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[1.] Mária LETANOVSKÁ

AIRPORT CONGESTION AND CONGESTION CHARGES

[1.] University of Zilina, Faculty of Operation and Economics of Transport and Communication, Air Transport Department, Univerzitna 1, Zilina, SLOVAKIA

Abstract: This article discusses about today congestions problems and it introduces some instrument to deal with congestion. The paper deal with the third level airports slots allocation system and its effects on the congestion level at the airports. The main part of the article solves airport charges and mainly congestion charges that are one of the possible amendments into the coordination system, which is under review. Congestion charges are introduced in models regarding to the operators airplanes size, scheduling time, destinations distance and others. Conclusively there is consideration about advantages and disadvantages of congestion pricing or charges.
Keywords: congestion, charges, third level airport, coordination, allocation, airport slots

1. INTRODUCTION

During the past decade air transport congestion has increased in Europe and also in the U.S. The main reasons are growing demand, constrained capacity of infrastructure, and disruptions of scheduled services. The congestion is caused by the imbalance between demand and capacity is improved by the improvements of utilisation of existing capacity, physical expansion of infrastructure, and demand management. The first option has shown to have the limited effect. In many cases, the second option has been difficult or even impossible to be implemented in the short-term due to the various political and environmental constraints in terms of noise, air pollution and land use. The last, demand management has recently been considered as potentially viable option to relieve the congestion problem.

In addition to the institutional instruments, demand management at airports embraces the economic instruments such as congestion charging and auctions of slots (U.S) and allocation of airport slots. A central issue of the congesting charging relates to the estimation of marginal delay cost imposed by an additional flight to all other subsequent flights during congested period. In such a context, the additional flight has to pay its private cost of delay and a charge equivalent to the marginal cost of delays imposed on the subsequent flights during congestion period. This charge may increase the overall flight cost, and thus compromise its overall profitability. The current charging system at the European and U.S. airports is mainly based on the aircraft weights and has a little in common with the above concept of congestion charging.

Figure 1 – Congestion at the airport

This article deals with the congestion charging at an airport. In addition to this introduction, the paper consists of these sections: demand versus capacity, congestion changing, inputs for charging and conclusions.

2. DEMAND AND CAPACITY

Airport congestion causes delays of flights. In general, delay is defined as the difference between the actual and scheduled time of being at the 'referent location'. The threshold for either arrival or departure delayed flights is the period of 15 or more minutes behind the schedule [4].

At the European and U.S. airports, the congestion and delays have become their common (and inherent) operational characteristic. Following the statistics the proportion of delayed flights has been different in both regions. In Europe, this proportion has varied between 17% and 30% for arrivals, and 8% to 24% for departures. In the U.S., the proportion has varied between 22% and 40% for arrivals, and from 19% to 38% for departures. In general, more frequent delays have taken place at the U.S. than the European airports. Delays at airports are generally expressed as the averages per any flight and the averages per delayed flight (the total delay divided by the number of all or by the number of only delayed flights per period, respectively) (EUROCONTROL/ECAC, 2002; Federal Aviation Administration, 2002).

Table 1–Proportion of delayed flights Source: EUROCONTROL/ECAC, 2002; Federal Aviation Administration, 2002

European airports (2001)	(%) of delayed flights		U.S. airports (1999)	(%) of delayed flights	
	Arrivals	Departures		Arrivals	Departures
Paris CDG	24.6	21.8	Chicago-O'Hare	33.6	29.9
London Heathrow	17.4	21.0	Newark	38.4	31.0
Frankfurt	30.8	18.9	Atlanta	30.9	26.8
Amsterdam	25.7	23.2	NY-La Guardia	40.1	28.9
Madrid/Barajas	19.6	20.0	San Francisco	32.1	21.5
Munich	19.0	19.0	Dallas-Ft. Worth	21.7	23.7
Brussels	29.8	27.7	Boston Logan	37.7	29.3
Zurich	23.2	23.8	Philadelphia	40.4	37.9
Rome/Fiumicino	-	12.5	NY-Kennedy	28.0	19.0
Copenhagen/K	17.8	10.3	Phoenix	29.6	30.8
Stockholm/Arlanda	-	8.0	Detroit	24.6	26.3
London/Gatwick	19.6	24.3	Los Angeles	26.1	20.8

Dynamic interaction of the demand and capacity cause congestion at airports. The rate of such interaction is commonly measured by ratio of the intensity of demand and capacity (or the capacity utilisation ratio), which generally may take the values lower, equal or greater than one. Specifically, if the intensity of demand is equal to the capacity, this ratio is equal to 1.0 (or 100%). At the most European and U.S congested airports, contrary to the above-mentioned averages, this ratio often reaches or even exceeds the value 1.0 (100%), particularly during the short peak periods of an hour or quarter of hour, which suggests occurrence of the significant congestion and delays(Federal Aviation Administration, 2001; 2002a). This gives rise to the question of managing this ratio and thus congestion below the threshold levels. In the short-term, this seems to be possible by the demand management, and particularly by using its economic instrument - congestion charging.

3. CONGESTION CHARGING

The theory of congestion pricing was developed for roads. Economists recognized that peak road usage is excessive because individual users do not take into account the delays imposed on all other users. Charging a congestion toll equal to the cost of the external delays each user generates will appropriately restrict peak use.

Congestion pricing follows the same logic when applied to airlines, with one important difference. Individual road users are atomistic; each driver is a small part of the total traffic on the road. By contrast, the airlines using a congested airport are typically nonatomistic; most individual airlines account for an appreciable share of the total traffic at the airport. This difference matters for airport congestion tolls, since a nonatomistic airline, unlike an atomistic driver, takes into account a portion of the congestion caused by each of its flights. Specifically, the airline considers the congestion each flight imposes on all the other flights it operates. In other words, it recognizes that scheduling an extra peak-hour flight will slow down its existing flights, possibly making the airline reluctant to add the flight.

The airline's partial internalization of congestion means that the congestion externality is not as severe with airports as it is with roads. The overscheduling of flights is thus not as excessive as the overuse of a rush-hour freeway. As a result, airport congestion tolls can be less punitive than in the context of road congestion tolls. Just as with road pricing, the airport toll is based on the marginal congestion damage (MCD) from an extra flight, which equals the increase in operating cost for all the affected airlines plus the value of the lost time for their passengers. But because the airline internalizes some of its congestion, the toll does not equal the full MCD, as it would in the road case. It instead equals the MCD multiplied by one minus the carrier's flight share, which equals the portion of the extra congestion that is not internalized by the airline. The formula thus charges the carrier only for the congestion it imposes on other airlines, exempting the congestion it imposes on itself.

For example, at an airport served by three identical airlines, each would pay a congestion toll equal to MCD times 2/3, reflecting the fact that 2/3 of the congestion from an extra flight falls on other carriers. MCD varies over the day, being high at peak hours and low (even zero) in the off-peak periods. Thus, the toll computed by this formula will vary over the day, disappearing when the airport is not crowded [10].

Up to date, despite being theoretically matured clear and warmly recommended by the academic economics and policy-making literature, congestion charging has still not found practical application at the congested airports. The main causes could be summarised as collision with the overall airport objectives including the lack of real cases, complexity of measurement, ambiguity of the concept and barriers within the industry.

Most airports worldwide have always intended to grow under given circumstances due to their internal (economic) as well as wider external (economic and political) regional and national interests. The growth has assumed attraction of as great as possible traffic. Under such circumstances, physical expansion of infrastructure capacity has always been used as the most feasible long-term solution for relieving congestion despite the various short-term social, political and environmental barriers. Consequently, the very rare, if any, airports have considered congestion charging as the viable short-term remedy. At the same time, the revenues from combined aeronauticaland non-aeronautical charges have provided coverage of the airport operational costs and partly funding of investments [11].

4. INPUTS FOR CONGESTION CHARGING

Three groups of inputs are used in application of the proposed modeling procedure [10]:

» Data on the demand

The hourly rates of the number of flights demanding service and their corresponding capacity at the airport for every day in calculation have been used for estimating congestion and delays. There are factors that have influence on the demand such a time of departure or arrive during the day, type of operator and its business model, connection flights, and

» Capacity, for estimation of congestion and delays under given circumstances

Designation of the capacity is for the long discussion, but for this paper is important to list the factors influenced the capacity. They are: noise, ATC, runway, apron, terminal and others (political and demographical aspects, airport surroundings and competitors.

» The aircraft operating costs and airfares, for assessing profitability of the particular flights

The aircraft operating cost have been expressed per block hour, in dependence on the seat capacity.

5. RESULTS AND OTHER ALTERNATIVES

Today, congestion charging is not real instrument how to fight with congestion. There are still some obstacles to introduce this. There are also some current systems for coordination of capacity and also for the trading or pricing it.

The main is airport slot allocation system and parts of it are: primary slot trading (U.S. market) and secondary trading (some EU airports). Within the slot coordination system there will be introduced some amendments, which could have positive impact comparable to congestion charging [5]. These are:

» Penalties and sanctions – sanctioning of an air carrier for providing misleading information and late hand back, in some circumstances coordinator shall withdraw series of slots instead of sanctioning.
» Slot reservation – it is an introduction of charging system where airport managing body uses this system with an aim to force carriers from late slot returning into the slot pool.
» Slot mobility and secondary trading – this part of the amended regulation consists of the secondary slot trading allowance, where slots could be exchanged and transferred within the regulation, with or without financial compensation.

Penalties and sanctions can improve coordinators work and make quicker and more flexible slot allocation. If there is information about a slot that the carrier is not able to operate, this information has to be sent to coordinator as soon as possible; so another carrier could get this slot. Sanctions should be established as a punishment for carrier who is a wrong-doer.

Another type of sanctioning rule says that the misuse of airport slots have to be sanctioned. Because of such circumventions, airport coordinators could sanction the airlines for misuse of their slots. This could help the better slot utilization and also to avoid congestion in the future.

Idea of slot reservation fee was introduced in one of the proposals for amendments within the current regulation.

Handing back slots in time (before the slot return date) would allow for an increase of slots reallocated, hence better use of capacity. It would also address the issue of over-bidding for slots or holding on to slots that will not be used to prevent competition. Slot reservation fee/deposit should be revenue neutral for airports and would reward the best airlines in class. No prior down payment for airlines – should be part of airport charges (could be a % of airport charges and would be offset against airport charges). The period between slot allocation and slot return deadline would allow airlines the flexibility to make adjustments and optimise their slots (with no liability). Airline liability would accrue from slot return deadline. Payment would be due on day of operation (or failed operation). Airlines would not be liable if unable to operate a slot due to circumstances outside their control.

6. CONCLUSIONS

The paper has dealt with modeling of the congestion charging at airports. At present, congestion charging has not been practiced at the airports worldwide despite many of them have already charged differently the services during the peak and off-peak periods. The additional flight scheduled at the beginning of the congestion period has imposed the greatest marginal delays, and vice versa.

The marginal costs have increased in proportion to the increasing of these delays on the one hand and the size of the succeeding aircraft on the other, and vice versa.

It is well known in the literature that congestion tolls by a congestible facility such as airport serve two purposes: first as a means for demand management and second as a source for investment financing. When carriers have market power, they will be able to internalize congestion costs – fully by a monopolist and partially by oligopolists – by setting a higher ticket price so that passengers will eventually bear the costs that they impose on each other. Such practice by the carriers can well serve the purpose of demand management, as the higher ticket price will curtail demand and reduce congestion. Nevertheless, the internalization of congestion costs by the carriers would effectively deprive the airport of an important source of funds for its capacity investment, which may lead to financial problems for the airport.

Conventional economic wisdom suggests that congestion pricing would be an appropriate response to cope with the growing congestion levels currently experienced at many airports. Several characteristics of aviation markets, however, may make naive congestion prices, equal to the value of marginal travel delays, a non-optimal response. This paper has developed a model of airport pricing that captures some of these features. The model reflects that airlines typically have market power and are engaged in oligopolistic competition, and that a part of external travel delays that aircraft impose are internal to an operator and hence should not be accounted for in congestion tolls. We have also briefly considered the issue of policy coordination between airports.

This paper analyzes pricing and slot-allocation mechanisms when profits are important to an airport, owing to budget constraints or profit maximization. We find that pricing and slot trading/slot auctioning do not lead to the same results. Total traffic is higher under slot auctions than under congestion pricing. Furthermore, if airport profits matter just marginally, then slot auctions will outperform pricing in terms of achieving a higher objective-function value. On the other hand, if airport profits matter sufficiently highly, which mechanism is better is then very much dependent on parameter values. In particular, pricing may be strongly preferred over slot auctions for certain parameter values (especially when airlines are very asymmetric).

Congested airports analysis suggests that strategic behavior on the part of the airport that cares about its profit can have a significant bearing on the comparison of price vs. slot-based approaches to congestion management, depending on what is asked from the airport, and what matters to the airport. This is because, for some parameter values, one mechanism may lead to larger airport profits while at the same time reducing airlines' profits and the value of the overall objective function. Hence, if a regulator asks airport managers to maximize a certain objective function, but the choice of a flight-allocation mechanism is left to the airport, there may be social welfare losses, with the extent of welfare losses depending in general on cost and demand parameters. Paper results thus imply that, if airport profits matter, then there is no simple solution as to which mechanism should be employed or implemented.

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