the estimation are:

Route profits = -0.730 - 0.210e-4 * DISTRATIO + 3.26e-4 * NDEST
- 0.044 * CARRDIST - 1.85 * log N

and

Spoke costs = -0.208 + 2.726 * TOTGATES + 0.136 * CARRGATES

Log likelihood = -6612.973633

We have not yet been able to calculate standard errors for these estimates, so we cannot determine their significance, but we can still draw some preliminary conclusions based on the signs of the estimates as long as the tentative nature of those conclusions is clear. First, we note that while spoke fixed costs are substantially higher at larger airports (those with more total gates), it does not make a great deal of difference how large the operations of the hubbing carrier are (because the coefficient on CARRGATES is considerably smaller than that on TOTGATES). This suggests that most of the incremental costs of adding a spoke to a hub are the physical costs of making the airport larger; if a spoke is added by switching gates from a non-hubbing airline to the hubbing airline, the incremental costs are quite small in relative terms. Indeed, they may be zero if the estimated coefficient turns out to be insignificant. This result suggests that there are decreasing returns (rising incremental costs) in making hubs larger, although the returns decrease more slowly, perhaps not at all, if the increase is achieved by giving the hubbing carrier a larger share of the existing gates at the airport rather than by making the airport larger.

Second, the coefficient on ROUTDIST is negative. This is reasonable, since the costs of serving long routes, particularly fuel and the opportunity cost of pilot and crew time, are higher than those of serving short routes. Our current specification for distance is linear; however, if airlines have economies of hauling distance, the true relationship may be quadratic, with the ROUTDIST$^2$ term being positive. We hope to test for this in future regressions. Third, the airline heterogeneity measures are taking the expected signs; NDEST is positive and DISTRATIO is negative. This gives us reason to believe that we have correctly controlled for demand heterogeneity between carriers in the profit function.

Our next step is to add more variables to $X_i$*$\beta$, specifically the number of spokes served by the airline, and to use a quadratic functional form to allow for the possibility that incremental spoke costs might fall, then rise as the size of the network increases.

## 5. CONCLUDING REMARKS

As airlines continue to rely on hub and spoke networks to compete in an increasingly global market, economists and other researchers must weigh the costs and benefits associated with these networks. We add to a literature addressing these issues by evaluating the marginal

profitability of spokes within these networks. Our approach was innovative in several ways. First, we used entry as a signal of costs and profitability as did Berry. Second, we disaggregated costs as did Brueckner and Spiller, by directly measuring the fixed costs associated with adding a marginal spoke to an existing hub-and-spoke network. The combination of these two methods is an important first step towards identifying the optimal network structure.

Our data comprised three sets: a set of spoke-carrier observations, a set of route-carrier observations and a set of market-carrier observations. These data included demand characteristics, congestion indicators,[16] spoke cost variables, network cost variables and network characteristics. We restricted our sample to a small number of mid-sized hubs and data from the calender year 1992.

We presented some preliminary results that are both consistent with the literature and puzzling. Our results indicated slightly increasing, possibly constant returns to scale in airport presence and economies of scope in destination alternative. Both constant returns to scale and scope economies are consistent with the literature and suggest benefits to larger hubs and economies in network size. As we continue to include additional observations and variables to the model, and obtain standard errors, we hope to improve the reliability of these findings.

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[16] To be added in a later draft.

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## Data Appendix

Spoke Carrier Variables. These variables are based upon information regarding a particular carrier/spoke. In the case of non-entry, the data is reflective of the alternate carrier/spoke.

SUMPASS - The total number of passengers traveling with the carrier through the spoke regardless of the origin or destination of travel. (Source: DB1A and author's calculations).

SUMDOLL - The total revenue generated from passengers traveling with the carrier through the spoke regardless of the origin or destination of travel. (Source: DB1A and author's calculations).

ENTRY - A 0/1 variable indicating that the carrier in question has or has not entered the spoke in question. (Source: DB1A and author's calculations.)

TSCHED - The total number of flights that the carrier has scheduled throughout the year. (Source: T100)

TPERF - The total number of flights that the carrier has performed throughout the year. (Source: T100)

TSEATS - The total number of seats that the carrier has made available throughout the year. (Source: T100)

TPASS - The total number of seats that the carrier has filled throughout the year. (Source: T100)

VPLANE - The variance in plane size (as measured by total number of seats per plane) for the carrier on performed flights throughout the year. (Source: T100)

DIST - The great circle distance between the outlying airport and the hub. (Source: T100)

TOTGATES - The total number of gates at the hub airport.

CARRGATES - The number of gates the carrier controls at the hub airport.

Route Carrier Variables. These variables are based upon information regarding a particular carrier/route. The route includes the spoke in question as one of its "legs" and the hub-

endpoint as the other "leg." In the case of non-entry, the data is reflective of the alternate carrier/spoke and the endpoint.

ENDPASS - The total number of passengers traveling with the carrier through the spoke to the endpoint in question. (Source: DB1A and author's calculations).

ENDDOLL - The total revenue generated from passengers traveling with the carrier through the spoke to the endpoint in question. (Source: DB1A and author's calculations).

ENTRY - A 0/1 variable indicating that the carrier in question has or has not entered the spoke in question. (Source: DB1A and author's calculations.)

ROUTDIST - The great circle distance from the outlying airport to the hub in question and then from the hub in question to the endpoint. (Source: DB1A and author's calculations.)

ENDPTSHR - The share of the carrier at the endpoint reached via the spoke. (Source: DB1A.)

NSMLSAPT - The non-stop miles from the outlying airport.

TNPXAPT - The total number of passengers using the outlying airport.

INCMAPT - The average income in the SMSA of the outlying airport.

POPAPT - The population in the SMSA of the outlying airport.

WKFCAPT - The workforce in the SMSA of the outlying airport.

UNEMPAPT - The unemployment rate in the SMSA of the outlying airport.

NSMLSEND - The non-stop miles from the endpoint.

TNPXEND - The total number of passengers using the endpoint.

INCMEND - The average income in the SMSA of the endpoint.

POPEND - The population in the SMSA of the endpoint.

WKFCEND - The workforce in the SMSA of the endpoint.

UNEMPEND - The unemployment rate in the SMSA of the endpoint.

Market Carrier Variables. These variables are based upon information regarding a particular carrier/market. The market include all possible routes that could be used travel between the outlying airport on the spoke and the endpoint on our sample or routes. For each market we have observations for all carriers offering service between the endpoints.

N - The number of competitors in the market.

NDEST - The number of destinations available from the outlying airport in the market.

CARRDIST - The minimum distance traveled by the carrier in the market to connect the outlying airport and the endpoint.

Table 1
Spokes and Alternatives

| Hub and Carrier In Question | | Alternate Hub and Carrier | |
|---|---|---|---|
| Hub | Carrier | Hub | Carrier |
| Cleveland, OH | USAir | Cleveland, OH | Continental |
| | | Dayton, OH | USAir |
| Memphis, TN | Northwest | Nashville, TN | American |
| Nashville, TN | American | Memphis, TN | Northwest |
| | | Chicago, IL* | American |
| Cincinnati, OH | Delta | Cleveland, OH | USAir |
| | | Cleveland, OH | Continental |
| | | Dayton, OH | USAir |
| Philadelphia, PA | USAir | Baltimore, MD | USAir |
| | | Pittsburgh, PA | USAir |
| | | Washington, DC** | USAir |
| Pittsburgh, PA | USAir | Philadelphia, PA | USAir |
| | | Baltimore, MD | USAir |
| | | Indianapolis, IN | USAir |
| Dayton, OH | USAir | Cleveland, OH | USAir |
| | | Indianapolis, IN | USAir |
| Denver, CO | United | Denver, CO | Continental |
| Washington, DC** | USAir | Baltimore, MD | USAir |
| | | Washington, DC*** | United |
| Detroit, MI | Northwest | Cleveland, OH | USAir |
| | | Cleveland, OH | Continental |

Table 1 (cont'd)
Spokes and Alternatives

| Salt Lake City, UT | Delta | Las Vegas, NV | America West |
|---|---|---|---|
| Las Vegas, NV | America West | Salt Lake City, UT | Delta |
| St. Louis, MO | TWA | Chicago, IL* | United |
|  |  | Chicago, IL* | American |

\* O'Hare International Airport
\*\* Washington National Airport
\*\*\* International Airport at Dulles

Table 2
Some Summary Statistics

| Spoke Carrier Variables | | | | | |
|---|---|---|---|---|---|
| Variable | N | Mean | Std Dev | Minimum | Maximum |
| SUMPASS | 765 | 2575.68 | 2199.60 | 11.00 | 11899.00 |
| SUMDOLL | 765 | 805374.36 | 703166.18 | 2347.00 | 3713978.00 |
| ENTRY | 765 | 0.87 | 0.34 | 0.00 | 1.00 |
| TSCHED | 765 | 1408.74 | 1177.49 | 0.00 | 8205.00 |
| TPERF | 765 | 1388.87 | 1159.66 | 1.00 | 8127.00 |
| TSEATS | 765 | 197580.26 | 177157.87 | 97.00 | 1084548.00 |
| TPASS | 765 | 118927.13 | 116826.77 | 0.00 | 705672.00 |
| VPLANE | 765 | 1002.69 | 1844.18 | 0.00 | 15140.66 |
| DIST | 765 | 804.66 | 659.11 | 30.00 | 4129.00 |
| | | | | | |
| Route Carrier Variables | | | | | |
| Variable | N | Mean | Std Dev | Minimum | Maximum |
| ENDPASS | 39797 | 58.16 | 89.01 | 1.00 | 1245.00 |
| ENDDOLL | 39797 | 17727.40 | 28248.12 | 0.00 | 582041.00 |
| ENTRY | 39797 | 0.83 | 0.37 | 0.00 | 1.00 |
| ROUTDIST | 39797 | 1332.69 | 772.60 | 107.00 | 6975.00 |
| ENDPTSHR | 39797 | 0.17 | 0.23 | 0.00 | 1.00 |

# Does Airline Hubbing Benefit Hub Regions?

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# 1. Introduction

The purpose of this paper is to estimate the impact of airline hubbing activity on local air traffic and, by extension, local consumer benefits, in the United States. The crux of our inquiry involves the following "thought experiment": consider some airport (or system of airports serving the same region) that has a large amount of connecting activity--i.e. a "hub"--and imagine an alternative scenario in which the level of connecting activity is not so large. How would locally originating air traffic and the consumer benefits accruing therefrom be different under the latter scenario?

This is an important question, for several reasons. First, since airports are largely under local control, planning and management decisions tend to emphasize local considerations. When an airport is a hub, a large proportion of its traffic is non-local. Airport operators have generally encouraged hubbing activity at their facilities on the grounds that it leads to increased service that benefits the local area (Moore, 1988), while opponents have emphasized the financial and environmental costs of accommodating non-local traffic. This paper informs that debate by assessing the former claim.

This analysis is also relevant to questions concerning the finance and pricing of airport services. Insofar has hubbing generates local consumer benefits, there is justification for pricing structures that encourage it, even if these are suboptimal in other respects. For example, peak-load pricing has been advocated for airports. Such pricing would penalize airlines operating connecting banks, perhaps inducing them to move their hubs elsewhere. It is important to know how such a response would affect local consumer welfare. Likewise, in the context of privatization it is important to recognize that the benefits discussed in this paper are external ones--realized by the community at large rather than the airport operator. Insofar as they exist, special inducements may be necessary if private operators are to take them into account.

We restrict our scope to the benefits realized by consumers from changes in the supply of air passenger transport services to and from the hub region. We do not consider "benefits" in the form of increased employment or money circulating through the local economy. While sometimes termed benefits, these effects ought to be considered impacts,

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since they do not necessarily increase aggregate welfare. The benefits we consider are, however, associated with economic impacts since many air trips are related to other economic activities.

Our approach is simple. We estimate the relationship between the level of connecting activity (number of connecting passengers) in a regional airport system and the quantity of passenger traffic originating in the region. If, ceteris paribus, more connecting traffic results in more local traffic, this suggests that hubbing activity reduces the "generalized cost" of air travel for the local region. To quantify the associated benefit, we use fare elasticity results from other studies to estimate the fare change that would yield the same increase in local demand. Given the equivalent fare change and fare elasticity, we can estimate the change in consumer surplus deriving from increased hubbing.

We consider originations in the aggregate, without regard to whether the trips are being made by residents of the region or visitors to it. Consequently, our benefits are local in the sense that they accrue to individuals and firms who spend time in the local area, whether or not they actually live there. Local officials may be more directly interested in the welfare of residents than that of visitors. On the other hand, the trips by the latter generate revenues for local businesses, and for that reason are highly valued in most areas. It therefore seems reasonable to lump resident and non-resident trips together for purposes of this analysis.

The remainder of this paper is organized as follows. In Section 2, we review previous work in this area and propose a conceptual approach for measuring the local benefits from hubbing activity. Section 3 presents our methodology and data. Sections 4 and 5 contain the results of our empirical analyses, which are used in Section 6 to estimate regional benefits from hubbing activity. Conclusions are offered in Section 7.

## 2. Literature Review and Conceptual Framework

A large amount of literature has looked at issues related to the causes and

consequences of airline hubbing in the U.S. and elsewhere. These papers document that hubbing results in increased availability and frequency of non-stop service to the local area, but also, at least in the cases where there is a single dominant hubbing airline, increased fares. There have been few, if any, attempts to weigh these opposing factors, along with other impacts of hubbing on local service, in order to find the net effect.

The hubs of hub-and-spoke networks, almost by definition, have non-stop services to many destinations. This tendency is quantified by Bannia et al. (1992), who calculate for a given airline and airport, the proportion of other airports in the airline's system which it services non-stop from that airport. For hub airports this "hub index" is typically above 0.5, while for the vast majority of others it is under 0.1. The greater availability of non-stop service is also reflected in traffic statistics reported by the Transportation Research Board (1991), which show, in 1988, that the shares of local passengers flying direct are 80 and 72 percent for large and medium hub cities, as contrasted with 77 and 48 percent in cities of comparable size that are not hubs. The TRB (1991) also reports that departures per thousand local passengers in 1988 was approximately twice as high in hub cities as in comparably sized non-hub ones.

The enhanced services to hub regions are offset, to some degree, by higher fares. The TRB (1991) reports that, as of 1988, yields from traffic originating at large city hubs were 30 percent higher than that originating from large city non-hubs. When medium hub and non-hub cities are compared, the difference is 17 percent. The explanations for these differences have been discussed extensively (see for example Borenstein (1989), TRB (1991), Huston and Butler (1988). Borenstein's econometric results suggest that hub fares increase as a consequence of both enhanced service quality (fewer stops and higher frequencies) and greater airline market power (measured as the airline's share of originating traffic at the market endpoints). The market power effect derives from competitive advantages of market dominating airlines, including more attractive frequent flies programs, increased control of computer reservation systems, and a stronger reputation in the local market. Entry barriers related to limited availability of airport facilities and costs of starting service are also contributing factors.

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The net benefit of hubbing to the local region therefore depends on the relative importance of the service impacts and the fare impacts. The following "back-of-the-envelope" calculation illustrates the point. According to the TRB data, the average passenger originating from a medium-size hub city pays a one-way fare that is about $25 higher than if the city is not a hub. There is also approximately a one-in-four chance that the passenger flies direct as the result of the city being a hub (this is the difference between the 72 percent of passengers in medium hub cities who fly direct and the 48 percent who do so in medium non-hub cities). In order for this average passenger to be better off, they would have to value the direct service at $25/(1/4) or $100 in each direction. Assuming about a 2 hour difference in travel time, on average, between connecting and direct services in the same market, this would be equivalent to a value of travel time of $50 per hour. This compares with value of intercity travel time estimates in the literature, in 1990 dollars, of around $30 per hour (Brand et al, 1990; Morrison and Winston, 1985).

The above analysis is overly simplistic, however. First, the impacts of hubbing on local air service are more complex than simply increasing the availability of direct and non-stop flights. There are in addition frequency effects, schedule effects, aircraft size effects, congestion effects, and in the long run even airport layout effects. Second, differentiated pricing enables airlines to target higher fares to market segments that place a greater value on enhanced services. With differentiated pricing and heterogeneous travelers, results based on averages are not very meaningful. Furthermore, the enhanced air service available from hubs may in fact induce changes in the composition of air travel whose effect is to increase yield, even if fare structures are themselves unchanged. For example, many one-day, premium fare, business trips for meetings in the airport hotels around Chicago O'Hare result directly from the tremendous level of air service there. Finally, insofar as higher yields out of hubs are related to frequent flier programs, their impact depends on complex interactions among business travelers, who are willing to pay higher fares to accumulate miles, employers, who tacitly except this practice as a way of giving their workers a fringe benefit, and the federal government, which has

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proven unwilling or unable to tax this benefit. As Borenstein (1989, p. 346) notes, "one can imagine an allocation of costs and benefits from such kickbacks [that is, frequent flier miles awarded to business travelers] in which the only net loser is the government."

Figure 1 summarizes the above relationships into a conceptual framework. An airport's or region's **hub status** characterizes the level and concentration of hubbing that occurs their. The level and concentration of connecting traffic, and the extent to which it is on-line rather than interline, are primary indicators of this variable. Hub status affects the **air service supply function** at an airport. This function relates the quantity, quality, and price at which air service offered in an o&d market to the level of traffic in that market. The function interacts with the demand functions for air service between the local region and other places to yield equilibrium traffic levels. The shift in the supply function therefore shifts the traffic levels. Additional traffic changes may occur if changes in the supply function cause changes in the demand function, as the economic composition of the region changes in response to the greater availability of air service.


## 3. Methodology and Data

The conceptual framework presented in the previous section can be used as a basis for quantifying the local benefits of airline hubbing. Indeed, it suggests a number of approaches, of varying levels of difficulty, complexity, and richness. At one extreme, one might try to quantify each of the relationships depicted by the arrows in Figure 1. In addition to requiring a detailed analysis of how hub status effects service supply, this approach would entail an understanding of how various service attributes effect overall service quality, and careful study of the demand side of the system. The presence of different market segments--such as business and leisure--compounds the challenge, since each has its own service preference structures, demand elasticities, and so on.

We opt for a far simpler approach, in which we treat all airline passenger services from a given airport as a single, composite service. We hypothesize that hubbing activity changes the generalized cost of that service, downward as a result of service

improvements, and upward because of fare increases. If the net impact is non-zero, there should be a change in originating traffic, resulting from a move along the demand curve, and perhaps a shift of that curve as well.

Based on this concept, we can estimate local benefits from hubbing in a given region using the following steps:

1. Determine the relationship between the degree of hubbing and the level of originating traffic in the region.

2. Using this relationship, predict the level of originating traffic at the airport under some alternative hubbing scenario.

3. Determine the fare elasticity of originating traffic and average fare at the airport.

4. Use the results of 3 to calculate the change in fare that would have the same impact on traffic as the alternative hubbing scenario in step 2.

5. Use estimated demand change and equivalent fare change to estimate the change in consumer surplus between the present hubbing scenario and the alternative scenario.

The main empirical challenge of this approach is in step 1. To accomplish this step, we gathered originating and connecting traffic data for 50 major U.S. regions, for the years 1976, 1984, and 1992. The earlier year serves as a baseline, since it is just before the advent of deregulation. 1984 corresponds roughly with the end of the first phase of deregulation, during which there was substantial hub formation and development, particularly on the part of upstart regional carriers such as USAir and Piedmont. The 1992 data captures additional hub development, mainly by more established carriers like United, American, and Delta.

We analyzed the above data statistically in order to assess whether and to what degree connecting activity influences local traffic levels. Two forms of statistical analysis were employed. The first approach involves classifying the fifty regions according to their level and intensity of connecting activity, and the changes therein over the 1976-1992 period. We compare originating traffic levels, or changes in such levels, among regions in the different classes to assess the impact of hubbing activity.

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In the second approach, we used these data to estimate an econometric relationship between connecting activity and originating traffic. The amount of connecting traffic is entered into regressions in which originating traffic is the dependent variable.

## 4. Classification Analysis

We begin by comparing the local demand levels for regions of different hub status. As noted above, the concept of hub status encompasses both the level of connecting traffic and the intensity of such traffic. Figure 2 plots the 50 regions considered in this analysis on a graph whose axes correspond to these variables. The horizontal axis is the level of connecting traffic for the year 1992, while the vertical access is the ratio of connecting traffic to originating traffic, a variable we term the *hub ratio*. It is clear from Figure 2 that the simple dichotomy of hub versus non-hub cannot be readily applied to the U.S. airport system. There are regions with high levels of connecting traffic and hub ratios, and with low levels of connecting traffic and low hub ratios, that clearly correspond to hubs and non-hubs. But there are also instances in which connecting traffic is high while the hub ratio is low, and vice versa. Further, the appropriate boundaries between "high" and "low" values for these variables are less than obvious. Rather than arbitrarily dividing these observations into two groups, it is preferable to look for a more natural set.

Table 1 proposes a set of six hub status categories (see Ivy (1993), for an alternative classification scheme based of network accessibility). The first, which we term *megahubs*, includes regions with extremely high levels of connecting activity (12 million or more connecting enplanements in 1992) and in which the majority of enplanements is connecting (that is, with hub ratios greater than 1.0). These include the three most famous (or infamous) hubs--Atlanta, Chicago, and Dallas. The second group, *large specialist hubs*, compares to the first in terms of their hub ratios, but have only about half as much connecting activity, reflecting their smaller local markets. Like the first group, these are interior cities--Charlotte, Pittsburgh, Minneapolis, and Pittsburgh. A third group, *large non-specialist hubs*, have connecting traffic levels similar to the second, but considerably

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smaller hub ratios. The nation's premier coastal cities--New York, San Francisco, and Los Angeles--as well as the high growth sunbelt areas of Houston and Phoenix, are included here. The next lowest connecting traffic levels are associated with the *small specialist hubs*, which have hub ratios comparable with mega- and large specialist hubs, but with an even smaller local traffic base. These are second- or third-tier interior cities such as Cincinnati, Memphis, and Raleigh-Durham. The remaining group that might be considered hubs have connecting traffic somewhat below, and hub ratios well below, the small specialists. These include second-tier coastal cities such as Boston, Philadelphia, and Seattle, as well as the tourist destinations of Las Vegas and Orlando. Befitting their questionable status as hubs, we refer to them as *marginal* (in line with the other terminology, they might also be called small non-specialist hubs). Finally, the largest group, consisting of 26 of the 50 regions in our data set, are the non-hubs, all of which have hub ratios under 0.5 and connecting traffic well under 2 million. This group contains certain regions, such as Baltimore and Cleveland, in which airlines operate small hubs, but we do not view the volume and intensity of these operations as sufficient to justify hub status.

Table 2 compares local traffic intensities, measured as originations per capita, for the regions in the various categories. Megahubs and marginal hubs have the two highest values, while small and large specialist hubs have the smallest. The marginal hub results are strongly influenced by exceptionally high values for the tourist destinations of Las Vegas and Orlando. If these are excluded, the mean for this category drops to 1.40. With this correction, the strongest indication of a traffic stimulation impact from hubbing comes from the comparison of megahubs with all other categories. In contrast, the large and small specialist results suggest that regions in these categories do not generate more traffic because of hubbing; if anything the effect is the opposite. This finding, which probably derives from the fact that the specialist hubs are more strongly dominated by their hub carriers, is further supported in subsequent analyses.

The above results are based on a cross-sectional analysis, which may be confounded by numerous economic, demographic, and geographic factors that affect

regional demand for air travel. The influence of these confounding factors can be reduced by employing a panel analysis, in which the regional traffic levels are observed over several points in time. With this end in mind, Figure 3 plots the 1992 hub ratio against the 1976 hub ratio for each of the 50 regions. On the basis of this plot, one can identify the regions that experienced a change in hub status over this period as the points well above the 45-degree line. These regions either became hubs or became much stronger hubs over this period. We term such regions *strong emergers*, defining this category precisely using the (somewhat arbitrary) criteria that they have a 1992 hub ratio that is at least 1.0 and at least double the 1976 level. The strong emerger regions include 7 of the 9 large and small specialist hubs in the prior, cross-sectional, categorization. Regions in the other hub categories are excluded either because their 1992 hub ratio is too low or, in the case of the mega-hubs, because the ratio was already high in 1976.

We are interested in how the change in hub status in the strong emerger regions affected local traffic in those regions. To investigate this, we define a second category of regions, *non-emergers*. Non-emerger regions are required to have a 1992 hub ratio that is less than 0.5 and less than the hub ratio in 1976. These criteria ensure that strong emerger and non-emerger regions stand in marked contrast. The vast majority of non-emerger regions are non-hubs under the cross-sectional scheme; the remainder are marginal and large non-specialist hubs. Regions that fail to meet the criteria for either the strong emerger or non-emerger regions are simply labelled *other*.

Table 3 compares regions in these three hub development categories in terms of their average annual rate of change in originating traffic per capita between 1976 and 1992. The growth rate for strong emergers is, on average, 0.2 percent greater than that of non-emergers. While qualitatively consistent with our expectation, this difference is small and well within the standard errors of the mean values. Thus the panel analysis is consistent with the cross-sectional one in suggesting that hubbing has not stimulated local air traffic in specialist regions.

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## 5. Econometric Analysis

The second approach to assessing the relationship between hubbing activity and originating traffic is with an econometric model. A major advantage to this approach is that it can consider hubbing to be a continuous variable rather than a qualitative one. With the large variation in the levels and concentrations of connecting activity among hub airports, such a representation is clearly desirable. It avoids the need for subjective classification judgements, and, by taking into account all of the variation in the original data, extracts more information from it.

We try two different econometric methods. In the first we estimate a simple log-linear fixed effects model, whose basic specification is:

$$\ln(ORG_{it}) = \alpha_i + \beta_t + \omega \cdot \ln(POP_{it}) + \theta \cdot \ln(INC_{it}) + \lambda \cdot \ln(CON_{it}) + \varepsilon_{it} \tag{1}$$

where:

$ORG_{it}$ is originating traffic from region i in year t;

$POP_{it}$      is population of region i in year t;

$INC_{it}$      is real per capita income for region i in year t;

$CON_{it}$      is connecting traffic from region i in year t;

$\varepsilon_{it}$      is a stochastic error term;

$\alpha_i, \beta_t, \omega, \lambda$      are coefficients to be estimated.

In the above model, the $\alpha_i$ and $\beta_t$ are regional and time period fixed effects, while the remaining coefficients can be read directly as elasticities for their associated variables. The model can be estimated directly from the data, so long as CON is exogenous, rather than simultaneously determined with ORG. We will maintain the exogeneity assumption for purposes of our analysis.

We also estimated a variant of Model 1 in which the coefficient of $CON_{it}$ was allowed to differ by hub classification. In particular, we added a term, $\lambda_{sp} \cdot SPD_i \cdot \ln(CON_{it})$, where $SPD_i$ is a dummy variable set to 1 only for regions classified

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as Large Specialist or Small Specialist hubs. This was motivated by the results of the classification analyses discussed in the previous section. The models without and with the extra term are labelled Models 1a and 1b, respectively.

The models were estimated using a maximum likelihood procedure for regressions with autocorrelated error terms proposed by Beach and MacKinnon (1978) and implemented in the Time Series Processor Version 4.2 Statistical Software (Hall, 1992). The iterative procedure is similar to that of Cochrane and Orcutt (1949) except that the estimate of the autocorrelation in each iteration is based on a maximum likelihood procedure rather than the correlation coefficient. The procedure was employed in a manner so that only autocorrelation within the time series of individual regions is considered.

Table 5 presents estimation results. In both versions of the model, coefficients on CON and POP are both positive and statistically significant at the 0.01 level. The income elasticity is positive, but small and statistically insignificant. The time fixed effects imply that, controlling for the other factors, traffic grew markedly between 1976 and 1984--a consequence of supply-side changes brought on by deregulation--but did not change significantly between 1984 and 1992.

The Model 1a results imply an elasticity of ORG with respect to CON of about 0.1--a 10 percent increase in CON results in a 1 percent increase in ORG. Within the framework proposed here, this implies that increased hubbing makes air travel more attractive to local air travelers. On balance, therefore, it appears that the service advantages from hubbing activity outweigh the increased fares. However, the results of Model 1B reveal that this benefit does not is much less strong, or even non-existent, in the case of specialist hubs. This result is consistent with the findings from the previous section, and adds further support to the theory that dominating airlines have extracted for themselves the benefits of hub development in specialist regions.

While Model 1 is easy to estimate, and may yield useful estimates of the general sensitivity of originating traffic to hubbing activity, it is fundamentally flawed because it assumes a constant elasticity of originating traffic with respect to connecting traffic.

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The elasticity cannot be constant. When connecting traffic is very low relative to originating traffic, variations in it should have little effect on service supply and, by extension, local demand. And at the limit, zero connecting traffic clearly need not result in zero originating traffic, although this is what (1) implies.

It is therefore desirable to have a functional form in which connecting traffic is more important when it is large relative to originating traffic. One such form is:

$$\ln(ORG_{it}) = \alpha_i + \beta_t + \omega \cdot \ln(POP_{it}) + \theta \cdot \ln(INC_{it}) + \phi \cdot \ln[(CON_{it} + ORG_{it})/ORG_{it}] + \varepsilon_{it} \quad \textbf{(2)}$$

In Model 2, the connecting traffic term is replaced with a "hub traffic multiplier" (HTM) term reflecting the ratio or total traffic (CON+ORG) to originating traffic. This term is insensitive to CON when CON<<ORG, and is dominated by CON when CON>>ORG. This pattern of sensitivity is far more plausible than that implied by (1). Unfortunately, it cannot be estimated as easily, since it cannot be transformed so that ORG appears only on the left-hand side.

To estimate Model 2, we employ the following procedure. First, we estimate an instrument variable for ORG, using:

$$\ln(ORG_{it}) = \kappa + \beta_t + \omega \cdot \ln(POP_{it}) + \theta \cdot \ln(INC_{it}) + \varepsilon_{it} \quad \textbf{(3)}$$

In the second stage, we estimate the equation:

$$\ln(ORG_{it}) = \alpha_i + \phi \cdot \ln[(CON_{it} + O\hat{R}G_{it})/O\hat{R}G_{it}] + \pi \cdot \ln(O\hat{R}G_{it}) + \varepsilon_{it} \quad \textbf{(4)}$$

where $O\hat{R}G_{it}$ is the predicted value obtained from the from (3). Thus equation (4) models originating traffic as a function of a "natural" traffic level estimated using (3), a region-specific fixed effect, and the HTM estimated from (3). The region-specific fixed effects capture differences between a region's actual traffic and that predicted from (3) that are consistent across time. The $\phi$ coefficient will indicate intraregional correlation between these differences and the amount of hubbing as measured by the HTM. As with

Model 1, we also consider a variant in which the φ coefficient is allowed to vary for small and large specialist hubs.

Tables 6 and 7 summarize estimation results for both stages. The instrument variable equation estimates, obtained using OLS, feature a somewhat lower population elasticity and much higher income elasticity than were obtained in Model 1. Apparently, the income effect in the latter was absorbed by the regional dummy variables, and also to some extent by the time period dummies, which are shifted upward somewhat in the instrument equation results.

Table 7 shows that both the HTM and traffic instrument terms are highly significant. The latter is, as expected, close to 1, meaning that actual originating traffic is proportional to its instrumented value. The HTM coefficient is positive and highly significant in both versions of the model, but when it is allowed to vary for specialist hubs, the difference in statistically significant, and the estimate for non-specialist hubs roughly doubles. The results again demonstrate that hubbing activity has stimulated local traffic demand except in regions in the specialist categories.

The magnitude of the HTM estimate is considerably larger than that of the connecting traffic elasticity estimated in Model 1, but in fact the two models are quite consistent except when connecting traffic is very low. Figure 4, which compares the two models by applying them to Atlanta in the year 1992, shows how similar the predictions of the two models are for the range of connecting traffic values surrounding the observed data point. However, while Model 1b is log-linear in connecting traffic, the Model 2b is convex, and flat when connecting traffic is well below instrumented originations.

We also investigated variations of Models 1 and 2 in which connecting traffic coefficient were allowed to vary across all hub categories. With the exception of the specialist hubs, the estimates were quite similar, and we could not reject the hypthesis that they are in fact equal. Therefore we maintain the simpler specification in which these coefficients are allowed to vary only for the specialist hubs.

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## 6. Local Benefits of Hubbing Activity

The local benefits of hubbing activity can now be estimated. As noted previously, the procedure is to use the results of the previous section to estimate the level of originating traffic at an airport under some alternative hubbing scenario, i.e. quantity of connecting traffic, estimate the fare change that would have a similar impact on originating demand, and use these results to estimate the consumer surplus different under the two scenarios. This is an admittedly rough calculation, since it aggregates across markets and traveler types, as well as qualitative differences in how hubbing has affected fares and service in different regions. Nonetheless, the results, at least give an indication of the order of magnitude of the effects.

These calculations are based on the following assumptions. The alternative hubbing scenario is one in which there is zero connecting traffic. The assumed fare elasticity is -1, in the middle of the range of estimates cited in Hickling-Lewis-Brod (1996). The baseline fares for each region are derived from the USDOT 10 percent coupon survey for 1992.

On the basis of these assumptions, and the coefficient estimates for Model 2b, we arrive at benefit estimates that are summarized in Table 8. Megahubs are the clear winners, with regional benefits averaging nearly $800 million, or about $80 per origination. Large non-specialist and marginal hubs also benefit significantly from hubbing activity, with regional and per origination gains of around $200 million and $30 respectively. Small and large specialist hubs, in contrast, yield little benefit from hubbing, as, of course, do non-hubs (since non-hub regions have non-zero connecting traffic, the do realize some benefit from "hubbing" despite their status). In both cases, the regional estimates are in the $10-$20 million range, which, given the accuracy of these estimates, is not much different from zero. For non-hubs, these low figures reflect small quantities of connecting traffic, while for the specialist hubs they derive from the observed insensitivity of originating traffic to hubbing activity.

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## 7. Conclusions

Hubbing should benefit hub regions, for the same reasons as airlines engage in it. Airlines use hubs to consolidate traffic and therefore realize link economies of traffic volume. Through consolidation, airlines can offer direct service to more places, at higher frequencies, using larger aircraft. To avail themselves of these enhanced services, most travelers must make a connection at the hub, a penalty from which travelers to and from the hub region are spared. These travelers share the good fortune of students who live next door to their high school, or employees who can walk to their work site. Such groups benefit from economies of scale, without paying the extra transport cost required to attain such scale.

Our analysis shows that these benefits are realized in some instances, but not in others. Local travelers benefit from hubbing in the largest cities, or when hubbing activity is a significant but not dominant component of the regional airport traffic mix. They do not benefit from intensive hubbing activity in second- and third-tier cities. Therefore, most of the U.S. regions that became hubs after deregulation--the Charlottes, Salt Lake Cities, and Nashvilles--have not realized significant local air traveler welfare gains as a result. On the other hand, regions like Atlanta have benefitted mightily from hubbing, with consumer welfare gains on the order of $1 billion in 1992.

The regions in which hubbing generates local welfare gains are generally those in which it can coexist with a relatively unconcentrated market structure. Chicago, Dallas, and Atlanta have markets large enough to support reasonable competition despite the very strong presence of hubbing carriers. Boston, San Francisco, and Detroit sustain competition because connecting traffic is a modest part of the overall traffic mix. When both of these avenues to competition are closed, the local consumer benefits from hubbing seem to disappear.

On a more positive note, we find no evidence that hubbing has produced a net disbenefit in any region. In the worst case, hubbing is a "break-even" proposition for local air travelers, at least in the aggregate. Whether this aggregate result masks redistribution from fare sensitive leisure travelers to service-sensitive business ones is an

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important question the merits further research.

This analysis is not intended to fully assess the costs and benefits of hub development. On the negative side, the noise impacts, facility investment requirements, financial risk, and congestion effects have not been considered, while on the positive we have not considered revenues from user fees, taxes, and concession sales. In some regions, these items may represent second-order adjustments to the overall balance sheet. But in regions where hubbing offers little benefit to local air passengers, such considerations may be crucial to whether it should be encouraged, or even accommodated.

Table 1--Hub Status Category Definitions and Membership

| CATEGORY | DEFINITION | MEMBERSHIP |
|---|---|---|
| Megahubs | Very heavy connecting traffic and high hub ratio. | Atlanta, Chicago, Dallas |
| Large Specialist | Heavy connecting traffic and high hub ratio. | Charlotte, Minneapolis, Pittsburgh, St. Louis |
| Large Non-Specialist | Heavy connecting traffic and moderate hub ratio. | Detroit, Houston, Los Angeles, New York, Phoenix, San Francisco |
| Small Specialist | Moderate connecting traffic and high hub ratio. | Cincinnati, Memphis, Nashville, Raleigh-Durham, Salt Lake City |
| Marginal | Moderate connecting traffic and moderate hub ratio. | Boston, Miami, Orlando, Las Vegas, Philadelphia, Seattle, Washington |
| Non-hubs | Low connecting traffic and hub ratio. | Albuquerque, Baltimore, Buffalo, Cleveland, Columbus, Dayton, Hartford, Indianapolis, Jacksonville, Kansas City, Lexington, Milwaukee, New Orleans, Norfolk, Oklahoma City, Omaha, West Palm Beach, Portland, Reno, Rochester, San Antonio, San Diego, Syracuse, Tampa, Tulsa |

Table 2--Population, Originations, and Originations per Capita, 1992, by Hub Status Category

| CATEGORY | N | STATISTIC | POPULATION (thousands) | ORIGINATIONS (thousands) | ORIGINATIONS PER CAPITA |
|---|---|---|---|---|---|
| Megahubs | 3 | Mean | 5256 | 9822 | 2.00 |
|  |  | Std. Error | 1607 | 1824 | 0.23 |
| Large Specialist | 4 | Mean | 2189 | 3092 | 1.39 |
|  |  | Std. Error | 328 | 616 | 0.13 |
| Large Non-Specialist | 6 | Mean | 8778 | 10914 | 1.58 |
|  |  | Std. Error | 2833 | 2290 | 0.32 |
| Small Specialist | 5 | Mean | 1192 | 1704 | 1.51 |
|  |  | Std. Error | 172 | 111 | 0.18 |
| Marginal | 7 | Mean | 3493 | 5927 | 2.54* |
|  |  | Std. Error | 721 | 532 | 0.78* |
| Non-hubs | 26 | Mean | 1314 | 1916 | 1.66 |
|  |  | Std. Error | 134 | 201 | 0.20 |

*When the tourist destinations of Las Vegas and Orlando are excluded, the mean and standard errors are 1.40 and 0.20, respectively.

Table 3--Hub Development Category Definitions and Membership

| CATEGORY | DEFINITION | MEMBERSHIP |
|---|---|---|
| Strong Emergers | 1992 hub ratio over 1.0 and at least doubled from 1976-1992. | Charlotte, Cincinnati, Minneapolis, Nashville, Pittsburgh, Raleigh Durham, Salt Lake City, St. Louis |
| Non-Emergers | 1992 hub ratio under 0.5 and declined from 1976-1992. | Albuquerque, Boston, Buffalo, Cleveland, Dayton, Hartford, Jacksonville, Kansas City, Las Vegas, Lexington, Los Angeles, Milwaukee, New Orleans, Norfolk, Oklahoma City, Omaha, Portland, Reno, Rochester, San Antonio, San Diego, San Francisco, Seattle, Tampa, Tulsa, Washington |
| Others | All others. | Atlanta, Baltimore, Chicago, Columbus, Dallas, Detroit, Houston, Indianapolis, Miami, Minneapolis, New York, Orlando, Phoenix, Philadelphia, Syracuse, West Palm Beach, |

Table 4--Annual Growth Rate in Originations per Capita, 1976-1992, by Hub Classification

| CATEGORY | N | STATISTIC | ANNUAL GROWTH RATE IN ORIGINATIONS PER CAPITA |
|---|---|---|---|
| Strong Emergers | 8 | Mean | 2.44% |
| | | Std. Error | 0.39% |
| Non-Emergers | 26 | Mean | 2.23% |
| | | Std. Error | 0.36% |
| Others | 16 | Mean | 2.40% |
| | | Std. Error | 0.50% |

## Table 5--Estimation Results, Originations Model 1

| COEFFICIENT | DEFINITION | MODEL 1a ESTIMATE | MODEL 1b ESTIMATE |
|---|---|---|---|
| $\lambda$ | Connecting traffic elasticity. | $0.096^a$ | $0.150^a$ |
| | | $(3.29)^+$ | $(3.95)$ |
| $\lambda_{sp}$ | Connecting traffic elasticity correction, specialized hubs. | -- | $-0.095^b$ |
| | | -- | $(-2.13)$ |
| $\omega$ | Population elasticity. | $0.885^a$ | $0.800^a$ |
| | | $(7.36)$ | $(6.48)$ |
| $\theta$ | Income elasticty. | $0.085$ | $0.125$ |
| | | $(0.33)$ | $(0.49)$ |
| $\beta_{76}$ | Time fixed effect for 1976.* | $-0.327^a$ | $-0.332^a$ |
| | | $(-4.73)$ | $(-4.92)$ |
| $\beta_{84}$ | Time fixed effect for 1984.* | $-0.017$ | $-0.020$ |
| | | $(-0.31)$ | $(-0.37)$ |

Note: Region specific fixed effect estimates not presented.
[+]t-statistics in parentheses.
*Time fixed effect for 1992 forced to zero.
[a]Statistically significant at .01 level.
[b]Statistically significant at .05 level.

Table 6--Estimation Results, Originations Model 2, Originations Instrument Variable

| COEFFICIENT | DEFINITION | ESTIMATE |
|---|---|---|
| $\kappa$ | Constant | $6.592^a$ |
| | | $(8.38)^+$ |
| $\omega$ | Population elasticity. | $0.711^a$ |
| | | $(16.22)$ |
| $\theta$ | Income elasticty. | $1.083^a$ |
| | | $(3.29)$ |
| $\beta_{76}$ | Time fixed effect for 1976.* | $-0.235^b$ |
| | | $(-2.22)$ |
| $\beta_{84}$ | Time fixed effect for 1984.* | $-0.045$ |
| | | $(0.50)$ |

[+] t-statistics in parentheses.
*Time fixed effect for 1992 forced to zero.
[a] Statistically significant at .01 level.
[b] Statistically significant at .05 level.

Table 7--Estimation Results, Originations Model 2

| COEFFICIENT | DEFINITION | MODEL 2a ESTIMATE | MODEL 2b ESTIMATE |
|---|---|---|---|
| $\phi$ | Hub traffic multiplier elasticity instrument. | $0.262^a$ $(2.83)^+$ | $0.448^a$ $(3.66)$ |
| $\phi_{sp}$ | Hub traffic multiplier elasticity instrument correction, specialized hubs. | -- -- | $-0.405^b$ $(-2.24)$ |
| $\pi$ | Originations instrument. | $0.975^a$ $(24.22)$ | $0.996^a$ $(24.69)$ |

Note: Region specific fixed effect estimates not presented.
[+]t-statistics in parentheses.
[a]Statistically significant at .01 level.
[b]Statistically significant at .05 level.

Table 8--Estimated Benefits from Hubbing, 1992, by Hub Status

| HUB STATUS CATEGORY | BENEFITS PER REGION ($ MILLION) | BENEFITS PER CAPITA ($) | BENEFITS PER ORIGINATION ($) |
|---|---|---|---|
| Megahubs | 769 | 167 | 82 |
| Large Specialist | 19 | 8 | 6 |
| Large Non-Specialist | 257 | 47 | 27 |
| Small Specialist | 10 | 9 | 6 |
| Marginal | 162 | 91 | 38 |
| Non-Hubs | 18 | 15 | 8 |

Note: Based on assumed constant fare elasticity of -0.1 and 1992 average fare for trips originating in each region.

**Hub Status**

- Connecting Traffic Level
- Connecting Traffic
  Concentration (Hub Ratio)

**Air Service Supply Function**
- Non-stop Service
  Availability
- Service Frequency
- Fare Level
- Terminal Congestion and

**Local Air Travel Benefits**
- Fare Level
- Service Quality
- Traffic Level
- Consumer Surplus

**Local Air Service Demand Function**
- Regional Size and Income
- Regional Demographics
- Industrial Composition
- Tourist Attractions
- Convention Facilities

Figure 1--Conceptual Framework

Figure 2--Hub Ratio vs. Connecting Traffic, 1992
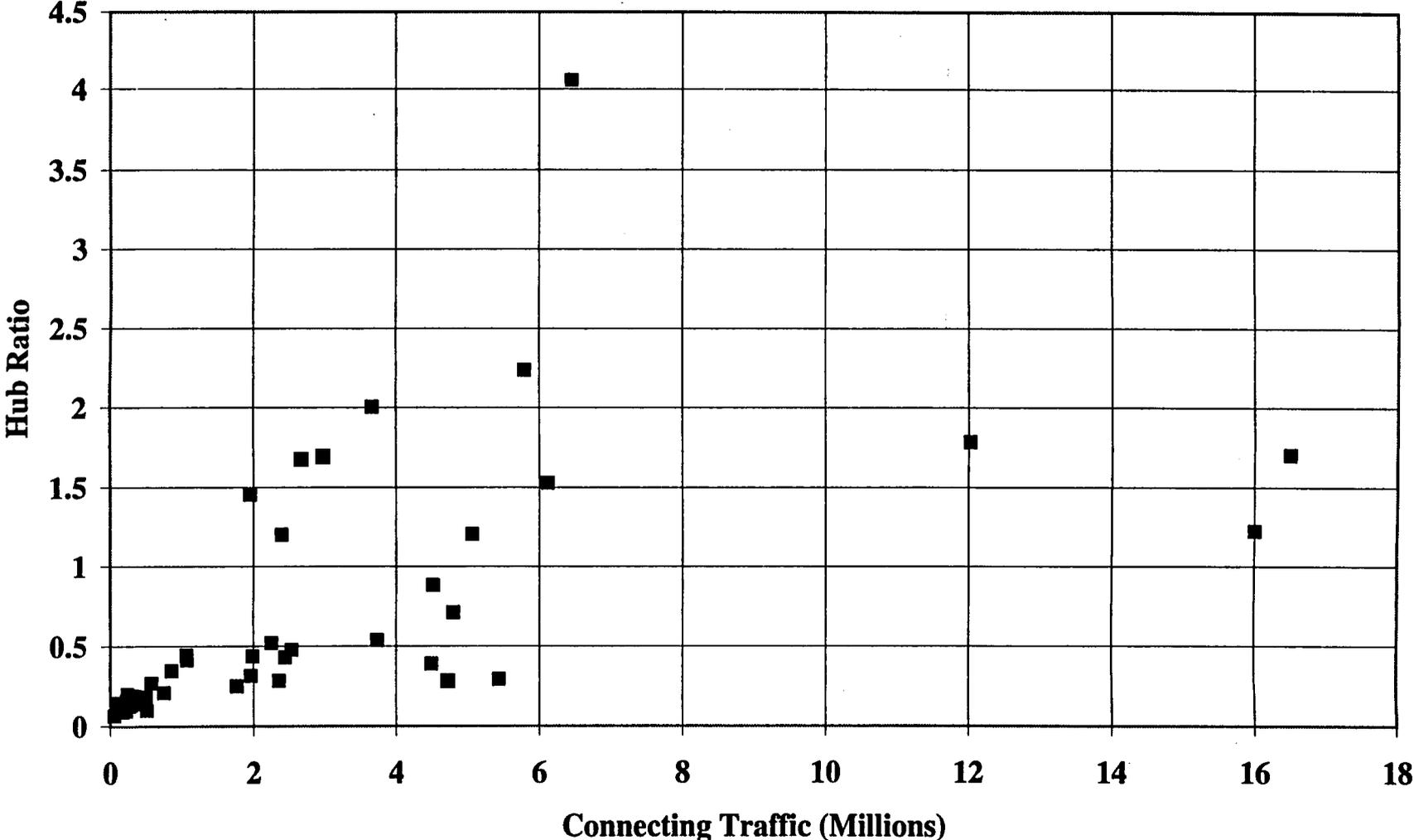
**Figure 3--Hub Ratio Changes, 1976-1992**
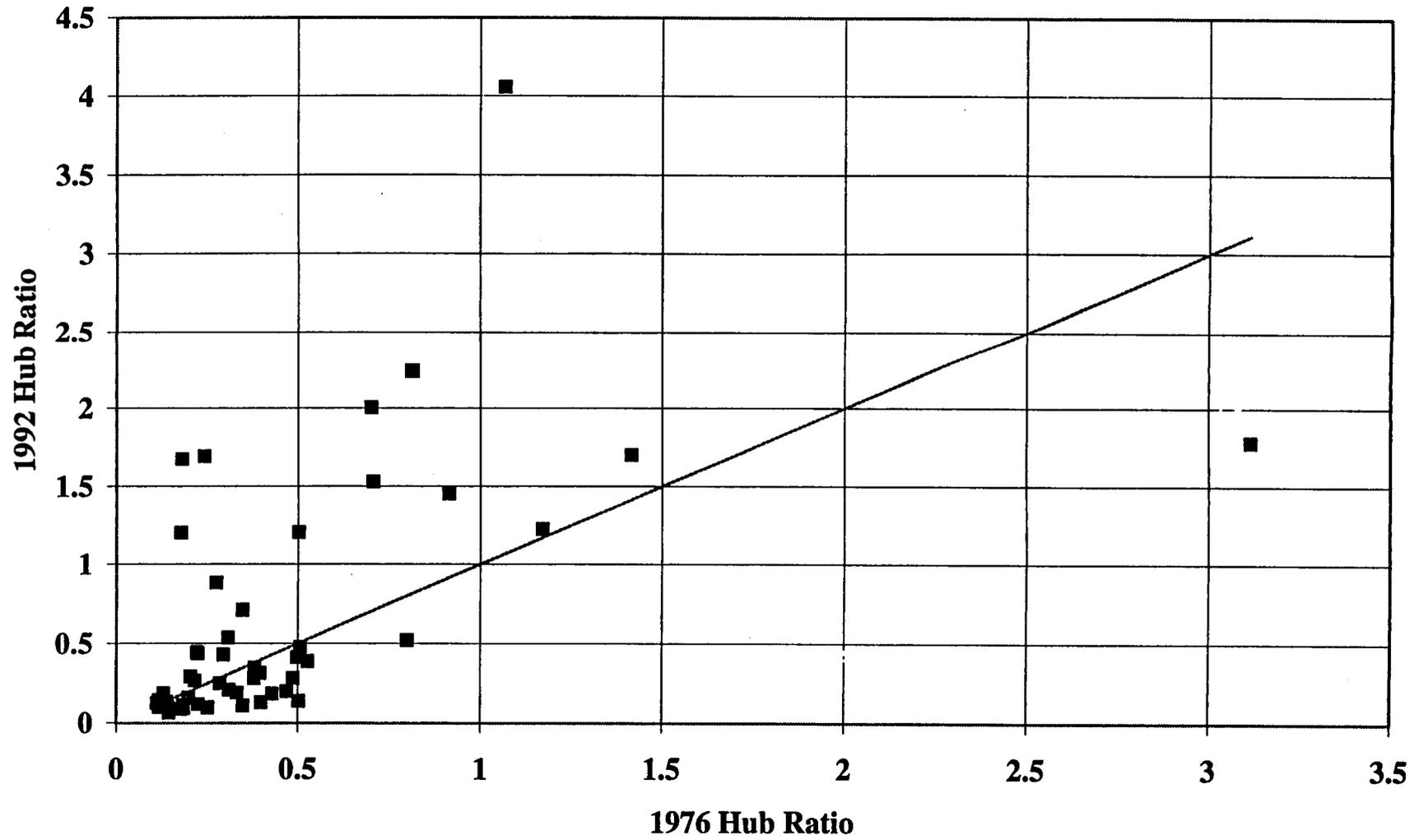
Figure 4--Originating vs Connecting Passengers, ATL, 1992
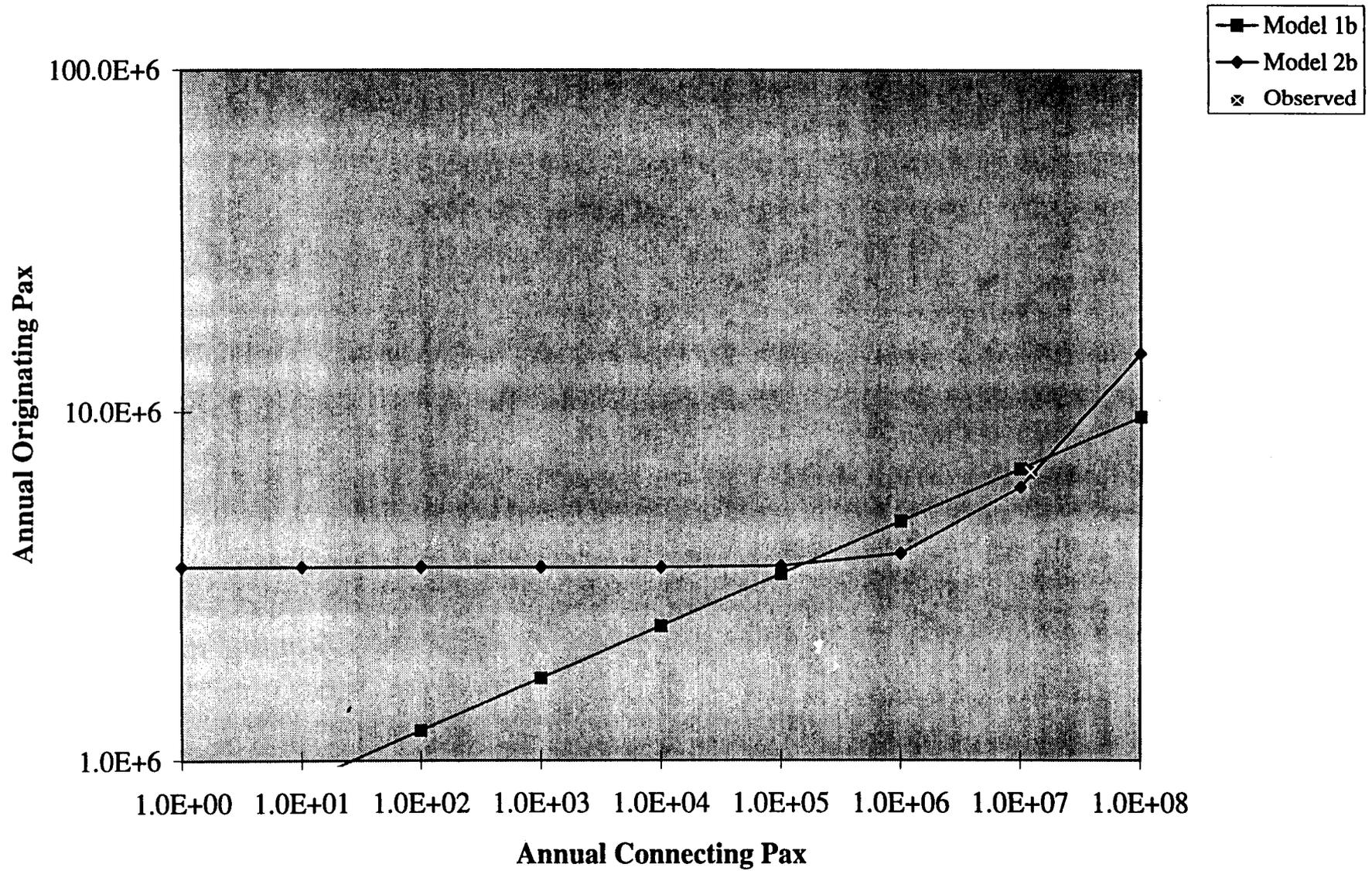
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# Airport Improvement Policy in Japan: New Methods of Airport Finance

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**Abstract**

Capacity shortage of international airports in Japan is the most crucial impediment to liberalization and free competition of international aviation. In this paper, we deal with the causes of the capacity shortage, Japanese institutional systems of airport improvement, and new financial methods for international airport capacity expansion in metropolitan areas. We emphasize the effectiveness of the joint-stock corporation system as a useful financial device. The introduction of the joint-stock corporation is one kind of airport privatization, but its characteristics completely differ from that of privatized airports in European countries and the United States.

**Key words**: International airports, Airport Financing, Government ownership, Temporary public corporation, Joint-stock corporation

## 1. Introduction

Insufficient traffic capacity in major Japanese airports is the most critical impediment to the liberalization and deregulation of the Japanese domestic and international air transportation markets. Although the Japanese Ministry of Transport (MOT) has tried to expand airport capacity for more than forty years, slow expansion of airport capacity, especially of international airports in metropolitan areas, has bought strong criticism from Japanese and foreign passengers and air carriers.

In this paper, first we explain past and present Japanese airport improvement plans and policy trends. Second, we describe inherent difficulties in Japanese airport expansion. Third, we compare the traditional Japanese airport improvement method with new forms of major

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international airports, and point out purposes and merits of new forms. Finally, we derive some policy implications.

## 2. The Institutional Methods of Airport Improvement in Japan

In this section, we introduce the legislative and institutional methods of airport improvement in Japan. The Japanese central government has a comprehensive responsibility for airport network improvement, although local governments are partially responsible for their own airports. A close study of local airports and the roles of local government in them is not necessary for our purpose, because we are concerned with international airport improvement. In the first three sections, we deal with three important factors of airport improvement in Japan, namely, the Airport Improvement Act of 1956 in section 2.1, the Five-Year Airport Development Plan in 2.2, and the Special Account for Airport Improvement in 2.3. In 2.4, we introduce the framework of the current Five-Year Plan.

### 2.1 The Airport Improvement Act of 1956

For several years after World War II, Japan was not allowed to operate air transportation, and all airports were requisitioned by General Headquarters (GHQ) of the Allied powers. In September 1951, Japan and the Allied powers signed the San Francisco Peace Treaty, which became effective in April 1952. The conclusion of this treaty allowed Japan to start air transportation again. In October 1956, the original Japan Air Lines made its initial flight. Because of the military domination of air transportation in the prewar and wartime periods, and the prohibition during the occupation, large scale civil air transportation in Japan only began at this late date.

Haneda Airport was returned to Japanese authority in July 1952, and renamed Tokyo International Airport. Itami Airport also was returned in 1958, and renamed Osaka International Airport. But, before the return of these airports, Japan needed to establish a legislative structure for civil aviation service. Thus, in 1956, the Airport Improvement Act was put into force as the basic law of airport development and administration.

The act defines airport institutional systems. First of all, the act classifies airports into three categories: Class 1, international airports, Class 2, major domestic airports, and Class 3, regional airports. Class 2 airports are divided into two categories — Class 2A airports which the central government administrates and Class 2B airports administered by local governments. Secondly, the act defines the airport providers and airport administrators for each category. In other words, the act prescribes who has authority to build and administrate airports in each category. Finally, the act prescribes burden shares of airport improvement costs between central and local governments for each airport category.

Table 1 describes numbers of airports in each category and the burden portion of the central government for each category. Basic facilities consist of runways, landing areas, taxiways, and

aprons. Secondary facilities are drainage and lighting facilities, roads, auto parking lots, and the other facilities related to the airport site.

### Table 1. Burden Share of the Central Government for Each Airport Category

| | Number* or Name | Provider | Administrator | The Central Gov. Burden Share | |
|---|---|---|---|---|---|
| | | | | Basic Facilities | Secondary Facilities |
| Class 1 | Haneda, Osaka | MOT** | MOT | 100% | 100% |
| | Narita | The Authority | The Authority | ------- | ------- |
| | Kansai | The Company | The Company | ----- | ------- |
| Class 2A | 20 | MOT | MOT | 2 / 3 | 100% |
| Class 2B | 5 | MOT | Local Gov. | 55% | no more than 55% |
| Class C | 49 | Local Gov. | Local Gov. | 50% | no more than 50% |

February 1997, Source: *Suji de miru koku 1997*

\* : The numbers do not including airports under construction
\*\* : MOT: the Ministry of Transport, i.e. the Central Government

It must be noted that the central government is not supposed to fund terminals. In general, airport terminals are provided by joint-stock corporations in which local governments and the private sector invest. The main reason for this separation of administrative bodies for runways and terminals was the revenue shortage of the central government.

It is important to bear in mind that, according to the Airport Improvement Act, the central government is fully responsible for international airports. Japan has four Class 1 airports, Tokyo, Osaka, Narita and Kansai. But the central government performs its responsibility as airport provider and administrator only for Tokyo and Osaka Airports. That is, Narita and Kansai Airports are exceptions to the regulation of the act.

## 2.2 The Five-Year Airport Development Plan

The main purpose of the establishment of the Five-Year Airport Development Plan was to indicate the national middle range targets of airport improvement and the necessary budgeting to reach these targets. In addition, setting of the Five-Year Plans has helped the Ministry of Transport to budget for airport improvement.

The Five-Year Airport Development Plan sets the schedule of airport network improvement as a national goal for that period and indicates the expenditure scale related to the schedule. The scheduled expenditure by the Five-Year plan is not necessarily attained, because the actual annual budget for airport improvement is decided by the National Diet every year based on the one year budget principle.

The First Five-Year Plan was for fiscal years 1967 through 1971. In response to rapid changes in air transportation, the First Plan was superseded by the Second Plan in 1971. Table 2 shows the changes in Five-Year Airport Development Plans from the First to the Sixth. In the period of the First and Second Plans, more than ten local airports were improved to be jet capable. In the next decade, a large portion of expenditures was applied to airport vicinity environmental

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countermeasure promotion, namely noise prevention. Finally, international airport improvement has been the focus since the Fifth Plan.

### Table 2. The First through Sixth Five-Year Airport Development Plans

| Plan | First | | Second | | Third | | Fourth | | Fifth | | Sixth | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plan Term | 1967—71(70) | | 1971—1975 | | 1976—1980 | | 1981—1985 | | 1986—1990 | | 1991—1995 | |
| Budget Scale excluding misc. | P | A (R) | P | A (R) | P | A (R) | P | A (R) | P | A (R) | P | A (R) |
| International Airports | 755 | 435 (57.6) | 2,660 | 1,595 (60.0) | 2,250 | 2,140 (95.1) | 6,200 | 1,828 (29.5) | 11,500 | 13,016 (113.2) | 19,250 | 22,248 (115.6) |
| Regional Airports | | | 1,180 | 784 (66.4) | 1,750 | 1,861 (100.6) | 3,100 | 2,970 (95.8) | 3,000 | 3,951 (131.7) | 5,300 | 4,890 (92.3) |
| Environmental Protection | | | 410 | 962 (234.6) | 3,050 | 3,424 (112.3) | 5,100 | 4,752 (93.2) | 1,700 | 2,168 (127.5) | 2,650 | 2,364 (89.2) |
| Safety Facility Development | | | 700 | 661 (94.4) | 1,350 | 920 (68.2) | 1,800 | 1,140 (63.3) | 1,800 | 2,047 (113.7) | 3,000 | 3,746 (124.9) |
| Total | 755 | 435 (57.6) | 4,950 | 4,002 (80.8) | 8,400 | 8,345 (99.3) | 16,200 | 10,690 (66.0) | 18,000 | 21,182 (117.7) | 30,200 | 32,248 (110.1) |
| Purposes | 1. HA, OA 2. RA | | 1. NA, KA 2. NA, RA 3. ASF 4. ENP | | 1. ENP 2. ASF 3. NA, KA 4. RA | | 1. TBP 2. RA 3. ENP 4. ASF | | 1. TBP 2. RA 3. ENP 4. ASF | | 1. TBP 2. RA 3. ENP 4. ASF | |
| Outcomes | OP of 5 RA | | UP of 11 RA | | 1. OP of NA 2. UP of 9 RA | | UP of 11RA | | 1. CO of new RW at HA 2. SW of KA | | 1. OP of KA 2. CO of 2nd TM at NA 3. CO of west TM at HA | |
| Runway Index | 474.6 | | 600.0 | | 661.4 | | 700.7 | | 760.4 | | 834.6 | |
| Domes. Pass. (ten thousand) | 1,543 (=100) | | 2,545 (164.9) | | 4,042 (262.0) | | 4,378 (283.7) | | 6,525 (422.9) | | 7,455 (483.1) | |
| Int'l. Pass. (ten thousand) | 384 (=100) | | 794 (206.8) | | 1,215 (316.4) | | 1,758 (457.8) | | 3,104 (808.3) | | 3,885 (1,011.7) | |
| Nominal GNP (trillion yen) | 75.2 (=100) | | 152.2 (202.4) | | 245.4 (326.3) | | 325.4 (432.7) | | 436.9 (581.0) | | 478.6 (636.4) | |
| Real GNP: 1990 (trillion yen) | 190.4 (=100) | | 237.3 (124.6) | | 292.7 (153.7) | | 345.4 (181.4) | | 436.1 (229.0) | | 454.6 (238.8) | |

Source : The Ministry of Transport

**Abbreviations**
P : Planned Expenditure,   A : Actual Expenditure,   R : Ratio of Actual Expenditure to Planned Expenditure
HA : Haneda Airport,   OA : Osaka Airport,   NA : Narita Airport,   KA : Kansai Airport,
RA : Regional Airports,   ENP : Environmental and Noise Protection,   ASF : Aviation Safety Facilities
TBP : Three Big Projects, Offshore Expansion on Haneda, Completion of Narita, and Opening of Kansai
OP : Open,   UP : Upgrade to jet capable,   CO : Completion,   SW : Start Construction Work
RW : Runway,   TM : Terminal
**Notes**

Runway Index : Total length of Runway Index = $\dfrac{\text{Total Length of Runway}(m)}{\sqrt{\text{Population(million)} \bullet \text{Area(thousand } km^2)}}$

Variables are evaluated in the final year of each Five-Year Plan, or at the end of the year.
However, for the Sixth Plan, 1994 figures are used.

### 2.3 The Special Account for Airport Improvement

The Second Five-Year Airport Development Plan was several times larger than the First. That means that financial problems occurred. Therefore, the Japanese government established the

Special Account for Airport Improvement to secure enough funding to finance improvement projects of airports in the Five-Year Plans. The function of the Special Account is similar to that of the Airport and Airway Trust Funds.

Revenues from airport users are transferred to the Account. Several fees and taxes for the Account were introduced almost simultaneously with the establishment of the Second Five-Year Plan. Airport user fees, including landing fees, lighting fees, and airplane parking fees, were established in 1970. Airway facilities user fees were introduced in 1971. The Air Fuel Tax Act of 1972 authorizes air fuel taxation. The Traveling Tax on air ticket fares for the Special Account was replaced by the National Consumption Tax for the General Account in 1989. However, the same amounts of the tax revenue are supposed to be transferred from the General Account to the Special Account for Airport Improvement.

Tax and fee revenues related to air transportation have been regarded as tolls for airports. The user burden principle has been applied to airport improvement. Thus, the central government has subsidized airport development very little by using its general funds. The main reason for the strong support for the user charge principle in the field of air transportation has been that air transportation was regarded as a luxury service. In fact, the Traveling Tax was one kind of excise tax for luxury transportation such as special cabin train and ship services.

**Figure 1. Revenue Components of the Special Account for Airport Improvement**
(Budget Bill, Fiscal 1996, billion yen)
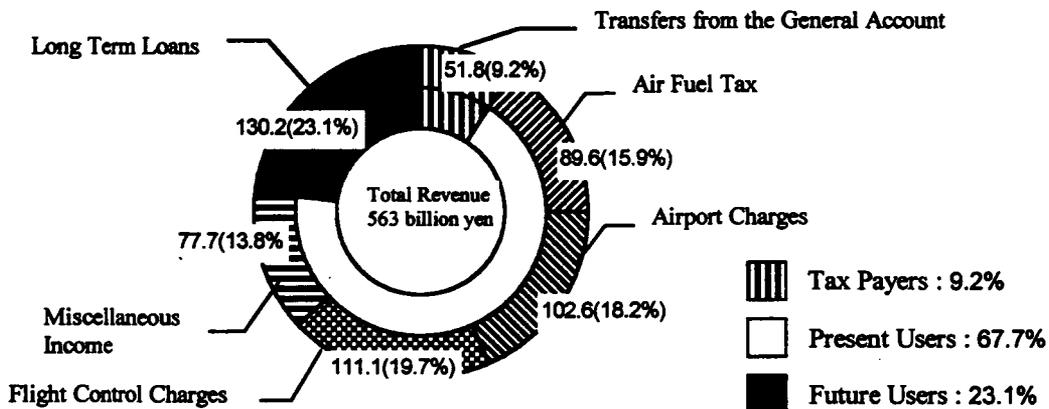


Source for figures: *Suji de miru koku 1997*

Figure 1 describes the amounts and proportion of each revenue source of the Special Account in fiscal year 1996. The revenue from the General Account forms less than ten percent of total revenue, and this amount is almost equivalent to that of the Traveling Tax which was abolished in 1989. In short, the user burden principle continues to apply to airport improvement.

**2.4 The Seventh Five-Year Airport Development Plan**

In December 1996, the Japanese Cabinet decided the Seventh Five-Year Airport Development Plan. This plan includes airport improvement projects from 1996 to 2000. Table 3 shows the scale of the seventh plan.

**Table 3. The Seventh Five-Year Airport Development Plan**

| Plan Term | Fiscal 1996—2000 |
|---|---|
| Total Budget Scale | 3,600 billion yen |
| Airport Development<br>  Major Metropolitan Airport except Kansai<br>  Kansai International Airport<br>  Regional Airports<br>Airport Vicinity Environment Promotion<br>Aviation Safety Facility Development | 2,596 billion yen<br>1,440 billion yen<br>574 billion yen<br>582 billion yen<br>337 billion yen<br>467 billion yen |
| Sub Total | 3,400 billion yen |
| Flexible Expenses | 200 billion yen |

Source: The Ministry of Transport

The seventh plan emphasizes the improvement of major international airports, and allocates 2 trillion yen to them. As for continuing projects, Haneda will spend about 600 billion yen for the offshore expansion, and Narita expends about 400 billion yen until 2000. The second phase of Kansai Airport is allocated at about 570 billion yen.

It is noteworthy that two new major metropolitan airport projects were authorized in the budget. One is the Chubu Airport near Nagoya, another is the Third Tokyo Metropolitan Airport. Both of these are budgeted at 200 billion yen for feasibility surveys. The seventh plan indicates that the second phase of Kansai and the two new airports are the "New Three Big Projects," while the present "Three Big Projects" are the improvement of Narita, the offshore expansion of Haneda, and the construction of Kansai.

# 3. The Delay of International Airport Improvement and the Shortage of Funds

We previously mentioned that Japan started from a situation of almost no modern airports and then rapidly developed an airport network, and we reviewed the institutional systems which administered its rapid expansion. These institutional systems have contributed to its steady expansion. However, there is now an international airport capacity shortage. In this section, we discuss the causes of this shortage. The strong movement against Narita Airport is the main reason for delays in its expansion, but this is not our present concern, because this is specific to Narita. We review the demand aspect of air transportation in section 3.1 and the supply aspect of funds for airport improvement in 3.2. In addition, we deal with the high cost factors for airport improvement in Japan in 3.3.

## 3.1 The Rapid Increase of Air Transportation Demand

It is easy to imagine that rapid and continuous increase in air transportation demand results in a shortage of airport capacity. The expansion of an airport network requires a long time period.

Thus, a time lag easily occurs between increase in demand and increase in airport capacity. In fact, most major international airports in the world are struggling with the recent rapid air transportation demand increases.

In addition, Japan has experienced discontinuous change in the trend of international air transportation. The trend of the number of Japanese overseas travelers, most of whom use air transportation, changed in 1985 when the yen began to appreciate rapidly due to the Plaza Accord. Figure 2 reveals clearly this trend change.

**Figure 2. Actual and Forecast Japanese Overseas Travelers and Foreign Visitors**

(ten thousands)
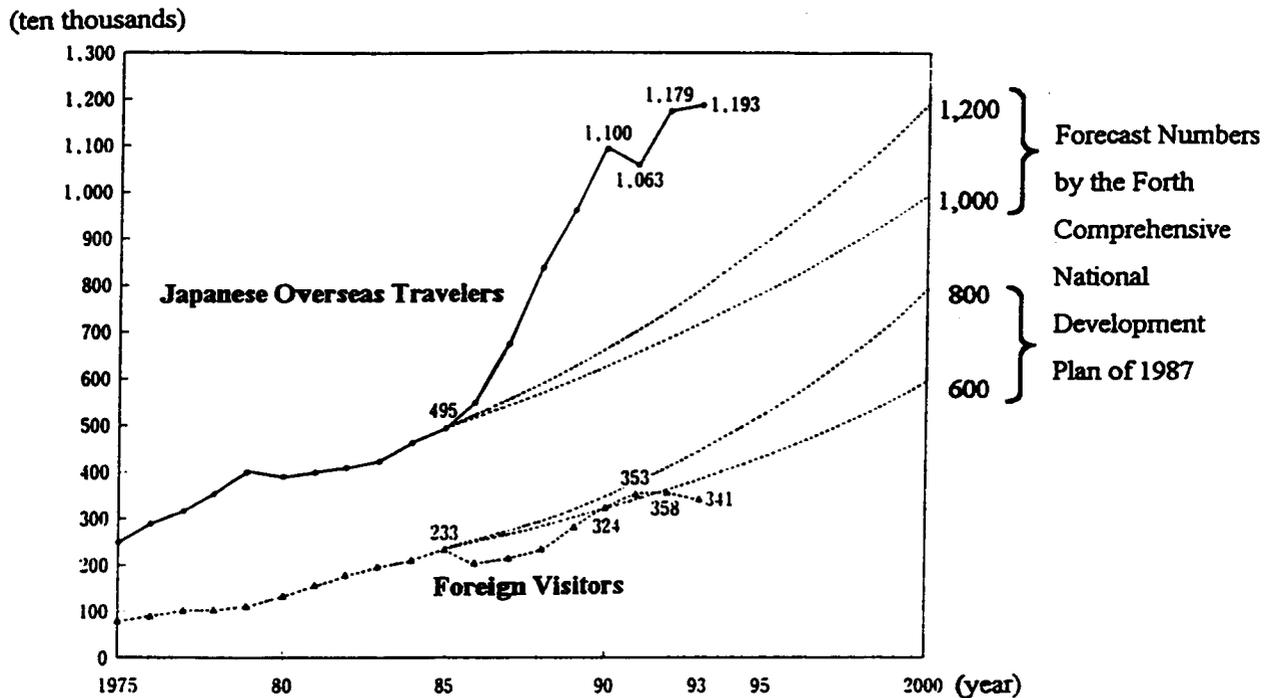


Source: Egashira, K. (1994), "Issues in The National Land Policy for New Era,"
*Quarterly Review MOBILITY*, No. 97, 43-53. (in Japanese)

Figure 2 also describes the forecast numbers of the Fourth Comprehensive National Development Plan produced by the National Land Agency in June 1987. This plan outlines policies for national development toward the twenty first century. The Ministry of Transport participated in the development of this plan, and so the demand forecast in the Fifth Five-Year Airport Development Plan was consistent with the forecast of this plan. Figure 2 tells us that these plans underestimated future demand for international airports. This underestimated future demand has caused the delay of international airport capacity improvement.

**3.2 The Shortage of Funds for International Airport Improvement**

We deal here with the difficulties of the supply side of airport service, and focus on financial problems when the central government is the main airport provider and administrator. We should separate funding shortage problems into two categories — general problems of airport funding and those of major metropolitan airports.

There are four main problems of the Special Account for Airport Improvement. First, the account is relatively small, receiving little money from the General Account. The expenditure of the account is the amount which the central government spends for airport improvement. This has been less than 1.5 percent of total central government public works spending in last decade. The amount for airports has been less than 65% of fishery ports or 40% of seaports for more than the last fifteen years. Airport users pay most of the expenses of the account, while general taxpayers bear the costs of the Special Account for Seaport Improvement or the subsidization scheme for fishery ports.

Clearly, the user burden principle applies to airport improvement, which means that Japanese believe that air transportation users should not be subsidized. This judgment arises from the public belief that air transportation services are a luxury for the wealthy. This belief is losing strength, but is still dominant.

Second, the account has no means of directly imposing fees on consumers of air services. That is, Japan does not have any fees similar to the Ticket Tax and Air Freight Bill Tax in the United States. According Figure 1, the account imposes several fees on airlines, while the Airport and Airway Trust Fund gathers more than eighty percent of its funds from final air transportation service consumers. It is more difficult to increase fees on airlines than on final users. In fact, the landing fees in Class 1 and Class 2A airports have not increased since 1980. Airlines oppose the increase of nationwide uniform airport charges by network expansion, because their marginal revenue decreases with the network expansion.

Third, the revenues from terminal business are not transferred to the account, because the ownership and operation of airport terminals are separated from central government activity. Originally, in the 1950s, the government had no fund for terminal construction, and so left terminals to joint-stock corporations' activities. It did not invest in these corporations. Therefore, the account can not get any revenues from terminal business activities.

Fourth, the account can not obtain revenue from the operation of Class 2B and Class 3 airports. The Airport Improvement Act mandates that the administrators of these airports be local governments. These administrators have the right to impose airport user charges such as landing fees. The account subsidizes the construction of these airports, but does not receive any returns from its expenditures. In contrast, the United States Airport and Airway Trust Fund increases revenues through the Ticket Tax, while it does not receive any airport user charges. This problem is also related to the whole charging system for airport uses.

With respect to major metropolitan airports, for example Haneda Airport, the funding shortage problem has increased. First, Haneda has worked as a main subsidizer for the construction of

many new local airports. Such cross-subsidization is efficient and reasonable only when it is limited to the amount of network effect. However, Haneda has contributed much more to the account than this limitation. Thus, Haneda has become too congested to accept new flights, while many local airports have been completed and should be connected to Haneda Airport by regular flights.

Second, we should mention that political issues have affected the delay in the expansion of Haneda Airport. The Japanese airport network plan indicates that every prefecture has a right to own at least one airport. However, several prefectures do not need to have an airport. Political arguments for equity or equality related to transportation infrastructure networks often force profitable facilities to donate excess revenues to form the networks.

### 3.3 The Heavy Expenditure for Airport Improvement

The funding shortage, which delays airport improvement, is related to the high costs of improvement. Airport development in Japan is extremely expensive, especially in metropolitan areas where most air transportation demands exist. In this section, we review the causes of high costs of airport improvement in Japan.

First, high land prices increase airport construction costs. Part of these high land prices can be attributed to a high level of economic activity. If we compare Japan with the United States, we see that Japanese GDP (Gross Domestic Product) is about half that of the United States, although this relative proportion depends on the exchange rate. The Japanese population is also approximately half the American, while the area of the United States is roughly twenty five times than Japan. Thus, the amount of GDP per acre in Japan is about twelve times larger than that of the United States. Furthermore, more than seventy percent of Japanese territory is so mountainous that efficient economic activity is difficult. Therefore, it is not surprising that land prices in Japan are fifteen or twenty times of American ones (Also see Sakakibara[1994]).

High land prices can be attributed partially to public administration systems which are based on traditional Japanese behavior. Many Japanese have a tendency to be attached to land ownership, especially lands inherited from ancestors. Some Japanese refuse to move to another place even if they are offered compensation by public authorities, or will suffer deterioration of their living environment. Ordinary Japanese have not accepted the concept of eminent domain, and think that enforcement of land acquisition by eminent domain is unfair as well as highly unusual treatment. In addition, the compulsory land acquisition procedure is time-consuming and regarded as the worst possible method, so that public officials hesitate to resort to it. Public authorities will therefore spend more money to acquire necessary land, in order to avoid the problems of compulsory acquisition.

Second, the cost of noise protection is high in Japan. The completion of the compulsory movement of neighboring residents and farmers is more difficult than that from the airport site itself, even though people in these surrounding areas suffer from airport noise. That is, even if public authorities can force residents on the site of an airport to move, and so acquire the land for

the airport, it can not force residents in the surrounding area to move to more noise-free areas. So, people who remain in the area complain about noise pollution. Therefore, the airport or public authority in charge of noise pollution has to spend large amount of money to compensate them.

Table 2 describes the Special Account for Airport Improvement spending of 343 billion yen for environmental protection in the period of the Third Five-Year Plan and 475 billion yen in the period of the Fourth Plan. These expenditures were more than forty percent of the total expenses of the account during these plan periods. Including the expenses from the account, the central government has spent more than 1 trillion yen since 1967 to provide various noise protection devices not only for public facilities but also for individual residences, including double-glazed windows, air conditioners, and television adjusters.

Besides these two factors, there are several rational and irrational causes, such as high construction costs for public works, for the very large expenditures for airport development in Japan. In addition to monetary expenditures, it takes a long time to construct new airports in metropolitan areas.

Roughly speaking, until recently, Japanese, except for business executives and prosperous travelers going abroad, have thought that international airports bring only negative effects to them. Recently, this anti-airport feeling has begun to change, but still remains strong among ordinary Japanese. Therefore, we must accept high costs on the inescapable condition, and have to design appropriate methods for the necessary improvement of international airports.

## 4. Two New Forms of Airport Improvement Compared with the Traditional System

As mentioned in sections 2.1 and 2.2, according to the Airport Improvement Act of 1956, the central government has the responsibility for construction, administration and operation of Class 1 airports. But of the four airports categorized as Class 1, only Haneda and Osaka are operated by the central government. As for the two more recent airports, Narita and Kansai, the central government has taken different paths for their administration and operation, both of which are exceptions to the fundamental principle of the Airport Improvement Act.

In principle, the Japanese government is supposed to own and operate directly major international airports. The first exception to this principle was in 1966 when the New Tokyo International Airport Authority was established. The second is the Kansai International Airport which opened in 1994, built and operated by a joint-stock corporation. The principal purpose of these exceptions was to raise funds for construction of these two new major international airports.

In this section, we examine three forms of ownership: Haneda Airport as an example of government ownership, Narita Airport as a public corporation, and Kansai as a joint-stock corporation, and compare these three systems by describing their merits and demerits in terms of finance methods. In 4.1, we describe the role and problems of Haneda Airport as a subsidizer for other airports, and introduce the finance system for the expansion of Haneda Airport. In 4.2, we focus on Narita Airport as a temporary public corporation, and indicate the financial advantages compared with government ownership. The main topic in 4.3 and 4.4 is the financial systems and

strategies of Kansai Airport which is a joint-stock corporation which seems to be unprofitable. We focus on the fund raising of the first runway opened in 1994 in 4.3, and that of the second runway in 4.4.

## 4.1 Government Ownership

Government ownership of airports, or a substantial government commitment to airport improvement is common, especially during the stage of the development of air transportation. During the occupation after World War II, airports were taken over and air transportation was prohibited in Japan. Finally, in 1951 Japan again started civil air transportation. Therefore, government ownership of airports was widely accepted. In the first half of this section, we consider the characteristics of the Tokyo International Airport (hereinafter Haneda Airport) as a subsidizer. The second half explains the financing for the offshore expansion of Haneda Airport.

### 4.1.1 Characteristics of Haneda Airport

Government ownership of airports in Japan has been associated with a uniform airport user charge and cross-subsidization among airports. Haneda Airport had been profitable and one of the main contributors to fund raising for airport network formation in Japan. However, the offshore expansion project of Haneda Airport changed this situation. Even though Haneda Airport with its offshore expansion is profitable in the long term, it can not contribute to airport network improvement funding during the expansion. We focus on Haneda Airport as a main contributor and on this change in its financial situation.

At the stage of network formation of transportation infrastructure, cross-subsidization of unprofitable by profitable routes or of routes under construction by existing routes is often used as a device of financing for a whole network. Several trust funds of transportation in the United States have played a critical role as a method of pooling revenue to provide necessary funds for less trafficked routes. The Highway Trust Fund and the Airport and Airway Trust Fund in the United States are typical examples of cross-subsidization, as is the revenue pooling system of the Japan Highway Public Corporation which is in charge of expressway network formation (see Fujii[1989]).

Cross-subsidization brings two problems. One is inefficient economic performance, another is a perception of inequity or unfairness. Even if cross-subsidization is inefficient, implementation of cross-subsidization can be accepted from the viewpoint of balanced national development, because it can cultivate rapid formation of transportation infrastructure.

With respect to the highway network, the scale and scope of cross-subsidization needs to be limited when most of the network system is completed. For example, in the United States, the ISTEA (Intermodal Surface Transportation Efficiency Act of 1991) prescribed that ninety percent of fuel tax revenue be returned to the original states where the fuel tax was charged, and so has limited the maximum scale of cross-subsidization between states to no more than ten percent. In addition, the Japanese government and the Ministry of Construction are seeking to decide the

standards for limits of cross-subsidization among routes which the Japan Highway Public Corporation operates as toll highways.

Air transportation is different from the highway network, because stronger network effects among airports exist. If a new airport is opened and flights between the new airport and an existing one begin, the demand for the existing airport increases. Therefore, cross-subsidization from existing airports to new airports is justified more strongly than between highway routes.

The strong demand for cross-subsidization, which is associated with political pressures whose purposes are regional development and the backward linkage effect of public works, produces an excessive burden on profitable existing airports. The first principle of network formation for several kinds of transportation infrastructure in Japan is equality, followed by fair distribution and efficiency. For instance, the 14,000 km national expressway network plan was set so that all cities of 100,000 or more population would be within one hour of an expressway entrance. With respect to airports, all prefectures should have at least one airport with jet plane capability. The scale of airport network has been decided from the viewpoint of equality, not on the efficient balance of demand and supply.

Japanese have believed that the price of public services which the government offers must be equal among users, even if different user consumes the service at different places and times. Different costs of providing the same kind of service occur at different places and times, so the same price under different cost conditions is one kind of price discrimination, and brings inefficiency.

The uniform user charge scheme sometimes causes a continuous increase of price level, otherwise the progress of network formation is postponed. Another possibility under conditions of unchanged price levels is that profitable airports develop a shortage of capacity even as new unprofitable airports are built.

This last option was chosen in Japan. The level of landing fees, including the special landing fee, has not been changed since 1980, except for the introduction of the National Consumption Tax in 1989. On the other hand, twenty four airports in addition to the Kansai Airport were opened or upgraded to jet capability between 1981 to 1995. Haneda and a few other profitable airports have continued to give their revenue to the Special Account for Airport Improvement in order to finance newly opened or upgraded airports, while these profitable airports have had little capacity improvement.

### 4.1.2 The Offshore Expansion of Haneda Airport

To keep the same level of uniform airport user charges and transfer the revenue from profitable existing airports to an expansion of the airport network can delay necessary traffic capacity expansion for subsidizing airports. Haneda Airport is a typical example.

These problems of funding shortages for the expansion and delay of improvement of Haneda Airport had been widely recognized at an earlier period. Then, the Japanese administration introduced a new scheme to improve Haneda Airport. It uses borrowing from the Government Treasury Investment and Loan Program, which previously had been unavailable for airport use.

The Special Account for Airport Improvement will pay back principal and interest for the loan from future airport revenues. This was the first loan to the Special Account for Airport Improvement. While the Special Account is related to the Five-Year Plan, it employed a one-year budget system without any borrowing. As frequently mentioned, a one-year budget system brings underinvestment in facilities which are profitable in the long term. Without borrowing, the offshore expansion project of Haneda Airport would have never started.

Haneda Airport has two runways, but they are not parallel to each other. Traffic demand for Haneda Airport achieved maximum possible utilization level around 1971. The Ministry of Transport limited Haneda Airport to domestic transportation when Narita Airport was opened in 1978. The policy of allocating international flights to Narita Airport allowed the Ministry time to plan the expansion of Haneda Airport. Finally, the Ministry began to expand Haneda Airport into Tokyo Bay in 1984.

The completion of this project will offer two parallel runways and one crosswind runway. The number of annual landings and takeoffs will be increased to about 255,000, while that before the expansion was only 160,000. This is a three-step project, and the second has been completed. The total cost including land fill has been predicted at about 1,480 billion yen.

## 4.2 Public Corporation

In late 1950's, only a few years after Japan had started civil aviation again, the Ministry recognized the need for a new large international airport with four parallel runways for the Tokyo metropolitan area. In 1962, the Ministry of Transport officially began to search for an appropriate place for a new airport. In 1966, the Cabinet decided the location and scale of the new airport. The planned scale was changed from four to two parallel runways later.

The construction work on Narita Airport, located about 40 miles east of central Tokyo, began in 1969, but the completion of the first runway was delayed from 1971 to 1975 and its opening until 1978 because of fierce opposition from a coalition of local inhabitants and left wing activists. The second passenger terminal was opened in 1992, and the airport annually handles about 120,000 flights and some 24 million passengers. The maximum of number of landings and takeoffs and passengers will be increased to 220,000 flights and 38 million passengers, when the second runway is completed.

The New Tokyo International Airport Authority (hereinafter Narita Airport Authority) is in charge of the construction, administration and management of Narita Airport. Narita Airport Authority was established in 1966 by the New Tokyo International Airport Authority Act of 1965. This Act authorized that Narita Airport Authority is the airport provider and administrator. According to the Airport Improvement Act, the Minister of Transport has the responsibility of being the provider and administrator of Class 1 airports. Therefore, Narita Airport Authority was the first exception in the institutional system of airport ownership and administration.

In this section, we focus on the characteristics of Narita Airport Authority, and describe its financial merits. We will emphasize that Narita Airport Authority is not similar to ordinary airport authorities in the United States and European countries, but is a temporary public corporation.

### 4.2.1 The Establishment of Narita Airport Authority

The Japanese government established Narita Airport Authority for two reasons.

The first was the shortage of funds in the Special Account for Airport Improvement. When the construction plan of Narita Airport arose, the Account was prohibited to borrow money. Furthermore, Haneda Airport was the main source of funding for the Special Account, and Haneda's profits were inadequate to finance previous Special Account commitments as well as the Narita Airport construction project, so a new funding source was necessary.

The cost of airport improvements near metropolitan areas in Japan is the most expensive in the world. In fact, Narita Airport Authority spent about 285 billion yen from 1966 to 1977 for the construction of only the first runway and the first passenger terminal.

Therefore, the government decided to separate Narita Airport from the revenue pool of the Special Account. In other words, the government distinguished international air transportation from domestic.

Secondly, although the existing airports could not finance a new large international airport, Narita Airport had been predicted to be profitable in the long term. This was because it is authorized as the principal international airport in Japan, which means that most international air transportation to and from the Tokyo metropolitan area would have been transferred from Haneda Airport. Stand-alone management including long term finance would have seemed to be possible for Narita Airport with appropriate financial assistance and institutional support of the government.

The introduction of the public corporation system to airport construction was an attempt to overcome the governments one-year budgetary principle. However, this procedure was not new to transportation infrastructure in Japan. Similar systems had been introduced for railroads, seaports and highways by the early 1950's.

Public corporations can be divided into two types. One is a going concern such as the Japan National Railways before privatization, and the other is a temporary concern. Japan had the Japan Highway Public Corporation as an example of a temporary concern related to transportation, while it considered the institutional system for a new airport in Tokyo. The Narita Airport Authority belongs to the category of the temporary concern public corporation.

### 4.2.2 Financing by Borrowing and the Redemption Scheme

It is helpful to describe the function of a temporary public corporation before explaining the fund raising of Narita Airport in detail. Take a toll bypass road for example:

A public road corporation which is in charge of construction and management of a bypass borrows money to carry out its work. Suppose that in principle, a local government has to improve and administrate public road facilities. So, such a corporation is an exception to this principle. The corporation is required to charge tolls to bypass users, and repay all the principal and interest

for the borrowed money, as well as maintenance costs, through the toll revenue. The toll level is calculated on the premise that total terminal revenues would be equal to total terminal costs including interest.

The transaction at the end of the redemption period is important. When the corporation redeems all principal and interest, it is supposed to give the assets of the bypass to the government, and dissolve. If the government invests in the corporation, the capital must be also repaid by the toll revenue. The corporation will have no assets on the balance sheet at the end of redemption period because all capital will have been returned to the government through revenues.

The Japanese government has supplied twenty percent of total construction costs of Narita Airport as capital investment. This capital investment comes from the Special Account for Airport Improvement. Furthermore, since the Account does not seek any dividends from this investment, there is an effective subsidization of the sum of this foregone interest.

To finance the remaining eighty percent, Narita Airport Authority issues two types of bonds. One is purchased by the government through the Government Treasury Investment and Loan Program. The other kind is publicly offered. Narita Airport Authority is supposed to finance seventy percent of interest-bearing funds by the former, and the remaining thirty percent by the latter.

User fees from airlines are the main source of revenue for Narita Airport. In addition, Narita Airport imposes PSFC(the Passenger Service Facilities Charge) for departing international passengers as a direct user charge. Compared to major airports in the world, the percentage of non-air transportation revenue such as concessions is small, because Narita Airport Authority can not expand businesses beyond the limits set by the New Tokyo International Airport Authority Act.

Narita Airport Authority is expected to transfer its airport facilities to the central government and dissolve when the loan is redeemed. In principle, the airport will then contribute to the Special Account as a new donor. However, the government will probably propose the privatization of Narita Airport Authority in the future.

### 4.3 Joint-Stock Corporation

The Kansai International Airport which opened in 1994 has several noteworthy characteristics. First, it was built by reclaiming land three miles off-shore in the southeastern part of Osaka Bay. Second, it is noise-free because of its location. Third, the airport provides Japan with its first twenty-four-hour airport. Fourth, the airport offers comprehensive connection service between international and domestic flights. Fifth, surface access by trains and cars and marine access by boats are well organized for major cities in the Kansai metropolitan area. Sixth, the construction cost was very expensive, 1,470 billion yen for one runway. Finally, the airport is owned and operated by a joint-stock corporation. The official name of the corporation is Kansai International Airport Company, Ltd.(hereinafter, Kansai Airport Company).

The last two facts seem to be inconsistent each other. Large investment cost makes the project risky. In general, national governments directly conduct large scale risky national projects such as

international airports. Even if the privatization of the British Airport Authority is successful, privatization at the stage of infrastructure improvement completely differs from that at the stage of operation and administration. In fact, the Airport Policy of 1985, which set the fundamental direction for the privatization of BAA, concluded that large scale capacity expansion in the London metropolitan area would not be needed so that the privatization of BAA was justified. In short, the privatization of the Kansai International Airport is based on a different justification. In this and the following sections, we describe the purpose and framework of the finance system related to Kansai Airport.

### 4.3.1 The Purpose of the Formation of a Joint-Stock Corporation

The first purpose of privatization, in general, is to improve economic efficiency through promotion of entrepreneurship. Each entrepreneur advances their productive efficiency by minimizing their costs in order to maximize their profits. With respect to Kansai Airport Company, no one believes that the company minimizes the construction cost of the airport. Clearly, the purpose of the privatization is not to improve efficiency.

The purpose of the formation of a joint-stock corporation was simply to raise funds from both local governments and private companies. The central government had already decided to invest the same percentage of total construction costs in Kansai Airport Company as it did in Narita Airport, that is twenty percent. As mentioned before, in principle the government is responsible for major international airports, but this principle had already violated in the case of Narita Airport and its burden of twenty percent had become a precedent. The Ministry of Finance, but not the Ministry of Transport, persisted in keeping the twenty percent rule, and wanted to make it a precedent. The twenty percent scheme was established as the rule of burden sharing between the central government and others with respect to major international airports, when the institutional framework of Kansai Airport was decided.

Unfortunately, Kansai Airport is less profitable than Narita Airport. First, the scale of economic activities in its metropolitan area is smaller than that in Tokyo. In order to mitigate this disadvantage, the Ministry of Transport planned that Kansai Airport would be an ideal airport with good access to the Kansai area and good connections between international and domestic flights. In addition, at first the Ministry decided that Osaka International Airport would have redundant capacity and therefore be closed, so that all air transportation demands for the Kansai area would be concentrated at Kansai Airport. However, recently it decided to keep Osaka Airport in service.

Secondly, construction was expensive, because the airport was constructed on an artificial island. In addition, the predicted construction cost was uncertain, because no one could forecast the exact rate of ground subsidence. In fact, the first estimated construction cost was about 1,000 billion yen including interest until the opening, but the real cost increased to about 1,500 billion yen.

In short, both the demand and supply situations for Kansai Airport were worse than Narita Airport. Therefore, the official feasibility study suggested that the amounts of thirty, rather than twenty percent, of total construction costs should be financed by zero interest money.

The Ministry of Finance insisted on the twenty percent principle, which means the central government could spend a maximum of twenty percent of total construction costs. Thus, the Ministry of Transport had to create a new device to finance the remaining ten percent with zero interest. It decided to adopt a joint-stock corporation, and supply a special legal position to the corporation by the Kansai International Airport Company Ltd. Act of 1984.

This act allows the central government, local governments and private companies to invest in the company. The investors do not have any economically rational incentive to invest money in the corporation, because they will not get any dividends from the corporation for a very long time.

In short, this act allows the company to receive the remaining ten percent of the costs with zero interest from local government and private companies. More concretely, the local governments and private companies each invest a total of five percent in the Airport Company.

According to the early feasibility study, total costs would be about 1,000 billion yen, but actually it became about 1,500 billion yen, mainly because ground subsidence occurred more rapidly than expected and completion was delayed. Even still, the revised feasibility study in 1990 supposed that Kansai Airport would be profitable in the middle term with a total cost of 1,430 billion yen. The study reported that the company would be annually profitable five years after opening, and as its cumulative profits would offset accumulated losses, then it would be able to pay dividends after another four years. The company would finish redeeming all fixed liabilities twenty-three years after completion. However, no one believed this calculation. The local governments and private companies which had invested in the company have not actually sought dividends, at least in the short and middle terms.

### 4.3.2 The Justification for a Joint-Stock Corporation

Even if the practical purpose of a joint stock corporation is to finance the construction of the airport, the burden on local governments and private companies is not necessarily justified. The investment of these governments and companies means that the Kansai region bears a portion of the costs of what is a national project. This regional cost allocation of a public project requires justification, which we examine here.

Justification of a policy which imposes this regional burden relies on the benefit principle, which means that each beneficiary of a project should share the cost of the project according to benefits it gets. This is the so-called principle of "returning gains from development".

For example, transportation investments such as the construction of a new commuter railroad cause increases in land prices. We frequently observe this phenomenon in suburban areas in Japan. The major Japanese private railroad companies internalize and capture these spillover benefits by operating real estate and housing enterprises.

In general, improvement in transportation infrastructure brings several economic development effects which sometimes are called external effects. Pecuniary external economies are also important from the viewpoint of cost allocation, while economics focuses only on technological externalities and ignores pecuniary ones because they are regarded only as transfers between

economic agents. Actually, transfers of benefits from a project are significant in consideration of the cost allocation of the project.

First, with respect to a backward linkage effect, any projects in a certain region which demand labor, materials and equipment produce multiplier effects in that region. In other words, projects give the region injections which increase regional income. Therefore, the opportunity cost of such an effect, on the grounds that the relevant project is financed by the national treasury, is the loss of expected income increase in other regions if that same money was spent in these other regions. The backward linkage effect of increase in income in a certain region is merely a transfer from others.

As an extreme example, the construction of Kansai Airport required considerable landfill for the reclaimed island, so that the price of fill in the region approximately doubled. Because transport costs are high for fill dirt, the Kansai Airport Company had to buy expensive local fill dirt. The fill dirt providers in the Kansai area made profits of up to one hundred percent. Clearly, such rents are just income transfers to relatively richer people in the region.

Second, improvements of transportation infrastructure in a certain region make the region more attractive to businesses, so factories, offices, and other facilities move to this region from other areas. Increases in the numbers of such facilities and economic activities bring additional income tax revenues to local governments, and also raise property tax revenues based on rising real estate values and the number of these facilities. Since newcomers move from some other region, these tax revenue increases amount to transfers from the other region.

Third, if transportation infrastructure improvement causes increases in regional land prices, these increases also are transfers from the users of the infrastructure to land owners. These transfers can be eliminated if the operator of the infrastructure charges sufficiently higher fees to users. However, these fees are usually regulated lower than such sufficiently high levels and sometimes at a level below their costs.

Under all of these situations, some income redistribution is required from the beneficiaries to the infrastructure operator from the viewpoint of equity or fairness.

It is ideal to identify and directly charge beneficiaries according to their benefits. Practically, direct charges are impossible because of expensive transaction costs and political opposition. Even approximate methods such as SAD (Special Assessment Districts) or TIF (Tax Incremental Finance Districts) are not accepted in Japan.

In the case of Kansai Airport, the central government has used approximate methods instead of direct charges. More concretely, it asked local governments and major private companies in the Kansai region to invest in the airport company. They have accepted this proposal, because they knew the project brought large and broad economic benefits to the region.

### 4.4 Separation of Foundation Work and Superstructure: Phase II of Kansai Airport

The plan for Phase II of Kansai Airport consists of the second runway and the second terminal. The completion of Phase II will increase the capacity of annual number of landings and takeoffs

from 160,000 to 230,000. The construction cost is predicted to be 1,560 billion yen, while that of Phase I was 1,458 billion yen.

It is obvious that Phase II is less profitable than Phase I, and the development effects of Phase II are smaller than Phase I. A similar estimation applies to social benefits. All aspects except the backward linkage effect indicate that the completion of Phase II is less necessary. But, in December 1996, about fifteen months after the opening of the airport, the Japanese government decided to begin Phase II. More precisely, the Ministers of Finance and Transport agreed on the fundamental finance framework of Phase II. And, the seventh Five-Year plan for airport improvement, which the Cabinet approved in December 1996, one year after the Ministers' agreement, authorized an expenditure of 574 billion yen from the Special Account for Phase II from 1996 to 2000.

This decision was controversial, which means that it is more difficult to justify Phase II than Phase I. In the first half of this section, we discuss the motivation and possible justification of Phase II. In the second half, we review financial measures for Phase II.

### 4.4.1 The Motivation for the Construction of the Second Runway

The official justification relies on the forecast for long term demand for Kansai Airport. It seems reasonable that traffic demand will exceed the present capacity of Kansai Airport in 2010. This prediction can justify the construction of the second runway. On the other hand, we can easily note that many congested airports have a tendency to postpone large scale improvements. For example, Heathrow Airport has adopted conservative investment policies in order to avoid the risk associated with large scale investments. To show sufficient demand for large projects gives governments an opportunity to justify these projects, but some economists emphasize that it is a necessary but not sufficient condition.

The motivation for the second runway has primarily depended on enthusiasm rather than the rational judgment of self interest. We have often heard "Rehabilitate the Kansai (or Revitalize the Kansai)" as a slogan in the Kansai area. This slogan implies more than it appears. People in the Kansai area have worried about its continuous relative decline of economic power vis a vis the Tokyo metropolitan area. The Kansai area had been the national capital for more than one thousand years until the Meiji Restoration in 1868, when Tokyo became capital. Kansai businesses have long been famed for entrepreneurial aggression, but the recent concentration of international and domestic economic activity in Tokyo has sharply increased their anxiety. Thus, "Rehabilitate" means to recover past glory and obtain an advantage over Tokyo.

Kansai Airport has become the symbol of the "Rehabilitation" of the Kansai area, because the airport has several notable aspects such as the location and twenty-four hour operation. In conclusion, the political leaders and business executives in the Kansai area have been willing to bear a portion of the cost of Kansai Airport, even if this burden is economically irrational.

The completion of Phase II will give the region an opportunity for further development. Especially if air traffic capacity in the Tokyo metropolitan area will continue to be restricted to the present level due to the strong opposition against the expansion of Narita Airport, the Kansai

Airport with two parallel runways would be able to become the principal gateway to Japan. Some people in the Kansai region have imagined this scenario as a part of the "Rehabilitation" of the Kansai.

Another possible justification for Phase II is related to the inherent characteristics of transportation infrastructure. With respect to large scale infrastructure such as airports, seaports and expressways, providers of infrastructure are not the same as the direct users of this infrastructure. Fair competition among airlines as direct users of airports brings efficient and fair results when there is excess airport capacity which guarantees free entry and free exit to air transportation services.

Sometimes there is a shortage of transportation infrastructure without harmful effect to competition among private transport carriers. For example, deregulation policies in the trucking industry are minimally affected by highway congestion. In short, a government can allow anyone to begin a trucking business, even though the highway network is heavily congested.

Of course, we can consider some types of bidding systems for slots at congested airports. However, bidding systems at congested airports bring only the transfer of rents from air carriers with existing slots to airport operators. In other words, it improves only the short term economic efficiency of resource allocation, but does not benefit consumers.

When insufficient airport capacity restricts the number of slots, free competition through the bidding for limited slots does not improve air transportation service benefits for final users. The competition among air carriers will increase passengers and shippers only when airport facilities have enough excess capacity to accept new flights. Particularly, airports near metropolitan areas should have excess capacity sufficient to cope with future increases in traffic volume, because the construction of new airport facilities takes a long time while rapid increases in air traffic are predicted everywhere, especially in Asia.

### 4.4.2 The Scheme for the Separation of Super- and Infra- Structure

Public authorities have a responsibility to provide excess airport capacity, because rational private agents have no incentive to own excess facilities. In fact, private transportation infrastructure owners have a tendency to postpone large scale facility investments. For example, the privatized British Airport Authority has tried to postpone the construction of the fifth passenger terminal at Heathrow Airport, and major Japanese private railroad companies have enjoyed adequate profits without large scale investments, which has resulted in heavily congested trains.

As we mentioned above, Kansai Airport Company is organized as a joint stock corporation with investment from local governments and private companies, and therefore is not motivated to postpone large scale investments and seek excess profits. In fact, the facilities investment plan of the company requires the permission of the central government. In other words, the company has no decision making power about its capacity, and related decisions are controlled by the government. In addition, the setting of its airport user charges, including the Passenger Service Facility Charge, is regulated by the Ministry of Transport. Therefore, in principle, if the

government orders the corporation to construct a new facility, the corporation can not refuse the order.

However, the Phase II project would be extremely unprofitable if the Phase I financial scheme was adopted in Phase II. The government could not mandate the corporation to begin Phase II without a new financial system. Furthermore, the government has proposed the separation of the Phase II project into foundation work and superstructure, and persuaded local governments and private companies in the Kansai area to finance a greater portion of the foundation work, which means that they have a much greater burden than in Phase I.

Let us look closely at the separation scheme, the so-called the "separation of super- and infrastructure." In the case of Phase II, superstructure is defined as ordinary airport facilities including runway and terminal, while infrastructure means the foundation work of landfill for the second runway and second terminal. More concretely, it is reclamation and earthwork of the land for the second runway and terminal. Thus, the cost of foundation work replaces land acquisition costs in usual airport construction.

The costs of foundation work and superstructure in Phase II have been estimated at 1,140 billion yen and 420 billion yen respectively. The Kansai International Airport Company is in charge of the superstructure. The financial scheme of the superstructure is roughly the same as that of Phase I, in which the amount of thirty percent of total cost is invested by governments and private companies. The central government is supposed to invest twenty percent, while only the private companies, not including the local governments, are required to invest the remaining ten percent.

The official feasibility study indicated that with respect to the foundation work another twenty-five percent should be financed with zero interest. The rule of two to one for central government investment to regional investment is applied to this amount. The central government and the local governments will lend two thirds and one third respectively to the corporation, with zero interest. Also, each government is supposed to invest the same thirty percent of the total cost of foundation work. Table 4 shows the amounts of interest-free funds and their percentages of the total cost, which each agent finances for Phase II of Kansai Airport, and compares this to the financial scheme of Phase I.

## Table 4. The Sources and Shares of Interest-Free Funds

| Agents (Sources) | Funding Types | Narita | Kansai Phase I | Kansai Phase II | |
|---|---|---|---|---|---|
| | | | | Airport Facilities | Foundation Works |
| The Central Government | Investment | 20% | 20% | 20% | 20% |
| | Interest-Free Loans | ------ | ------ | ------ | 1 / 6 ( = 16.7%) |
| Local Governments | Investment | ------ | 5% | ------ | 10% |
| | Interest-Free Loans | ------ | ------ | ------ | 1 / 1 2 ( = 8.3%) |
| Private Sector | Investment | ------ | 5% | 10% | ------ |
| % of total | | 20% | 30% | 30% | 55% |

Source: The Ministry of Transport

Besides the commitment of the central government, a portion of the burden of the airport facilities is allocated to private companies. The justification for this depends on the judgment that the operation of the airport facilities will be profitable in the long term.

On the other hand, the land for the airport continues to exist in the same place, and eternally yields tax revenues to local governments. This judgment can partially justify the burden increase for the local governments in the Kansai area.

It may be worth pointing out that seventy percent of the superstructure costs and forty five percent of foundation work costs are financed by interest-bearing loans or by bonds, and that these loans and bonds are either guaranteed by the government or receive special treatment from the Japan Development Bank. The Japan Development Bank is a government financial institution, and offers special interest rates for developmental projects which the government identifies. The present interest rate in April 1997 is only 2.70%.

### 4.5 Summary and Implications of the Financial Methods

In the previous section we have reviewed the financial systems of major international airports, and now we can summarize merits and demerits of each system from a comparative viewpoint and derive some policy implications. In section 4.5.1, we deal with the increase in flexibility of sources of airport improvement funds. And we discuss the changes in obligation of the central and local governments in 4.5.2.

#### 4.5.1 The increase in financial flexibility

Let us start this section with Table 5 which shows the relationships between financial methods and ownership categories. In Table 5, the symbols indicate the possibility and effectiveness of the financial systems. For example, circles indicate that each financial method is available and substantial, and crosses mean that it is impossible or prohibited. Triangles represent that marked methods have limited effectiveness.

**User Fees**: Each airline pays airport user charges for landing, airplane parking, etc. In the cases of public or joint-stock corporations, revenues from airlines directly contribute to corporate income. However, airport user charges of Haneda Airport only indirectly and insubstantially contribute to Haneda's projects, because its revenues are transferred to the Special Account for Airport Improvement. In other words the revenue pooling system applies to the airport.

Passenger Service Facilities Charges, which are the most direct charge to final users of airports, are collected only by stand-alone corporations. All revenues from the charges are allocated to the airports which levy a charge for service. Therefore, the charges offer a source for financing capacity improvement of the airports.

Government administered airports do not impose any charges on air passengers in Japan. In theory, it is possible to introduce Passenger Facility Charges in Japan similar to those in the United States. Rather, an appropriate increase in airport charges for airlines is needed to raise revenues for the Special Account, because landing fees for Class 1 airport have not changed since 1980.

## Table 5.  Financial Possibilities of Three Categories of Ownership

| Ownership Category / Financial Method | Government Ownership (Haneda) | Public Corporation (Narita) | Joint-Stock Corporation (Kansai) |
|---|---|---|---|
| **User Fees** | | | |
| Airport Charges | △ | ○ | ○ |
| Passenger Service Facilities Charge | × | ○ | ○ |
| **Concessions** | × | △ | ○ |
| **Bonds and Loans** | | | |
| Borrowing from GTIL | ○ | × | × |
| Issuing Bonds placed to GTIL* | × | ○ | × |
| Issuing Bonds guaranteed by the Government** | × | ○ | ○ |
| Borrowing from Banks etc. | × | ×⁺ | ○ |
| **Central Government** (Non-Interest Funds) | ○ | ○ | ○ |
| **Local Government** (Non-Interest Funds) | × | ×⁺ | ○ |
| **Private Sector** (Non-Interest Funds) | × | × | ○ |

＊ : G T I L : The Government Treasury Investments and Loans

＊＊ : Some bonds are not guaranteed by the Government

○ : available

△ : available, but restricted or less effective

× : impossible or prohibited

×⁺ : possible, but exceptional, rare or not implemented

**Concessions:** Generally speaking, business activities by governments and public authorities are extremely restricted in Japan. Thus, Haneda Airport can not carry out concession activities. In addition, most terminal buildings are institutionally and administratively separated from airport providers and administrators. Concretely, most terminals including Haneda Airport are built and owned by joint stock corporations in which local governments, local private companies, banks, airlines and others invest. Therefore, the Special Account can not receive concession revenues, even if businesses are allowed into the airports.

Narita Airport Authority and Kansai Airport Company own terminal buildings, and therefore can get concession revenues. The scope of activities for public corporations is highly restricted to public actions by the articles of corporation. Thus, the concession revenues of Narita Airport are more restricted than Kansai Airport. In conclusion, with respect to concessions a joint-stock corporation is more flexible than a public corporation.

**Bonds and Loans:** All types of airports use bonds and/or loans to finance their capacity improvement. Bonds and loans are redeemed by future revenues. All three systems can utilize interest bearing instruments, although actual procedures and forms depend on airport ownership. The government controls improvement and expansion plans of all three airports, and also controls their financial plans. Therefore, the flexibility of bonds and loans does not depend on airport ownership. One can say that the Ministry of Finance decides amounts and conditions of bonds and loans.

**Central Government**: It goes without saying that the central government has a duty to improve the international airport system. The Airport Improvement Act of 1956 mandates full central government responsibility for the system. However, the reduction in its burden portion is unavoidable and reasonable when its financial ability is limited.

**Local Government**: In principle, local governments are not allowed to invest in Class 1 airports, and so can not invest in Haneda Airport. The possibility of investment in public corporations by local governments depends on their authorization laws. However, local governments near Narita Airport would not have invested in the airport, because negative effects such as noise are considerable. Even if local governments recognize its positive economic effects, they can not spend local tax revenues on the airport, because many taxpayers, mostly farmers, have strongly opposed its construction.

One of the purposes of the formation of the Kansai Airport Company as a joint-stock corporation is to allow local governments and private companies to invest in the company. Kansai Airport Company sets a good precedent for the "returns of development gains" of large scale infrastructure improvement through a joint-stock corporation system.

**Private Sector**: Private companies can not invest in public corporations nor government agencies. Only the joint-stock corporation system offers an opportunity of investment to the private sector. Of course, private enterprises have no incentive to invest in a corporation if it is unprofitable. It is controversial whether investment in Kansai Airport Company is economically rational, because its profitability is not certain. In this case, we may say that the central government forced private enterprises to invest in the Kansai Airport Company. But, it seems more reasonable that the central government succeeded in making them return their development gains to the Kansai Airport Company.

Suppose that the feasibility study was accurate and the Kansai Airport Company becomes profitable. We also know that purely private project of the airport is not feasible. This means that the financial support from governments has decreased project risk to the extent that private agents can calculate their profits and losses and are willing to invest in the Company. Regardless of the expectations of the private sector, the central government has succeeded in obtaining funding from private enterprises.

**4.5.2 The Changes in roles of governments**

Here we discuss the changes in the extent of the obligation of the central and local governments. To discuss the extent of obligation is to make the cost allocation pattern clear. In other words, we deal with the changes of the burden pattern of international airport improvement as institutional form changes.

Let us begin with the central government. Who pays for the central government? The general answer is taxpayers. But, as we mentioned in previous sections, in the case of airports, air transportation users supply most of the revenues for the Special Account for Airport Improvement. The allocation of monetary costs to each generation depends on the timing of the redemption of principal and interest of bonds and/or loans. Besides the scale of concessions and subsidization for

other airports, the temporary public corporation system is the same as a government ownership system from the viewpoint of the final payers. As we mentioned in 4.2, Narita Airport will be transferred to the national airport pooling system, when total principal and interest of the bonds are redeemed. Therefore, the role of the central government was not substantially changed by the introduction of the public corporation system.

Rather, its role seemed to be expanded to concessions. Joint-stock corporations in which local governments and private sector invest have charge of the construction and operation of terminals in government-owned airports. No central government agencies could operate concession businesses in airports until Narita Airport Authority was established.

From the viewpoint of the opportunity cost of funds, the present generation can not shift the burden to future generations, because they can not use the resources of future generations. However, the present generation can change the pattern of burden and distribution of future generations. For example, if the government finances airport improvement by issuing bonds instead of by taxation, it gathers funds from the capital market and can reduce fees which the present users pay. Thus, the present central government makes sure that transfer from users to bond holders will be completed in the future, though the future central government can also postpone this transfer to more distant future generations.

In short, to abolish a one-year budget system, which does not include any bonds and loans, means that the government mitigates the restriction on the burden allocation pattern among airport users in future generations. Issuing bonds and borrowing expand the power of the present central government.

In principle, economic agents are willing to buy bonds and lend money, even though the central government highly controls the systems of issuing bonds and borrowing for airports. Compared with airport charges which are regarded as a kind of tax, it is easier to raise money through bonds and loans. Their introduction gives the central government more flexibility and choice in fund raising.

On the other hand, the introduction of the joint-stock corporation system explicitly does not increase and may even reduce the scope of central government involvement. Provision of interest-free funds has the same effect as subsidization of the amounts of foregone interest attributed to the funds. In addition to the twenty percent which the central government invested, Kansai Airport required another ten percent of total costs as interest-free investments. Local governments and private companies were responsible for this ten percent, which means that the commitment of the central government was relatively reduced.

It is noteworthy that the responsibility of governments for the Second Phase of Kansai Airport has been greater than for previous projects. Theoretical justification of this increase is attributed to excess capacity for free competition of air transportation services. If this justification is accepted, we have to carefully consider who should pay for the excess capacity. The final payers differ in the case of the central government from the case of local governments. Central government funds are financed by present airport users, because the central government spends money from the

Special Account. On the other hand, local governments have to finance the funds by imposing tax and/or issuing bonds. These bonds are general obligation but not revenue bonds. Thus, taxpayers in the Kansai region bear the responsibility. However, it may be reasonable that the central government increases general funds for excess capacity.

If excess capacity of the airport will bring benefits only to future air transportation users, the expenditure from the Special Account is justified. In this case, the increase in local government burden is not necessarily justified, if the burden portion of the First Phase is appropriate from the viewpoint of the "returns of development gains." We derive a different answer when we suppose that the first burden portion of the region was smaller than optimal, or that the excess capacity benefits regional economic activities in the future.

## 5. Concluding Remarks

There are several implications from the experience of Japanese airport improvement strategies and related financial policies.

First, the establishment of Narita Airport Authority as a temporary public corporation which introduced the separation from the revenue pooling system created a stand-alone finance system for this new metropolitan international airport. This strategy and goal are similar to those during the establishment boom of airport authorities in the United States in the 1960's. However, it is a unique situation that Narita Airport Authority is not a going concern as are airport authorities in the United States and other Western countries. In principle, Narita Airport will be brought into the national pooling system, when all of its bonds and loans are redeemed. In spite of this principle, probably the Authority will be privatized. Thus, one possibility is that the revenue from selling the equity will be transferred to the investment capital for the Third Tokyo Metropolitan Airport through the Special Account.

Second, the purpose of the formation of the Kansai International Airport Company as a joint-stock corporation is to collect funds from local governments and the private sector, but not to obtain an improvement of efficiency as in the case of the British Airport Authority. This method is effective, because the acquisition of interest-free funds is significant and crucial for the feasibility of such large scale projects. A variation of this method has been applied to the Second Phase of Kansai Airport which is known as one of the "New Three Big Projects". It is reasonable to expect that the joint-stock corporation system will be applied to two other projects, Chubu Airport and the Third Tokyo Metropolitan Airport.

If this method is applied to the Third Tokyo Metropolitan Airport, the Tokyo area will have three different ownership type airports, namely Haneda as government ownership, Narita as a public corporation, and the Third Airport as a joint-stock corporation. These three airports are potentially substitutes for each other. Therefore, several problems will have to be solved, for example, traffic allocation rules, coordination of airport user charges, and the possibility of the privatization of Narita Airport.

Regardless of this necessary coordination, the joint-stock corporation method is effective as a financing tool. In addition, this method is justified by the principle of the "returns of development gains". As a policy implication, the joint-stock corporation system for new airport construction can be useful in countries, such as those in East Asia, with high population density and increases of air transportation.

Finally, the larger responsibility of the central government for Phase II of Kansai Airport has an important policy implication. In air transportation, capacity shortage of airports is a crucial impediment to free and fair competition among air carriers. Governments, especially national governments, have to be responsible for redundant capacity of transportation infrastructure, such as international airports. Therefore, national governments are obligated to provide excess capacity in major international airports in order to promote free competition of air transportation, even though airport privatization currently prevails in the world.

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