DIFFERENT

User Reaction and Efficient Differentiation of Charges and Tolls

DELIVERABLE D5.2

FINAL RESULTS AND RECOMMENDATIONS FOR DIFFERENTIATED CHARGES AT AIRPORTS

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Main Editor:	Ofelia Betancor, Pilar Socorro and Juan Luis Jiménez (EIT)[1]
Partners Contributed:	Eric Pels and Christiaan Behrens (ESI-VU), Bernhard Wieland and Christos Evangelinos (TUD), Stane Bozicnik (UM-TEMM)
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DIFFERENT Project Office

Transport Research Institute
Napier University
Edinburgh, UK
Tel: + 44 131 455 3202
e-mail: H.Condie@napier.ac.uk
Web: www.different-project.eu

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EXECUTIVE SUMMARY

This deliverable analyses the effects of differentiated airport charges by studying – through different methodological approaches – five case studies based on several European airports (Gran Canaria and Madrid-Barajas, in Spain, the airports in the London area, Hamburg and Ljubljana airports).

Although all of them focus on the problem of airport charges differentiation, the approach is different in each case, depending on the existing situation and data availability. In some cases (Gran Canaria, Madrid and Ljubljana airports) no data was available on the potential reaction of airport users to charge differentiation. Consequently these cases are centred on the consequences as derived from the lack of airport charges differentiation and on recommendations to better allocate the existing capacity. The methodological approach used in the cases of London area airports and Hamburg is different. Their starting point is a situation where airport charges are already differentiated and datasets on their effects are available.

The case study for Gran Canaria airport considers the problem of peaks associated with massive tourist arrivals and departures as determined by tour-operators. Important investment resources are being allocated to the airport because of the peak nature of demand, and without consideration of other alternatives to allocate existing capacity. The demand pattern is mandated by tour-operators imposing very high costs on society. Therefore, the aim of this case study is to tentatively estimate these costs and explore incentives mechanisms, in particular alternatives airport pricing schemes, in order to induce a more efficient utilization of airport capacity. The analysis indicates that demand peaks are dynamic in time but also in space when a network of airports is considered. Any pricing policy aimed at a more efficient use of airport capacity should consider this fact.

The actual fare structure at the airport is determined by AENA, the public entity in charge of managing the whole network of Spanish airports. The structure and level of charges is quite homogenous for all the airports, and only differentiated by type of airport and by type of flight. Thus, smaller airports charge lower prices whereas domestic flights also enjoy lower fares. There are no additional differentiation criteria but for the MTOW of aircraft which is in fact an international practice. Such a fare structure not only affects the behaviour of airlines and ultimately tour-operators, but also has consequences upon a number of other economic agents.

Our estimate is that a total of around 1 million euros per month is being borne by economic agents either at or outside the airport as a result of the peak-load demand, and quite probably also induced by the current airport pricing policy that does not differentiate according to traffic conditions. Hotels and apartments establishments are the most affected. They are followed by passengers, who experiment the lowest time quality when doing the check in previously to departures.

We believe that this case study adds value to the existing literature on the peak-load problem at least in three aspects: (i) although it concentrates on a particular airport, the methodology used could be easily transferable to other airports with similar inefficiencies; (ii) it should be able to contribute to the cost-benefit analysis of pricing policies at airports and other utilities and (iii) it illustrates a situation in which decisions on charges or the allocation of slots, and on infrastructure investments are taken at different instances, giving rise to inefficiencies that would have not appeared if both responsibilities were resting at the same institution.

On the other hand, the Madrid Barajas airport case study concentrates on how the actual level and structure of airport charges can have an influence on competition between airlines when these can choose among different terminals, therefore emphasising the scope of price differentiation by type of terminal. In this case, the initial allocation of slots at the new facilities was subject to great controversy among Spanish airlines, though finally Iberia and its partners of the Oneworld alliance, ended operating from the new Terminal 4, whilst its main national competitor, Spanair, and its partners of Star alliance, were allocated at the old facilities. One of the main consequences of such allocation is quite probably a reduction in the level of competition among airlines.

Many airports around the world have recently built or are in the process of constructing or rebuilding new terminals. Airlines operating in those airports must be reallocated between the new and old facilities. However, the international airlines associated with a given group will insist on being located in separate terminals in order to facilitate transfers between themselves and minimize the loss of passengers to airlines outside their group. For the case of Madrid Barajas Airport, we use a theoretical model to show, in general, that if airlines are allocated to separate terminals, the lack of competition in transfer flights significantly affects the ticket prices of the whole network, the competition between airlines is reduced, the ticket prices are higher and the consumer surplus and the social welfare are lower. Only in some routes and under certain conditions on the market size, the ticket prices may be lower.

In the London area, London Heathrow (LHR) is known to be the most congested airport. Some say there is a single peak, which lasts all day. Looking at the number of destinations available from LHR and the number of airlines operating from it, one could say that LHR is one of the most popular airports in the world. Given the congestion costs it may also be one of the most hated airports in the world. For European destinations and a number of intercontinental destinations, alternative airports in the London area are available. Price differentiation at London Heathrow could be used to spread demand evenly throughout the day, but given the high demand levels throughout the day it may have little effect. Price differentiation between airports may be used to give passengers – and airlines – an incentive to choose another airport. The British Airport Authority (BAA) privately operates a number of airports in the London area,[2] while a number of airlines (e.g. British Airways, Aer Lingus, Air France – KLM) use multiple departure airports in the London area, sometimes to the same destination. So next to competing with other airport operators, an airport operator may also try to give airlines and passengers incentives to use alternative airports to reduce congestion costs.

In this research we determine the price elasticity of market share for different passenger types in European markets originating in the London area. The underlying reasons are twofold. Firstly, price differentiation to maximize revenues, or manage passenger flows through congested airports is possible only if passengers respond to price changes (i.e. demand is elastic). Secondly, it is a common conjecture that the emergence of low-cost carriers led to fierce competition between airlines, and in some cases airports. In this research we determine how market shares change when the total price of a trip changes. The analysis is based on the *total* price (i.e. airline fare plus airport taxes), because passengers respond to this price. Estimating separate elasticity coefficients for airport taxes and airline fares is not feasible, since the airport tax may be constant across a large number of respondents and alternatives, which creates numerical difficulties. We estimate different models for leisure and business travellers, as it is a common finding in the literature that these passengers have a different willingness-to-pay, and thus a different price elasticity of demand.

The estimation results presented are derived using the nested logit model. The conclusions from this research are that: i) cross-elasticities of demand between airports are relatively low, indicating that there is little competition within markets; ii) there is little evidence that price elasticities for business travellers are lower (in absolute value) than price elasticities for leisure travellers; and iii) a likely effect of price differentiation is that passengers switch destinations or modes, rather than switch between peak and off-peak, or switch airport to reach the same destination.

Hamburg airport was one of the first airports in Germany to be privatized by selling a big part of its shares. It was the first German airport imposing price cap regulation and one of the first differentiating its charges according to noise emissions. The development of traffic figures in Hamburg shows that restructuring the charging regime was an important step for the airport. However, regarding the differentiation principles there are no considerable effects recognizable. In addition, the proportions of the two-part tariff became more variable after the reorganisation. This enables users (especially legacy carriers) to concentrate on their plans of expanding service frequency. The empirical findings combined with all heuristic findings provide safe evidences to argue, that the introduction of noise charges at Hamburg airport did not induce carriers to use less noisy aircrafts.

A very important aspect for the introduction of the differentiated noise charges was that no major interest group objected it. The policy makers were in favour of it; the users could live with it because at

2 Heathrow, Gatwick and Stansted.

the same time they could achieve the introduction of their favoured price level and price structure; the airport could improve its environmental image and finally the environmental organisations were not really content with it, but they found the principles of the new charging scheme better than the old ones. The rejection of the initially proposed differentiated noise charge is the main evidence that, the regulatory framework (particularly the consultation system) gives carriers the opportunity to intervene in the setting process of the pricing rules. Consequently the reasons for the current price structure are more detectable in the positive theory of regulation, described in WP 2 and WP 3 (see hypothesis H8 and H9 in D 3.2.)

Finally, the case study of Ljubljana Airport, illustrates also the problem of congestion at peak periods. Although it is an airport with a moderate level of demand, the existing and anticipated growth of travel demand calls for the introduction of additional, congestion dependent differentiated charging schemes. Besides several projects aiming to increase the capacity of the Ljubljana Airport facilities, the differentiated airport user charges are to be seriously considered in order to reallocate the existing demand pattern and to provide a more efficient utilisation of airport capacity. Differentiated pricing schemes could be rational and efficient responses to such challenges. This case study provides a thorough analysis of transport demand at the Ljubljana Airport and has identified peak periods during the time of a day, a day in a week and a season in the year. A preliminary analysis of price elasticity of demand also indicates that by introduction of differentiated congestion pricing schemes, charter and low-cost carriers would be more affected.

1 INTRODUCTION

This deliverable analyses the effects of differentiated airport charges by studying – through different methodological approaches – five case studies based on several European airports (Gran Canaria and Madrid-Barajas, in Spain, the airports in the London area, Hamburg and Ljubljana airports). This report continues and extends the work presented in the intermediate deliverable D5.1.

Many different services and activities are carried out at airports nowadays. These activities are usually grouped into *airside* and *landside*, and the fare structure of the airport tends to mimic this grouping. In general, the main charging concepts at any given airport include landing charge, passenger charge, freight charge, parking charge, security charge, etc. Although there are minor variations across airports, the basic structure of airport charges is always the same, and simply reflects the International Civil Aviation Organization (ICAO) recommendations. For example the landing charge is generally based on the maximum take off weight (MTOW) and cannot be discriminatory.

The degree of airport charges differentiation in Europe has been already presented in Deliverable 2.1 of this project. It was shown that the main differentiation criteria were:

- Aircraft weight
- Period of the day (e.g. day, night)
- Flight type (e.g. national or international)
- Traffic condition (peak/off peak)
- Aircraft noise
- Aircraft emission levels (pollutants)

The five case studies deal specifically with some of the above mentioned criteria, examining their current effects on real airports. Nevertheless, the issue of airport congestion is considered as of special importance; for this reason it will be analysed in more detail in four of the case studies. The problem of airport congestion has been subject to controversy and, to some extent, its definition is not always clear in the existing literature.[3] Although it is usually studied (by analogy) using the same principles adopted for road congestion, this is quite a different phenomenon, since entry at airports *markets* is not random (Nombela et al., 2004), but scheduled after negotiations between airport's managers and airlines. Congestion at airports occurs when there are "too many" users in the system (e.g. terminal or runways), users that consequently assume a higher generalized cost for their trip. If we can identify who and when causes congestion, we will be able to charge them and force them to internalize the costs they impose on other users. If the congestion problem only appears in certain periods of time (e.g. hours, days,…) the way in which the internalization is conducted is through peak-load pricing mechanisms. On the contrary, when congestion arises due to a suboptimal strategy of airports' managers, airports' agents or even airlines, (e.g. lack of personnel available to handle luggage), other types of congestion pricing mechanisms should be applied. Nowadays, this sort of congestion pricing is usually not considered, whether in the literature or in real situations.

The case study for Gran Canaria airport considers the problem of peaks associated with massive tourist arrivals and departures as determined by tour-operators. Important investment resources are being allocated to the airport because of the peak nature of demand, and without consideration of other alternatives to allocate existing capacity. The demand pattern is mandated by tour-operators imposing very high costs to society. In this sense, the aim of this case study is double: to analyze and quantify the costs imposed on society as a result of the peak-load demand and to explore alternative airport pricing schemes in order to induce a more efficient utilization of airport capacity.

On the other hand, the Madrid Barajas airport case study concentrates on how the actual level and structure of airport charges can have an influence on airlines competition when they can choose among different terminals, therefore emphasising the scope for price differentiation by type of terminal.

3 Congestion should be also distinguished from the concept of scarcity. Scarcity effects occur where users can not get a desired slot due to the presence of other users (Doll and Jansson, 2005).

This case study will also briefly address a possible differentiation of charges at the airport in accordance with air pollution and congestion costs.
In the case of the London area airports, user charges to airlines vary substantially between peak and off-peak periods. This leads to the question of what the consequences of such differentiated charges are. To understand how and to what extent these charges are transferred to passengers, airline ticket prices for flights during various parts of the day are analysed. The statistical analysis is carried out with a dataset containing information from a sample of UK airports including both those with and without peak-pricing. The case intends to characterize users' responses to price differentiation in the context of airport choice decisions.

Hamburg airport has currently no capacity problems; it is one of the so-called secondary airports in Germany and its management is actively trying to attract new customers. Differentiation in Hamburg landing-fees mainly takes place with respect to noise emissions, with the aim of encouraging airlines to use less noisy aircrafts. In this context, the objective of this case study is to analyse whether the Hamburg price differentiation scheme has had any effect so far (e.g. whether airlines indeed use less noisy planes), and to what extent this effect has altered travel behaviour.

Finally, the aim of the Ljubljana airport case study is to analyse the existing charges structure at the airport and to identify possible additional differentiation of airport charges in order to optimise and to redistribute the traffic demand outside the peak traffic periods.

The structure of the report is the following: we first provide a brief overview of the methodological approach used (Section 2), and then present and discuss final results for each case (Sections 3 to 7). Section 8 summarises results and recommendations. Finally, Section 9 includes the main bibliographical references.

2 METHODOLOGICAL APPROACH

The five case studies included in this document – Gran Canaria, Madrid-Barajas, London area, Hamburg and Ljubljana airports -- have been analysed using different methodologies. Although all of them focus on the problem of airport charges differentiation, the approach is different in each case, depending on the existing situation and data availability. The case of Gran Canaria airport, for example, illustrates a situation where charges are barely differentiated and, specifically, there is no peak/off-peak differentiation. Therefore no data was available on the potential reaction of airport users to charge differentiation, except for the feedback we were able to obtain from a series of contacts established with air carrier representatives. Consequently, the case is centred on the consequences as derived from the lack of airport charges differentiation and on recommendations to better allocate the existing capacity.

A similar situation can be found in Madrid-Barajas airport: the case explores a type of differentiation that is not being applied at this airport. By using a theoretical framework based on standard microeconomic principles and welfare economics, the case develops recommendations for better practices, while simultaneously forecasting the consequences of changes in the current situation.

The methodological approach used in the case of London area airports and Hamburg is different. Their starting point is a situation where airport charges are already differentiated and datasets on their effects are available. In the case of London airports, some of them are already applying peak pricing, whilst for Hamburg there is a noise charge in place. In both cases the approach is based on econometric analysis.

Finally, the approach in the case of Ljubljana airport is mostly descriptive of the current situation in terms of relevant variables like traffic demand at different periods or the existing airport charging scheme aiming to identify potential for differentiation of airport charges and a better allocation of existing capacity. As for the Gran Canaria and Madrid Barajas airports, the studied differentiation of airport charges policies is not being applied at the moment.

Table 2-1 provides a summary of the case studies analysed.

Table 2-1 Categorization of Case Studies

Case Study	Partner responsible	Focus	Markets	Methodology	Differentiation already in place[4]
Gran Canaria Airport	EIT	• Peaks associated with tourist arrival	Passengers	Field work: questionnaires	No
Madrid Barajas Airport	EIT	• Differentiation by type of terminal • Treatment of congestion and air pollution	Passengers and freight	Theoretical model	No
London Airports	ESI-VU and ITS	• Peak pricing and airport choice	Passengers	Econometrics	Yes
Hamburg Airport	TUD	• Treatment of airport noise	Passengers and freight	Econometrics	Yes
Ljubljana airport	UM-TEMM	• Demand peaks	Passengers and freight	Descriptive	No

4 Apart from the standard practice like differentiation according to aircraft weight or to type of flight which are standard practice at airports in the world.

3 GRAN CANARIA AIRPORT: A PEAK LOAD DEMAND PROBLEM

3.1 INTRODUCTION

The Canary Islands is a Spanish Archipelago inhabited by 1.9 million people situated in the Atlantic Ocean, 2,500 kms to the Southwest of Portugal. It is composed of seven islands – Lanzarote, Fuerteventura, Gran Canaria, Tenerife, Gomera, La Palma, El Hierro – all of them served by modern transport infrastructure including eight airports.[5] Five of these airports are international, and four of them (Gran Canaria, Tenerife South, Lanzarote and Fuerteventura) are ranked among the eleven busiest in Spain (AENA, 2006). Of course, the relevance of the tourist industry explains these figures.[6] Apart from Spaniards, the most important tourist flows have their origin in the United Kingdom and Germany, followed by the Nordic countries. Traditionally, most foreign tourists arrive to the islands through a tour-operator, which sells them a holiday package including flight and accommodation. Interestingly, tour-operators conduct their operations by concentrating on a given weekday all flights from the same origin. For instance, most flights from the UK arrive at and leave from Gran Canaria on Mondays and Saturdays, thus demanding a more intensive use of capacity on those days. A similar pattern can be found at the other airports, though the selected peak days within the week usually differ across tour-operators and origins, but they are a common feature in most tourist airports. It is important to note that even tourists that made their own holiday arrangements (an increasing number, thanks to internet) can buy their flights from the same airlines that sell their seats to tour-operators, and therefore create the same problem.

This case of Gran Canaria airport will be particularly focused on the problem created by the peaks in capacity associated to tourist arrivals and departures as scheduled by tour-operators. Important investment resources are being allocated to the airport because of the peak nature of demand, and without consideration of other possibilities to allocate existing capacity, as other alternatives for charging airlines at airports. The demand pattern is a consequence of the tour-operators strategies and imposes very high costs not only to the airport, but to society in general. It is not only that the use of airport capacity and facilities is exacerbated, but also the island accommodation and transport capacity.

In this sense, the aim of this case study is to analyse and quantify the costs imposed on society as a result of the peak-load demand and to explore alternative airport pricing schemes in order to induce a more efficient utilization of airport capacity.

The case study has been divided into four parts:

1. Demand analysis.
2. Review of previous relevant work in the literature.
3. Identification and quantification of external costs associated to peak periods borne by private and public agents at the airport and by economic agents located outside the airport but directly related to tourism.
4. Analysis of available alternatives in order to reach a more efficient capacity allocation. It is in this context that the effects of price differentiation mechanisms on airlines are investigated.

3.2 DEMAND ANALYSIS

In this section we review the main features of demand at Gran Canaria airport. We start by providing an overall picture of the main types of traffic, and then focus on the time-distributional aspects of flights, that is, on the nature and importance of peaks at the airport.

5 One in each island, except in Tenerife, where there are two (North and South).

6 During 2006 more than 9.5 million foreign tourists arrived to the Canary Islands (2.9 million to Gran Canaria).

As already mentioned, Gran Canaria airport is an international one, ranked fifth among Spanish airports.[7] As shown in Figure 3-1 and Table 3-1 traffic reaches almost 10 million passengers per year. More than a half of total traffic is Europe related (54 percent) whilst almost the other half (44 percent) corresponds to inter-island and other national flights.

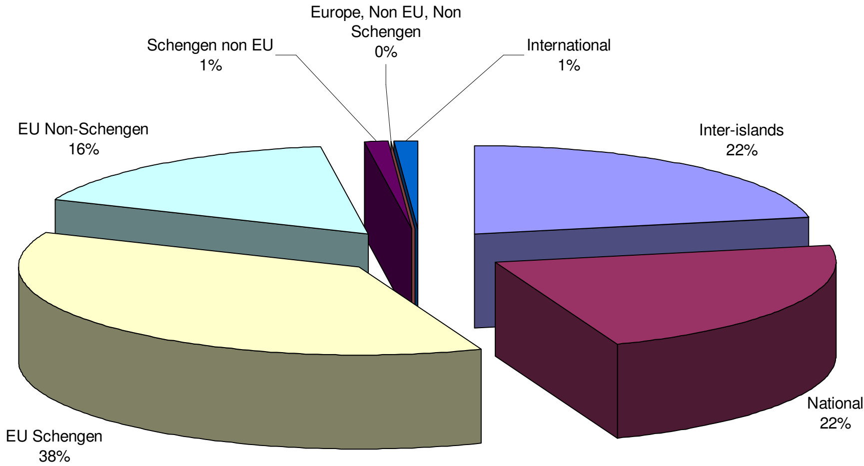


Figure 3-1 Distribution of Passengers. Gran Canaria Airport in 2006.

Table 3-1 Distribution of Passengers. Gran Canaria Airport in 2006

Inter-islands	National	EU Schengen	EU Non-Schengen	Schengen, Non EU	Europe, Non EU, Non Schengen	International	TOTAL
2,196,846	2,206,324	3,720,369	1,629,637	105,862	2,324	110,805	9,972,167

It is worth mentioning that most flights coming from the European Common Space are usually charter flights. In fact, British tourists mainly fly on charter flights, while Germans usually arrive on scheduled ones. Nevertheless this distinction between scheduled and charter flights is nowadays less relevant than in the past, and more frequently regarded as an artificial separation.

Figure 3-2 shows that both national and inter-islands traffic levels are more stable than the international one (including EU and others), which exhibits a peak during autumn and winter, but falls substantially in spring and summer.

7 Madrid, Barcelona, Palma de Mallorca and Malaga occupy the previous positions.

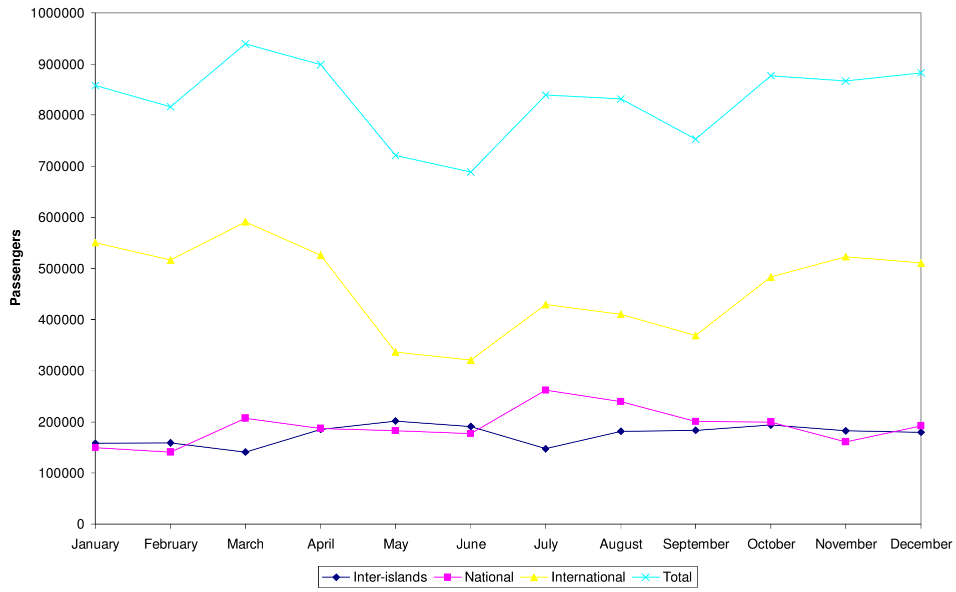


Figure 3-2 Monthly Distribution of Passengers. Gran Canaria Airport in 2006

3.2.1 National and Inter-Islands Flights

In general, most inter-islands and national flights are regular ones, with little variability within the year, except during summer holidays, when national tourists increase. An important characteristic of inter-island flights is that all routes have been declared as Public Service Obligations since 1998. In a deregulated context it implies new re-regulation of aspects like air fares, frequencies or capacity offered. Under this institutional context and supported by routes with strong demand, Binter Canarias is the dominant air carrier with a market share well above 80 percent. A relatively new company, Islas Airways, operates the remainder traffic.

The routes from Gran Canaria to Tenerife North (33 percent), Fuerteventura (29 percent) and Lanzarote (27 percent) are the most important ones (see Figure 3-3). In absolute terms, the route Gran Canaria-Tenerife North is considered as the densest one, with traffic levels greater than 725,000 passengers per year (data for 2006).

With respect to the remaining national traffic to and from mainland Spain, Figure 3-4 shows the importance of Madrid-Barajas as a hub airport, as described in the next case study. More than 1.4 million passengers (64 percent) flew in 2006 to/from Madrid-Barajas airport from/to Gran Canaria. Barcelona and Seville airports are the following more important destinations, though well behind the Madrid traffic levels.

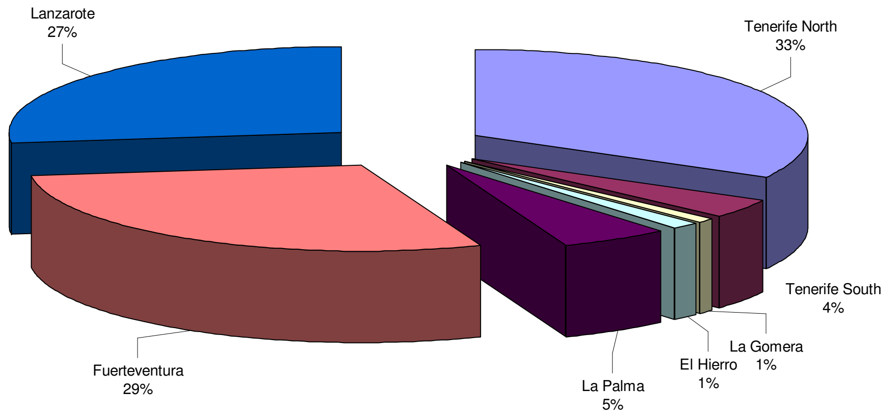


Figure 3-3 Distribution of Inter-Islands Passengers with Origin/Destination in Gran Canaria Airport (2006)

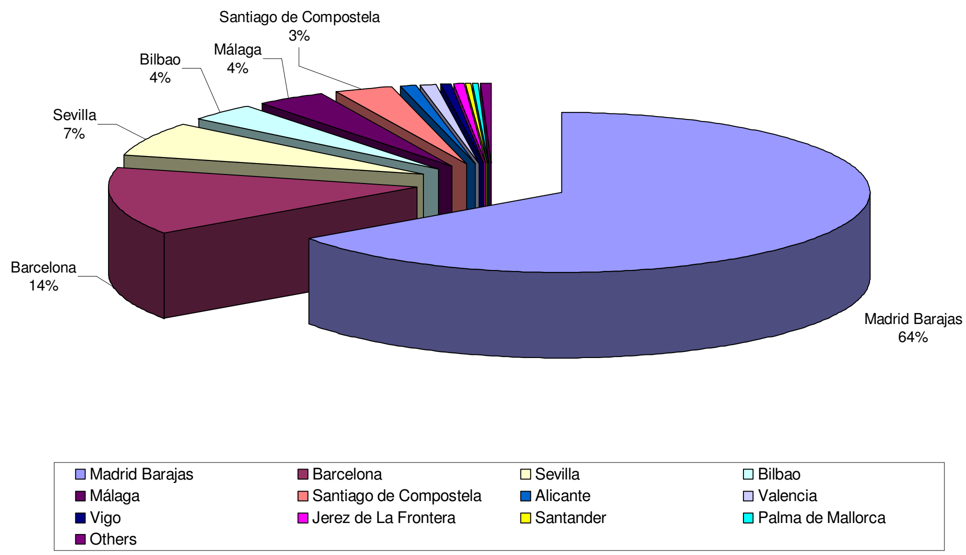


Figure 3-4 Distribution of National Passengers with Origin/Destination in Gran Canaria Airport (2006)

Considering market shares by airline, Iberia enjoys a dominant position, moving during 2006 around one million passengers (38 percent). Spanair (29%) and Air Europa (19%) are the second and third more important carriers in this national market.

3.2.2 International Flights

As we can see in Figure 3-5 three quarters of total non-national traffic comes from Germany, The United Kingdom and the Nordic countries, with German tourists being the most numerous at 28 percent of the total.

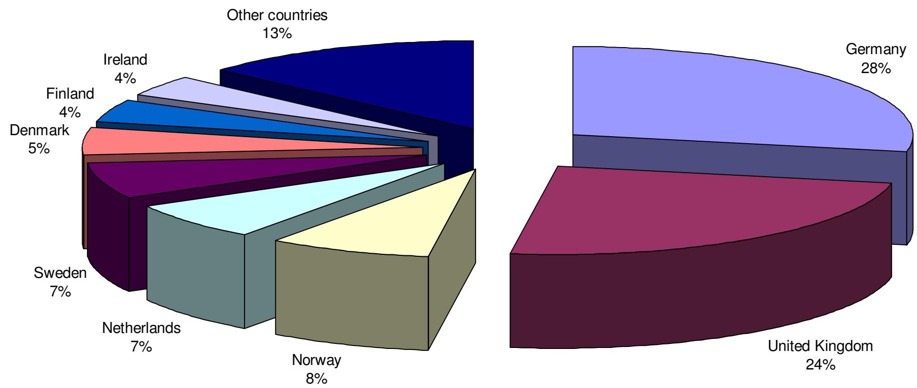


Figure 3-5 Origin of Non-National Passengers. Gran Canaria Airport in 2006.

Gran Canaria airport is well connected with many European airports. In 2006 there were a total of 159 destinations but the most relevant ones, according to number of passengers were:[8] Amsterdam Schiphol (309,600), Manchester (303,929), London Gatwick (291,981), Oslo (238,460), Frankfurt (221,449), Düsseldorf (207,430) and Helsinki (173,178).

Concerning air carriers in the international market (see Figure 3-6) figures for year 2006 do not show the existence of a dominant carrier. On the contrary, there are many airlines involved, and just a couple of them with market shares exceeding 10 percent. In 2006 Condor and Hapag-Lloyd enjoyed the highest shares (10 percent) with a traffic level of 0.58 million passengers each one. It was followed by MyTravel (6.8 percent, 0.36 million passengers), Transavia (4.8 percent, 0.25 million) and Thomas Cook (4.6 percent, 0.24 million passengers). Nevertheless at the beginning of 2007 there were several collusive movements within the sector. On one hand, tour-operators MyTravel and Thomas Cook merged, and so did First Choice and Thomson on the other hand. This increased concentration implies a reduction in competitors and, therefore, we should expect higher market shares of individual airlines in the future.

8 It is important to note that the existence of the route does not necessarily mean that this is accessible to residents in the Canaries, as many flights are sold completely through the tour-operators.

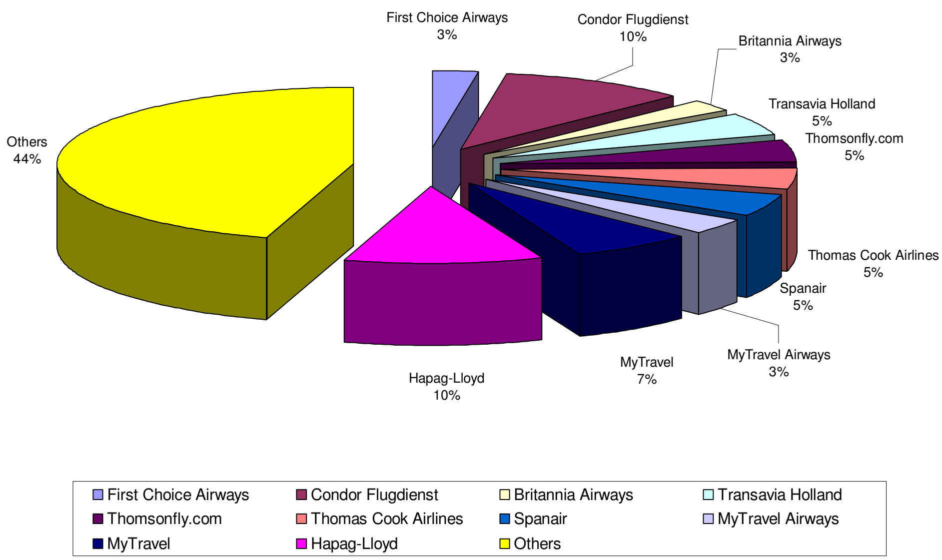


Figure 3-6 EU Passengers per Company, Gran Canaria Airport in 2006

3.2.3 Analysis of Peaks

Due to the touristic nature of most of its traffic, capacity demand at Gran Canaria airport exhibits peaks at different periods. Firstly, we can consider the tourist peak season (autumn and winter) versus the off-peak season (spring and summer); secondly we can analyse daily peaks within a given week (e.g. Mondays and Saturdays, as described); finally, the peaks may reappear by hours in a same day (e.g. midday or early afternoon hours).

The capacity of any airport is given by the capacity of its facilities (runways and terminals).[9] In the case of Gran Canaria airport, and for the terminal, it is convenient to distinguish between the arrivals lounge and the departure lounge capacities. We will see later that there are no major problems in the arrivals area. The main problem arises at the departure area due to the limits imposed by the check in and security "filters", that do not allow to handle more than 3,000 passengers per hour. On the contrary, the design capacity of the arrivals area would allow processing a number of passengers close to 6,000. It should be noted that reaching such a limit would be very rare giving the constraint in the departures area, as there is almost a correspondence between number of departing and arriving passengers, as they occupy the same aircrafts. This circumstance is illustrated by Figure 3-7. It can be seen that the worst peak hour in a whole year has been moving around the 6,000 figure during the last years, though increasing steadily since 2000. This means that no more than roughly 3,000 passengers will be in the departures area and therefore the same number should be found in the arrivals area.

9 The airport has two runways, though for security reasons and due to the small distance between them they can not be used simultaneously.

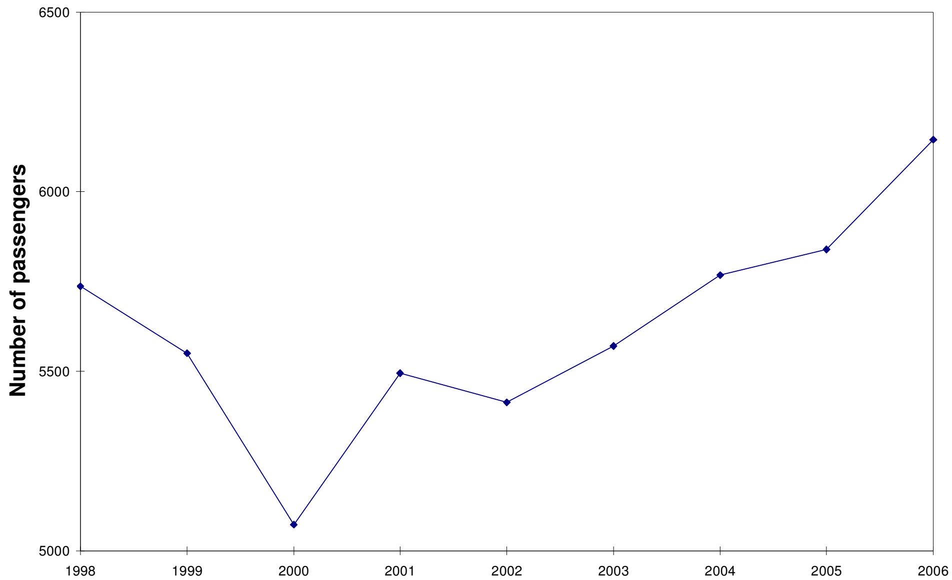


Figure 3-7 Maximum Number of Passengers in a Peak Hour, Gran Canaria Airport

However one of the main features of demand at Gran Canaria airport is the daily distribution of passengers and operations. We illustrate this with weekly data for passengers during January and March 2006.[10] Figure 3-8 and Figure 3-9 show all passengers at the airport in a reference week of January and March 2006 at hourly intervals. During these weeks, Mondays, Wednesday and Saturdays appear as the most important peak days, though the worst hour is located in the selected Wednesday in January. In addition, most passengers arrive/leave at midday or early afternoon flights.[11] A more detailed analysis of peaks by type of flights allows us to deduce that peaks are imposed by flights from the EU, mostly flights from Germany and the United Kingdom and as a result of the way tour-operators organize their activities. Inter-islands and other national flights are quite stable along the week.

One of the most interesting characteristics of peaks – their dynamics -- is also illustrated by these figures. Since peaks can evolve over time, any pricing policy aimed to a more efficient use of airport capacity should consider this fact. Even more, any pricing policy should take into consideration the whole network of airports within the Canary Islands, as Figure 3-10 and Figure 3-11 show. Again, peaks are dynamic, in time and also in space. Surprisingly, the peak days at Gran Canaria and Tenerife South move like a wave from one to the other. The peak day at Gran Canaria is usually the off-peak day at Tenerife South, and vice-versa. The only exception is Thursdays, when the peak moves to Lanzarote, a smaller airport than Gran Canaria and Tenerife South. A similar peak-pattern can be found at Fuerteventura, for which Mondays and Wednesdays correspond to the peak periods. This finding also demonstrates that there is no special preference for coming to the Canaries on a given day, as the peak moves along the week from one airport to another.[12]

10 Note these are two "peak" months in terms of the tourist season.

11 This has to do with convenience of departing and arriving times. For instance, someone leaving from Manchester would like to take a plane that departs at 10 a.m., arriving in Gran Canaria four hours and a half later. This arrangement would allow him to start his journey from home around 7 a.m. that can be regarded as a convenient time.

12 This was also checked by reviewing different tour-operators offers. No special preference for travelling on a given day was detected either to the Canary Islands or to other destinations.

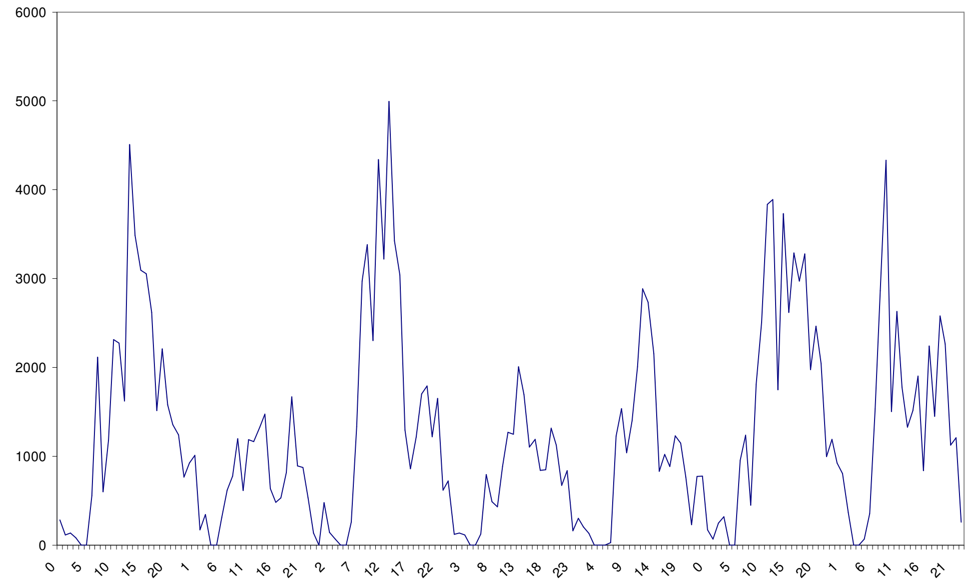


Figure 3-8 Distribution of Total Passengers per Hour, Week of January 2006, Gran Canaria Airport

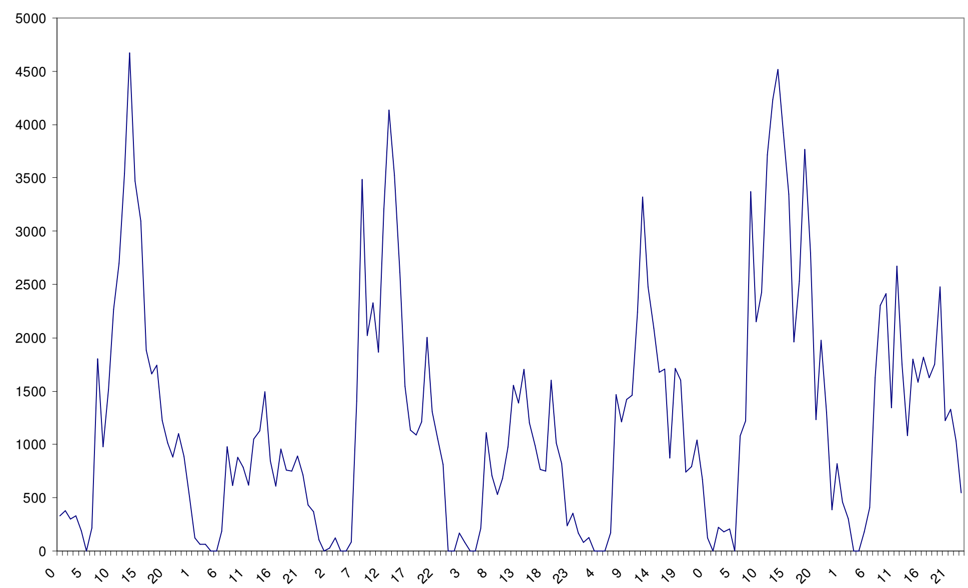


Figure 3-9 Distribution of Total Passengers per Hour, Week of March 2006, Gran Canaria Airport

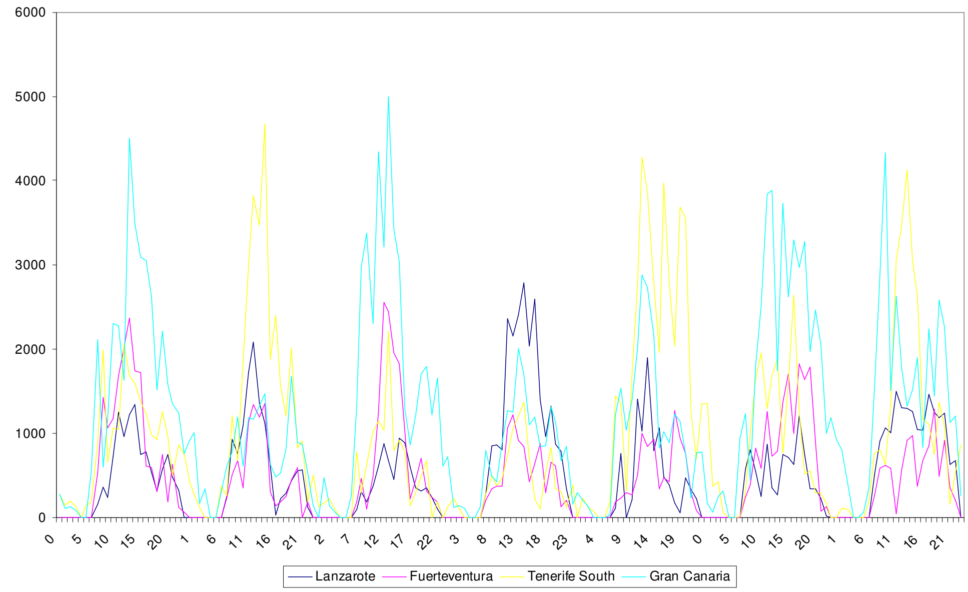


Figure 3-10 Distribution of Passengers by Hour, Lanzarote, Fuerteventura, Tenerife South and Gran Canaria, Week of January 2006

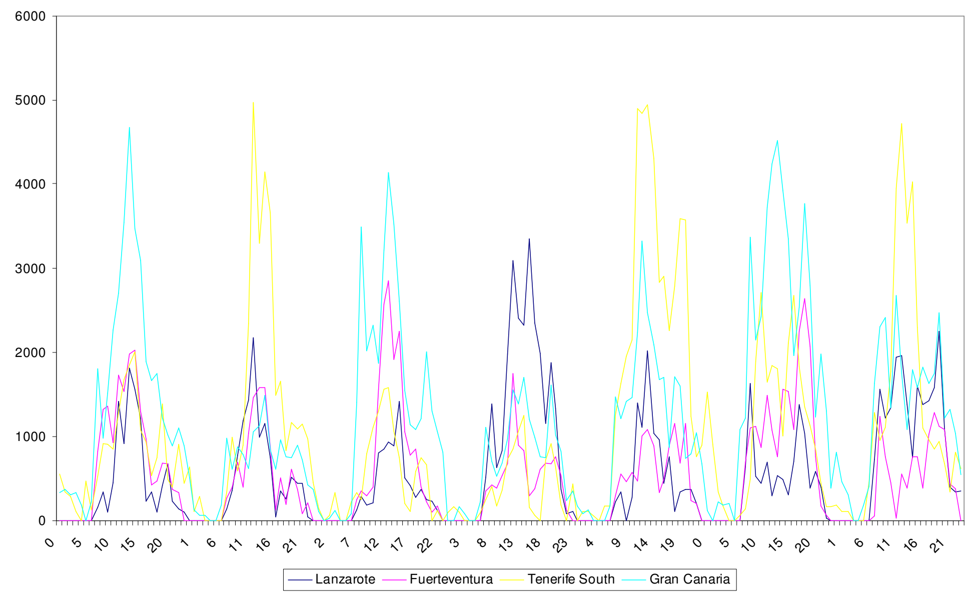


Figure 3-11 Distribution of Passengers by Hour, Lanzarote, Fuerteventura, Tenerife South and Gran Canaria, Week of March 2006

The question of how close is Gran Canaria airport to its capacity limit is answered by Figure 3-12, Figure 3-13 and Figure 3-14. Regarding the runways capacity (maximum of 36 movements per hour), it can be seen that some peaks are already quite close to maximum capacity. At the terminal, the capacity problem differs per area: as already mentioned, the arrivals area is not at all problematic,[13]

13 The arrivals area capacity does not include the outside space where other people wait to meet passengers after they have got their luggage.

and even at the peak days and hours it remains below 50% of capacity usage. On the contrary, the departures area reaches its limits during several days in January.

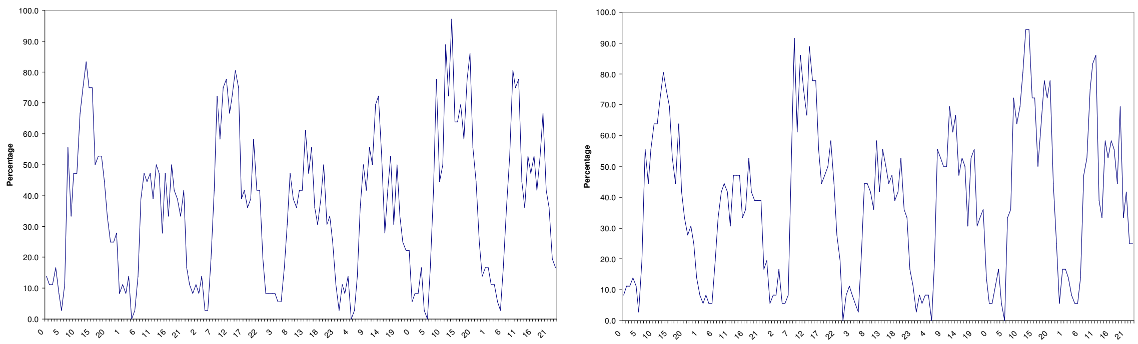


Figure 3-12 Percentage of Runway Capacity Utilisation, Week of January (left) and March (right) 2006

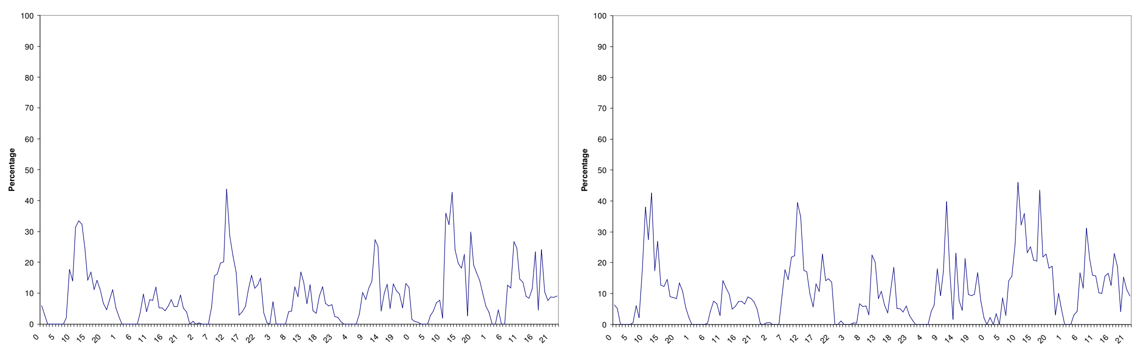


Figure 3-13 Percentage of Terminal Capacity Utilisation, Arrivals Area, Week of January (left) and March (right) 2006

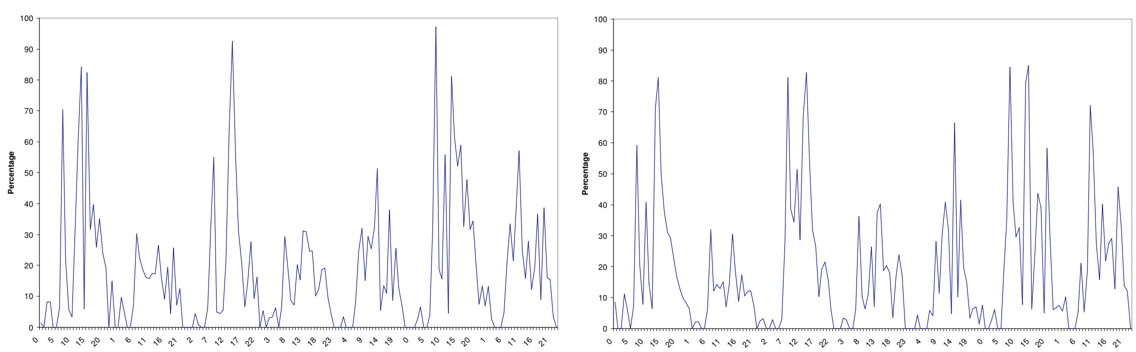


Figure 3-14 Percentage of Terminal Capacity Utilisation, Departures Area, Week of January (left) and March (right) 2006

3.3 REVIEW OF RELEVANT LITERATURE

Peak-load pricing refers to the pricing of economically non-storable commodities whose demand varies periodically. Thus, with uniform prices over time, the quantity demanded rises and falls periodically. To meet demand at the peak periods would then require firms to over-invest in capacity that will be under-utilized over the remainder of the cycle. Since the capacity is costly, this over-investment in capacity is the basis for the peak-load problem and the motivation for using prices to mitigate this inefficiency.

The economic literature concerning peak-load pricing is rather extensive. The early literature on peak-load pricing used to link public utility pricing to economic efficiency and marginal cost, using the main results of the growing field of applied welfare economics. Clear examples are the works of Bye (1926 and 1929), Lewis (1941), Boiteux (1949 and 1951), Houthakker (1951), Little (1953), Steiner (1957), and Hirshleifer (1958). Other authors extended these preliminary models in order to include the use of more than one technology to meet demand (see Crew and Kleindorfer, 1971), or demand and supply uncertainty (see, for example, Brown and Johnson, 1969, Visscher, 1973, Carlton, 1977 or Chao, 1983).

While in the economic literature peak-load pricing was originally conceived as a pricing mechanism for monopolies, either public or private regulated ones, its use has now spread to some competitive industries, such as the air transport industry.

Peak-load pricing in transport has been traditionally linked to congestion problems. Congestion occurs when too many users enter into a limited-capacity infrastructure. The economic solution for this problem requires users to pay for the costs they impose on other users. A practical implementation of this principle is to charge users during peak hours, aiming to redistribute those users with a lower valuation for trips to alternative routes or time periods. However, as Nombela et al. (2004) point out, peak-load pricing in air transport is different than congestion pricing, since the social cost of flights delays depends on the impacts generated on subsequent flights and is not necessarily more costly during peak periods. Airport congestion fees should reflect the real impacts caused to all agents. Since a delay at hour t may have an impact up to hour t+2, Nombela et al. argue that delays at early hours within the day should be more heavily penalized than those at the end of the day, even if they occur during non-peak hours. Usual recommendations for peak-load pricing at airports ignore this fact, and thus are not likely to provide agents with the right incentives to put the maximum effort in avoiding flight delays. They conclude that peak-load pricing is an efficient mechanism to respond to a non-uniform demand profile which creates differences in the opportunity costs of supplying capacity at different periods of time, but it is not necessarily the right mechanism to deal with an externality which exhibits this feature of not being always higher at peak times.

There are few papers applying the peak-load pricing principles to the air transport industry. We can mainly refer to the papers of Daniel (1995, 2001), Daniel and Pahwa (2000), Adler and Berechman (2003) and Janic (2005).

Daniel (1995, 2001) develops a stochastic-bottleneck model with stochastic queues, time-varying traffic rates, and endogenous, intertemporal adjustment of traffic in response to queuing delay and fees. The simulation model is implemented using Minneapolis-St. Paul airport traffic data for the scheduled and real operating times of every arriving and departing flight during the first week of May 1990. The simulation model determines equilibrium traffic patterns, queuing delays, lay-over costs, congestion fees, airport revenues, efficiency gains, and distributional effects of congestion pricing. On the one hand, no-congestion fee simulations replicate real traffic patterns very well. On the other hand, congestion fee simulations predict significant intertemporal traffic adjustments in response to pricing. In particular, congestion pricing reduces the surpluses of general, regional, and miscellaneous aviation but increases surpluses of airports, major airlines, and airline passengers. Daniel concludes that the magnitude of the gains far outweighs the losses, so the redistribution of surpluses can make congestion pricing Pareto improving.

Daniel and Pahwa (2000) compare three empirical models of airport congestion pricing: a standard peak-load pricing model with econometrically estimated demand and delay functions (Morrison, 1983, and Morrison and Winston, 1989); a deterministic bottleneck model with traffic adjusting intertemporally to congestion prices (Vickrey, 1969, and Arnott et al., 1993); and a bottleneck model with time-dependent stochastic queuing (Daniel, 1995). Simulations are made using Minneapolis-St. Paul airport traffic data. They conclude that the models produce similar traffic patterns under weight-based pricing, but differ significantly under congestion pricing. Moreover, they demonstrate the importance of structural modelling of endogenous, stochastic traffic rates and queues that produce lower fees at peak and slack-demand periods than other models. They also show the advantage of tolls that vary continuously - instead of by hour - to spread the peak and moderate extreme fee levels. By demonstrating that such a charge involves modest changes in average fee levels and retains periods of low priced airport access, Daniel and Pahwa try to make this pricing mechanism more acceptable by policy makers, the industry and the public.

Adler and Berechman (2003) develop a model to compute the optimal charges at an airport, considering the revenue requirements of airports, the establishment of congestion charging in peak periods and the introduction of noise and engine emissions social charges. Using data from Schiphol airport (Amsterdam), they conclude that Schiphol is currently charging higher than optimal tariffs and collecting monopolistic rents. However, if congestion and noise charging are further developed and engine emission social costs are introduced, the current tariffs ought to increase by 17% in peak periods and 2% in off-periods, resulting in an efficient use of airport slots and avoiding delays given the current capacity. In other words, Adler and Berechman show that, under such an approach, the distribution of traffic between peak and off-peak periods is more uniform than under the present pricing mechanism where peak and off-peak charges are equal.

Finally, Janic (2005) develops three models to evaluate congestion charges at an airport. Congestion charging implies internalizing the cost of marginal delays that a flight imposes on other flights due to congestion. However, marginal delays and, thus, congestion charging vary during the day. The three models developed are: a queuing model based on diffusion approximation for quantifying relevant congestion; a model to estimate marginal delays and their costs imposed by each flight on other flights during congestion; and a model to estimate the profitability of each flight burdened by the congestion charge from the airline's point of view. The models are applied to the traffic scenario of New York LaGuardia airport. Janic finds that congestion charging provides a general stimulus for airlines to change their fleet in favour of larger aircraft. Moreover, congestion charging contributes to the consolidation of the market position of the incumbent airlines, discourages new entries and thus compromises competition at the airport.

In practice, the theory of peak-load pricing has had a crucial effect in some sectors, such as the electricity industry, through the introduction of time of day electricity rates and interruptible service offerings. In other sectors, such as the air transport industry, the peak-load pricing theory has been less applied. Indeed, although the use of airports' facilities is usually characterized by peaks, there are few examples of airports around the world applying peak-load pricing. The London airports provide a clear exception, applying a peak-load pricing mechanism with time-of-day seasonal pricing not just to aircraft landings but also to passenger terminal usage and aircraft parking.

Peak-load pricing in airports would imply pricing at short-run marginal cost. However, Crew et al. (1995) claim that applying peak-load pricing to airports is not as effective as in other industries because of the airline's grandfather interests in landing slots. A slot is the right to land or take-off at a particular time. The grandfather rights imply that an airline retains its rights to a time in the next period. On the other hand, given the considerable value of some routes and slots relative to the short-run marginal cost of landing or taking-off, the scope for peak-load pricing in order to change times of operation is quite limited.

Schank (2005) also describes problems to be borne in mind when an airport is considering implementing this pricing mechanism. He analyses three cases: Boston, New York and London. Except for the London case, all airports failed in applying peak pricing mechanisms. There are mainly three reasons: first, in most cases the elasticity of demand between peak and off-peak periods for air travellers is low, which makes the assumption that passengers can switch their arrival times at minimal societal cost rather tenuous. Second, there may be institutional barriers to peak pricing theory that prevent effective implementation. In general, peak-load pricing affects small aircraft users and General Aviation operators more directly. Thus, it is necessary that an alternative airport exists, in order to attract users diverted as a result of the new pricing structure.[14] Finally, it might be extremely hard to

14 For example, Boston Logan airport failed in implementing a peak-load pricing mechanism because smaller aircraft users challenged it in Court, arguing that those charges did not represent a fair allocation of costs to small aircraft users. The pricing mechanism was found to be discriminatory because there was no acceptable alternative airport for diverted users. As a result of the court's ruling, the airport was forced to drop the pricing mechanism. All of their subsequent appeal attempts failed.

calculate marginal costs in an accurate manner. Therefore, though peak-load pricing is an efficient mechanism from a theoretical point of view, sometimes it may be difficult to implement. However, if the demand elasticity between peak-load hours is sufficiently high (as in the case of low-cost flights or charters) and/or there exist alternative airports or modes of transport, peak-load pricing might be successfully implemented.

The main conclusions concerning the implementation of peak-load pricing in airports are summarized in Table 3-2.

Table 3-2 The Implementation of Peak-Load Pricing in Airports

Definition	• Peak-load pricing refers to the pricing of economically non-storable commodities whose demand varies periodically. • Peak-load pricing in air transport is different than congestion pricing. • Peak-load pricing in airports would imply pricing at short-run marginal cost.
Advantages	• With peak-load pricing the demand is redistributed in a more uniform way. • To meet demand in peak periods, airports do not have to over-invest in capacity that will be under-utilized in load periods.
Disadvantages	• Peak-load pricing is not necessarily the best mechanism to deal with externalities that are not always higher at peak times, such as the flights delays.
Barriers	• The existence of grandfather rights. • Low elasticity of demand between peak and off-peak periods. • Institutional barriers. • It might be difficult to calculate short-run marginal cost in an accurate manner.

3.4 THE COSTS OF NO DIFFERENTIATION

The actual fare structure at the airport is determined by AENA (Aeropuertos Españoles y Navegación Aérea), the public entity in charge of managing the whole network of Spanish airports. The structure and level of charges is quite homogenous for all the airports, and only differentiated by type of airport and by type of flight. Thus, smaller airports charge lower prices whereas domestic flights also enjoy lower fares (AENA, 2006). There are no additional differentiation criteria except for the MTOW of aircraft which is in fact an international practice.[15]

Such a fare structure not only affects the behaviour of airlines and ultimately tour-operators, but also has consequences upon a number of other economic agents located either at or outside the airport. A categorization of the type of agents affected is detailed in Table 3-3.

Table 3-3 Agents Affected by Airport Fare Structure

At the airport
• Passengers • Airport service providers: ○ Commercial services (restaurants, shops, etc) ○ Ramp and traffic handling ○ Fuel provision ○ Rent a car
Main agents outside the airport
• Bus companies • Hotel and apartments

15 It was only by the end of year 2007 that a noise charge has been introduced at the most busiest airports in Spain: Madrid and Barcelona.

All these agents are the costs bearers of the current policy (or the benefit recipients of a differentiated pricing policy based on capacity utilization). Of course the tour-operators would be on the other side as they are benefiting out of the current policy. Nevertheless, there is a very important cost bearer group that has not been included in the table above. This is the one formed by tax payers, who will have to bear a new and huge airport investment that might have been delayed in the presence of a more efficient pricing policy. Neither the benefits for tour-operators nor the costs for the tax-payers were included in our estimates.[16] Finally, we cannot anticipate the consequences for AENA of an alternative pricing policy, though in principle the new pricing scheme could be designed under the restriction of revenue neutrality.

In what follows we present costs estimates and methodological procedures for each of the agent categories in Table 3-3.

3.4.1 Passengers' Costs

For the estimation of passengers' costs we have distinguished between the arrivals and departures areas at the airport terminal. With respect to the latter, we observed that passengers departing from the airport usually arrived there around two hours and a half in advance independently of the day of the week. This implies that they are not spending more time at the airport during a peak day when compared with and off-peak one, though they are for sure experiencing quite different waiting conditions. For this reason and in order to estimate passengers' costs we identified two critical sections: check in and security. The benchmark for reference were the times spent by a theoretical passenger assuming a uniform distribution of demand along the hours of a given week, which in turn is the expected result that would be induced by a peak pricing policy. Consequently the costs for passengers in the departure area and going through check in and security, are given by the difference of time costs when we compare the benchmark (passengers are uniformly distributed along the week) and the current case in which passengers have to wait under crowded conditions.

The situation at arrivals is slightly different. In that area we detected differences in total times required to exit the terminal, and consequently have valued those times.

Actual times spent for check in and security procedures and in the arrivals area were collected during the period from 9th to 15th April 2007 and from 9 a.m. till 5 p.m. This week is assumed to be representative enough of the whole year (see Figure 3-72). Only passengers from UK, Germany and the Nordic Countries were considered, as these are the ones imposing the peak nature of demand.[17] Finally, even having a congested terminal and runways at the peaks, this fact did not translate into important delays for flights; therefore it is important to be clear that the issue for Gran Canaria airport, and in the case of passengers, were not flight delays, but as already mentioned, the waiting times conditions or the quality of waiting in the case of departures, and total times required to exit the terminal building in the arrivals section.

During the sampling week, a total of 217,922 passengers used the airport, 45 percent as arriving and 55 percent as departing passengers. Out of this total, around 87 percent were passengers from UK, Germany and the Nordic Countries.

The representativeness of our sample is shown at Table 3-4, 3-5 and 3-6. In total we have covered around 60 percent of the total population either in terms of flights or passengers. The case of the security area is slightly different as other national passengers mixed there as well. Hence, Table 3-6 refers to total number of passengers in a given day, including national and non-national ones. In turn, the number of passengers analysed refers to total passengers that used the security system from 9 a.m. till 5 p.m., though the actual queuing times were counted only for passengers that were randomly selected every five minutes.

16 There are also some additional external costs associated with a greater production of pollutants under congested conditions. This is outside the scope of this work.

17 Other national or international carriers and passengers may be also affected by the congested conditions at the terminal. Such costs were not included in our results.

We are aware that we have left out of our sample some of the flight of interest; however we think that passengers on those flights were not at the highest peak of the day (i.e. before 9 p.m. or after 5.p.m) and consequently were experiencing better time conditions (see Figures 3.8 and 3.9).

Table 3-4 Representativeness of Sample: Departures and Arrivals Area, Flights from UK, Germany and Nordic Countries

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
Departures								
Flights analyzed	34	5	47	10	18	52	23	189
Total flights	49	6	66	14	33	88	41	297
Sample	**69.4**	**83.3**	**71.2**	**71.4**	**54.5**	**59.1**	**56.1**	**63.6**
Arrivals								
Flights analyzed	37	5	37	9	12	30	15	145
Total flights	48	8	63	15	33	83	41	291
Sample	**77.1**	**62.5**	**58.7**	**60.0**	**36.4**	**36.1**	**36.6**	**49.8**

Table 3-5 Representativeness of Sample: Departures and Arrivals Area, Passengers from UK, Germany and Nordic Countries

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
Departures								
Passengers analyzed	7422	1106	8154	1581	3539	9960	3857	35619
Total passengers	9676	1282	11291	2404	6414	16814	7576	55457
Sample	**76.7**	**86.3**	**72.2**	**65.8**	**55.2**	**59.2**	**50.9**	**64.2**
Arrivals								
Passengers analyzed	7455	912	5500	1334	2203	4930	2491	24825
Total passengers	8643	1061	7430	1809	3261	10516	6310	39030
Sample	**86.3**	**86.0**	**74.0**	**73.7**	**67.6**	**46.9**	**39.5**	**63.6**

Table 3-6 Representativeness of Sample: Security Area, Total Passengers

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
Passengers through security								
Passengers analyzed	11357	1980	11540	2560	5157	14138	7475	54207
Total passengers	15563	5740	17529	6579	10353	24800	15030	95594
Sample	**73.0**	**34.5**	**65.8**	**38.9**	**49.8**	**57.0**	**49.7**	**56.7**

Costs estimates for passengers are reported in Tables 3-7, 3-8 and 3-9. For the conversion of times into costs we have used and updated values reported in the Heatco project (Bickel et al., 2006). The reference value for travel time is a weighted average of 11 euros per hour.[18] In our specific case study we need a value which would capture the willingness to pay of passengers to avoid waiting, either at

18 For UK, Germany, Finland and Sweden. The weights were number of passengers.

the check in or security sections or in the arrivals lounge. To our knowledge there is not enough evidence for airports in this regard, as the available evidence in fact comes from other modes and situations. Hence we have followed the general recommendation given by Heatco, which advices to increase in-vehicle time values by a factor of 2.5 for waiting, or by 1.5 when passengers on public transport have to stand in over-crowded conditions. We have finally increased our reference value by a factor of 2, in order to account for crowded conditions at the terminal.

Table 3-7 Check-in Area, Costs of Time for a Representative Week

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Time in queue (minutes)							
Average time per passenger	44.2	51.6	33.7	37.2	45.6	43.0	37.3
Standard deviation	24.1	19.1	21.4	12.6	19.6	38.1	22.3
Maximum time	124	82	112	53	83	115	100
Average number of check in desks opened	3.7	2.6	3.9	3.1	3.4	3.7	3.9
Comparison with uniform distribution (34.1 minutes)							
Difference per-passenger	10.2	17.6	-0.3	3.2	11.6	9.0	3.3
Total time wasted for all the passengers	75554	19443	-2413	5001	41037	89768	12688
Economic values (Euros)							
Cost per passenger	1.86	3.21	-0.05	0.58	2.12	1.65	0.60
Cost for total passengers	**13814**	**3555**	**-441**	**914**	**7503**	**16413**	**2320**

Table 3-8 Security Area, Costs of Time for a Representative Week

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Time in queue (minutes)							
Average time per passenger	4.2	2.6	5.4	2.4	5.2	5.1	3.8
Standard deviation	1.8	0.8	4.0	1.0	5.2	3.2	3.7
Maximum time	11	5	20	6	20	14	18
Average number of security points opened	3.4	2.2	3.1	2.0	3.1	3.6	3.1
Comparison with uniform distribution (4.1 minutes)							
Difference per-passenger	0.1	-1.5	1.3	-1.7	1.1	1.0	-0.3
Total time wasted for all the passengers	1309	-2934	14637	-4321	5684	13636	-2100
Economic valuation (Euros)							
Cost per passenger	0.02	-0.27	0.23	-0.31	0.20	0.18	-0.05
Cost for total passengers	**239**	**-536**	**2676**	**-790**	**1039**	**2493**	**-384**

Table 3-9 Arrivals Area, Costs of Time for a Representative Week

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Time (minutes)							
Average time per passenger	46.6	52.2	46.0	37.9	38.3	47.0	42.8
Standard deviation	8.8	16.4	8.1	7.6	6.6	7.5	10.4
Maximum time	66	74	61	56	54	68	66
Comparison with average (44.4 minutes)							
Difference per-passenger	2.2	7.8	1.6	-6.5	-6.1	2.6	-1.6
Total time wasted for all the passengers	16449	7111	8659	-8690	-13372	12661	-3889
Economic valuation (Euros)							
Cost per passenger	0.81	2.85	0.58	-2.38	-2.22	0.94	-0.57
Cost for total passengers	**6015**	**2600**	**3166**	**-3178**	**-4890**	**4630**	**-1422**

Our results show that the highest costs for passengers arise at the check in desk, Saturday being the worst day, followed by Monday. Interestingly, a peak day like Wednesday seems to be under very efficient operating conditions,[19] and the passengers in that day would be slightly harmed by the change in policy. Also very interesting is the situation of Tuesday which in spite of being an off-peak day, has the highest cost per passenger as the number of check in desks opened is also the lowest. Apparently this is one of the days selected for free disposal of handling personnel, who in turn would be moving to the Wednesday or the weekend. Cost figures for the security and arrivals area are lower and more unevenly distributed.

3.4.2 Airport Services Providers

The airport services providers at Gran Canaria Airport face similar demand peaks, and consequently are also facing additional costs. We have interviewed all of them, asking several questions concerning costs but also related to their preference over demand. Table 3-10 summarises the main results. It can be seen that all of them identify the tour-operator as the ultimate cause of demand peaks, all state that as a consequence they require to contract additional personnel and hence the vast majority would rather prefer facing a uniform demand. Table 3-11 shows estimated costs for these agents. The costs are given by the additional personnel required in order to respond to demand.

Table 3-10 Gran Canaria Airport Services Providers, Some Results from Survey

Sector	No. of firms	Main peak day	Second peak day	Explanation	Need more personnel?	Preference over demand
Jewellery	1	Monday	Wednesday	Tour-operator	Yes (100%)	Uniform (100%)
Rent-a-car	5	Monday	Wednesday	Tour-operator	Yes (100%)	Uniform (2), Current situation,(2) and indifferent (1)
Handling	4	Wednesday (3), Saturday (1)	Saturday (2), Sunday(1) and Friday(1)	Tour-operator	Yes (100%)	Uniform (100%)
Newspapers , duty free	3	Monday	Wednesday	Tour-operator	Yes (100%)	Uniform (100%)
Restaurants	2	Monday	Wednesday	Tour-operator	Yes (100%)	Uniform (100%)
Fuel	2	Monday and Wednesday	Wednesday and Saturday	Tour-operator	Yes (100%)	Uniform (100%)

19 The number of checking desks opened is the highest.

Table 3-11 Gran Canaria Airport Services Providers, Monthly Costs

Sector	Additional personnel	Average labour cost (€)	Total costs (€)
Jewellery	1	1044	1044
Newspapers, duty free	22	904	19895
Restaurants	30	928	27827
Handling	101	959	96816
Fuel	11	959	10544
Rent-a-car	9	959	8627

3.4.3 Bus Companies

A similar approach to that applied to airport services providers has been used for the estimation of costs in the case of bus companies. There are six bus companies providing transport services for tourists at the airport, and again the required transport capacity is mandated by tour-operators. The majority of bus companies provide school transport as well, which worsens the capacity problem when the services overlap. All companies are aware of the problem, and able to quantify the number of additional personnel needed, although two of them subcontract services instead. Table 3-12 reports basic results obtained during the survey. Taking into account salaries for the sector, the total monthly cost raises to 136,818 euros.

Table 3-12 Bus Companies, Some Results from Survey

Company	A	B	C	D	E	F
Markets	Tourism and school transport	Tourism and school transport	Tourism and school transport	Tourism	Tourism and school transport	Tourism and school transport
Working with tour-operator	Yes	Yes	Yes	Yes	Yes	Yes
Number of tour-operators working with	5	4	14	1	2	1
Main market	German	British, German, Scandinavian	British, German and other	British, German, Scandinavian and others	British, German, Scandinavian	British
Peak days for tourist transport	M, W, Sa, Su	M, W, Sa, Su	M, W, Sa, Su	M, W, Sa, Su	W, Sa, Su	M, Sa
Peak hours for tourist transport	10-14	11-14	10-13	09-15; some hours at night	Almost the whole day	10-17; 17-01
Peak days for school transport	M, Tu, W, Th, F	M, Tu, W, Th, F	M, Tu, W, Th, F	-	M, Tu, W, Th, F	M, Tu, W, Th, F
Peak hours for school transport	08-09; 14-15	07-08; 12-13	07-08; 12-13; 15-16	-	06-07; 09-10	08-09; 15-16
Explanation	Tour-operator	Tour-operator	Tour-operator	Airlines	Tour-operator and airlines	Tour-operator
Need more personnel?	Yes	Yes	Yes	No	No	Yes
How much?	3 drivers 1 engineer	100 drivers	25 drivers	Subcontract	No	Subcontract
Preference over demand?	Uniform	Uniform	Uniform	Uniform	Uniform	Uniform

3.4.4 Hotels

The population considered in order to estimate costs for hotels and apartments is given by the establishments which are members of *Federación de Empresarios de Hostelería y Turismo de Las Palmas (FEHT)*. This group includes 98 percent of hotels and 50 percent of apartments. The majority of lodgings are located to the South of the island. Out of this total population we have selected a representative sample as shown in Table 3-13. The main results obtained from surveys are presented in Table 3-14.

Table 3-13 Sample Analysed, Hotels and Apartments

Firms	1 key	2 keys	3 keys	4 keys	1 star	2 stars	3 stars	4 stars	5 stars	Total
Total firms	45	205	8	2	4	11	35	38	6	354
Sample	10	30	2	0	1	3	9	9	1	65
Percentage	22.2	14.6	25.0	0.0	25.0	27.3	25.7	23.7	16.7	18.4

Table 3-14 Hotels and Apartments, Some Results from Survey

	Working with tour-operator (%)	More than a market (%)	Main peak day	Peak hours	Explanation
1 key	100	20	Wednesday (50%), Monday (44%)	10-17	Tour-operator
2 keys	73	34.5	Wednesday (51%), Monday (27%)	10-17	Tour-operator
3 keys	50	50	Monday (50%), Saturday (50%)	11-17	Tour-operator
1 star	100	0	Wednesday (100%)	10-17	Tour-operator
2 stars	100	100	Variable	Variable	Tour-operator
3 stars	88	45.5	Wednesday (77%)	10-17	Tour-operator
4 stars	77	33.4	Wednesday (55%)	10-17	Tour-operator
5 star	100	0	Monday (100%)	11-17	Tour-operator
Total sample	**81.5**	**37**	**Wednesday (51%); Monday (31%)**	**10-17**	**Tour-operator (100%)**

Details for costs calculations are given at Tables 3-15 and 3-16. As much as 41 percent of establishments state that as a consequence of tour-operators' demand they require more personnel, and 61 percent of the sample declares a preference for a uniform demand.

Table 3-15 Hotels and Apartments, Additional Personnel Required

	Need more personnel?	How much and type?	Average personnel per hotel and type	Preference for a uniform demand
1 key	40%	1 reception 1 restaurant 2 cleaning 1 maintenance	0.25 reception 0.25 restaurant 0.50 cleaning 0.25 maintenance	60%
2 keys	43.3%	2 reception 32 cleaning 2 maintenance	0.15 reception 2.5 cleaning 0.15 maintenance	70%
3 keys	50 %	3 cleaning	3 cleaning	50%
1 star	0 %	-	-	100%
2 stars	67 %	1 reception	0.5 reception	33%
3 stars	33 %	2 reception	0.67 reception	33%
4 stars	44 %	18 reception 19 restaurant 13 cleaning	4.5 reception 4.75 restaurant 3.25 cleaning	66%
5 stars	0 %	-	-	100%
Total sample	**41.5%**	**24 reception 20 restaurant 48 cleaning 2 maintenance**	**-**	**61.5%**

Table 3-16 Hotels and Apartments, Estimated Monthly Costs

	Number of hotels	Hotels that do need more personnel A	Average personnel per hotel and type B	Average monthly cost per type C	Total monthly costs A*B*C
1 key	45	18	0.25 reception 0.25 restaurant 0.50 cleaning 0.25 maintenance	Reception: 872.65 Restaurant: 843.32 Cleaning-maintenance: 893.27	3,926 3,794 7,589 3,794
2 keys	205	89	0.15 reception 2.5 cleaning 0.15 maintenance	Reception: 912.85 Cleaning-maintenance: 893.27	12,186 198,752 11,925
3 keys	8	4	3 cleaning	Cleaning: 927.57	11,130.84
1 star	4	0	-	-	-
2 stars	11	7	0.5 reception	Reception: 912.85	3,194
3 stars	38	12	0.67 reception	Reception: 979.49	7,875
4 stars	35	15	4.5 reception 4.75 restaurant 3.25 cleaning	Reception: 1012.83 Restaurant-cleaning: 953.58	68,366 67,942 46,487
5 stars	6	0	-	-	-
Total sample	**354**	**147**	**0.9 reception 0.7 restaurant 1.8 cleaning 0.07 maintenance**		**446,967**

3.4.5 Summary of Costs

A total of around 1 million euros per month (see Table 3-17) is being borne by economic agents either at or outside the airport as a result of the peak-load demand,[20] and quite probably also induced by the current airport pricing policy that does not differentiate according to traffic conditions. Hotels and apartments establishments are the greater in number, and also the biggest costs bearers. They are followed by passengers, who experiment the lowest time quality when doing the check in previously to departures.[21]

Table 3-17 The Costs of a Non-Differentiated Airport Pricing Policy

Agents	Monthly cost	Annual cost	Percentage
Passengers: Check in area	191,001	2,292,012	19.3
Passengers: Security system	20,530	246,360	2.1
Passengers: Arrivals	29,993	359,914	3.0
Total passengers	**241,524**	**2,898,288**	**24.4**
Hotels	446,967	5,360,364	45.1
Airport services providers	164,753	1,977,036	16.7
Buses	136,818	1,641,816	13.8
Total other agents	748,538	8,979,216	75.6
TOTAL COSTS	**990,062**	**11,877,504**	**100.0**

3.5 CONCLUSIONS AND RECOMMENDATIONS

Many airports around the world are suffering from peak-load demand problems. To meet demand at the peak periods airports usually over-invest in capacity that will be under-utilized over the remainder of the cycle. Although the economic literature concerning peak-load pricing is rather extensive, there are few papers in the literature estimating the real costs of the peak-load problem. Most papers find a justification for the application of peak-load pricing policies just in the reduction of the inefficiency created by the over-investment in capacity. However, in this case study we show that the costs of the peak-load problem might be much more extensive, affecting not only the agents inside the airport, but also to other related sectors of the economy.

This case study also illustrates a situation in which decisions on airport charges and on airport investments seem to be taken at different instances. Demand peaks at Gran Canaria airport are associated to tourist arrivals and departures as scheduled by tour-operators. These peaks have been an important determinant of new investments at the airport without consideration of alternatives policies like charging higher prices when capacity is scarcer. Fair to say, the current airport charging regime was established by law, which by definition makes it pretty rigid.

Such peaks and loads in the demand give rise to a whole set of costs that are borne by economic agents located either at or outside the airport. All these agents are the costs bearers of the current situation. Tax payers at large will be bearing as well a very important cost associated with the new and huge airport investment that might have been delayed in the presence of a more uniform demand. Our estimated cost for the peak-load problem in Gran Canaria airport is almost 12 million euros per year, excluding the costs borne by tax-payers as a consequence of over-investment in capacity. Such a

20 If these costs are assumed to perpetuity and with an interest rate of 5 percent, the net present value of such rent would raise to 240 million euros.

21 We use the term “time quality” to indicate that passengers would be at the airport two hours in advance anyhow as it was the case. The question here is how they spend their time, queuing or in a more relaxed environment, for instance reading or having a coffee.

social cost would undoubtedly justify a change in the airport charging policy or at least in the procedure to allocate slots.

The peak-load problem is usually mitigated through peak-load pricing, which would imply pricing at short-run marginal social cost. However, although peak-load pricing is an efficient mechanism from a theoretical point of view, sometimes it may be difficult to implement because (i) it might be difficult to calculate the short-run marginal cost in an accurate manner, (ii) the existence of grandfather rights or institutional barriers and (iii) a low elasticity of demand between peak and off-peak periods. If peak-load pricing cannot be implemented for any of these reasons, alternative policies may be considered, such as restricting the number of slots to be granted to the airlines during peak days. However, the growing importance of low cost carriers in air transport markets, the possibility to extend the differentiated policy to other airport charges such as those of handling operations, or even more important, the difficulty to fund huge airport investments based on peak capacity needs, are among the counter arguments to bear also in mind when implementing a new pricing policy aimed to redistribute demand.

Additionally, we have shown that peaks are dynamic, and for our case study they appeared to be dynamic in time but also in space. Such a finding suggests that in order to design a new pricing policy we need to take into account the whole network of airports within the Canary Islands, as they are operated by the same institution and as the several destinations within the Archipelago seem to be close substitutes. In this respect, any pricing policy aimed to redistribute the peaks would have to be flexible enough to react to subsequent changes in the demand. A situation in which airports announce new prices with few weeks or even days in advance would be much desirable as it would contribute to a more efficient utilization of the airport capacity.

Finally, during the preparation of this case study we were told many times that airlines were not sensitive to changes in airport charges. Nevertheless we contacted the representatives of some airlines and asked them about their ability to move flights to off peak hours and days. Our feedback is that they are willing to move operations between peak and off peak days as far as they remain within the same hourly interval when they are compensated through lower airport charges. This initial response could be considered as evidence of demand sensitiveness at least on the airlines side. In turn, how tour operators would respond to that will depend on the ability of air carriers to pass on to them the savings in airport charges and on how much this would weight on the total tour operators activities balance.

To sum up, we believe that our paper adds value to the existing literature on the peak-load problem at least in three aspects: (i) it concentrates on a particular airport, though the methodology used could be easily transferable to other airports with similar inefficiencies; (ii) it should be able to contribute to the cost-benefit analysis of pricing policies at airports and other utilities and (iii) it illustrates a situation in which decisions on charges or the allocation of slots, and on infrastructure investments are taken at different instances, giving rise to inefficiencies that would have not appeared if both responsibilities were resting at the same institution.

4 MADRID BARAJAS AIRPORT: DIFFERENTIATION BY TYPE OF TERMINAL

4.1 INTRODUCTION

Madrid-Barajas is the main gateway of the Spanish airport system. During 2006 more than 45 million passengers travelled through this airport. It has experienced an increase of more than 60 percent in its traffic levels since 1999, with an average annual increase of 7.4 percent. At the beginning of 2006 it opened new facilities -- the new Terminal 4 -- that left the airport with four passengers' terminal buildings and four runways, and a design capacity that duplicated the existing one. After this expansion Madrid-Barajas can process a maximum of 80 million passengers per year. The airport occupies a prominent position within the European ranking (5th) and also an important one at the international level (13th).

As mentioned in the previous case study, the level and structure of airport charges is quite homogeneous and barely differentiated among Spanish airports (but to consider the importance of airports by traffic levels or type of flights).[22] The opening of the new facilities at Madrid Barajas may help to illustrate some problems associated with the lack of charges differentiation at the terminal level. In fact, the initial allocation of slots at the new facilities was subject to great controversy among Spanish airlines that wondered whether moving to the new facilities was convenient for them. Ultimately, Iberia and its partners of Oneworld alliance operate from the new terminal 4, whilst its main national competitor, Spanair and its partners of Star Alliance are located at the old facilities. Moreover, a new interesting development has also taken place at the airport: easyJet and Ryanair, the most important low costs carriers in Europe have entered the airport taking advantage of the new spare capacity. Both have decided to use the old facilities.

One of the main consequences of such an allocation is quite probably a reduction in the level of competition among airlines. Terminal 4 is not easily linked with the old terminals. At the moment there is a free bus service, but the whole journey, including waiting times at bus stops may take around half an hour. A passenger in transit should add the time needed to collect his luggage and exit the terminal in case of interconnection of flights. As a result the combination of flights from the passengers' point of view has become more troublesome than in the past, when all the airlines were closely situated. This case study will focus its analysis on how the current level and structure of airport charges can have an influence on this situation, and on what role it can play in altering it. In particular it will put emphasis on the scope of price differentiation by type of terminal.

Finally the case study will also briefly consider a possible differentiation of charges at the airport in accordance with air pollution and congestion. Though after the expansion in capacity the airport is no longer congested, it used to be so in the past and previous research projects have already estimated congestion costs (see UNITE project, Nombela et al., 2002).

The case study has been divided in three main parts:

1. Analysis of demand.
2. Review of relevant cases and literature.
3. Analysis of alternative pricing mechanisms through development of theoretical welfare models.

4.2 DEMAND ANALYSIS

As we can see in Figure 4-1 and Table 4-1, about half of total passengers come from domestic flights (46 percent). EU Schengen flights are the second more important group (25 percent), whereas International flights represent the third group in importance (20 percent). But data for domestic flights may be unreliable: the Spanish air transport system is organized as a hub-and-spoke network, where Madrid-Barajas is the main hub. Thus, while for example the route Milan-Gran Canaria might be

22 See section 3.4.

considered as an international flight, this hub-and-spoke system implies that the route Milan-Madrid is considered as international and Madrid-Gran Canaria as domestic (see section 4.3).

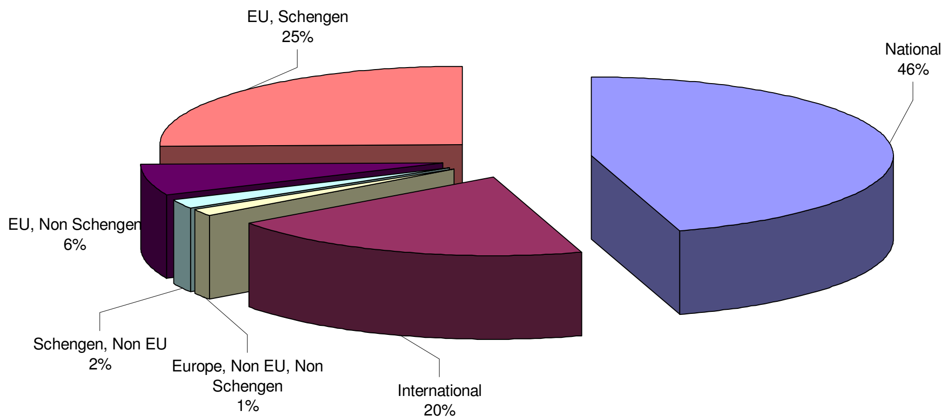


Figure 4-1 Distribution of Passengers, 2006, Madrid Airport

Table 4-1 Distribution of Total Passengers, 2006, Madrid Airport

National	International	Europe, Non EU, Non Schengen	Schengen, Non EU	EU, Non Schengen	EU, Schengen	TOTAL
20,628,534	8,974,226	598,300	869,374	2,948,007	11,446,806	45,465,247

Freight distribution is another important service provided at Madrid airport. Since 2001, total cargo has increased by 12.5 percent. In 2005, 333 thousand tonnes were moved at the airport. In Figure 4-2 it can be observed that the highest market share is for national freight (22 percent), followed by freight from/to United States (14 percent) and Germany (8 percent). Concerning distribution of freight by companies (see Figure 4-3), Iberia has a dominant position. The remaining companies represent small shares in the market.

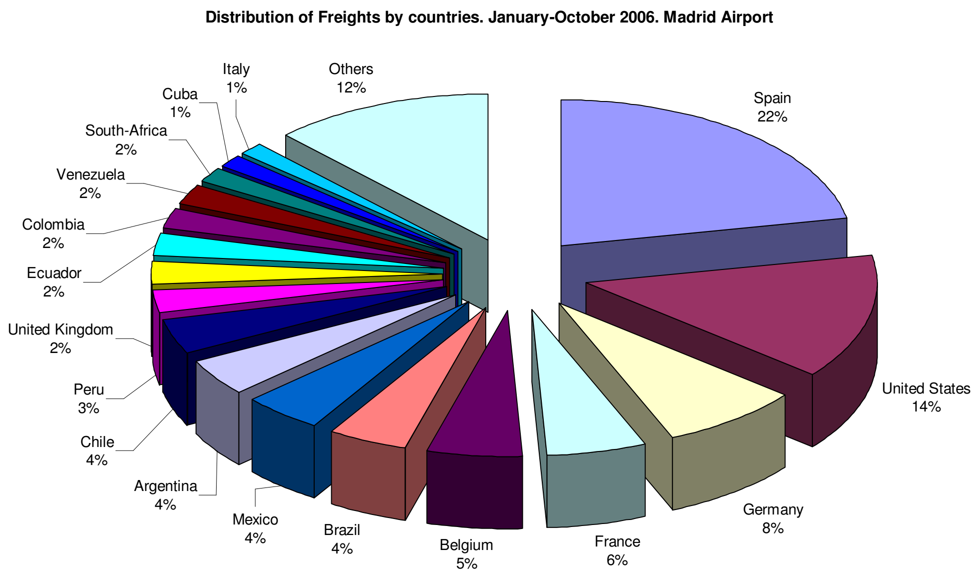


Figure 4-2 Distribution of Freight by Countries, January-October 2006, Madrid Airport

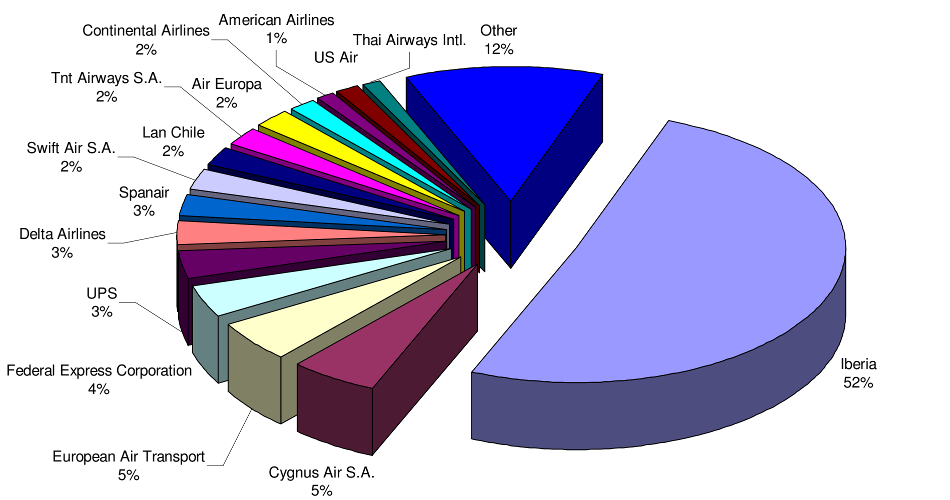


Figure 4-3 Distribution of Freight by Companies, January-October 2006, Madrid Airport

4.3 Terminals and Companies

Madrid Airport has four passenger terminals. Terminals 1 to 3 are the oldest ones and are well interconnected. Terminal 4 and its satellite 4S are part of the new facilities. As already mentioned, the distribution of companies by terminals is not random. Iberia and its alliance (Oneworld, which include British Airways, American Airlines, LAN, Qantas, Finnair, etc) decided to operate at the new terminals. Spanair and their associated partners from Star Alliance (Lufthansa, US airways, TAP Portugal, Scandinavian Airlines, United Airlines, etc) remained at the old terminal buildings.

The new distribution of carriers by terminals has altered companies and consumer's behaviour. Terminal 4 is a modern and nice facility, with an impressive undulating roof and beautiful modern structures,[23] though it has the disadvantage of being further split into the main Terminal (T4) and its satellite (4S), which implies higher transfer times on average. In addition many users are still not familiar with the new terminal, and moreover average luggage delivery times are longer due to the longer distances it has to go through. On the contrary, the old terminals are more flexible in this regard, with better accessibility. Nevertheless, the buildings are older, but are under renovation works at the moment. All in all, Iberia (IBE) is the dominant carrier, as we can see in Figure 4-4. Spanair (JKK) and Air Europa (AEA) are the second and third companies at national level.

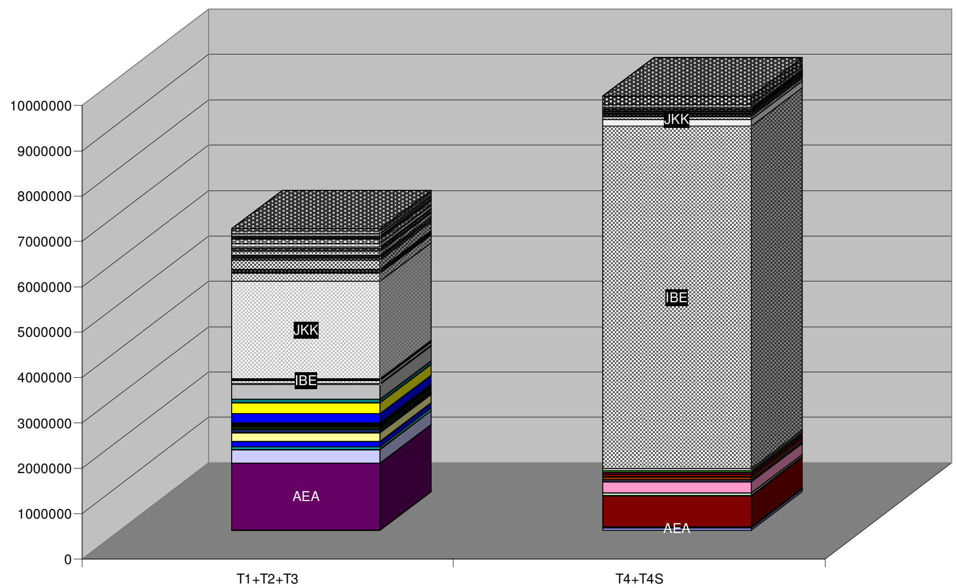


Figure 4-4 Distribution of Passengers by Groups of Terminals, February-June 2006, Madrid Airport

One of the main questions to be answered is to what extent the new allocation of capacity has modified consumer's behaviour. Figure 4-5 gives some insights in this regard. Using the inter-annual variation of total passengers by companies, it can be observed that Spanair experienced important increases, even higher that those experienced by Iberia since the opening of the new facilities. Nevertheless this effect attenuates over the time.

23 The design of the Terminal T4 in Madrid/Barajas is so grandiose that it has been awarded the Stirling prize, sponsored by the Royal Institute of British Architects.

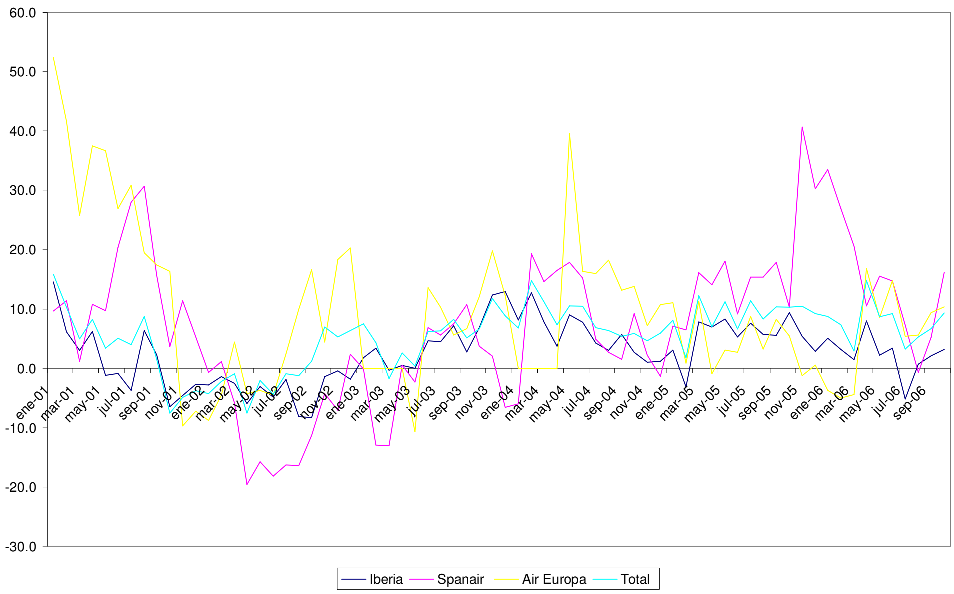


Figure 4-5 Inter-Annual Variation of Passengers by Companies, 2001- September 2006,. Madrid Airport

Regarding the daily distribution of passengers and using data for May 2006 (see Figure 4-6), all terminals show a similar trend. Saturdays are the off-peak days, while Mondays and Fridays are the peak ones. Terminal 4 is usually above the level of 50 thousand passengers per day, its satellite 4S is above 20 thousands, a closer number to that of passengers processed through Terminal 2 that are around 25 thousands.

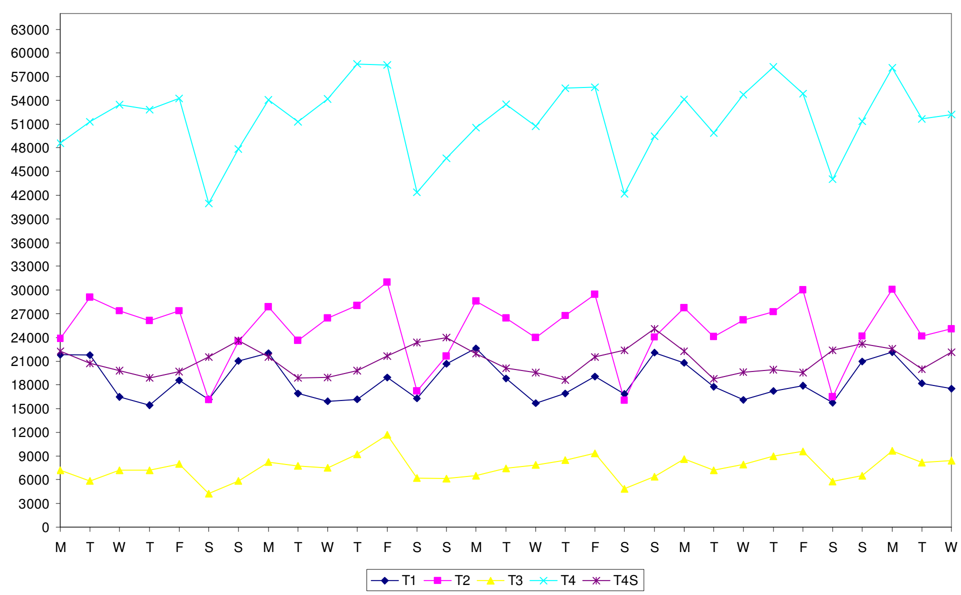
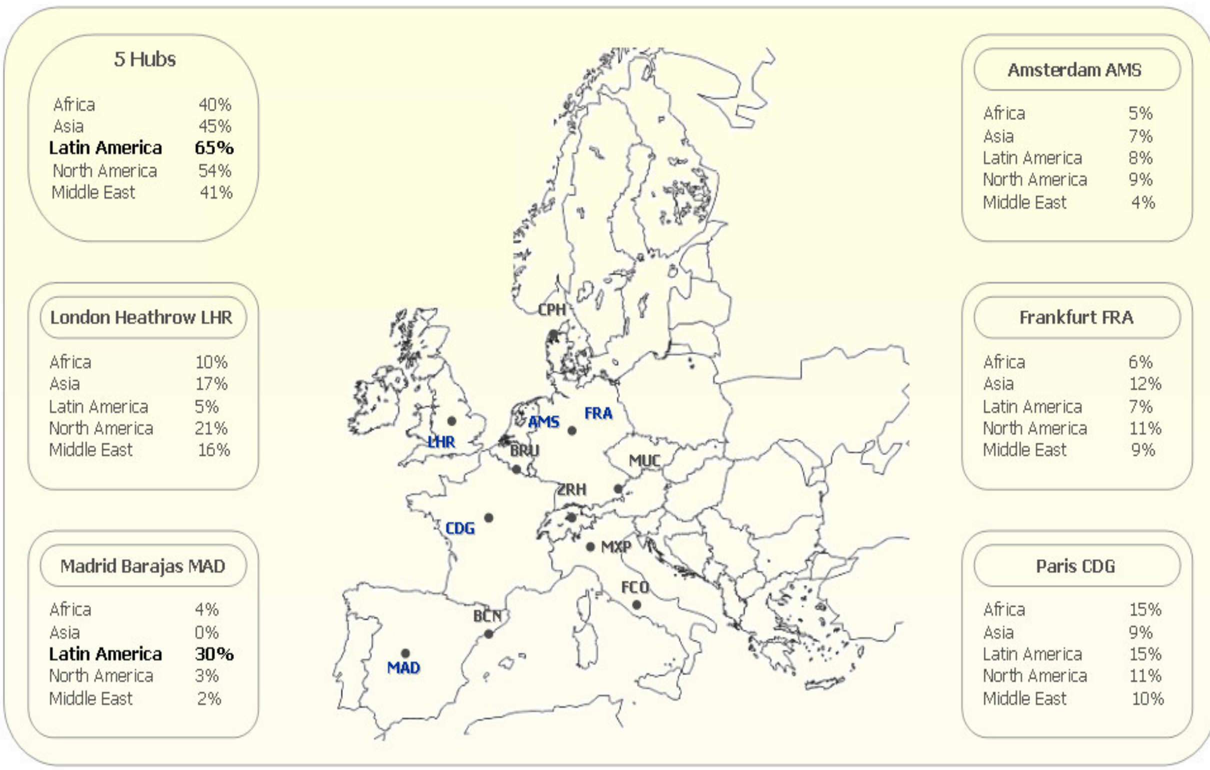


Figure 4-6 Distribution of Passengers by Terminal, May 2006, Madrid Airport

Although terminals T1, T2, T3, and T4 are completely different in their main characteristics, they are subject to the same airport charges. Indeed, the level and structure of airport charges is quite homogeneous and, as previously noted, barely differentiated among Spanish airports. Given the lack of charges differentiation by type of terminal in Madrid/Barajas, the initial allocation of slots at the new facilities was subject to great controversy among Spanish airlines. In June 2003, it was decided to allocate both Iberia (and its partners of Oneworld) and Spanair (and its partners of Star Alliance) to the new facilities of terminal T4. However, in November 2004, such a decision was changed and all the slots in T4 were given to Iberia. Spanair was against such a change and went to court, but it finally lost. The judge argued that “the unique objective of Spanair was to capture Iberia’s traffic, which is legitimate from the commercial point of view, but does not affect the social welfare”.[24] In this case study we show that, despite the court’s ruling, the decision of allocating Iberia and Spanair to separate terminals does have important effects on ticket prices, consumer surplus and social welfare.

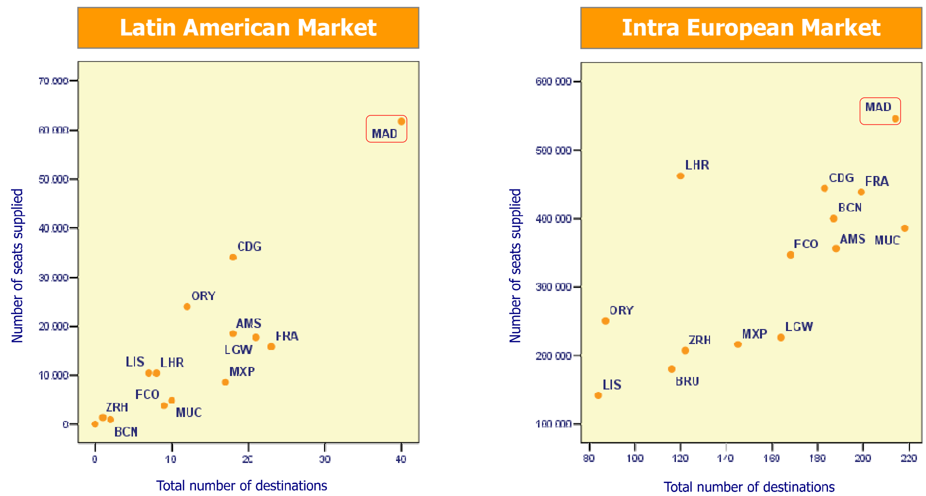
The Spanish air transport system is organized as a hub-and-spoke network, where Madrid/Barajas is the main hub. Around 45 percent of total passengers in Terminal T4 are transfer passengers, while 25 percent of total passengers in T1, T2 and T3 make a transfer. Moreover, Madrid/Barajas is the main hub connecting Europe and Latin-America (see Figure 4-7 and Figure 4-8).



Source: AENA. EMMA survey 2006.

Figure 4-7 Madrid/Barajas Airport is the Main European Hub to Latin America

24 Sentence nº 32/2006 pronounced on the 10th of February 2006 by “Juzgado Central de lo Contencioso-Administrativo nº 7 de Madrid”.



Source: AENA. EMMA survey 2006.

Figure 4-8 Madrid/Barajas Airport is the Main Link between Europe and Latin America

There are some restrictions on international service due to bilateral agreements, which limit the entry of new carriers on routes between some countries. Although these restrictions have been removed in many cases through "open skies" agreements, there are many examples in which those restrictions still exist. Such is the case between Spain and some Latin American countries, where Iberia and the Oneworld alliance enjoy bilateral agreements and operate either as monopolists or with a strong market power (see Figure 4-9). Although Spanair is the main Iberia's competitor in the Spanish domestic routes, Spanair and the Star Alliance group do not operate any direct flight connecting Madrid and Latin America. Figure 4-10 shows all the Spanish domestic routes in which Spanair and Iberia compete. This type of network configuration and level of competition is the basic framework for the model developed in the following section.

One of the main consequences of the allocation of airlines to separate terminals is quite probably the reduction in the level of competition among airlines. This conclusion is supported by the EMMA survey conducted by the Spanish air transport authority AENA in 2006. In such a survey transfer passengers where interviewed in order to find out their arrival terminal, their departure terminal, the required time for transfer, and the number of those who changed airline and picked up their baggage. All these data are reported in Table 4-2.

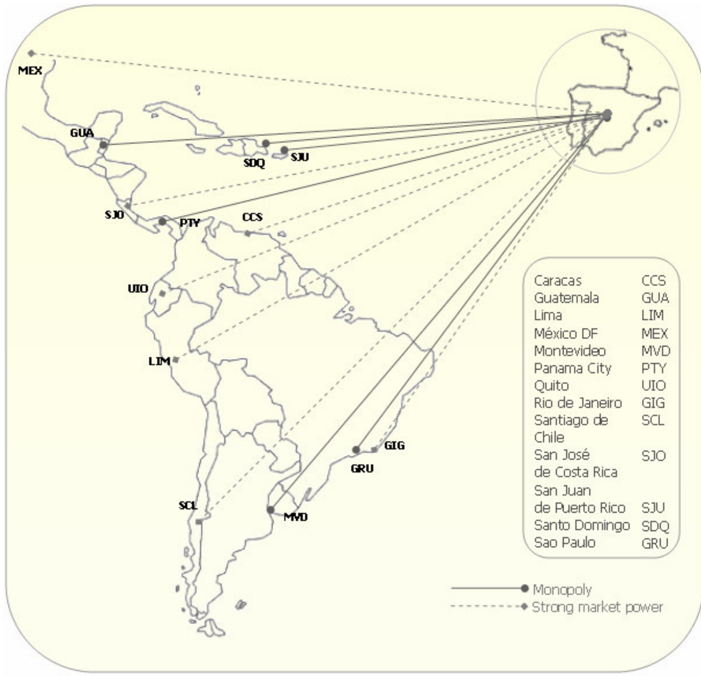


Figure 4-9 Latin American Routes in which Iberia and the Oneworld Alliance Operate either as Monopolists or with a Strong Market Power

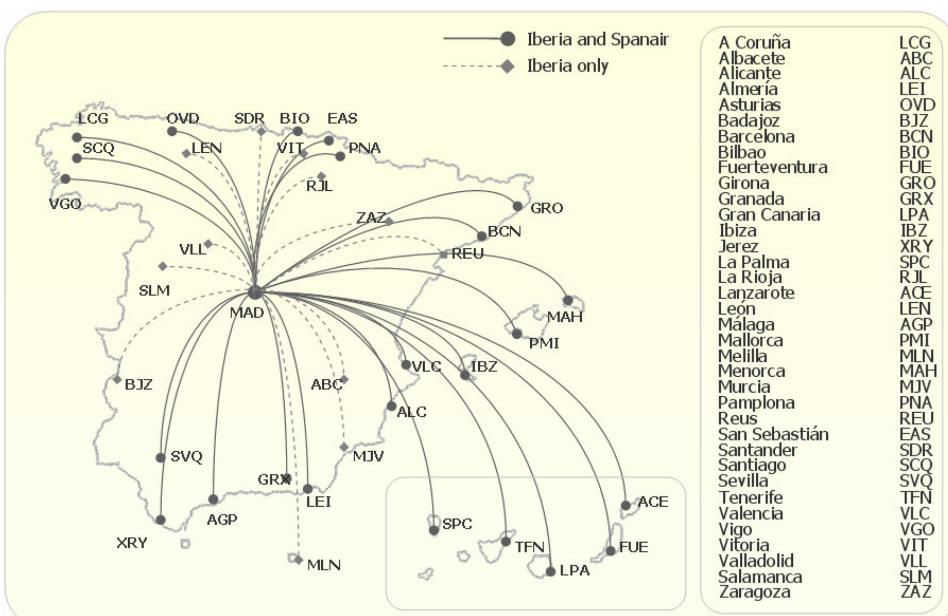


Figure 4-10 Spanish Domestic Routes in which Spanair and Iberia Compete

Table 4-2 Transfer Passengers in Madrid/Barajas Airport

Arrival Terminal	Departure Terminal	Thousands of interviewed passengers	% with respect to total transfer passengers	% with respect to total passengers	Average time for transfer (in hours)	% of interviewees that change the airline	% of interviewees that pick up their baggage
T123	T123	1937	24%	9%	3.33	56%	26%
T123	T4	422	5%	2%	4.00	100%	64%
T4	T4	5367	66%	24%	2.58	11%	7%
T4	T123	407	5%	2%	4.16	100%	66%
Total		8133	100%	36%	2.91	31%	18%

Source: AENA. EMMA survey 2006.

Most transfer passengers arriving or departing from a certain terminal do the transfer within the same terminal. Only 10 percent of transfer passengers move from/to terminals T1, T2 or T3 to/from terminal T4. The reason is that moving from terminal T4 to terminal T1, T2 or T3 increases the average time for transfer around 60 per cent with respect to the case in which passengers do the transfer within T4. On the other hand, moving from terminal T1, T2 or T3 to terminal T4 increases the average time for transfer around 25 percent with respect to the case in which passengers do the transfer in terminals T1, T2 or T3 (even though more than half of the transfers in terminals T1, T2 or T3 imply that passengers change airline). Thus, in order to reduce their transfer time, most passengers prefer to depart from their arrival terminal.

From the data available in Table 4-2 we can conclude that, since Iberia (and its partners of Oneworld) and Spanair (and its partners of Star Alliance) are now allocated to different terminals, the combination of flights between these airlines has become more troublesome than in the past, when the airlines were closely located.

4.4 REVIEW OF RELEVANT CASES AND LITERATURE

The existing literature concerning the differentiation of airports' charges by type of terminal is rather scarce. However, most of the airports in Europe have constructed or are in the process of constructing new terminals with different characteristics and services than the previous ones. In this context, it is worth wondering whether airports offering different terminals should charge different prices.

Over the last 50 years, passenger traffic in airports has increased by an average of about 8 percent worldwide. For the specific case of Madrid/Barajas, passenger traffic has increased by an average of about 7.4 percent over the last 8 years.

Although there may be some airports in the same area competing for the local demand, most airports compete for transfer traffic. The fraction of airport passengers transiting through the airports is frequently more than a half of total traffic, with, at some airports, as many as three out of four passengers continuing their trip on another flight within one or two hours. Such a high rate of transfers in Europe can be found for example in Amsterdam (De Neufville, 1995). Those airports that cannot provide quick, reliable connections between flights for passengers, baggage and aircrafts, will not be competitive and will lose passengers and revenues.

Given the important growth of demand and the increased competition between airports, these must invest in new facilities responding to airlines' needs. Some examples can be found in Table 4-3.

Table 4-3 Examples of Airports that are Constructing or Rebuilding New Terminals

Airport	New terminal investments
Dublin Airport	• It is in the process of constructing a new terminal capable of handling up to 15 million passengers per year. • The new terminal T2 will raise capacity at the airport to a potential 35 million passengers per year. • This new terminal will cost €365 million.
Düsseldorf International Airport	• It completed a huge six-year expansion project in 2003, called Airport 2000 Plus, at a cost of €378 million. • It included restructuring Terminal A, deconstruction of an underground garage and an access road in front of the terminal, extension and architectural refitting of the central building and its extension in front of gate C
Frankfurt Airport	• It is in the process of building Terminal 3. • The project includes construction of 75 aircraft stands and docking positions and associated taxiways. A new maintenance hangar for Lufthansa's A380s will be built in the south area. • The airport operator Fraport AG has earmarked €3.4 billion for the expansion, the most significant privately financed investment project in Germany.
London Heathrow Airport	• It is in the process of constructing the new terminal 5. • The ongoing construction of Terminal 5 is the biggest capital improvement project at this airport, costing £4.2 billion. • Phase one of the project is scheduled to be completed and open by April 2008 with the second phase opening in 2011. • Passengers numbers are expected to grow by 27 million a year as a result of phase one, and then by a further three million a year after phase two.
London Stansted Airport	• It is one of the fastest-growing airport in Europe and it is dominated by low-cost carriers Ryanair, easyJet and Air Berlin. • The British Airport Authority (BAA) expects to invest £550 million to address the gap between the facilities this airport has today and what is needed to cope with 35 million passengers per year with a single runway. • The major elements of the strategy are progressive expansion of the terminal and satellites.
Madrid Barajas Airport	• It has recently constructed the new terminal T4, at a cost of €6200 million. • The new terminal area includes a main building and a satellite, two new runways, 65 fingers, a car park and roadways. • The new Terminal 4 is 2 kilometres away from Terminals 1, 2 and 3. • Terminal 4 is dedicated for Iberia flights (and all the flights of the members of Oneworld Alliance). While all the flights of Air Europa and Spanair (and all the flights of the members of Skyteam and Star Alliance) remain in Terminals 1, 2 and 3.
Manchester Airport	• Terminal 2 Phase 2 is part of a multimillion-pound project that will see capacity more than doubled from its current 7 million passengers to more than 18 million per year. • It is also investing in the airfield, adding apron capacity to Terminals 1 and 2 in the form of six wide body/twelve narrow body stands.
Milan Malpensa Airport	• Its ongoing capital improvement programs include a third module and new satellite added to the terminal that cost €320 million, and €103 million invested in a third runway.
Paris/ Roissy-Charles de Gaulle International Airport	• On March 17, 2005, it decided to tear down and rebuild the whole part of Terminal 2E, whose roof partially collapsed, at a cost of approximately €100 million. • There are also other extensions taken place in 2007: ○ Satellite 3, whose construction can been seen by arriving passengers at Terminals 2E and 2F, is scheduled to open in the first half of 2008. A further Satellite 4 is planned to open in 2012 to provide additional capacity, again relying on the check-in and baggage handling infrastructure of 2E and 2F. ○ The construction of a new terminal building, Terminal 2G, began in September 2006.
Stockholm Arlanda Airport	• It has recently completed $1.1 billion in improvements including a new control tower and runway and expansion of one of the international terminals.
Vienna International Airport	• Its expansion program, with €245 million in investments scheduled in 2005, included completion of a new control tower, expansion of the Cargo Centre, addition of another level to the Car Park, addition of 30 new check-in counters and expansion of the baggage sorting system.

The organisation of airlines into worldwide groups is having significant repercussions on airports. As De Neufville (2000) points out, the international airlines associated with a given group will insist on being located in identifiable sections of an airport. They will want to facilitate transfers between themselves and they will attempt to wall themselves off from the rest of the airport, to minimize loss of passengers to airlines outside their group. They will thus want to have their own customs services and other operations. The new American Airlines buildings at New York/Kennedy, the Continental/SAS facility at New York/Newark or the Iberia new terminal at Madrid/Barajas are clear examples of this phenomenon.[25]

The allocation of different airlines (or alliances of airlines) to different terminals that are not properly connected may have important consequences in terms of competition, especially for transfer flights. Once a transfer passenger is within a certain terminal there are important costs associated with moving to other terminals. However, this lack of competition might be mitigated through an appropriate pricing mechanism, consisting on charging different terminals at different prices.

Moreover, different terminals with different characteristics should be charged at different prices. In other words, airports should offer different products. Thus, older facilities with different level of services in processes for handling passengers and aircrafts, and different access to the public transport system should be subject to different charges. This idea is included in the last Proposal for a Directive of the European Parliament and of the Council on Airport Charges (Article 8):[26]

"*Member States shall take the necessary measures to allow the airport managing body to vary the quality and scope of particular airport services, terminals or parts of terminals, with the aim to provide tailored services or a dedicated terminal or part of a terminal. The level of airport charges may be differentiated according to the quality and scope of such services.*"

There are some examples in the world in which such differentiation of charges by terminals has already been put in practice, as illustrated in the following (De Neufville, 2006):

- The low-cost airline JetBlue in New York/Kennedy has preferred to use one of the oldest and most cramped passenger buildings on the site (Terminal 6). On this basis, the JetBlue building at New York/Kennedy will come in about $40 per annual passenger served, in contrast to about $130 for the American Airlines passenger building across the way.
- The new terminal, called MP2, opened at Marseille airport in 2006 is exclusively for low-cost airlines and their passengers. The idea of this terminal is to eliminate many services usually provided at airports, running the terminal as cheaply as possible. For example, passengers have to carry their bags to the scanners themselves and then walk across the tarmac to their waiting planes. There are no walkways or buses. The result is greatly reduced costs and thereby also reduced airport charges (five times less than for the airport's main terminal). This has made the terminal attractive to a number of low-cost airlines, including Ryanair, easyJet and Virgin Express.
- Berlin/Schönefeld has dedicated a charter flight building to the use of easyJet.
- Geneva has created a low-cost passenger building.
- Kuala Lumpur/Subang is developing a low-cost passenger building near its cargo facilities.
- Paris/de Gaulle has been using Terminal 9 as a low-cost and charter facility.
- Warsaw has reactivated an old building specifically for low-cost airlines.

However, despite the above examples, most of the American and European airports still charge the same prices for different facilities. Such is the case of Madrid/Barajas in which the prices paid for the use of the new terminal T4 are exactly the same as those paid in T1, T2 and T3.

25 In some US airports there are the so-called dedicated terminals (terminals built and financed by a particular airline). However, this system is not usually applied in European airports.

26 http://ec.europa.eu/transport/air_portal/airports/doc/2007_proposal_directive_airports_charges_en.pdf.

4.5 THE MODEL

4.5.1 Benchmark

We consider a simple network structure with a domestic and an overseas route. The domestic route is operated by two airlines, airline 1 and airline 2, while the overseas route is operated just by airline 1. Such a network structure is shown in Figure 4-11.

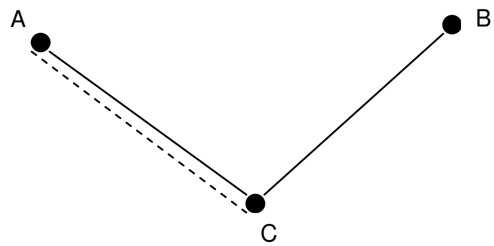


Figure 4-11 The Network

Airline 1, which uses city C as a hub, operates both an overseas route to/from city B and a domestic route to/from city A. However, airline 2 operates just the domestic route to/from city A. In the Iberia - Spanair (Oneworld - Star Alliance) competition model, the domestic route AC may correspond, for example, to the route Gran Canaria - Madrid and the overseas route CB to Madrid - Sao Paulo.

The network structure depicted in Figure 4-11 yields two possible routes, AC and CB, but three city-pair markets, AC, CB, and AB. In the city-pair AC, passengers may travel either with airline 1 or airline 2, while in the city-pair CB they can only use airline 1. For the city-pair AB, passengers can choose to fly just with airline 1 from A to C and from C to B, or they may choose to fly with airline 2 in the route AC, and then change to airline 1 for the route CB. We will assume that, for the city-pair AB, changing from airline 2 to airline 1 implies a switching cost for passengers denoted by s.

We assume passengers exhibit brand loyalty to particular carriers, that is, airlines sell differentiated products. In particular, we consider that, whenever airlines 1 and 2 compete, passengers have preferences over the two airlines and they like variety. Following Dixit (1979) and Singh and Vives (1984), we consider that passengers maximize:

$$U(q_1, q_2) - \sum_{i=1}^{2} p_i q_i,$$

where q_i is the round-trip traffic operated by airline i in a certain city-pair market and p_i is its price. U is assumed to be quadratic and strictly concave:

$$U(q_1, q_2) = \alpha q_1 + \alpha q_2 - \frac{1}{2}(\beta q_1^2 + \beta q_2^2 + 2\gamma q_1 q_2), \quad (1)$$

where α, β and γ are positive parameters (goods are substitutes) and $\beta > \gamma$. This utility function gives rise to a linear demand structure, and direct demands can be written as (see Dixit, 1979, and Singh and Vives, 1984, for further details):

$$q_1 = a - bp_1 + dp_2$$
$$q_2 = a - bp_2 + dp_1, \tag{2}$$

where $a = \alpha/(\beta+\gamma)$, $b = \beta/(\beta^2-\gamma^2)$, and $d = \gamma/(\beta^2-\gamma^2)$. γ/β expresses the degree of product differentiation, ranging from zero when the goods are independent to one when goods are perfect substitutes (homogenous market).

For the sake of simplicity and similarly to Brueckner (2001), we consider that the demand for travel is the same in each city-pair. Airlines 1 and 2 compete with differentiated products in the route AC, so the demand in the AC market is given by:

$$q_1^{AC} = a - bp_1^{AC} + dp_2^{AC}$$
$$q_2^{AC} = a - bp_2^{AC} + dp_1^{AC}. \tag{3}$$

The route CB is operated just by airline 1, so the demand in the CB market is given by:

$$q_1^{CB} = a - bp_1^{CB}. \tag{4}$$

Finally, for the city-pair AB, passengers may fly with airline 1 from A to C and from C to B, or they may decide to fly with airline 2 the first segment and then change to airline 1. Thus, the demand in the AB market is given by:

$$q_1^{AB} = a - bp_1^{AB} + dp_{2+1}^{AB}$$
$$q_2^{AB} = a - bp_{2+1}^{AB} + dp_1^{AB} \tag{5}$$

where, $p_{2+1}^{AB} = p_2^{AC} + p_1^{CB} + s$, and $p_1^{AB} \le p_1^{AC} + p_1^{CB}$. In other words, if passengers decide to fly with airline 2 the first segment and then change to airline 1, they must pay the ticket price of airline 2 in the first segment AC, plus the ticket price of airline 1 in the second segment CB, plus a switching cost s. This is possible because of the brand loyalty that implies that a carrier can raise its fare above that charged by its competitor without losing all of its traffic. On the other hand, if passengers decide to fly with airline 1 in both segments the non-arbitrage condition must be satisfied, that is, purchasing the round trip AB should not be more costly than buying two round trips, one from A to C and the other from C to B. Otherwise, nobody would purchase the round trip AB and airline 1's pricing policy would be no valid.[27]

The level of the switching cost that AB passengers must pay if they decide to fly the first segment with airline 2 depends on how easy is switching from airline 2 to airline 1. In general, if both airlines operate in the same terminal the shift would be easier. On the contrary, if the two airlines operate in different terminals, far from each other and with poor connections, switching costs may be excessive. For the sake of simplicity, we consider only two extreme cases for the switching cost, being either negligible (which corresponds to the case in which airlines operate within the same terminal and shifts from one airline to the other are very easy) or so high that it is not worth for any passenger to travel first with airline 2 and then change to airline 1 (which corresponds to the case in which airlines operate in separate terminals and shifts become too costly)

Finally, marginal operating costs for airlines are assumed to be constant and identical for both airlines in all the routes. In particular, the round-trip cost of carrying q_i passengers on the route r is given by

27 A similar assumption is made by Brueckner (2001).

$C(q_i^r) = cq_i^r$, where $c > 0$ denotes the constant marginal operating cost, and q_i^r denotes the passengers carried by airline i (for $i = 1, 2$) on the route r (for $r = AC, CB$ in case of airline 1 and $r = AC$ in case of airline 2). In order to have the model well defined, we assume that $a > c$. Note that the marginal cost of carrying passengers for the city-pair AB is $2c$, since no direct flights are available.

4.5.2 Airlines 1 and 2 Operate in Separate Terminals

In this section we analyse the ticket prices charged by airline 1 and airline 2 when airlines operate in separate terminals and shifts from one airline to the other are too costly. In other words, we analyse the situation in which the switching cost s is so high that no AB passengers are willing to fly with airline 2 in the AC route and move to airline 1 in the route CB. Thus, the demand for airline 2 in the AB market is zero and airline 1 captures all the AB traffic. Airline 1 operates as a monopolist in the AB market and its demand is given by:

$$q_1^{AB} = 2a - bp_1^{AB}. \tag{6}$$

Airline 1 chooses the optimal ticket prices for each market - p_1^{AC}, p_1^{CB}, and p_1^{AB} - in order to maximize its total profit. Airlines 1's total profit includes the profit that airline 1 obtains in the AC market -when competing against airline 2 with differentiated products-, and the profits that airline 1 obtains in the CB market and in the AB market as a monopolist. Formally:

$$\underset{p_1^{AC}, p_1^{CB}, p_1^{AB}}{Max} \begin{Bmatrix} (a - bp_1^{AC} + dp_2^{AC})(p_1^{AC} - c) + (a - bp_1^{CB})(p_1^{CB} - c) \\ +(2a - bp_1^{AB})(p_1^{AB} - 2c) \end{Bmatrix} \tag{7}$$

Airline 1's first order conditions are obtained by setting the first derivatives of its total profits with respect to p_1^{AC}, p_1^{CB}, and p_1^{AB}, respectively, equal to zero:

$$a - 2bp_1^{AC} + dp_2^{AC} + bc = 0. \tag{8}$$

$$a - 2bp_1^{CB} + bc = 0. \tag{9}$$

$$2a - 2bp_1^{AB} + 2bc = 0. \tag{10}$$

Airline 2 only competes with airline 1 in the AC market. Therefore, airline 2 must choose the optimal ticket price p_2^{AC} in order to maximize the profits that it obtains in the AC market when competing against airline 1 with differentiated products:

$$\underset{p_2^{AC}}{Max} \ \{(a - bp_2^{AC} + dp_1^{AC})(p_2^{AC} - c)\} \tag{11}$$

The first order condition for airline 2 is given by:

$$a - 2bp_2^{AC} + dp_1^{AC} + bc = 0. \tag{12}$$

Let us denote by $\overline{\overline{p_1^{AC}}}$, $\overline{\overline{p_2^{AC}}}$, $\overline{\overline{p_1^{CB}}}$, and $\overline{\overline{p_1^{AB}}}$ the optimal ticket prices charged by airline 1 and airline 2 when airlines operate in separate terminals and shifts from one airline to the other are too costly. The optimal ticket prices are obtained by solving the system of equations given by expressions (8), (9), (10), and (12):

$$\overline{\overline{p_1^{AC}}} = \overline{\overline{p_2^{AC}}} = \frac{a+bc}{2b-d}; \ \overline{\overline{p_1^{CB}}} = \frac{a+bc}{2b}; \ \overline{\overline{p_1^{AB}}} = \frac{2a+2bc}{2b}. \quad (13)$$

Proposition 1*: If airlines operate in separate terminals and shifts from one airline to the other are too costly, airline 1 and airline 2 charge the same ticket price in the AC market, while in the CB and the AB market airline 1 charges the monopoly price.*

4.5.3 Airlines 1 and 2 Operate within the Same Terminal

In this section we analyse the ticket prices charged by airline 1 and airline 2 when both airlines operate within the same terminal and shifts from one airline to the other are completely costless, that is, $s=0$. Airline 1 is a monopolist for the overseas route CB, while airline 1 and airline 2 compete with differentiated products in the domestic route AC. For the city-pair AB, passengers must do a transfer at airport C. Transfer passengers may decide to fly the whole trip with airline 1 and pay a ticket price p_1^{AB}, or they may decide to fly from A to C with airline 2 and from C to B with airline 1, paying $p_{2+1}^{AB} = p_2^{AC} + p_1^{CB}$ for the whole round-trip.

Similarly to section 4, airline 1 chooses the optimal ticket prices for each market - p_1^{AC}, p_1^{CB}, and p_1^{AB} - in order to maximize its total profit. In this case, airlines 1's total profit includes the profit that it obtains in the AC market -when competing against airline 2 with differentiated products-, the profit that it gets in the CB market as a monopolist, and the profit that it obtains in the AB market. For the AB market airline 1 can earn profits either through those transfer passengers that decide to make the whole trip within airline 1's aircrafts, or through those AB passengers that decide to flight in the route AC with airline 2 but who must compulsorily flight in the route CB with airline 1. Formally, airline 1 must solve the following maximization program:

$$\underset{p_1^{AC}, p_1^{CB}, p_1^{AB}}{Max} \begin{Bmatrix} (a-bp_1^{AC}+dp_2^{AC})(p_1^{AC}-c)+(a-bp_1^{AB}+dp_2^{AC}+dp_1^{CB})(p_1^{AB}-2c) \\ +(a-bp_1^{CB})(p_1^{CB}-c)+(a-bp_2^{AC}-bp_1^{CB}+dp_1^{AB})(p_1^{CB}-c) \end{Bmatrix} \quad (14)$$

Once again, first order conditions are obtained by setting the first derivatives of airline 1's total profits with respect to p_1^{AC}, p_1^{CB}, and p_1^{AB}, respectively, equal to zero:

$$a-2bp_1^{AC}+dp_2^{AC}+bc=0. \quad (15)$$

$$2a-4bp_1^{CB}+2dp_1^{AB}-bp_2^{AC}+2bc-2cd=0. \quad (16)$$

$$a-2bp_1^{AB}+2dp_1^{CB}+dp_2^{AC}+2bc-dc=0. \quad (17)$$

Airline 2 operates just in the AC route. However, it may sell tickets to both AC passengers and AB passengers, since there might be AB transfer passengers willing to fly the AC route with airline 2 and the CB route with airline 1. Thus, airline 2 chooses the optimal ticket price p_2^{AC} in order to maximize the profit that it obtains both in the AC and the AB market. Formally:

$$\underset{p_2^{AC}}{Max} \ \left\{(a-bp_2^{AC}+dp_1^{AC})(p_2^{AC}-c)+(a-bp_2^{AC}-bp_1^{CB}+dp_1^{AB})(p_2^{AC}-c)\right\} \quad (18)$$

Airline 2's first order condition is given by:

$$2a - 4bp_2^{AC} + dp_1^{AC} - bp_1^{CB} + dp_1^{AB} + 2bc = 0. \tag{19}$$

Let us denote by $\overline{p_1^{AC}}$, $\overline{p_2^{AC}}$, $\overline{p_1^{CB}}$, and $\overline{p_1^{AB}}$ the optimal ticket prices charged by airline 1 and airline 2 when both airlines operate within the same terminal and shifts from one airline to the other are completely costless, that is, $s = 0$. In this case, the optimal ticket prices are obtained by solving the system of equations given by expressions (15), (16), (17), and (19):

$$\begin{aligned}
\overline{p_1^{AC}} &= \frac{1}{2}\frac{15ab^3 - 2ad^3 + 15b^4c - 2cd^4 - 6abd^2 + 7ab^2d - 3bcd^3 + 7b^3cd - 3b^2cd^2}{b^3d - 9b^2d^2 + 15b^4 + d^4}, \\
\overline{p_2^{AC}} &= \frac{6ab^3 - ad^3 + 6b^4c - 2abd^2 + 3ab^2d - 3bcd^3 + 6b^3cd - 3b^2cd^2}{b^3d - 9b^2d^2 + 15b^4 + d^4}, \\
\overline{p_1^{CB}} &= \frac{1}{2}(3b+d)\frac{4ab^2 - ad^2 + 4b^3c + cd^3 - 3bcd^2 - 3b^2cd}{b^3d - 9b^2d^2 + 15b^4 + d^4}, \\
\overline{p_1^{AB}} &= \frac{1}{2}\frac{9ab^3 - 2ad^3 + 24b^4c + 2cd^4 - 3abd^2 + 10ab^2d - 7b^3cd - 21b^2cd^2}{b^3d - 9b^2d^2 + 15b^4 + d^4}.
\end{aligned} \tag{20}$$

Proposition 2: *If airlines operate within the same terminal and shifts from one airline to the other are completely costless, airline 2 charges a lower ticket price than airline 1 in the AC market. On the other hand, if the market size is high enough, airline 1 charges a ticket price higher than the monopoly price in the CB market.*

Proof: *See Appendix 1.*

When airlines operate within the same terminal and shifts from one airline to the other are completely costless, there exist some AB passengers willing to fly the domestic route with airline 2 and the overseas route with airline 1. Thus, in order to encourage AB passengers to fly the first part of their trip within its aircraft, airline 2 has incentives to decrease the ticket price in the AC market. On the contrary, in order to encourage AB passengers to buy the whole trip to airline 1 instead of flying the first part with airline 2, airline 1 may have incentives to increase the ticket price in the CB market over the monopoly price.

4.5.4 Comparisons

Let us compare the ticket prices, airlines' total profits, the consumer surplus, and the social welfare in the cases in which airlines operate within the same terminal or not.

On the one hand, lower prices and higher quantities are always better in welfare terms. On the other hand, consumer surplus for market M, with prices (p_1^M, p_2^M) and quantities (q_1^M, q_2^M), is defined as:

$$CS^M = U(q_1^M, q_2^M) - p_1^M q_1^M - p_2^M q_2^M \tag{21}$$

which is a decreasing and convex function of prices.

Proposition 3: *If we compare ticket prices, consumer surplus, and social welfare in the cases in which airlines operate and do not operate within the same terminal, we can conclude that:*

- <u>For the AC and AB markets:</u> if airlines operate within the same terminal, ticket prices are lower, and the consumer surplus and the social welfare are higher.

- For the CB market: if airlines operate within the same terminal, ticket prices can be lower, equal or higher. In particular, if the market size is large enough, tickets prices are higher and the consumer surplus and the social welfare are lower.

Proof: *See Appendix 1.*

The lack of competition in the AB market when airlines operate in separate terminals affects the ticket prices of the whole network. For the AC and AB market the effect is unambiguous: the lack of competition in the AB market when airlines operate in separate terminals is always detrimental in social terms. However, for the CB market the effect may be welfare decreasing if the market size is high enough. The reason is that if the market size is high enough, airline 1 has incentives to increase the ticket price over the monopoly price in order to discourage AB transfer passenger to flight the domestic route with airline 2.

Proposition 4: *If we compare airlines' total profits in the cases in which airlines operate and do not operate within the same terminal, we can conclude that total profits for airline 2 are higher if airlines operate within the same terminal, while profits for airline 1 are lower.*

Undoubtedly, airline 1 is always better off when there is no competition in the AB market and it operates as a monopolist in both the CB and AB market. On the contrary, airline 2 is always better off when it operates the domestic route and it can carry passengers from both the AC and AB market.

Proposition 5: *Even if the network effects are not considered, if airlines operate in different terminals with different characteristics, the degree of product differentiation increases. Thus, ticket prices are higher and the consumer surplus and the social welfare are lower.*

Proof: *See Appendix 1.*

Throughout all the this case study we have considered that the fact that airlines operate in separate terminals only affects the competition in the AB market, since shifts from one airline to the other may be too costly. However, if airlines operate in different terminals with different services and different characteristics, the degree of product differentiation may also be affected. Passengers flying in the domestic route may prefer airline i not only because of brand loyalty, but also because they prefer the services and facilities of the terminal used by airline i. The higher the degree of product differentiation, the more different airlines are for passengers. Thus, the higher the degree of product differentiation, the lower the competition between airlines and the higher ticket prices.

4.6 Differentiation According to Congestion and Air Pollution

As already mentioned in the introduction of this deliverable, congestion at airports occurs when there are "too many" users in the system (e.g. terminal or runways), users that consequently assume a higher generalized cost for their trip. If we can identify who causes congestion and when it appears, we will be able to charge them and force them to internalise the costs they impose on other parties. If the congestion problem only appears in certain periods of time (e.g. hours, days,…) the way in which the internalisation is conducted is through peak-load pricing mechanisms. On the contrary, when congestion arises due to a suboptimal strategy of airports' managers, airports' agents or even airlines, (e.g. lack of personnel available to handle luggage), other types of congestion pricing mechanisms should be applied. Nowadays, this sort of congestion pricing is not usually considered either in the literature or in real situations.

Consequently, if an airport regulator intends to differentiate airport charges according to congestion, the first step is to identify the type of congestion and who causes it. The second is to price it. After the expansion of facilities in 2006, Madrid Barajas has had no longer congestion problems. Nevertheless, if traffic demand continues increasing it might become congested again. In a previous European project (UNITE), Nombela et al. (2004) developed a methodology to quantify congestion costs at this airport. The situation at Madrid Barajas at that time was one of important flight delays, with consequences on passengers and airlines.[28]

Flight delays are nowadays a common feature suffered by most European air travellers, and many of these delays are not directly caused by the same company that operates a delayed flight. Delays are originated by a number of factors, which are generally difficult to disentangle if one wants to determine the exact causes of the problem. And, additionally, when a plane is delayed and must be moved out of its original schedule, it involuntarily imposes changes in departing or arrival times for other flights, which are subsequently delayed in a cascade-effect.

Nombela et al. (2004) analyses in detail the process of generation of flight delays at Madrid airport, using data of scheduled and actual arrival/departure times. The objective pursued with this case study was twofold:

- Try to understand the phenomenon of airport congestion through the analysis of flight delays.
- Evaluate congestion costs both for passengers and airlines.

Using data from AENA the authors evaluated total and marginal congestion costs, by adding passengers and airlines' costs associated to congestion. Data did not allow assigning precisely what were the causes of flight delays, therefore the approach was to evaluate costs of users of Madrid airport, with the caveat that some of the problems suffered by travellers might be originated at other airports.

The work with the series of average delays within the period of reference (month of July, years 1997 to 2000), showed that there was a high correlation between arrival and departure delays at Madrid, and that the average departure delay was always higher than the average arrival delay. This was considered as evidence that most of congestion costs evaluated in this work were indeed originated at Madrid. Another interesting result stemmed from the analysis of the distribution of average delays across a typical day. This showed how, on average, flight delays follow an accumulative process during the day, due to the cascade effects that some perturbation at a particular point generates for all the next scheduled flights.

Adding up all flight delays above 30 minutes, during the month of July, it was found that passengers using Madrid airport lost more than 1 million hours. Meanwhile, airlines suffered a total loss of around 7,500 plane-hours (these figures correspond to July-2000). A monetary valuation of all these external effects borne by airport users yielded a total amount of 664.8 million € per year.

Marginal congestion costs were also estimated, using the number of flights delayed by more than 15 minutes and working with daily averages taken for working days (since delays at weekends follow a different pattern). Results obtained were such that each delayed flight generated in July 2000 a marginal cost of 7,100 € (arrivals) or 6,700 € (departures).

We should point out that both the methodological approach and the required information as applied in Nombela et al. (2004), are simple enough for this work to offer some guidance for future work in other countries. Moreover, the characteristics of air transport are not in essence very different from those of other scheduled transport modes which might suffer from congestion problems (e.g. railways, or ports). Therefore, this type of study could even be extended to analyse congestion in other modes.

On the other hand, implementation of air pollution charges at airports is not a common practice at all, while noise charges are somehow better known, and in this sense a bit more frequent (Betancor and Martin, 2006) at airports around the world. Madrid Barajas airport charges are not differentiated

28 It should be noted that the type of congestion that affected Madrid airport before the expansion of facilities was different than the problem of congestion in the case of Gran Canaria airport. In the first case the consequences were mostly in terms of flight delays. In the later we did not observe relevant flight delays, but a congested terminal that imposed different waiting costs upon passengers and also important costs on other economic agents.

according to aircraft pollution emissions,[29] and it has been only very recently (December 2007) that the noise criterion has been introduced to differentiate charges at Madrid.

Noise at airports is a troublesome externality that is usually tackled through a whole set of abatement procedures. Noise charges are not particularly recommended by an international organization such as ICAO. However market oriented measures intended to internalise externalities are gaining popularity day by day. In the case of airports noise charges can be found in about 20 percent of airports around the world, though in most cases the basis for charge setting is not an estimate of the cost caused to third parties.

Betancor and Martin, (2006) provide some estimates of the total, average and marginal costs of noise at Madrid Barajas airport for two periods of reference, the actual and future scenario in which the new capacity is available. Estimates of the total costs of noise show that this will be decreasing substantially (43%) from year 2000 to the future scenario. Such a reduction in the noise costs is the result of a combination of several abatement measures, including reduction of noise at source and careful selection of approaching and climbing procedures, though some redistribution of noise costs among city councils is also taking place. This is in spite of the fact that number of people, and houses affected by noise are greater for the future scenario (though levels of noise exposure are smaller), and that number of operations and processed passengers are expected to roughly double in the coming future.

The methodology to estimate and introduce air pollution charges at Madrid Barajas airport could follow a similar approach as that applied by the above authors for the case of a noise charge. The starting point would be very similar: there will be several measures applied simultaneously, and among them there might be a case for the inclusion of air pollution charges. An important point, however, is to bear in mind that this charge should aim to recover the social costs of air pollution at the airport area, rather than just to recover abatement or insulation costs only.

4.7 CONCLUSIONS

Many airports around the world have recently built or are in the process of constructing or rebuilding new terminals. Airlines operating in those airports must be reallocated between the new and old facilities. However, the international airlines associated with a given group will insist on being located in dedicated terminals in order to facilitate transfers between themselves and minimize the loss of passengers to airlines outside their group.

In order to better understand the main insights of the model we consider the case of the Madrid/Barajas airport. At the beginning of 2006, Madrid/Barajas opened new facilities, the new terminal T4. Iberia and the Oneworld group were allocated to the new facilities while Spanair and the Star Alliance remained at the old terminals. Spanair was against this decision and went to court, but it finally lost. The judge argued that the allocation of Iberia to the new terminal T4 and Spanair to the old facilities does not affect the social welfare. In this case study we show that, despite the court's ruling, such a decision does affect social welfare.

We use a theoretical model to show, in general, that if airlines are allocated to separate terminals, the lack of competition in transfer flights significantly affects the ticket prices of the whole network, the competition between airlines is reduced, the ticket prices are higher and the consumer surplus and the social welfare are lower. Only in some routes and under certain conditions on the market size, the ticket prices may be lower.

Following the recommendations of the last Proposal for a Directive of the European Parliament and of the Council on Airport Charges (Article 8), different terminals with different characteristics (which is clearly the case of Madrid-Barajas airport) should be subject to different airport charges. Moreover, the allocation of airlines to terminals should promote the competition between airlines, and be non-discriminatory. Finally, we would like to highlight that the adverse network effects of allocating airlines to different terminals may be mitigated if terminals were well connected, and shifts from one terminal

29 In Europe this practice can be found at airports in Sweden, Switzerland and United Kingdom.

to the other were not too costly in terms of time for transfer passengers (which is clearly not the case of Madrid/Barajas airport). All these considerations should be carefully taken into account when constructing new facilities at airports and deciding the reallocation of airlines to such new facilities.

Finally, some previous works that have developed a methodology to estimate congestion and noise costs at this airport are already available. This could be the basis to differentiate charges based on congestion at the airport (if congestion problems eventually appear) and according to aircraft air pollution emissions.

5 LONDON AREA AIRPORTS: PEAK PRICING AND AIRPORT CHOICE

5.1 INTRODUCTION

In the economics literature there is an ongoing discussion about airport competition. Do airports compete? If so, do they compete for passengers or airlines? On the website of London Gatwick the link that passengers can follow to book a flight is accompanied by the comment “Whether it's scheduled, charter or low-cost, we can do all the searching for you so be impulsive and book a flight now” (www.gatwickairport.com). Interestingly, Gatwick Airport, like many other airports, targets passengers directly: use our airport, and we find a good flight (airline) for you.

Low-cost airlines play an important role in the discussion on airport competition. Airlines like Ryanair prefer smaller regional airports over the established hubs because these airports are cheaper and offer lower turn-around times. Such airport-airline combinations offer competition to the ‘established’ airport-airline combinations (e.g. BA-LHR). Even though BA may offer more low-fare tickets than some low-cost airlines, the airport tax may make the journey more expensive than a trip with a low-cost airline from a regional airport. In this study we determine passenger sensitivity to the total ticket price (including taxes), and we also determine the cross-price elasticity of demand, that is, the effect of a price change of e.g. Ryanair from Gatwick on the probability that BA from LHR is chosen.

In the London area, London Heathrow (LHR) is the most famous and most congested airport. Some say there is a single peak, which lasts all day. Looking at the number of destinations available from LHR and the number of airlines operating from LHR, one could say that LHR is one of the most popular airports in the world. Given the congestion costs it may also be one of the most hated airports in the world. For European destinations and a number of intercontinental destinations, alternative airports in the London area are available. Price differentiation *at* London Heathrow could be used to spread demand evenly throughout the day, but given the high demand levels throughout the day it may have little effect. Price differentiation between airports may be used to give passengers – and airlines - an incentive to choose another airport. The British Airport Authority (BAA) privately operates a number of airports in the London area, while a number of airlines (e.g. British Airways, Aer Lingus, Air France – KLM) use multiple departure airports in the London area, sometimes to the same destination. So next to competing with other airport operators, an airport operator may also try to give airlines and passengers incentives to use alternative airports to reduce congestion costs.

In this research we determine the price elasticity of market share for different passenger types in European markets originating in the London area. The underlying reasons are twofold. Firstly, price differentiation to maximize revenues, or manage passenger flows through congested airports is possible only if passengers respond to price changes (i.e. demand is elastic). Secondly, it is a common conjecture that the emergence of low-cost carriers led to fierce competition between airlines, and in some cases airports. In this research we determine how market shares change when the total price of a trip (airline fare plus airport taxes) changes. The analysis is based on the *total* price (i.e. airline fare plus airport taxes), because passengers respond to this price. Estimating separate coefficient for airport taxes and airline fares is not feasible, since the airport tax may be constant across a large number of respondents and alternatives, which creates numerical difficulties. We estimate different models for leisure and business travellers, as it is a common finding in the literature that these passengers have a different willingness-to-pay, and thus a different price elasticity of demand.

5.2 DATA

The empirical analysis uses surveys from the Civil Aviation Authority (U.K.), combined with frequency data from the Official Airline Guide (OAG). We use three different periods: January-March 2003, April-October 2003 and November 2003-March 2004. Table 5-1 presents the shares of business and leisure passengers for these periods[30].[31] In the London area, Luton and Stansted are clearly important

30 More tables could be produced based on the available data.

airports for leisure traffic. Gatwick is also predominantly used by leisure travellers, although the share of business passengers is considerably larger when compared to Luton and Stansted. Gatwick, Luton and Stansted are important airports for the low-cost airlines. The distribution of leisure and business passengers at Birmingham, Bristol and East Midlands is comparable to that of Gatwick.

Table 5-1 Shares of Business and Leisure Passengers

	Jan-March 2003		April-Oct 2003		Nov 2003-March 2004	
	Business	Leisure	Business	Leisure	Business	Leisure
BHX			29.4%	70.6%	37.3	62.7%
BRS			20.9%	79.1%	29.0%	71.0%
EMA			20.9%	79.1%	29.9%	70.1%
LCY	46.4%	53.6%	33.6%	66.4%	47.9%	52.1%
LGW	31.2%	68.8%	28.0%	72.0%	30.0%	70.0%
LHR	41.5%	58.5%	36.3%	63.7%	37.0%	63.0%
LTN	17.7%	82.3%	19.7%	80.3%	26.0%	74.0%
STN	12.7%	87.3%	9.2%	90.8%	12.4%	87.6%
Total	33.7%	66.3%	26.4%	73.6%	31.6%	68.4%

Table 5-2 shows the 10 most important destinations for each departure airport[32]. Dublin, Edinburgh and Glasgow are among the most popular destinations within Ireland and the UK. Amsterdam and Frankfurt are important destinations within Europe. It is interesting to see that Paris is not a 'top' destination, even though it appears frequently in the ten most important destinations. This is probably caused by the Channel Tunnel; since the opening of the Channel Tunnel, high speed rail became the dominant mode in the London-Paris market. At first sight there seems to be no regional specialization of airports. Destinations that are only served from one origin-airport are highlighted in boldface.

Table 5-3 shows the aggregate market shares of easyJet, Ryanair and the legacy carriers in the leisure and business markets (i.e. all business travel and leisure travel from the airports mentioned in footnote 26). This table only gives a global indication of the relative importance of carriers in these markets. For a more detailed analysis specific markets need to be selected. Ryanair has a market share of up to 5% in the business market. easyJet has a market-share of up to 14% in the business market. Given the fact that the 'legacy category' is an aggregate of a number of conventional (legacy) carriers, some of which are not active in the same markets as low-cost carriers, we may conclude that the low-cost carriers have a considerable market share in the markets in which they are active. Since easyJet and Ryanair try to avoid congested airports, it seems that the low-fare airlines operating from airports, which are, relatively speaking, uncongested (compared to LHR), are successful in attracting leisure *and* business travellers looking for a travel alternative with relatively short check-in and boarding times as well as low fares.

31 BHX=Birmingham, BRS=Bristol, EMA=East Midlands, LCY=London City, LGW=London Gatwick, LHR=London Heathrow, LTN=Luton, STN=London Stansted

32 ABZ=Aberdeen; ALC=Alicante; AMS=Amsterdam; ANR= Antwerp; ARN= Stockholm; ATH=Athens; BCN=Barcelona; BRU=Brussels; CDG=Paris; CIA=Rome Ciampino; CPH=Copenhagen; DND=Dundee; DUB=Dublin; DUS=Dusseldorf; EDI=Edinburgh; FRA=Frankfurt; GLA=Glasgow; GVA=Geneva; HHN=Frankfurt Hahn; MAD=Madrid; MJV=Canary Islands; MUC=Munich; NCE=Nice; ORK=Cork; OSL=Oslo; PIK=Prestwick Glasgow; PMI=Palma Mallorca; PRG=Prague; RTM=Rotterdam; ZRH=Zurich

Table 5-2 Ten Most Important Destinations per Airport, June 2003 (Including the Number of Respondents Flying to the Specified Destination)

BHX		BRS		EMA		LCY		LGW		LHR		LTN		STN	
DUB	271	EDI	316	EDI	478	DUB	587	EDI	263	DUB	925	EDI	372	DUB	251
EDI	172	GLA	313	GLA	283	AMS	460	DUB	204	AMS	705	GLA	369	ALC	232
FRA	157	DUB	227	PRG	268	FRA	459	AMS	203	EDI	438	AMS	221	**PIK**	201
GLA	152	AGP	199	ALC	237	EDI	387	BCN	129	CDG	407	DUB	219	**CIA**	198
AMS	142	ALC	176	AGP	190	ZRH	260	AGP	125	GLA	382	NCE	187	EDI	128
CDG	132	AMS	152	DUB	157	**BRU**	218	GLA	121	FRA	322	AGP	172	PRG	122
MJV	116	PMI	126	BCN	155	**RTM**	215	PMI	114	**ARN**	244	CDG	170	**HHN**	121
DUS	105	CDG	124	CDG	131	CDG	176	ALC	105	CPH	242	**GVA**	142	GLA	111
MUC	90	NCE	119	MJV	106	**DND**	176	**MAD**	88	**ATH**	203	BCN	140	**ORK**	102
ALC	87	PRG	110	NCE	93	**ANR**	173	**ABZ**	82	**OSL**	186	ZRH	134	CPH	94

Table 5-3 Market Shares of Carriers

	November 2002		June 2003		November 2003	
	Business	**Leisure**	**Business**	**Leisure**	**Business**	**Leisure**
Legacy[33]	85.5%	63.8%	81.4%	61.1%	81.0%	58.9%
Ryanair	4.5%	15.8%	4.6%	14.3%	5.1%	15.2%
easyJet	10.0%	20.4%	14.0%	24.6%	13.9%	25.9%
Total	100%	100%	100%	100%	100%	100%

5.3 MODEL

To determine the passenger sensitivity to fares and frequency we use a nested logit model.[34] In the survey data a traveller has indicated to fly to a specific destination[35]. From the OAG-files, we identify the alternatives (departure airport and airline combinations) available to that traveller[36]. The model assumes that the traveller chooses an alternative from *all* available alternatives. Note that in practice some alternatives may be ignored because the traveller is not aware of the alternative or because the traveller does not consider some alternatives as relevant.

33 A legacy carrier is a carrier established before the deregulation of the aviation markets. In short: a carrier which is neither a low-cost carrier nor a charter airline.

34 A more technical description of the model is available.

35 We use the destinations that attracted more than 50 respondents.

36 The potential departure airports are listed in Table 5-1. The exact set of departure airports depends on the destination.

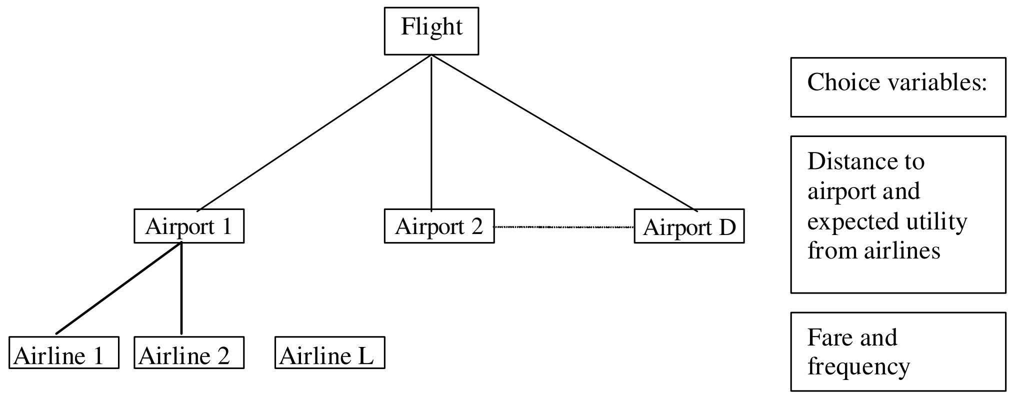


Figure 5-1 Choice Structure

The choice for the alternative is based on the expected cost associated with the alternative. The traveller pays for the airline ticket, but also has to travel to the airport, and pay the airport tax (which is collected by the airline). Furthermore, we include the log of the frequency as a measure of size of the alternative. The choice structure is depicted in Figure 5-1. The choice for a departure airport depends on the accessibility of the airport (in this case measured as the distance), and the expected utility of the airlines available at the airport. If there are many airlines flying to the destination from an airport, compared to the other airports, the probability that this particular airport is chosen increases (because the number of seats available from this airport increases). The probability that we choose an airline depends on the fare and frequency.

In modelling terms, the probability that we choose airline A (an airline from the available set of alternatives {airline 1, …, airline L} in Figure 5-1), given that we use airport D (an airport from the available set of departure airports), P(*airline A*|*airport D*), is the probability that the cost (utility) of airline A is lower (higher) than the cost (utility) of the other airlines available from airport D, where the cost is a linear function of the fare and frequency. If the fare or airport tax increases, the cost increases (utility decreases), and if the frequency increases the cost decreases (utility increases). Likewise, the probability that we choose airport D, P(*airport D*) is the probability that the cost of using airport D is lower than the cost of the other airports, where the cost depends on the distance to the airport (accessibility) and the expected utility of all airlines (the aggregated utility of all airlines departing from D). The probability that we choose the combination of airport D and airline A (operating from D) is *P*=P(*airport D*)*P(*airline A*|*airport D*).

With the nested logit model we estimate the parameters associated with the fare, frequency, accessibility and maximum expected utility. These parameters determine how the probability *P* that we choose the combination of airport D and airline A depends on the fare, frequency and accessibility. Using these parameters we can determine the elasticities. For instance, a price elasticity of *x* tells us that a 1% change in the price causes a change in the probability *P* of *x*%.

5.4 ESTIMATION RESULTS

In Appendix 2 the parameter estimates are listed. All parameters have the expected sign. Using these parameter estimates, we can compute elasticities for each respondent in the sample. First, we present elasticities that are aggregated to the airport level[37]:

[37] These 'aggregate' elasticities are calculated using the choice probabilities as weights (actually, we present weighted averages at the airport level).

Table 5-4 Direct Elasticities; Efare=Fare Elasticity; Efreq=Frequency Elasticity, Edist=Distance Elasticity

	9.1.2003 – 31.3.2003						1.4.2003 – 31.10.2003					
	Business			Leisure			Business			Leisure		
Airport	Eprice	Efreq	Edist	Eprice	Efreq	Edist	Eprice	Efreq	Edist	Eprice	Efreq	Edist
BHX	.	.	.	.	.	.	-0.22	0.23	-0.41	-0.4	0.4	-0.17
BRS	.	.	.	.	.	.	-0.11	0.18	-0.19	-0.3	0.43	-0.25
EMA	.	.	.	.	.	.	-0.06	0.16	-0.24	-0.3	0.48	-0.23
LCY	-0.29	0.64	-0.54	-0.2	0.52	-0.57	-0.25	0.24	-0.47	-0.2	0.16	-0.05
LGW	-0.16	0.58	-0.58	-0.1	0.53	-0.55	-0.19	0.28	-0.73	-0.4	0.39	-0.17
LHR	-0.33	0.71	-0.41	-0.2	0.51	-0.35	-0.36	0.32	-0.48	-0.5	0.44	-0.08
LTN	-0.08	0.56	-0.91	-0.1	0.59	-1.14	-0.12	0.25	-0.85	-0.2	0.32	-0.17
STN	-0.06	0.44	-0.73	-0	0.13	-0.28	-0.15	0.33	-1.39	-0.1	0.13	-0.07

For example, when price of travel by British Airways from London City is increased with 10% (due to an increase in fare or airport tax), the probability that the combination of British Airways *and* London City is chosen decreases by 2.9%. If the probability that the combination BA and London City is chosen is 50%, this means that an increase in the average fare of 16 pounds (see Table 5-5) leads to a market share for BA/LCY of 48.55%. Note that this is not a decrease in total demand: the decrease in the number of passengers served by this airline is an increase in the number of passengers served by all other airport-airline combinations. Table 5-5 presents the average fares at different airports observed in the sample.

Table 5-5 Average Fares (£)

	Average fare			
	Winter 02		Summer 03	
	Leisure	Business	Leisure	Business
BHX			133.75	184.69
BRS			111.13	130.18
EMA			93.83	86.99
LCY	160.97	241.38	148.31	223.40
LGW	96.29	138.57	129.37	168.23
LHR	150.47	230.75	166.94	252.63
LTN	80.47	64.40	103.54	88.17
STN	64.86	60.30	89.22	87.48

Table 5-4 and Table 5-5 give, at an aggregate level, the effect of, for instance, a price change of an airline-airport combination on the market share of that airline-airport combination. Next, we look in more detail at the effects of price or frequency changes of low-cost carriers. Table 5-6 and Table 5-7 give the cross-elasticities in the market to Dublin. Specifically, the tables give the effects on market share following a change in fare or frequency by Ryanair operating from Gatwick. Note that at this level of detail the number of respondents over which the elasticity can be aggregated can be rather small (the number of respondents is included in the table).[38]

38 Note, however, that the parameters on which the elasticities are based are statistically significant.

Table 5-6 Cross-Elasticities: Effect of a Change in Fare or Frequency by Ryanair/Gatwick in the Market to Dublin[39]

		Business Nov 02			Leisure Nov 02		
		Efare	Efreq	N	Efare	Efreq	N
LCY	EI	0.0111	-0.0661	12	0.0115	-0.0688	56
LHR	BD	0.0091	-0.0619	14	0.0100	-0.0609	57
LHR	EI	0.0086	-0.0564	26	0.0104	-0.0642	75
LTN	FR	0.0033	-0.0230	6	0.0076	-0.0470	35
STN	FR	0.0043	-0.0293	13	0.0118	-0.0735	56

Table 5-7 Cross-Elasticities: Effect of a Change in Fare or Frequency by Ryanair/Gatwick in the Market to Dublin

		Business June 03			Leisure June 03		
		Efare	Efreq	N	Efare	Efreq	N
BHX	EI	0.0003	-0.0009	11	0.0095	-0.0217	68
BRS	BA	0.0002	-0.0005	12	0.0114	-0.0258	7
EMA	WW	0.0001	-0.0004	30	0.0094	-0.0214	85
LCY	EI	0.0093	-0.0274	19	0.0102	-0.0233	180
LHR	BD	0.0095	-0.0280	24	0.0100	-0.0227	78
LHR	EI	0.0085	-0.0252	51	0.0100	-0.0227	138
BHX	FR	0.0002	-0.0006	13	0.0097	-0.0221	62
BRS	FR	0.0003	-0.0008	27	0.0113	-0.0256	85
LTN	FR	0.0032	-0.0095	26	0.0095	-0.0215	94
STN	FR	0.0064	-0.0188	18	0.0106	-0.0241	105

For instance, if Ryanair decreases its fare by 6.5 pounds (10%, see Table 5-8), the market share of Aer Lingus operating from London City decreases by 0.093%[40]. This seems to be a very small decrease in market share. But Aer Lingus also loses market share at London Heathrow, and British Midland looses at London Heathrow. The exact loss in market share/number of passengers can be determined in a numerical exercise, in which the total number of passengers in the market is predicted. Using the estimated probabilities and elasticities we can then determine how a change in fares leads to a shift in passengers from one airline to another.

39 N=number of respondents, EI=Aer Lingus, BD=British Midland, FR=Ryanair, WW=BMIBaby, BA=British Airways

40 So the decrease in the number of passengers is 0.093*probability that the alternative is chosen*number of passengers in the market.

Table 5-8 Average Fares, London-Dublin (£)

		Average Price (jun03)	Average Freq (jun03)
BHX	EI	96.09	35
BHX	FR	65.86	21
BRS	BA	185.31	13
BRS	FR	64.81	19
EMA	WW	81.88	18
LCY	EI	101.11	21
LGW	BA	110.75	21
LGW	FR	65.7	28
LHR	BD	95.51	51
LHR	EI	100.55	91
LTN	FR	86.18	33
STN	FR	63.27	81

Table 5-9 and Table 5-10 present similar elasticities for the market London-Amsterdam. Although the individual cross-elasticities again seem to be low, they are higher when compared to the London-Dublin market. One possible explanation may be the total number of alternatives available in the market London-Amsterdam. Especially leisure travellers may consider all available options. As a result of the relatively high elasticities, the aggregated response to a change by easyJet in the London-Amsterdam market may be relatively high.

Table 5-9 Cross-Elasticities: Effect of a Change in Fare or Frequency by easyJet/Gatwick in the Market to Amsterdam[41]

		Business Nov 02			Leisure Nov 02		
		Efare	Efreq	N	Efare	Efreq	N
LCY	UK	0.0108	-0.0748	5	0.0078	-0.0491	5
LGW	BA	0.0056	-0.0387	4	0.0027	-0.0172	4
LHR	BA	0.0121	-0.0839	12	0.0070	-0.0441	11
LHR	BD	0.0120	-0.0828	10	0.0085	-0.0532	16
LHR	KL	0.0148	-0.1023	13	0.0094	-0.0588	39
LGW	U2	0.0058	-0.0405	8	0.0037	-0.0233	34

41 N=number of respondents, EI=Aer Lingus, BD=British Midland, FR=Ryanair, WW=BMIBaby, BA=British Airways, U2=easyJet, KL=KLM, HV=Transavia

Table 5-10 Cross-Elasticities: Effect of a Change in Fare or Frequency by easyJet/Gatwick in the Market to Amsterdam

		Business June 03			Leisure June 03		
		Efare	Efreq	N	Efare	Efreq	N
BHX	KL	0.0049	-0.0109	23	0.0359	-0.0609	48
BRS	KL	0.0009	-0.002	26	0.0329	-0.0557	66
EMA	WW	0.0027	-0.0061	5	0.0374	-0.0634	51
LCY	KL	0.0211	-0.0466	41	0.0293	-0.0496	103
LGW	BA	0.0090	-0.0199	25	0.0276	-0.0467	32
LHR	BA	0.0182	-0.0401	26	0.0284	-0.0481	41
LHR	BD	0.0172	-0.0378	12	0.0287	-0.0486	42
LHR	KL	0.0238	-0.0523	27	0.0285	-0.0483	78
STN	HV	0.0175	-0.0385	1	0.0323	-0.0547	4
LGW	U2	0.0116	-0.0256	9	0.0275	-0.0466	27

5.5 DISCUSSION

The estimation results presented in this note are derived using the nested logit model. All discrete choice models have shortcomings. Specifically, we assume that all alternatives (in e.g. the London-Dublin market) are available to all respondents. In fact, some respondents may not consider all alternatives (there are models nowadays that may incorporate this). More importantly, it is assumed that seats are available, while in fact some seats may be ‘sold out’. To model this we would require more detailed data, which is not available. Finally, we include the frequency as an explanatory variable (most authors do this), while the frequency of service offered by an airline may in fact depend on the probability that an airline is chosen. This issue has not yet been addressed in the literature.

Two important policy questions may be answered using the results of this analysis: do low-cost airlines operating from a secondary airport compete with full-service airlines serving a main airport in a multiple airport region, and do the estimated demand elasticities imply that price differentiation will be successful? The results show that the cross-elasticities of demand are rather low; there seems to be only a small effect of price change at one airport on the market share at another airport. This may indicate that competition is not as strong as expected, but one should realise that we look at the elasticity at the market-level. A price change in a market may well lead passengers to change their destination. This effect cannot be captured within our model due to data limitations (such data are simply not available). The same can be said for price differentiation. Changing prices to spread demand in a certain market over time or over different airports operated by the same airport operator may lead to the situation where passengers decide to change their destination. One may hypothesise that at this moment, scarcity rents at congested airports are divided between airports and airlines. An increase in the passenger charge at, for instance, London Heathrow allows the airport operator to capture a larger part of the scarcity rent (i.e. airport revenues are increased at the expense of airline revenues). If airlines do not adjust their fares, price sensitive passengers may divert to other airport-airline combinations (i.e. choose other destinations and airports *and* other airlines). *If* airlines lower their fares in order to prevent this, we would again witness relatively low cross-elasticities. In order to fully analyse this, we would again need data on the destination choice, which is not available.

Finally, we find that the direct price elasticity of demand varies only little between business and leisure travellers, contrary to what was expected from the literature. One would expect that business travellers fly during peak hours, and are relatively inelastic. But because of the capacity constraints at London airports, airlines may operate on the elastic part of the demand curve during peak hours, even though the demand function for business travellers may be steeper for business travellers when compared to leisure travellers.

The conclusions from this research are thus that: i) cross-elasticities of demand between airports are relatively low, indicating that there is little competition within markets; ii) there is little evidence that price elasticities for business travellers are lower (in absolute value) than price elasticities for leisure travellers; and iii) a likely effect of price differentiation is that passengers choose different destinations, departure airports or modes, rather than switch between peak and off-peak.

The data do not allow us to analyse the destination choice, which means that the conclusions do not provide a complete picture. But still the results indicate that peak-load pricing, or setting relatively high prices at congested airports, may lead to a redistribution of scarcity rents. As a result, the cross-elasticities (between airports) are relatively low, and it may seem that such pricing schemes have little effect. But it should be realised that i) such pricing schemes have the effect that the slots will go to the airlines that carry passengers that are willing to pay the high prices (i.e. the passengers that bring the highest value to the local economy) and ii) scarcity rents are transferred from international airlines to local airports, where they can be spent on capacity, noise mitigation measures, etc. The presence of competing airports, airlines and destinations thus will likely influence the effect of price differentiation at airports. Such effects may not be a move towards less congested airports, but an allocation of capacity towards flights with a high value to the economy, as price differentiation intends. In order to analyze this empirically, data on destination choice and departure time preferences is needed, which can only be collected in a stated preference survey. This would be a follow-up to the current analysis.

6 HAMBURG AIRPORT: THE INTRODUCTION OF A NOISE CHARGE

6.1 INTRODUCTION

Hamburg airport has passed through several stages of development within the last two decades. It was the second airport in Germany which was (partly) privatised, the first which introduced price cap regulation and one of the first which restructured its charges and separated noise charges from the rest of airport charges. This chapter therefore examines the impact of the airport's new charging regime initially on demand and in a further step on aircraft choice by the carriers. We will show that in contrast to what the neoclassical economic theory says, price differentiation in Hamburg airport didn't have any effect. The reasons for this paradox are very likely to be found within the theory of political economy. Furthermore, the findings will be discussed with respect to their accordance with the hypotheses given in WP 3 (see Del. 3.1 pp. 31-33).

6.2 HISTORICAL REVIEW: PRIVATISATION AND REGULATION

In this subsection we shall analyse the current regulatory regime in Germany and the reasons for regulating Hamburg airport. Subsequently, a historical review will be made, in order to obtain a better view of the factors that led to the introduction of price cap regulation.

6.2.1 The Current Airport Regulatory System in Germany

In Germany, there are several legal acts providing the regulatory framework for regulating airports. However, the main element is that airport regulation in Germany is mainly left to the discretion of the federal states (the so called Bundesländer)[42]. According to the effective law (LuftVG, LuftV-ZO) airport charges must be submitted for approval to the respective federal state authority. The federal government is empowered to object federal state decisions, but in practice never used this entitlement. The fact that there is no central airport regulatory authority results in an uninformed regulatory landscape. The most used practice is cost based regulation. The regulatory authorities approve the submitted charges by examining the criteria of cost relatedness, accordance with the transport policy and reasonability. To that aim the future costs and revenues are calculated. Among the cost factors are counted the depreciation of capital and a reasonable rate of return on capital. In most of the cases the single till principle is applied. Therefore, the applied airport regulation in Germany is closer to a rate of return regulatory system than to a cost plus one. The criterion for the accordance with the transport policy is mostly used in order to achieve conformity with the general transport policy. This results in most cases in differentiated charges according to the ICAO noise chapters. Airlines are playing an active role within this framework. Carriers participate in closed hearings, in which the general public is not allowed to be present. The regulator is acting as a moderator at these hearings. Exactly this point seems to fit very well with the positive theoretical framework provided in WP 3.1 (Grossmann/ Helpmann model). The policy maker will implement a policy set with compromises, in order to achieve personal as well as social welfare objectives. However there are several shortcomings of the current regulatory system (Dummann, 2005, pp. 5-8):

- The regulator needs credible information regarding the costs. The corresponding principal-agent problem led very often in the past to very high charges.
- Applying the single till principle means that revenue increases in the non-aviation sector lead at the same time to decreases in the level of the charges. This might be convenient for the carriers, but airport management has less incentives to develop non-aviation activities.
- The existing regulatory framework provides no incentives to enhance efficiency.

42 The Federal Republic of Germany consists of 16 federal states, which are something like provinces and which have their own state government and their own competencies. The Free and Hanseatic City of Hamburg is one of them. In addition, the federal government is the executive power and represents the central policy making body in Germany.

- Additionally, there is no clear division of roles, since in most of the cases the regulator acts at the same time as a shareholder of the regulated airport. This means *de facto* that the regulator at the same time represents the interests of the industry he or she is supposed to regulate.

6.2.2 The Case of Hamburg Airport

Plans concerning the privatisation of Hamburg airport have already been existing since the beginning of the 80's. As in other transport modes, the federal government of Germany saw airport privatisation as a device to disencumber the public budget and to enhance efficiency in this sector. In addition, Hamburg airport has always been considered a very important location factor, which guarantees high economic activity and welfare and should therefore stay under the responsibility of the state. For that reason, the first steps in the direction of privatisation could only be made in 1995 and under the pressure of high budgetary deficits. This situation was extremely complex because of the ownership structure of Hamburg airport, whose stakes were held by the Free and Hanseatic City of Hamburg (majority) and by the federal government (minority). The federal government asked in 1995 the Free and Hanseatic City of Hamburg for its permission to sell its minority stakes. As a first step a consortium consisting of Hochtief AG and Aer Rianta International (Airport Partners AG) was awarded 36 percent of the total shares. This part was successively increased up to 49 percent. In Germany, most of the bigger airports are now formally privatised. However, real private ownership is limited to just three cases (Frankfurt, Düsseldorf and Hamburg). In the rest of the cases the shareholders are mainly the city of the airport concerned, the federal states, as well as the central government.

Reasons for regulating Hamburg airport can be found in every text book. The most widely used argument for regulating airports is the existence of natural monopoly. However, the theoretical discussion regarding the existence of natural monopoly in the airport sector is controversial among scientists. Doganis (1992. pp. 48) found out in a study concerning the British airport sector that average costs decreased until the output level of 1.5 M passengers. He found no evidence for the existence of diseconomies of scale for large airports. Therefore he concludes that bigger airports have lower unit costs than smaller airports. ICAO (ICAO, 2000, p.3) detected similar results. Other researchers (Pels, Nijkamp, Rietveld, 2003, pp. 341-361) separated passenger handling from air transport movements. Using Data Envelopment Analysis as well as Stochastic Frontier Analysis, Pels et al. found out, that average European airports are operating under constant returns to scale in the case of air transport movements and under increasing returns to scale when handling passengers. These results were also supported by Gillen and Lall (Gillen, Lall, 2001, pp. 283-306) for the US American airport sector. As a conclusion the question whether airports are natural monopolies has not been yet definitely answered. Niemeier (Niemeier, 2002, p.39) concludes that according to the empirical evidence secondary airports in Germany are operating under constant returns to scale for air transport movements up to the level of 150,000 movements and weak increasing returns to scale for passenger movements up to the level of 12.5 million passengers. Regarding Hamburg airport it seems that these conditions still hold, since Hamburg airport is about to exceed the figures named by Niemeier.

An additional reason for regulating Hamburg airport is the lack of solid intermodal competition (Niemeier, 2002, p. 39) at least within the wider metropolitan area of Hamburg. This situation (Niemeier calls it "the uncontestable hinterland") gives Hamburg airport the opportunity to impose monopoly prices. Therefore it is absolutely necessary to regulate Hamburg airport.

Participating actors in Hamburg proposed the introduction of a price cap regulation regime. The proposal included the following subtopics:

- Disaggregation of the regulated services. Following the essential facilities doctrine it was proposed to include in the tariff basket only those services, which cannot be duplicated within a reasonable time. Therefore the regulated charges are the fixed and variable landing charges as well as the parking fees. The rest of the services (ground handling, non-aviation activities) remained unregulated. The regulator argues at this point that Hamburg airport faces sufficient (potential) competition in the field of ground handling services and non-aviation activities.
- Connected with the topic above, it was proposed to reject the inclusion of the single till option in the contract. Nevertheless, the airport management is free to follow the single till option, if it thinks that this could increase airport activity. As a reason for this, it was argued that Hamburg

airport is expected to face capacity problems in the near future. The use of single till would lead to an increase in retail revenues and at the same time to a decrease in airport charges. Therefore, in times of congestion low landing fees convey the incorrect signal to airlines (regarding scarcity) and lead to distortions (Starkie, 2001, p. 128). In addition, single till lowers incentives to develop the non-aviation sector, as it functions as a tax for non-aviation activities.

- Price cap regulation leaves the tariff structure to the discretion of the airport management. This gives additional incentives to adopt such pricing schemes, which enhance efficiency.
- The proposed X Factor had the value of 2. Several assumptions have been made for the calculation of this value. First, the number of the employees needed for the regulated services is constant. Second, the increasing airport activity is to be served by the same number of workers. Third, the yearly airport activity growth was set at a level of 3.8 percent (Mandel, 1997, p. 15). This results in a productivity growth of about 4 percent. The productivity growth was proposed to be shared equally by the airport and the users (Greinus, 2004, p. 67).
- In order to enhance transparency a consultation and quality control system was introduced. The consultations are taking place between airport administration and users in a six month circle. The quality control system deals with periodical passenger surveys.

In the subsequent consultations air carriers managed, under leadership of Lufthansa, to form a coalition of one voice. In the consultation that took place after the proposal, air carriers saw the option of the implementation of price cap regulation predominantly positive. However, there were some objections mostly regarding the level of the X factor and the use of single till. Carriers argued that non-aviation revenues are highly connected to the passenger growth and therefore should be included in the regulatory regime. However, the regulator rejected this proposal. Furthermore, regarding the level of the X factor, airlines supported that the factor level should be raised by the level of 4, as the proposed value of 2 seemed to be inappropriate for them. The airlines argued that a faster increase in passenger figures than forecasted would result in above-average profits for the airport. After several consultation rounds, the regulator achieved a compromise by introducing the concept of sliding scales. For each percent of additional passenger growth lying over 4 percent, the X factor rises with 0.5 percent (Article 2, öffentlich-rechtlicher Vertrag über die Festsetzung und Anpassung regulierter Flughafenentgelte).

Since the federal government didn't change the legal framework mentioned above (LuftVG, LuftV-ZO), it was necessary to implement price cap regulation on a voluntary basis. According to that aim the Free and Hanseatic City of Hamburg closed a contract with the Hamburg airport. The contract had a duration of five years. In 2004 this contract was extended for five more years.

However, the implementation of price cap regulation does not mean that all the problems are solved. A close observation of the achievements of price cap regulation in Hamburg will show whether this step was justified and whether there are corrective amendments to be made. Starkie (Starkie, 2005, p.5) remarks that, according to recent observations price cap regulated airports (especially airports with capacity problems) in the UK and Ireland tend towards excessive investment by scheduling airport expansions rather than implementing efficient price structures. This can also be observed at Hamburg airport, which is about to undertake the so-called Hamburg 21 expansion program (see www.ham.airport.de).

6.3 The Restructuring Process of Take Off and Landing Fees at Airport Hamburg

This subsection deals at the beginning with the reasons for not implementing efficient pricing schemes by the airports. In a further step the restructuring process of the take off and landing fees of Hamburg airport will be presented. Flight noise plays in Hamburg since the beginning of the 70's a major role. This is therefore, the reason why price differentiation according to noise classes was introduced.

6.3.1 Why Airports do not Implement Efficient Charging Schemes

Closely connected with the regulatory regime are also pricing issues. Talking about efficient airport charges, Wolf (Wolf, 2003, pp. 121-131) stated that first best solutions (marginal cost pricing) within the airport sector lead to the known problem of deficit and he analysed several price differentiation schemes. He concluded that Ramsey pricing solutions are appropriate second best solutions in order to achieve the restriction of full cost coverage and minimization of welfare losses (compared to marginal cost pricing). In addition, he mentions that peak load pricing could be in the short run a valuable instrument to cope with capacity problems. However such pricing measures can hardly be implemented mainly due to lack of acceptance by the incumbent users. Starkie (Starkie, 2005, p. 6-7) gives the following reasons for not implementing efficient pricing structures:

- First, governmental ownership induces a situation in which a majority of airports does not seek profit maximization (Forsyth & Niemeier, 2003, pp. 14-15).
- Second, it is very difficult for airport managers to reject the traditional charging scheme based on the partly erroneous proposition that aircraft weight correlates with runway damage.
- Third, airlines opposed such pricing instruments, although they are using similar pricing schemes themselves (yield management).
- Fourth, airport managers are unwilling to adopt such pricing schemes since they regard this as counterproductive in order to implement capacity extension programs and therefore in order to achieve higher output figures in the long run.

Therefore Starkie proposes an inclusion of the charging structure in the regulatory framework. In addition, Schank (Schank, 2005, pp 417-425) demonstrated that peak load pricing in Boston and London failed because of the absence of acceptance by the user groups, who managed to form effective opposition to this pricing scheme. In New York peak-load pricing for La Guardia airport resulted in the exit of almost all commuter flights to Teterboro, a regional airport located in New Jersey.

6.3.2 The Current Charging System at Hamburg Airport

In parallel to the introduction of price cap regulation Hamburg airport proceeded to a reorganization of its charging structure system. The main element of the new charging system was the additional differentiation according to noise emissions, which however was limited to a small degree. The old pricing system was a two-part tariff, including a fixed and a variable component. The fixed component was based on the maximum take off weight (MTOW) and was differentiated according to the noise emission category of the aircraft, taking into account the ICAO Annex 16, chapters 2 and 3.

The problem of flight noise is not a recent issue in Hamburg. Since the beginning of the 70’s several environmental groups have been formed against flight noise, which later were unified into one group. These groups opposed airport activity and gained successively power. The policy makers in Hamburg recognized this and in order to appeal to these groups appointed in 1971 the commission against flight noise. During the whole consultation time concerning price cap regulation the commission was a part of the involved actors and brought out a proposal regarding a price differentiation scheme in order to alleviate the problem of flight noise. However, this proposal was regarded as unacceptable by the airport administration and they brought forward the argument that it was too strict and as a consequence the airlines would face serious problems, when scheduling flights from and to Hamburg. This could lead to an exit of users from Hamburg. The commission however did not give up its notion that landing fees should reflect environmental issues and came up with a second moderated proposal, which comprised the following points (Köhler, 2007):

- Introduction of two types of price differentiation
  - Surcharges for take offs and landings at night.
  - Separation of the noise charges from the rest of airport charges and development of a system of price differentiation according to the observed noise emissions.

- Implementation of the new system without additional burden for the users. The noise charge should induce airlines to use less noisy aircrafts, but it should not increase their total costs. Therefore, the new charging system was not scheduled to internalise the external costs of noise.[43]

The noise charge was to be subtracted from the fixed component of the start and landing charge.

In addition the commission proposed several technical improvements such as the construction of a noise protection hall, as well as avionics issues concerning the direction of take offs and landings in order to limit the number of the noise affected inhabitants.

The airport administration as well as the carriers accepted after consultations this proposal and as a result the airport proceeded, on the one hand, with the implementation of the new charging system, which was introduced at the end of 2001, and on the other hand with the technical improvements.

According to that aim Hamburg airport established its own noise measuring system and introduced seven noise classes. According to statements of airport officials the noise charge (reference year 2000) was subtracted from the fixed charge. However, the 3.00 € per 1000 Kg (see Table 6-1) seem to be very low. This could be an indicator of a price reduction (if the variable component of the charge remained constant), or a variabilisation of charges[44] (if the variable component of the charge has been raised).

In addition to the sum of the fixed charge and the noise charge a surcharge of 100 percent for flight operations between 10:00 p.m. and 10:59 p.m. and a surcharge of 200 percent for flight operations between 11:00 p.m. and 5:59 a.m. was imposed. These surcharges seem at first glance high enough to encourage users to start or land at other times.

Table 6-1 Fixed User Charge at Hamburg Airport Before and After 2002

Take off and landing fee for Turbojets **(Payable per tonne MTOW)**	**Before 2002**		**After 2002**
	Daytime	22:00-07:00	
Without ICAO accreditation	73.63 €	82.83 €	3.00 €
ICAO Annex 16 Chapter 2	46.02 €	55.22 €	3.00 €
ICAO Annex 16 Chapter 3	15.65 €	15.65 €	3.00 €
ICAO Annex 16 Chapter 3 (bonus list)	9.2 €	9.2 €	3.00 €

Source: Published Hamburg Airport Charges

Regarding the noise differentiated charges these can be seen in Table 6-2[45]:

43 According to the author's knowledge, the City of Hamburg did not assign any corresponding study dealing with the costs of noise.

44 The degree of variabilisation refers to the ratio of the variable component of the charge (payable per passenger) to the total charge.

45 In the list of the noise classes there are some more aircrafts, which however are not considered as relevant for the analysis.

Table 6-2 Noise Classes and Charges at Hamburg Airport

Noise Classes						
1	2	3	4	5	6	7
up to 71,9 dB(A)	72,0 to 74,9 dB(A)	75,0 to 77,9 dB(A)	78,0 to 80,9 dB(A)	81,0 to 83,9 dB(A)	84,0 to 86,9 dB(A)	up 87,0 dB(A)
5.50 €	**13.00 €**	**27.00 €**	**55.00 €**	**160.00 €**	**421.00 €**	**1350.00 €**
AC69	AT722	A3181	A300F	A3006	A3004	AN12
AC6T	AT725	A3191	A3202	A3102	A3302	B7073
AC70	BA31	AJ25	A3211	A3103	A3303	B7272
AT42	BA461	AJ25	A3212	A3201	AN26	B727F
AT422	BE55	AN2	B7373	A3402	B7271	B7472
AT423	BE58	B7376	B7375	A3403	B747S	B7473
AT424	BE60	BA462	B7377	B7374	DC93	BA115
AT425	BN2	BA463	B7378	B7474	DC94	C141
ATP	C406	BBJ	B7572	B7573	FK28	DC103
BA41	C525	BJ40	B757F	B7673	LR24	DC86
BE02	CJ1	C337	BE40	B7772	MD81	IL62
BE10	CJ2	C340	BH06	C130	MD82	IL76
BE20	CRJ7	C551	DA20	DC101	MD83	IL86
BE30	D328J	C560	DA21	DC3	MD88	TU34
BE3B	E121	C650	DA50	DC92	TU54	YK42
BE90	E145	CV44	FK10	DC95	YK40	
BE99	F2TH	CV58	FK27	G2	B7372	

Source: Published Hamburg Airport Charges

In addition, changes in the variable component of the regulated charge (payable per passenger) can be seen in Table 6-3:

Table 6-3 Passenger Charges at Hamburg Airport

Passengers	Before 2002	After 2002
Domestic flights	3.09 €	6.50 €
Flights from/ to Europe	3.83 €	7.35 €
International Flights	3.83 €	7.65 €

Source: Published Hamburg Charges, Flight Noise Appointee of the Free and Hanseatic City of Hamburg

Table 6-3 shows clearly that the charge per passenger has almost doubled. Here it has to be noted that any charge adjustments, resulting out of the price cap regulation had always been incorporated in the variable component of the charge (Köhler, 2007). However, according to Hamburg airport officials (Brockmann, 2007) due to the price cap regulation there have been no considerable changes in the price level, which stayed (nominally) almost constant within the last 5 years.

Concluding on the changes in the tariff structure, it seems, first, that a certain degree of price differentiation has been introduced. Second, the change in the proportion of the fixed and the variable charge indicates that the variable component has increased. However, from the existing set of data this can not be definitely inferred. The reason is that the whole calculation is kept closed from the public.

6.4 USER REACTIONS TO THE NEW HAMBURG CHARGING SCHEME

The reaction of the users to the pricing scheme described above can be separated in two categories: First general reactions and second reactions to the differentiation features of the pricing scheme. Regarding the general reactions it is necessary to analyse the demand development in Hamburg within the environment of a growing market. Therefore, demand will be analysed comparatively to other airports. In addition, it is very interesting to study airline reactions concerning aircraft size. To this end it is necessary to separate between aircraft movements and passengers. Reactions to the elements of differentiation will be studied by means of aircraft movements.

6.4.1 General Reactions: Demand Analysis

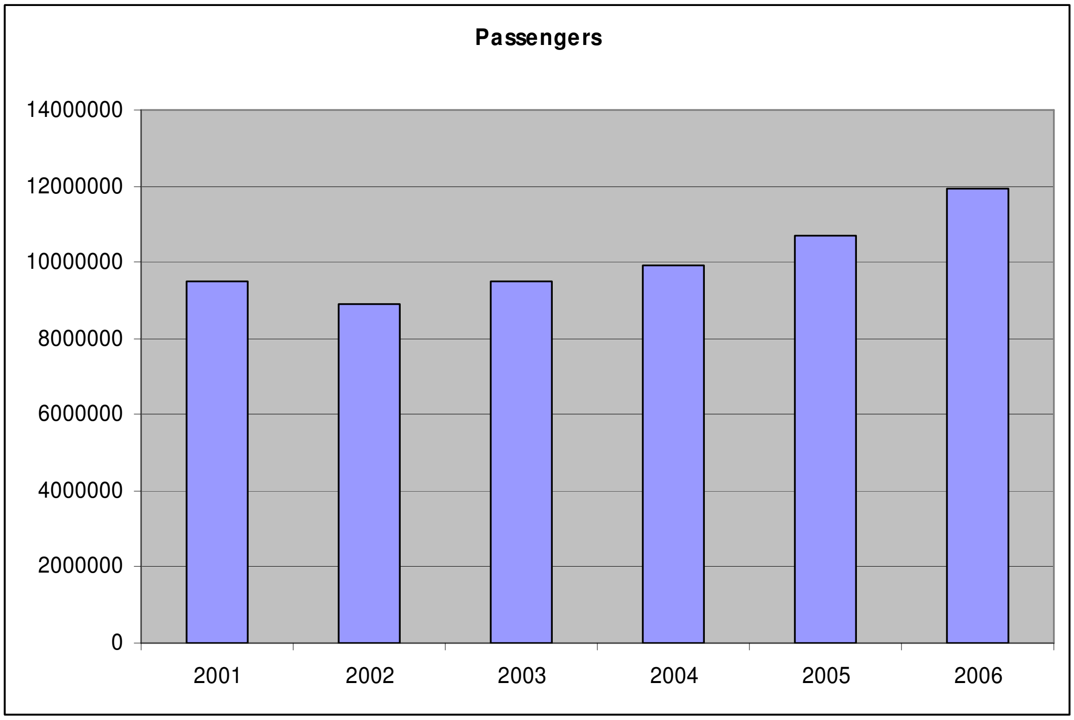
Before we proceed to the demand analysis, it is important to state, that carriers seem to be content with the policy followed by Hamburg airport. The reason for this is mainly the introduction of price cap regulation, a fact which induced a real landing fee decline, because although the nominal charging level stayed constant within the period of the last 5 years, real charges declined at the same time. Another possible reason could be the obvious change of proportions between the fixed and the variable component of the charge. In addition, the noise charge doesn't seem to cause as much "pain" to the users as it was expected, since carriers, driven from the need to decrease energy costs, are using more and more modern aircrafts, which provide at the same time enhanced noise protection. All these issues will be addressed within this subsection.

Air transport demand is expected to grow considerably in the next years and decades. According to demand forecasts from Boeing and Airbus this growth will be considerable in south eastern Asia and moderate in Europe and northern America[46]. The annual average growth for Europe is expected to reach the level of around 3.4 percent (Boeing, 2002, p. 37). Therefore, considerations about the growth at just one airport should be seen in context with other airports. In a growing market it is important to consider regional and other comparable airports.

In general Hamburg airport could achieve positive figures since the introduction of price cap regulation and the restructuring of its charges. Figure 6-1 shows that the number of passengers at Hamburg airport has steadily increased up to the level of almost 12 million passengers in the year 2006. 2002 was the only exception (negative growth) however this has to do with the impact of 9/11. The average growth rate was almost 4.9 percent a figure which is lying above the 2002 Boeing forecast for Europe. Concerning this point it is interesting to consider the number of movements since it is still possible that the carriers used larger aircrafts in order to meet the increased air transport needs.

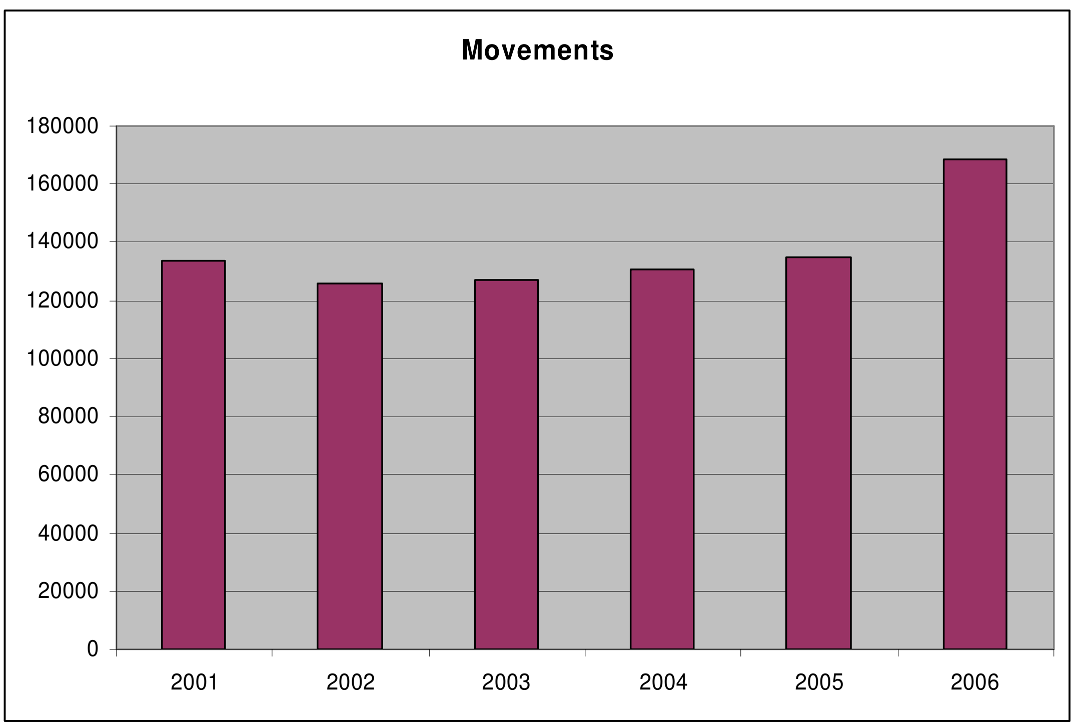
Figure 6-2 shows that especially in the years 2003, 2004 and 2005 aircraft movements did not grow at the same rate as the passengers did. Therefore the average annual growth in movements for the period under observation reaches the level of around 0.3 percent. The proportion between domestic and international flights did not change considerably. The ratio of movements for domestic flights to total movements had a range from 0.33 to 0.36. However, an observation of the monthly aircraft movement figures leaves no doubt about the recent development (see Figure 6-3).

46 Airbus forecasts show for the year 2020 about 8.3 trillion Passenger-kilometre. The respective figure of Boeing is 8.5 trillion Passenger-kilometres.



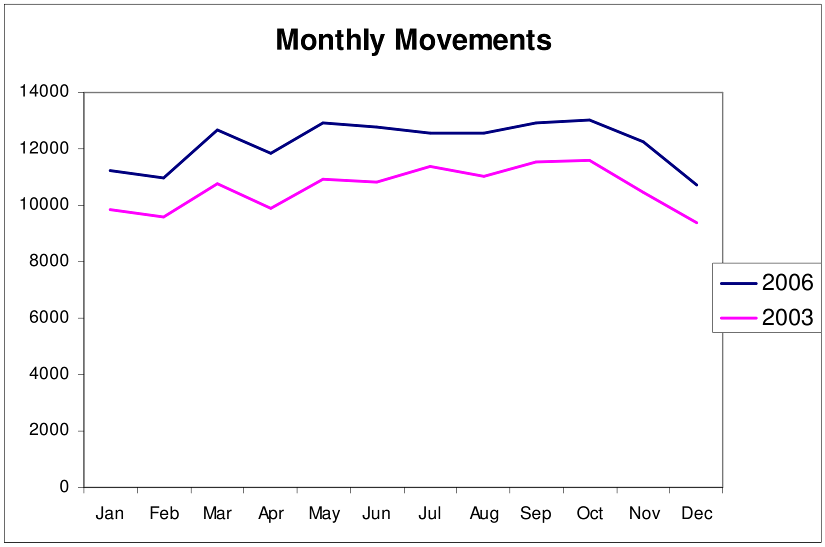
Source: Author's own calculations based on data from the Federal Statistics Agency

Figure 6-1 Passengers at Hamburg Airport



Source: Author's own calculations based on data from the Federal Statistics Agency

Figure 6-2 Movements at Hamburg Airport



Source: Author's own calculations based on data from the Federal Statistics Agency

Figure 6-3 Monthly Aircraft Movements

This means that around one third of the total flights serve the domestic market. It is obvious that carriers transported more passengers per flight within this period. However, due to the lack of such data, the development of passengers per aircraft cannot be accurately calculated.

The reason here is, that in the statistics provided by the Federal Statistic Agency as well as by the Appointee for flight noise protection of the Free and Hanseatic City of Hamburg it is not clearly recognisable which flights were passenger flights and which flights were cargo ones.

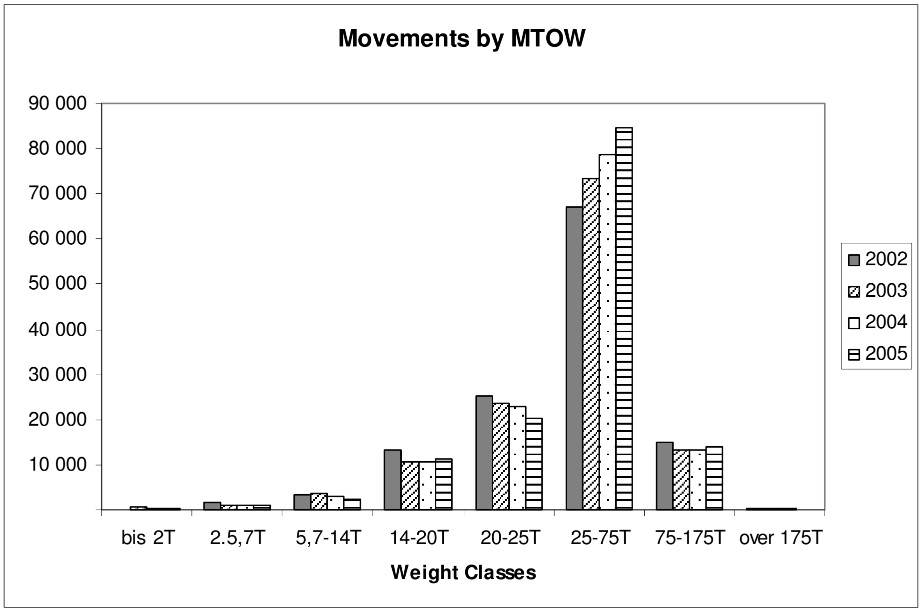
A rough figure in this case can give an idea about the possible direction of the answer to the passengers per flight. This figure can be seen in Table 6-4. The number for 'passengers per flight' is the result of the number of passengers divided by the number of movements:

Table 6-4 Gross Development of Passengers per Flight

Year	Passengers per Flight
2001	60
2002	59
2003	64
2004	65
2005	69
2006	71

Source: Author's own calculations based on data from the Federal Statistics Agency

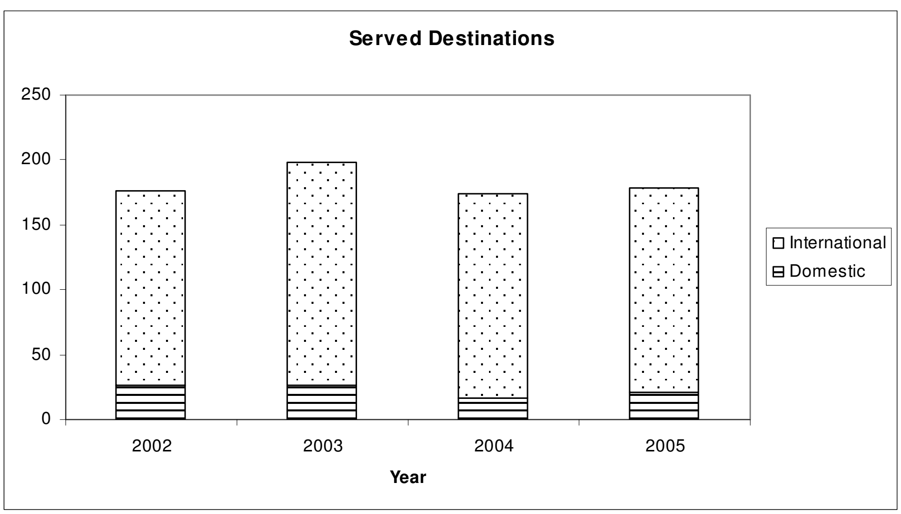
There is no doubt that passenger services have been operated either with a larger aircraft or with the same aircraft size but a higher load factor. In addition, regarding the aircraft size it would be very helpful to separate between short and long haul since long haul flights are served with large aircrafts. Givoni and Rietveld for instance (Givoni, Rietveld, 2006, p. 10) discussed inefficiencies resulting out of the trend to use smaller aircrafts in the short haul. Airlines seek a higher frequency of service, a matter which in its part is highly connected on the one hand with the forming of hubs and spokes and on the other hand with the use of inappropriate pricing structures. Such a trend could not be noticed so far for Hamburg. At this point a better look to the distribution of the movements by weight can help to derive some useful results.



Source: Author's own calculations based on data from the Federal Statistics Agency

Figure 6-4 Distribution of Aircraft Movements

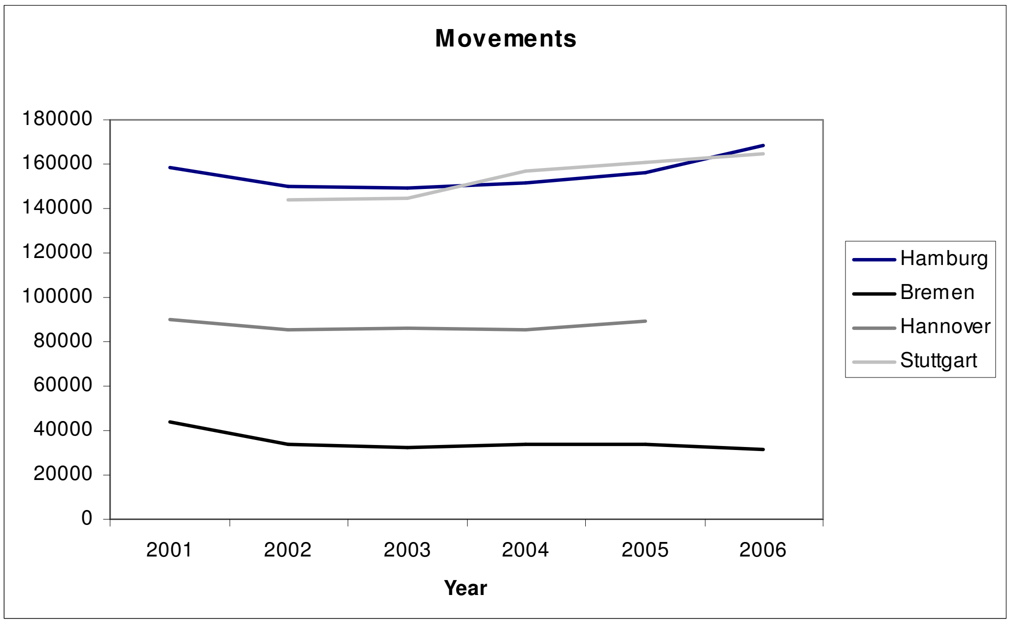
In Figure 6-4 there are several interesting findings which seem worth mentioning. First, movements of small aircrafts have decreased over time. Second, the class of 25 to 75 t, which represents all typical aircrafts (single-aisle), used within continental flights such as the whole B737 series and the respective Airbus models (A318, A319, A320 etc.) is increasing steadily. Third, movements of large aircrafts have not changed considerably. Combined with the fact that within the same period of time there was no essential change in the number of the destinations served (Figure 6-5), it can be inferred that air carriers increased the frequency of service within the existing network instead of using larger aircrafts (twin-aisle). This confirms the empirical Givoni/ Rietveld findings.



Source: Author's own calculations based on data from the Federal Statistics Agency

Figure 6-5 Destinations Served from Hamburg

Another important issue is the comparison with other German airports, since it is possible, that Hamburg airport gained from the charging practice above average compared to other German airports. It is useful to obtain knowledge: first, whether the are some other airports in the neighbourhood which won or lost output figures within this period and second what are the developments of German airports, which have a similar size as Hamburg airport. In order to deal with these issues the airports of Hannover and Bremen have been selected. The reason is that they could share parts of their catchment areas with Hamburg. As an airport with a similar size, the airport of Stuttgart seems to be comparable.



Source: Author's own calculations based on data from the Federal Statistics Agency

Figure 6-6 Comparison in Movements between the Airports of Hannover, Hamburg, Stuttgart and Bremen

Figure 6-6 shows that whilst airports of Hannover and Bremen reached constant or even declining figures, Hamburg airport could keep its high level. For the year 2006 it is impossible to make a comparison, as the rest of the airports have not announced their figures officially yet. It seems here that there are less regional interdependencies. Concerning the comparison of airports Hamburg and Stuttgart it is obvious that Stuttgart achieved a better performance starting with a lower level and resulting in a higher one than Hamburg. However it will remain to see, if Stuttgart (which by the way is a just formally privatised airport, is regulated with the old cost plus regime and uses a "typical" two-part tariff) could reach for the year 2006 the amazing figures of Hamburg.

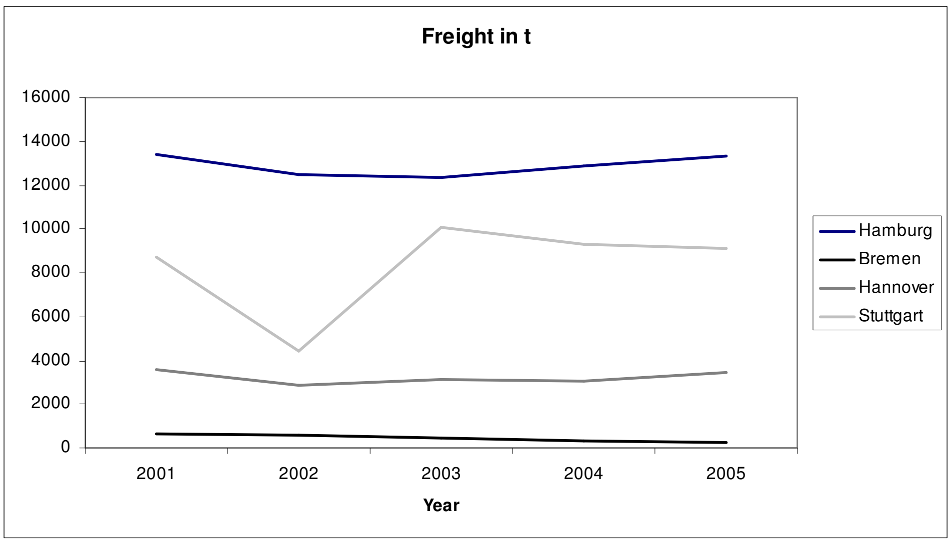
Concerning developments of freight figures in Hamburg and the other airports in comparison, Figure 6-7 shows that Airports Hamburg and Hannover recorded similar developments achieving 2003 their lowest figures. Airport Bremen can be regarded as insignificant and Stuttgart's developments seem to be inconsistent. However, there is no serious interrelationship among the outputs of the considered airports in evidence.

A better view on this issue can be formed when considering the market shares of Hamburg airport with respect to the German airport market.

Table 6-5 Market Shares of Hamburg airport with Respect to the German Airport Market.

Market Shares in percentage				
	Passengers		Freight	
Year	domestic	international	domestic	international
2001	9.7	5.4	9.1	0.6
2002	9.6	5.2	9.7	0.5
2003	10.2	5.0	10.9	0.4
2004	10.1	4.7	12.2	0.4
2005	10.4	4.9	12.1	0.3

Source: Federal Statistics Agency



Source: Author's own calculations based on data from the Federal Statistics Agency

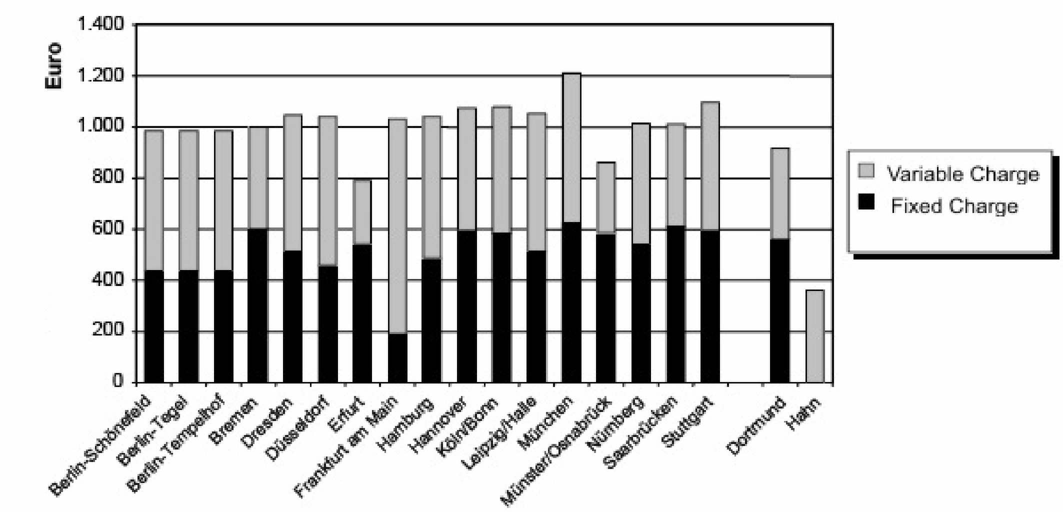
Figure 6-7 Freight in Hamburg, Bremen, Hannover and Stuttgart

In Table 6-5 it can be clearly seen that in both cases (passengers and freight) the market shares of Hamburg airport for international services are diminishing. At the same time its market share for domestic services increases considerably. A main reason for this phenomenon is the strengthening of the hub and spoke system with airport Munich elevated to the second major hub airport in Germany. Furthermore, regarding domestic freight, Hamburg seems to utilize its privileged location (the major German port) in a perfect way.

Concluding from the reactions of the price level it can be stated that Hamburg grew disproportionately well within the environment of a growing market. The declining real price level has a certain share in this development. The tariff structure (two-part tariff) combined with the very possible variabilisation of the charges, enabled users to increase service frequency and at the same time kept their take off and landing costs under control. This however, was possible, because Hamburg airport has still slots available. This situation is expected to change as Hamburg approaches its capacity limits. Airport administration copes with this problem by implementing capacity increase programs (Hamburg 21), instead of adopting efficient pricing rules.

6.4.2 Tariff Structure Reactions

Continuing the analysis above, it is useful to compare the degree of variability of airport charges in Germany. The degree of variability of a two-part tariff measures the variable part of the total charge in percentage. Öko-Institut (Öko-Institut., 2003, p. 53) calculated total airport charges (inclusive of noise related charges) of the major German airports for reference aircrafts for the year 2001. All aircrafts calculations gave almost the same result. Hamburg airport had in 2001 around 50 percent of its total charges variable. A B737-300 for instance having 83 passengers on board (65 percent load factor) and a MTOW of 63 t, would pay about 1000 € in total (see Figure 6-8). According to the current price list this amount has fallen to around 883 €. The fixed component of the total charge is around 344 €, that is around 39 percent. However, it is very likely, that for higher noise classes the charge became less variable. That means for the users, it is possible to expand service frequency in Hamburg, because in general modern short haul aircrafts are better off.



Source: Öko-Institut (2003) p. 53.

Figure 6-8 Comparison of Total Airport Charges for the Major German Airports. Reference case: Boeing-737 300 with 83 passengers on board and a weight of 63 t.

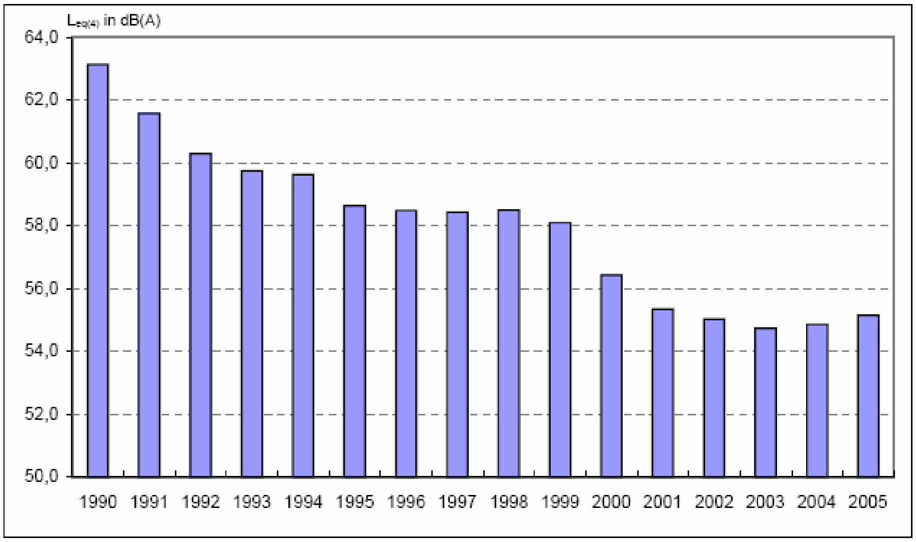
In order to gain certainty, whether the charge became more variable or not, a sample of 4,275 take offs and landings at Hamburg since 1998 has been collected and according to the effective charging system the factual degree of variability has been calculated. Table 6-6 confirms the assumed results. The degree of variability has almost doubled.

Table 6-6 Degree of Charge Variability at Hamburg Airport.

Period	Degree of Charge Variability (in Percentage)
Before 2002	37.64
After 2002	73.96

Source: Authors own calculations

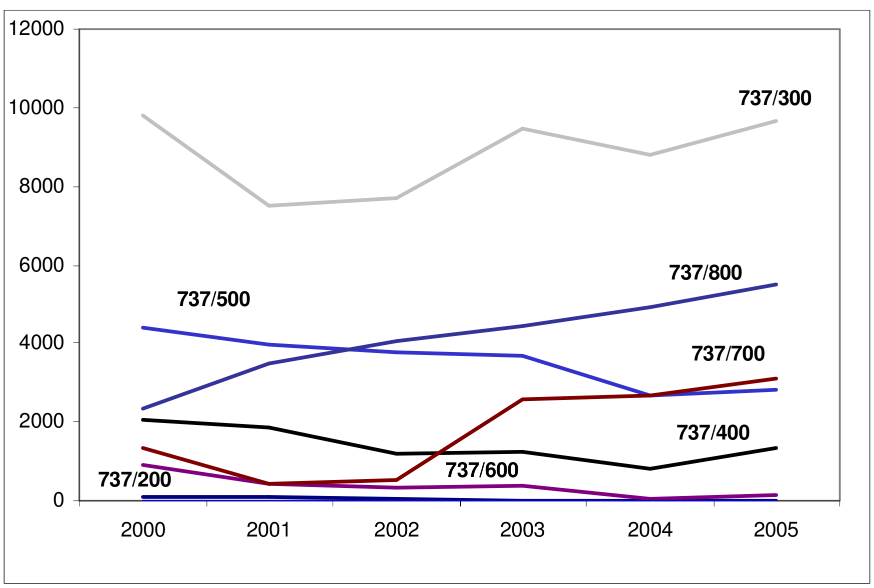
Turning to the differentiation elements of the tariff, Hamburg airport performs own measurements at certain points regarding the noise level. The noise level (see Figure 6-9) at Hamburg airport declined since the introduction of the new charging system (2002) infinitesimally.



Source: Wylensek, 2006, p. 23.

Figure 6-9 Noise Level at Hamburg Airport

However, since the beginning of the 90's the noise level has declined substantially. This evidence leads to the assumption that noise reduction is mainly the result of technical developments. ICAO regulation was a driver for developing new less noisy aircrafts. In the last years this trend was supported by the need of the carriers to abate energy costs (up to the current situation less energy consumption correlates strongly with less noise). For the future it is impossible to continue saving fuel and at the same time causing less noise emissions, because this process has reached its optimum. Less noisy aircrafts can only be constructed at costs of fuel utilisation (Köhler, 2007). Therefore, it is important to add a new chapter (eventually chapter 4) within the ICAO regulation, or to adopt more effective price instruments. A look at the take offs and landings within the Boeing 737 family in Hamburg confirms the assumption made above (see Figure 6-10).

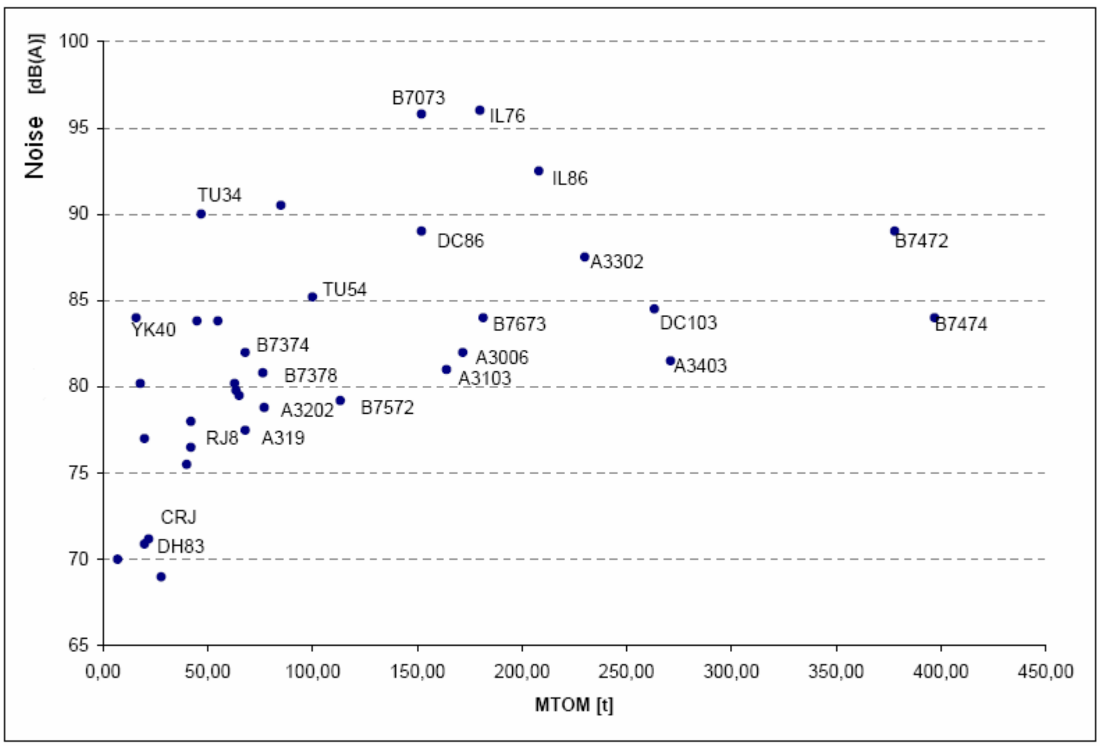


Source: Author's own calculations based on data provided by the appointee for protection against fight noise of the Free and Hanseatic City of Hamburg.

Figure 6-10 Number of Operations at Hamburg Airport within the Boeing 737 Series.

In Figure 6-10 the 200 series belonging to the fifth class declined strongly. The 200 series was produced between 1968 and 1988, and this seems to be the main reason for its diminishing use. Declining figures can also be seen regarding the 400, 500, 600 series. The 300, 400 and 500 series belong to the classical Boeing types and were produced between 1984 and 1999. Quite natural is also the development of the movements of the 700 and 800 series, which belong to the new generation that save fuel and have less noise emissions. The similarities between the 600 and 700 series may also be responsible for the development of 600 series. Users seem to buy the 700 series (812 overall deliveries) more than the 600 series (69 deliveries). Regarding the high figures of the 300 series it has to be stated that B 737 300 is the most successful model of the B 737 family (1413 deliveries)[47].

Taking all those considerations into account it can nonetheless be stated that the introduction of new aircraft models and the retirement of the older ones as well as the administrative measures taken in Hamburg, seem to be more responsible for the reduced noise level in Hamburg than the introduction of the price differentiation according to the noise classes. An additional reason is the trend of airlines to use smaller aircrafts, since bigger aircrafts have higher noise emissions (see Figure 6-4, Figure 6-11)., Figure 6-11 shows the relation between noise and weight. Here there are two trends recognizable. First, older aircrafts are noisier[48]. Second, the relation between noise and weight is not exactly linear. However single-aisle aircrafts of the latest generation are normally less noisy than twin-aisle aircrafts.



Source: Wylensek, (2006) p. Anlage 25.

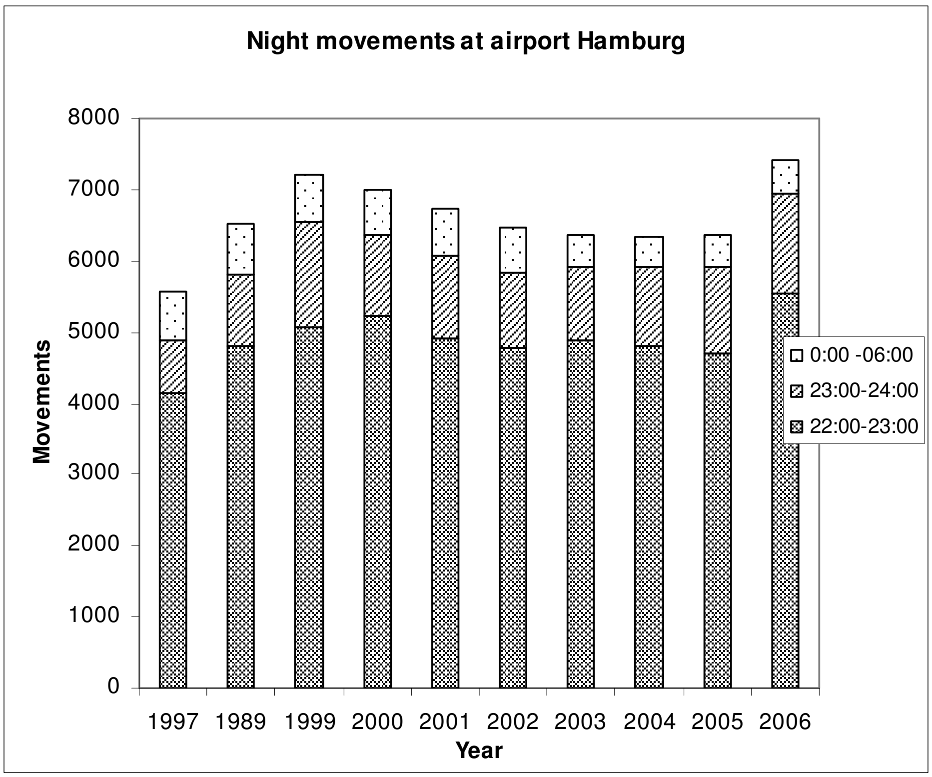
Figure 6-11 Relation between Noise and Weight

However, there are some possible effects of the pricing scheme. But these can be regarded as marginal. This could be the case if a carrier within its aircraft fleet has the possibility to use different types of aircrafts. Especially for noise classes six and seven and if the user is in the position to replace the aircraft it would be profitable. For instance, DHL replaced in Hamburg after the introduction of the noise related charge an old B 727 with a newer B 757. However, demand in the passenger market rather than the noise charge plays here the most important role. In Hamburg there are still Antonovs landing despite the 1350 € noise charge (Köhler, 2007).

47 For the number of deliveries of each model see at www.boeing.com

48 For instance B737 400 is noisier than the later typo of B737 800.

The second element of differentiation is the surcharges payable for night flights. These surcharges seem to be at first a good differentiation means in order to achieve environmental aims. In addition, the level of the surcharges (100 respective 200 percent) appears to be sufficient in order to generate the desired effect. However, Figure 6-12 shows that night movements have been declining since 1999 (three years before the restructuring of the charging system took place). More important is the fact that in the year 2006, the night movements increased with a rate of almost 17 percent. This could have had several reasons. The first reason could be slot scarcity due to the fact that Hamburg almost touches the limits of its capacity. Second, the parity of slots is especially for scheduled services very important. Landing time is a factor depending on starting time at origin and vice versa. Therefore, take off and landing times for scheduled services are constrained and users are often obliged to accept them. The third and most important reason is the demand. Figure 6-12 shows very clearly that also night flights are depending on the demand of the end market. If demand is there and the user can earn money by using his aircraft at this time, then there is no doubt that a surcharge will not play any particular role in his decision.



Source: www.fluglaerm-hh.de.

Figure 6-12 Night Movements at Hamburg Airport

A very important factor for the introduction of the differentiated noise charges was that no important interest group was against it. The policy was in favour of it, especially the Green Alternative List (GAL); the users did not combat it because they could combine it with certain advantageous price level and price structure changes; the airport was neither against it nor in favour of it and finally the environmental organisations were not really pleased, but found the new system better than the old one (Köhler, 2007).

As stated in this case, it seems to be a fact, that a price differentiation will always be implemented, if the main special interest groups favour it, whether its effect is recognisable or not. This paradox can only be explained within the framework of the positive theory of regulation. The lack of a central regulatory authority in Germany entails to a successful intervention of the users in the regulatory process and therefore in the charging system. Therefore, the proportion of the components of the two-part tariff (charging regime in almost all German airports) is crucial for the users, especially legacy carriers, since legacy carriers have to cope with the "problem" of enhanced competition from Low Cost Carriers (LCC's). A variabilisation of the tariff can on the one hand spread risks resulting out of demand fluctuations and on the other hand could help legacy carriers to extend their service frequency and therefore give more worth and power to their own network, which in its part can be seen as a means against the strategy of LCC's.

6.5 A Test on the Impact of the Differentiated Noise Charge

In order to recognise the possible effects of the noise charge at Hamburg a multinomial logit model is used. To that end a sample of 2,680 take offs and landings was collected. To this sample belong 40 major aircraft types landing at Hamburg (see Table 6-7).

Table 6-7 Major Aircraft Types in the Sample

Choice Code	Aircraft type	Movements	In percent
3	A 300 - 600	96	2.25
6	A 319	217	5.08
8	A 320 - 200	192	4.49
9	A 321 - 100	171	4.00
10	RJ 85	249	5.83
11	RJ 100	117	2.74
14	B 737 - 300	726	16.99
15	B 737 - 400	147	3.44
16	B 737 - 500	311	7.28
17	B 737 - 700	110	2.57
18	B 737 - 800	282	6.60
20	B 757 - 200	107	2.50
22	Canadair	560	13.10
23	Fokker 70	116	2.71
35	E 145	137	3.21
Number of observations			2,680

Source: Author's own calculations

Furthermore it is assumed that airlines are perfectly informed about demand. Perfect information about passenger (freight) demand as well as further flight related factors (e.g. distance) lead carriers to choose a certain aircraft size, which in this case is very well approximated with the take off weight. Increasing take off weight suggests increasing utility since carriers transport more passengers and/ or freight and therefore they can make more profits.

In addition, all the heuristic findings of this analysis have been incorporated in the model. That is at first the effect of price cap regulation. This effect is captured by a simple index. Every year real charges decrease by two percent. The first year is denoted with the value of one and all subsequent years are adjusted accordingly. The higher the value of the price cap index the lower the utility of the airline.

Furthermore, the degree of maximum variability of charge for each individual aircraft type has been calculated and incorporated in the model. Large aircrafts have a higher degree of variability. After the restructuring of the take off and landing fees this is also observable for smaller aircrafts. Increasing charge variability increases also expected utility, because airlines can catch the passenger's value of time better by offering more frequent flights.

Next, the differentiated noise charge as well as the surcharge for night flights was taken into account. Higher noise charges cause higher costs and therefore utility decreases.

Finally, a variable indicating the life cycle of the aircraft has been introduced. The reason for this is that older aircrafts will naturally be replaced after 30-35 years. Therefore, it is expected that within the observed period of time several aircraft models (e.g. B 727 200, Yak40, etc.) will be replaced because of their age.

From the analysis made above, we conclude that we estimate the probability that a certain aircraft type is used taken into account that utility is maximized if profit reaches its maximum. In other words we estimate the impact of airport related costs on aircraft choice given the impact resulting out of aircraft size (as already stated, revenues increase with increasing aircraft size).

Certainly, there are several additional factors affecting utility. In particular, the price of an aircraft affects capital costs, and therefore is a decisive parameter for the choice of aircraft A or B. Furthermore, maintenance related costs as well as fuel costs are crucial for carriers. Lastly, the possibility to choose another aircraft within the existing fleet of an airline is from the author's point of view an effect which is highly desirable for this analysis. However all the mentioned factors are airline related and therefore, the collecting of the corresponding data turned out to be impossible. Notwithstanding the lack of these data the model is in position to capture the general impact of noise charges a matter which combined with the heuristic findings can lead to reliable conclusions.

In Appendix 3 the estimation results (performed with the software biogeme) are listed. Almost all parameter estimates related to the aircraft model are statistically significant[49]. The weight related parameter (Beta (TOW)), is statistically significant as well. In contrast, all other parameter estimates are equal to zero.
This is with respect to the noise charges and the surcharge for night flights hardly surprising, since in the analysis made above this was already indicated. The economic interpretation of these results is that the differentiated noise charges as well as the surcharges for night flights have no impact on aircraft use. In other words the charging scheme at Hamburg Airport failed to motivate users to use less noisy aircrafts.

However, surprising are the results of the life cycle parameter. Apparently this is connected with the way that the index was constructed. Due to the lack of the respective data the year of the first delivery of the aircraft model concerned was used in order to calculate the life cycle index. However, the factual age of the aircraft concerned is relevant and not its maximum age. New data collection at this point is necessary.

Next, price cap regulation has no effect on aircraft use. This is conceivable since price cap regulation associates with the price level. Therefore, price cap regulation could have an impact on airport activity in general but not on aircraft choice.

Finally, the degree of variability has likewise no effect on aircraft choice. This is quite surprising, because variable charges favour smaller aircrafts, and have indirectly an impact on aircraft choice. A possible explanation at this point could be the nature of the flights taking place at Hamburg. Hamburg is a secondary airport in Germany and therefore it serves mainly as origin for domestic and continental destinations (small and medium haul). Therefore carriers use already smaller aircrafts.

6.6 CONCLUSIONS

Hamburg airport was one of the first airports in Germany that sold a big part of its shares. It was the first German airport imposing price cap regulation and one of the first differentiating its charges according to noise emissions. The development of output figures in Hamburg shows that restructuring the charging regime was an important step for the airport. However, regarding the differentiation principles there are no considerable effects recognizable. In addition, the proportions of the two-part tariff became more variable after the reorganisation. This enables users (especially legacy carriers) to

49 A 320 – 200 and A 321 – 200 are the only exceptions.

concentrate on their plans of expanding service frequency. The empirical findings combined with all heuristic findings provide safe evidences to argue, that the introduction of noise charges at Hamburg airport did not induce carriers to use less noisy aircrafts.

A very important aspect for the introduction of the differentiated noise charges was that no major interest group objected it. The policy was in favour of it; the users could live with it because at the same time they could achieve the introduction of their favoured price level and price structure; the airport could improve its environmental image and finally the environmental organisations were not really content with it, but they found the principles of the new charging scheme better than the old ones (Köhler, 2007). The rejection of the initially proposed differentiated noise charge is the main evidence that, the regulatory framework (particularly the consultation system) gives carriers the opportunity to intervene in the setting process of the pricing rules. Consequently the reasons for the current price structure are more detectable to the positive theory of regulation, described in WP 2 and WP 3.

Taking into account all findings described above, the analysis provides evidences for confirming hypothesis H8 described in D 3.2: *"The setting of Infrastructure-tariff will always be subjected to a strong political element. The positive theory aspect of setting infrastructure charges is therefore highly relevant. Lobbying activities will be a major explanatory variable for the tariff structure that will finally be implemented."* In addition, it seems that price differentiation will take place, if the most important interest groups are pro differentiation. This confirms hypothesis H9 (Del. 3.2): *Policy makers will react to lobbying influences and implement a kind of SIG equilibrium (like in the Stigler-Peltzman model or the Grossman/Helpman model described in Del. 2.1 and Del. 3.1 respectively). Infrastructure charges which correspond to such equilibrium may be turned "politically acceptable". This rules out tariff-structures, which increase the welfare (as compared to the status quo ante) of only one SIG even if total welfare effects should be positive.* Concerning the variabilisation of the price structure, the analysis provides evidences for confirming hypothesis H10b described in D 3.2: *Different proposed pricing rules lead to different behaviour of SIGs: "An implementation of non-linear pricing has as a result that SIGs will attempt to affect the proportion of the fixed and the variable components of the charge".*

7 LJUBLJANA AIRPORT: DEMAND PEAKS

7.1 INTRODUCTION

The aim of this case study is the analysis of existing differentiated charges at "Jože Pučnik" Airport in Ljubljana, Slovenia and the identification of possible additional differentiation of Airport charges in order to optimise traffic demand and to redistribute it outside the peak traffic periods. In order to find the optimal solution the case study will deal with the following topics:

- Traffic demand analysis
- Identification of congestion periods – potential for differentiated charges
- Existing airport charging scheme analysis
- Demand elasticity and its impact on traffic demand
- Conclusions and suggestions

Original and current data is used for the analysis of passenger demand and aircraft movements. Some assumptions were made concerning actual load factor per specific air company or airline and actual landing charges for individual air transport companies. The Airport management considers this information confidential. The assumptions for the topics within the "confidential data" area were made in collaboration with Airport officials, so it may be concluded that the average conclusions correspond closely to the reality. This holds good also for demand elasticity coefficients to be found in the scientific literature for other EU regions, which are assumed to be valid also for Slovenia.

7.2 ANALYSIS OF LJUBLJANA AIRPORT TRAFFIC DEMAND

Jože Pučnik Airport[50] is the international airport of Ljubljana, Slovenia. It is a mid-size airport accounting for 1.35 million passengers in 2006. The number of passengers passing through the airport increased by 10% in 2006 compared to 2005. 2007 figures suggest that this growth rate will continue in the future.

7.2.1 Aircraft Movements and Passenger Flows at Ljubljana Airport

A thorough analysis of traffic demand during the last four years forms the basis of the case study. The aim of the first part of the analysis is the determination of demand variation patterns and congestion issues at current Airport facilities.[51]

The Airport traffic is dominated by commercial passenger flights (see Figure 7-1). Scheduled passenger flights accounted for 67% of total aircraft movements in 2006, while charter and low-cost passenger flights contributed an additional 10% to total public passenger flights. 10% of the total Airport flights were cargo flights, 8% general aviation flights and the rest were technical, positional, training and other flights. Total aircraft movements in 2006 amounted to 40,991.

50 The Airport is located 26 km from Ljubljana.

51 In 2007 the passenger terminal was reconstructed and extended so as to enable compliance of the airport infrastructure with Schengen border requirements. In addition, a new passenger terminal with an annual capacity of 2.5 million passengers will be completed by 2010, to provide sufficient capacity for further development of airport activities. The aim of the airport is to increase the number of passengers to 2.2 million per annum by 2015. The Airport has a 3,300 metres long runway.

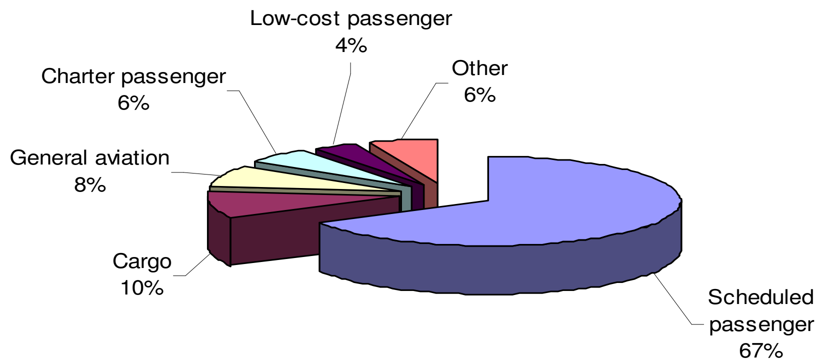


Figure 7-1 Aircraft Movements by Type of Flight in 2006

The majority of passengers using Ljubljana Airport travel by scheduled flights, which are mainly boarded by business passengers who account for about 70%. In 2006, 74% out of 1.35 million passengers passing through Ljubljana Airport travelled by scheduled flights (see Figure 7-2), 15% by charter and 11% by low-cost flights.

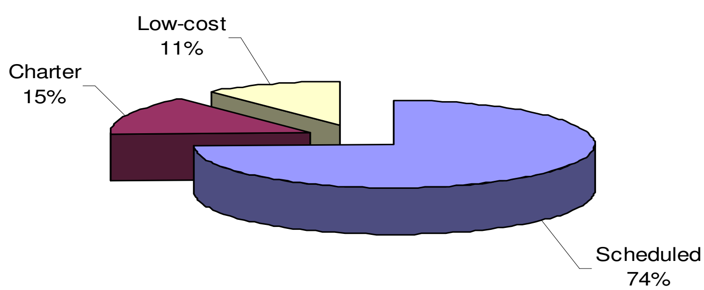


Figure 7-2 Distribution of Passengers by Type of Public Passenger Flight in 2006

It may be concluded that the 4% of total flights by low cost carriers accounts for 11 % of the total number of passengers travelling through Ljubljana Airport and that the 6% which are charter flights contribute 15% of passengers flows. The analysis proves that the average load factor of low cost and charter flights substantially exceeds the average load factor of the scheduled flights.

Competition among air carriers at the airport is moderate. About fifteen carriers offer their services at Ljubljana Airport. However, domestic air carrier Adria Airways dominates the market with 71% of total scheduled and charter flights in 2006. Only 29% of total scheduled and charter flights are provided by foreign air carriers. Low-cost flights are provided only by foreign carriers (Figure 7-3).

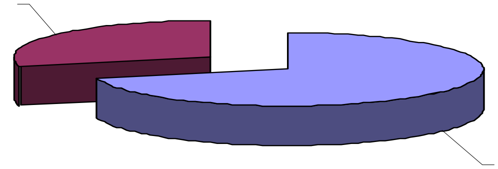


Figure 7-3 Distribution of Passengers by Origin of Carrier in 2006

7.2.2 Key Passenger Demand Patterns at Ljubljana Airport

Peak and Off-Peak Hours Analysis

Passenger traffic at the Airport increased steadily during the last few years by about 10% per annum. Average daily distribution of passengers at Ljubljana Airport varies and depends on the time of the day. The busiest traffic periods in each day are:

- 06:00 to 09:00 in the morning,
- 11:00h to 14.00h and
- 17:00 h and 19:00h in the evening.

Between the peak periods with high demand there are periods of low traffic. The observed variation of demand is characteristic for all the years under analysis

Figure 7-4 presents the average daily distribution of passengers at Ljubljana Airport in the years 2004, 2005 and 2006. Analysis of the average daily traffic dynamics during the last three years has shown three major peak periods and a smaller peak around midnight. Each peak period is followed by an off-peak period with relatively low traffic demand. In the years 2005 and 2006 a growth in traffic volume was recorded in both peak and off-peak hours (between 09:00 and 11:00). Traffic volume in 2006 is generally higher than in the previous two years, with absolutely the highest peak period between 17:00 and 19:00, with (on average) almost 400 passengers per hour.

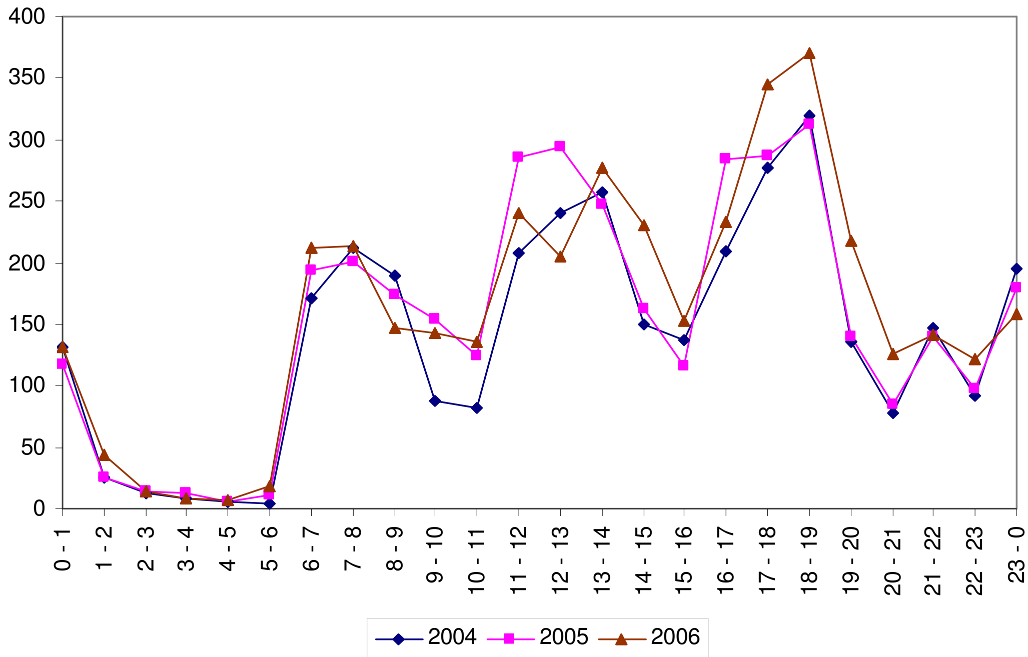


Figure 7-4 Average Daily Distribution of Passengers (2004-2006)

The number of passengers at the airport at any given time is composed of passengers arriving there and those departing to various destinations.

Analysis of Arrival and Departure Time Distribution

The average daily distribution of passenger arrivals has several minor peak periods with one significant peak between 17:00 and 18:00 (see Figure 7-4), which is growing from year to year.

The number of passenger arrival peak periods has increased in the period from 2004 to 2006, adding demand for the Airport off-peak periods, (see Figure 7-5).

On the other hand, the average daily distribution of passenger departures has three distinctive peaks, in the morning (06:00 to 10:00), at noon (11:00 to 15:00) and with the highest peak in the evening (18:00 and 20:00), as shown in Figure 7-6.

From 2004 to 2006, the amplitude of peaks in general increased, as did the number of passenger departures in the off-peak periods, as shown in the Figure 7-6.

Comparison of passenger arrivals and departures for the reference year 2006 shows a typical phase shift between arrivals and departures of about one hour (see Figure 7-7) in the morning and evening peak periods. The only exception is evidenced by the night aircraft arrivals, which depart in the morning and contribute to the morning peak hours. Passenger-departure peak periods are in the morning between 07:00 and 08:00, in the afternoon between 13:00 and 14:00, and in the evening between 18:00, and 19:00, while the lowest off-peak period is recorded between 9:00 and 10:00.

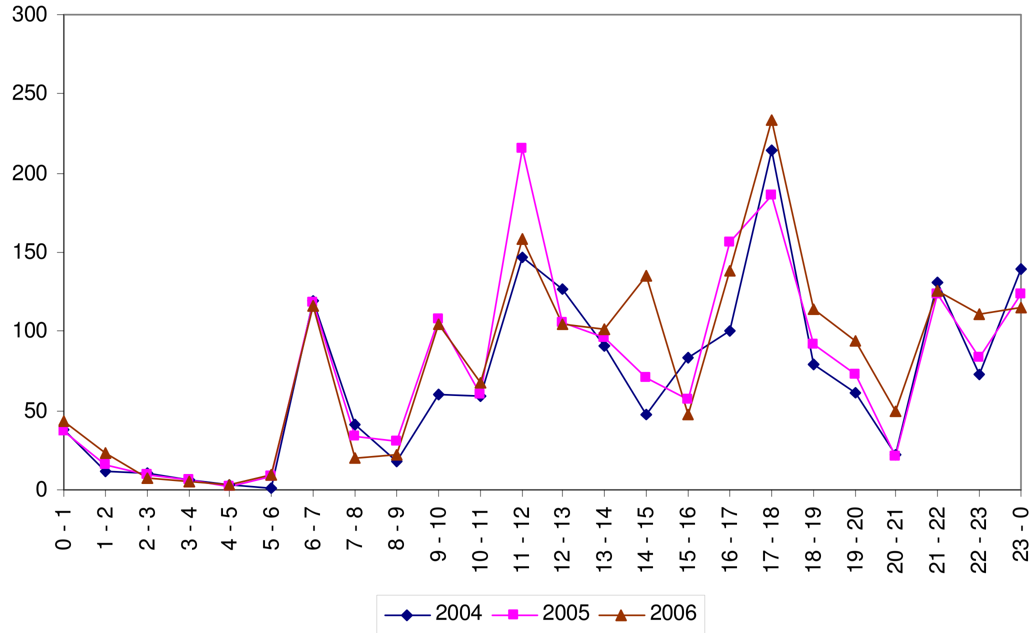


Figure 7-5 Average Daily Distribution of Passenger Arrivals by Year

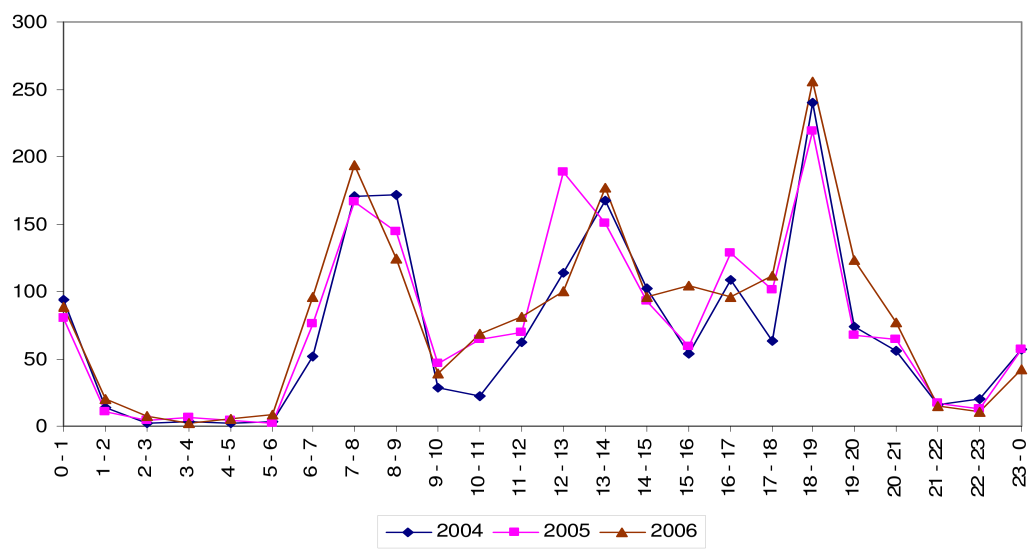


Figure 7-6 Average Daily Distribution of Passenger Departures

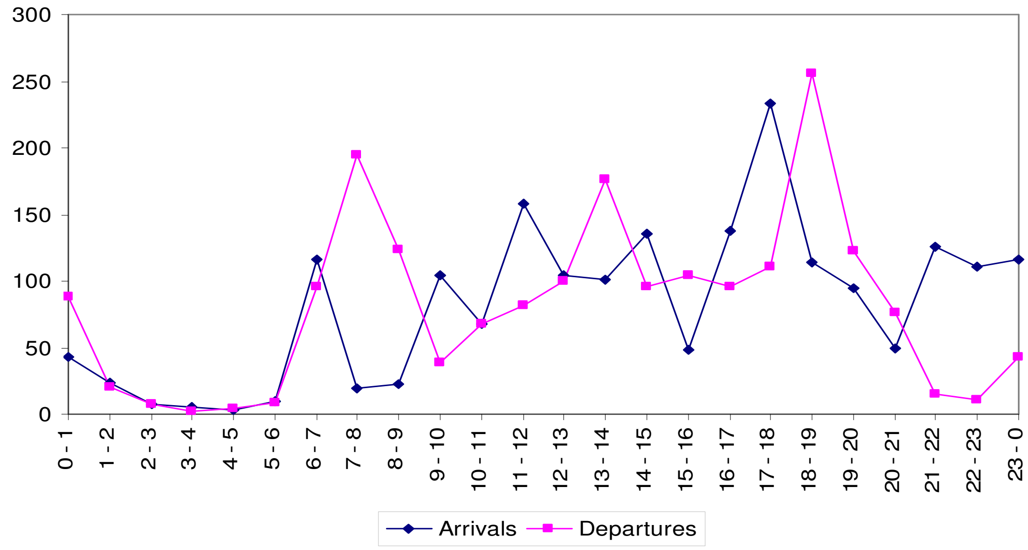


Figure 7-7 Average Daily Distribution of Passenger Arrivals vs. Departures in 2006

Type of Flights Analysis

The analysis of distribution of passenger traffic supply and demand at Ljubljana Airport took into consideration, besides the time characteristics of arrivals and departures, also the specific types of flights, such as:

- scheduled flights,
- low cost carriers and
- charter flights.

In order to assess the impact of different types of flights on the key demand patterns, average daily distribution of passenger departures for each type of flight will be examined.

In the years under analysis, as well as in 2006, the majority of passenger traffic was provided by the scheduled flights, (see Figure 7-8). Charter and low-cost carriers` flights contribute a certain number of passengers to peak traffic periods, mostly to the evening peak period. However, although their peaks are generally not in the same time-periods as the scheduled ones, the low-cost flights are encroaching into peak periods especially in the evenings.

It may be concluded that the scheduled flights still represent the majority of passenger traffic during the peak periods.

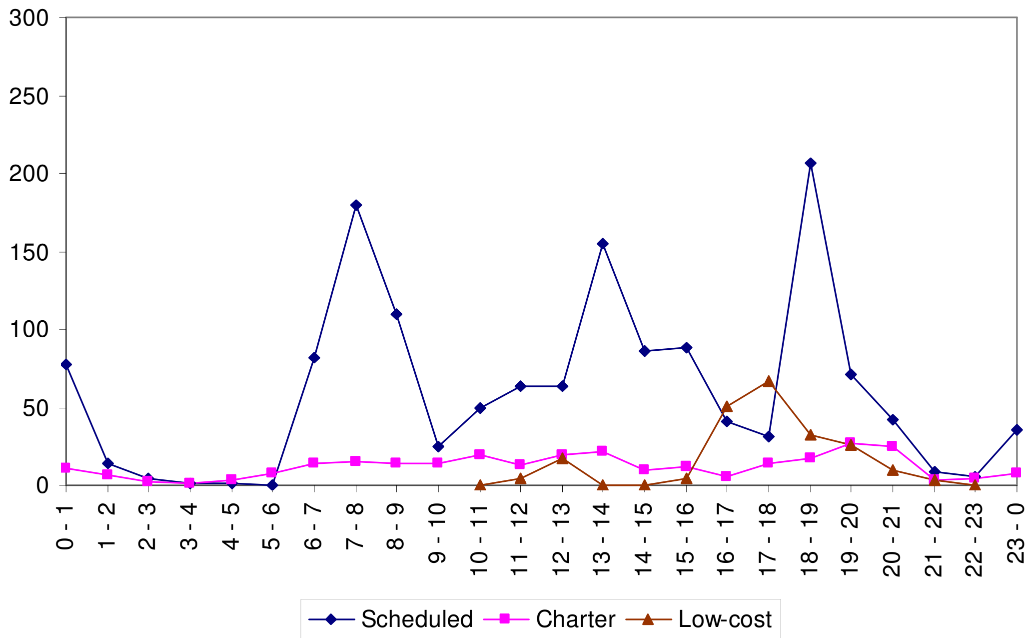


Figure 7-8 Average Daily Distribution of Passenger Departures by Type of Flight in 2006

7.3 PEAK AND OFF-PEAK DAYS OF THE WEEK TRAFFIC ANALYSIS

Besides peak hours, peak days of the week and peak months of a year for passenger traffic at Ljubljana Airport were also studied and compared with the available Airport capacities.

To identify seasonal variations of demand and their impact on traffic congestion at peak hours, passenger travel demand throughout the year 2006 was closely analysed.

For reference purposes the busiest month 2006 was taken; this was August. During August 2006 the busiest day of the week was Wednesday, as illustrated by Figure 7-9.

Average capacity utilisation of ground handling services on Wednesdays in August 2006 was close to 90% (as indicated at the right side of Figure 7-9); this corresponds to above 1.000 passengers (as indicated at the left side of Figure 7-9). However, on one particular Wednesday in August 2006, the traffic volume was close to the maximum stated capacity limits.

The principle of a phase shift between arrivals and departures, which is presented in Figure 7-7, for the year 2006 is also applied for traffic analysis in August of the same year (see Figure 7-10). Figure 7-10 shows the major passenger-departure evening peak period between 18:00 and 19:00. It is almost double the size of the other two peaks. On the other hand, there is a very low traffic demand between 16:00 and 17:00.

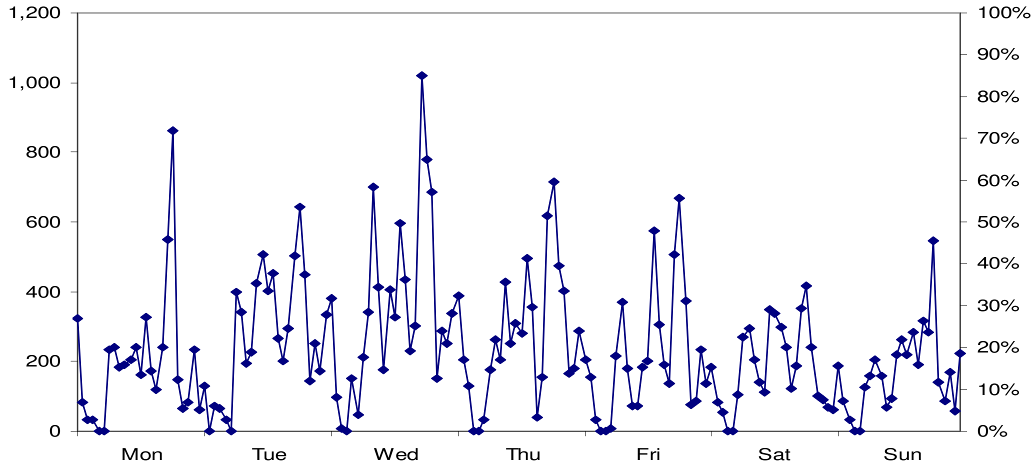


Figure 7-9 Average Daily Distribution of Passengers and Capacity Utilisations of Ground Handling Services by Day of the Week in August, 2006

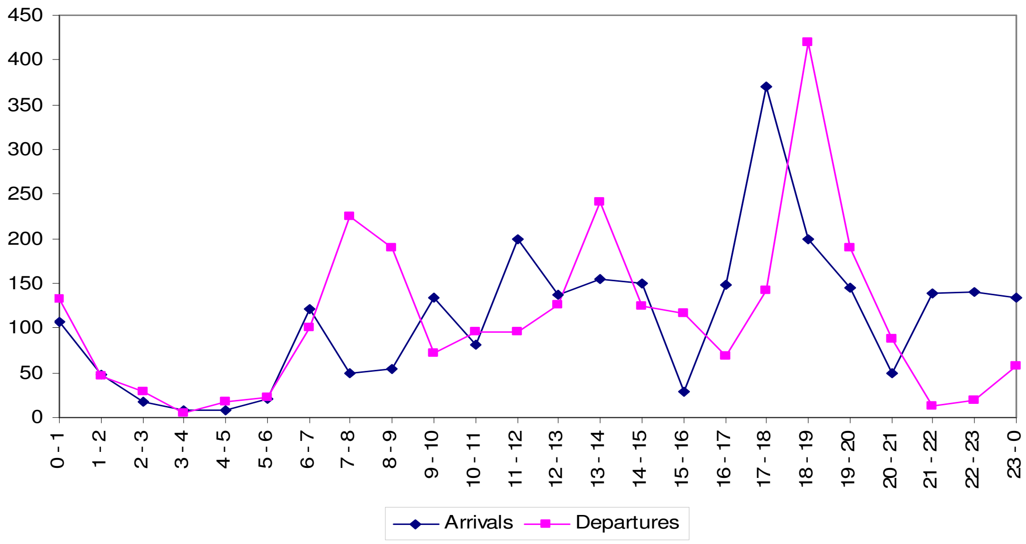


Figure 7-10 Average Daily Distribution of Passenger Arrivals and Departures in August, 2006

Congestion at peak periods during summer 2006 was caused by high demand from all carriers regardless of the type of flights they operate. Figure 7-11 clearly demonstrates the traffic demand situation at Ljubljana Airport in August, 2006.

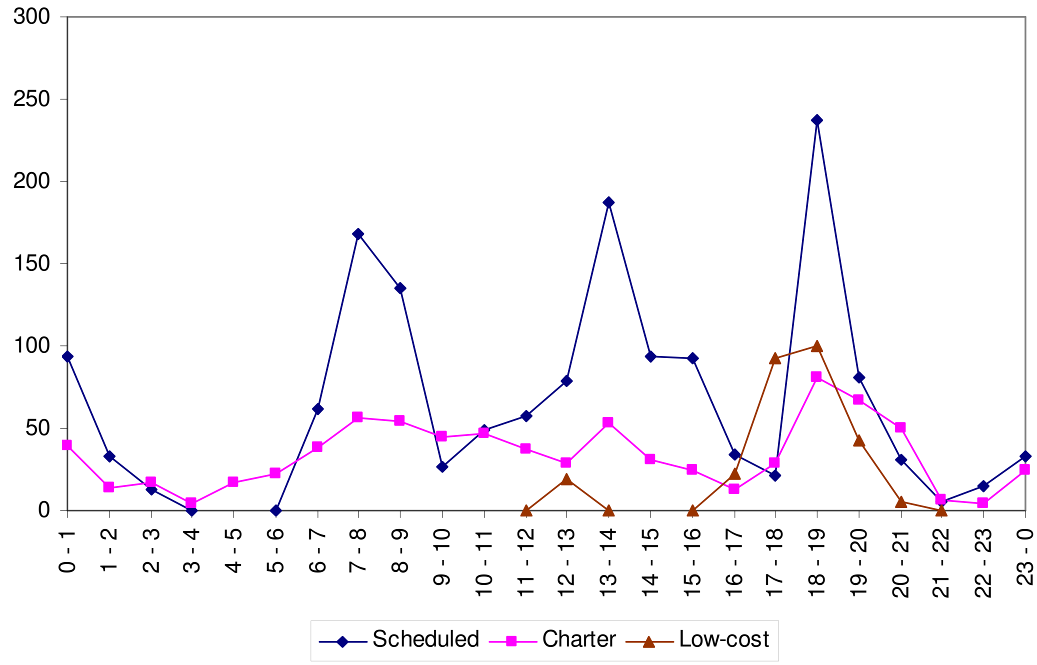


Figure 7-11 Average Daily Distribution of Passenger Departures by Type of Flight in August, 2006

Large numbers of passengers departing from the Airport at peak periods are causing aircraft congestion and also congestion at check-in counters. Congestion at the check-in counters will be solved by a new passenger terminal in the future but aircraft congestion requires an adequate new solution.

It may be stated that the additional congestion at peak periods at Ljubljana Airport is caused by the low cost carriers and charter flights, because they are trying to concentrate transport supply in the same specific time windows.

Turnaround Times of the Aircraft

Turnaround times of the majority of the air Carriers is about one hour (almost 40% of low-cost aircraft take off less than 30 minutes after landing and nearly 60% between 30 minutes and one hour. The majority of scheduled flights have turnaround times between 30 minutes and one hour. However, less than 10% of aircraft have a turnaround time of 30 minutes or under. (See Figure 7-12).

The same applies for the charter flights. Turnaround times of two hours and more are noted only for scheduled and charter flights which are operated mainly by domestic air Carrier Adria Airways.

Analysis of Apron Parking Capacity and Aircraft Turnaround Times in 2007

Turnaround times of the majority of the air Carriers is about one hour (almost 40% of low-cost aircraft take off less than 30 minutes after landing and nearly 60% between 30 minutes and one hour). The majority of scheduled flights have turnaround times between 30 minutes and one hour. However, less than 10% of aircraft have a turnaround time of 30 minutes or under. (See Figure 7-12).

Aircraft departing from the Airport in the morning peak period have the longest turnaround times which, on average, amount to 8 hours due to overnight stay at the Airport (see Figure 7-13). The low-cost carriers operate mainly in the evening peak period and have very short turnaround times. For instance, the average turnaround time of low-cost carriers between 18:00 and 19:00 is around one hour.

The analysis of turnaround times shows that they are on average rather short especially for the low cost carriers and charter flights. This is the reason why apron parking capacity is still sufficient. There is no reason at the moment to introduce additional differentiated congestion parking charges for aircraft.

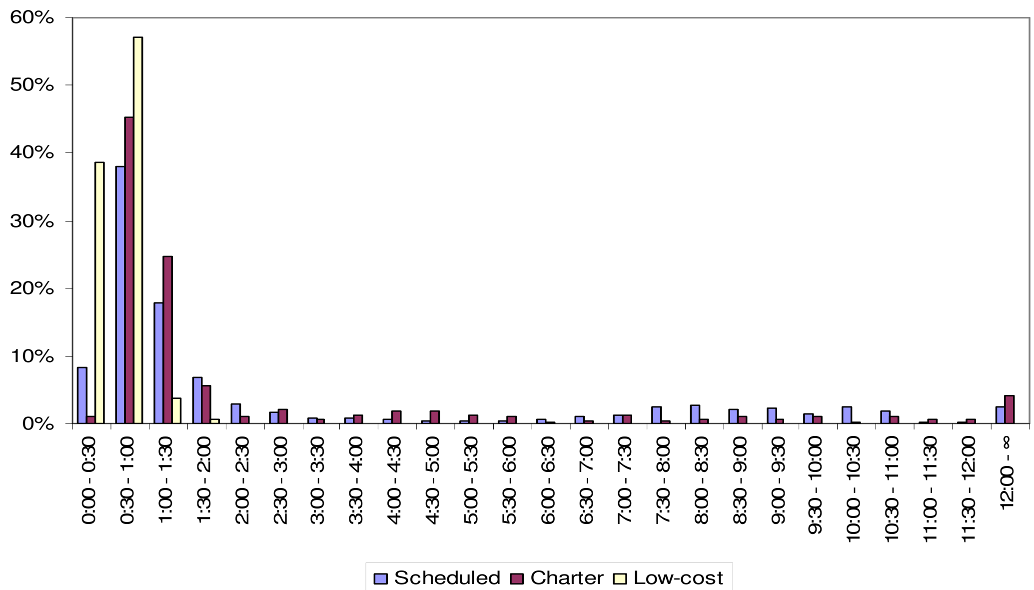


Figure 7-12 Average Relative Distribution of Turnaround Times by Type of Flight (January to August, 2007)

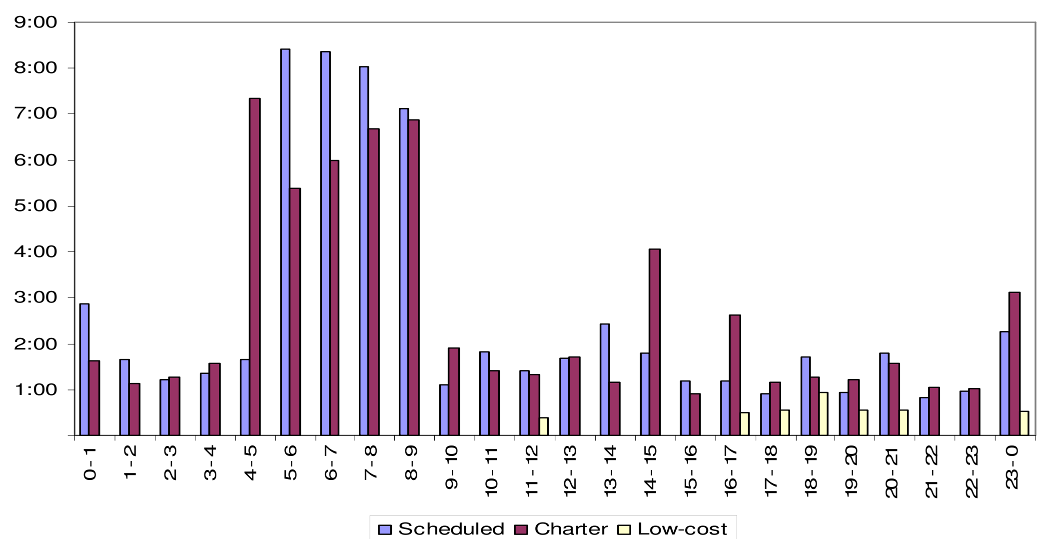


Figure 7-13 Average Daily Distribution of Turnaround Times by Type of Flight. (January to August, 2007)

Seasonality of Demand

Seasonality of demand over the whole year was also taken into consideration. The analysis shows that the months from May through October are the busiest months at Ljubljana Airport in all the years under consideration. In all years since 2004, (monthly) passenger traffic has been growing as indicated by Figure 7-14.

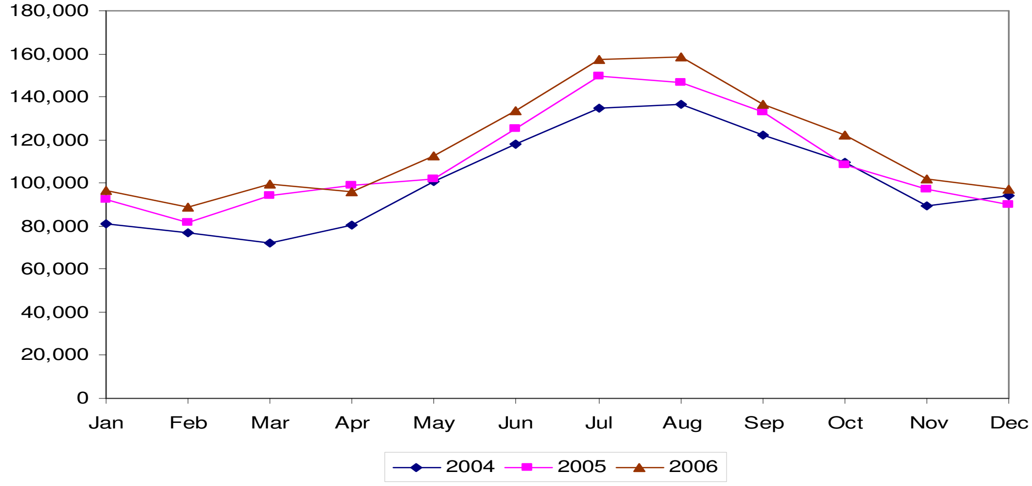


Figure 7-14 Monthly Distribution of Passengers by Year

In 2006, passenger traffic reached its maximum between July and August, when the number of passengers exceeded 160.000 per month.

The main reason for traffic congestion during the summer 2006 peak period is charter flights, as indicated by Figure 7-15. Scheduled flights accounted only for a slight increase during summertime, while low-cost carriers` flights accounted for more or less evenly distributed traffic dynamics throughout the year. Increase in charter flights during summer months is unambiguously linked to the holiday season.

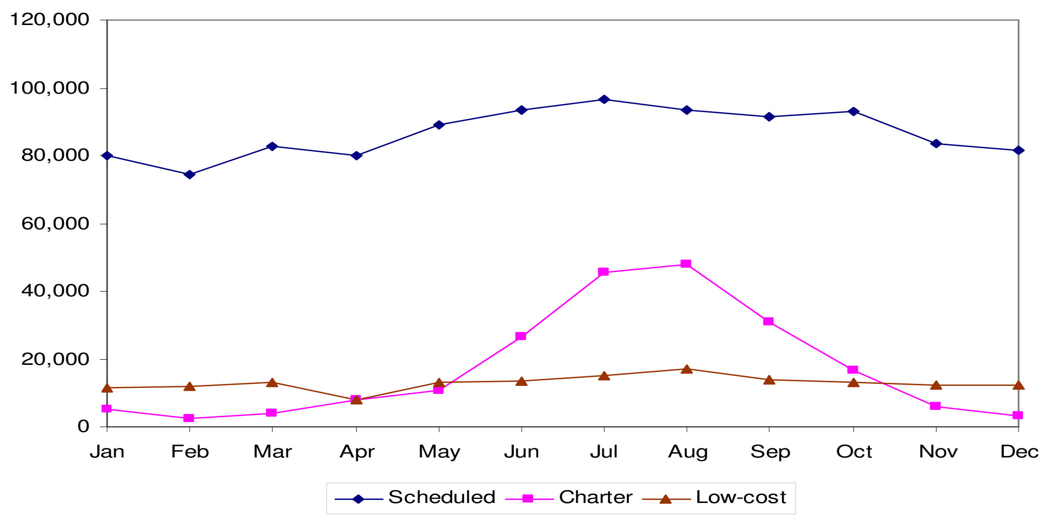


Figure 7-15 Monthly Distribution of Passengers by Type of Flight in 2006

7.3.1 Conclusions

Based on the analysis presented above, it may be concluded that there are the following theoretical potential periods for differentiated airport charges at Ljubljana Airport:

Peak Hours:

- 7 - 9 in the morning
- 18 – 20 in the evening

Day of the Week:

- Wednesday

Summer Months July, August:

- Charter Carriers during the summer (July, August)

Aircraft Parking (Longer Turnaround Times):

- At the moment, in spite of relative congestion, there are no reasons for introducing differentiated aircraft parking charges at Ljubljana Airport

7.4 THE EXISTING CHARGING SCHEME AT LJUBLJANA AIRPORT

The pricing policy in place at Ljubljana Airport, which follows the standards accepted by IATA, is in compliance with European Union regulations which require non-discrimination among carriers, price transparency, and cost based pricing.

The main differentiation criteria that are currently used at Ljubljana Airport are the following:

- Landing and parking charges according to Maximum Take-Off Weight (MTOW)
- Passenger and security services charged according to the number of departing passengers
- Ground handling services charged according to MTOW
- Centralised infrastructures charged according to the number of departing passengers and MTOW
- Night time surcharge for provision of certain services
- Surcharge for provision of certain services when landing is announced “at the last minute”
- Reductions for provision of certain services for certain types of flights (i.e. technical, positional, and non-commercial flights)

The following Tables 7-1 to 7-3 give us a detailed overview of the existing Airport charging scheme of Ljubljana Airport. In the tables are listed the services that are provided to commercial passenger Air Carriers by Ljubljana Airport with all applicable charges, as well as any reductions/surcharges that may be applied.

Ljubljana Airport Charging Scheme for Airport Services

Table 7-1 contains an overview of the prices for Airport services (landing, parking, passenger, and security services) and reduction / surcharge conditions at Ljubljana Airport.

Table 7-1 Ljubljana Airport Existing Charging Scheme (Airport Services)

Services		Differentiation criteria	Categories	Reductions / Surcharges
Airport services	Landing	MTOW	• Up to 2 MTOW → 6.00 EUR per MTOW • Above 2 MTOW → 12.50 EUR per MTOW	Reductions: • 50% for technical and emergency landing
	Parking	MTOW	For each started 24 hours → 2.60 EUR per MTOW	Reductions: • First 4 hours FOC
	Passenger services	Departing passengers	• Departing passengers → 17.00 EUR per passenger • Transfer passengers → 3.30 EUR per passenger	Note: not applicable to transit passengers staying in international area
	Security services	Departing passengers	→ 3.90 EUR per passenger	Note: not applicable to transit passengers staying in international area

Charging Scheme for Ground Handling Services

Table 7-2 provides details about ground handling services, which include operational services and provision of services to passengers, as well as provision of services to the aircraft, including also an overview of the existing system of reductions and surcharges.

Wholesale Charging Scheme for Use of the Centralised Infrastructure

Table 7-3 summarises the prices for the centralised infrastructure services (wholesale conditions) valid for alternative service providers, (e.g. air carriers providing certain services by themselves), and reduction/surcharge scheme.

Based on the overview given in tables 7-1, 7-2 and 7-3, it may be concluded that a differentiated charging system already exists at Ljubljana Airport. There is in force at the moment the following differentiated charging scheme:

- 25% surcharge for landing and departures at night and
- time-dependant surcharge for provision of services:
  - 25% for services announced 12-48 hours prior to landing and
  - 50% for services announced less than 12 hours prior to landing
- 50% reduction for technical and non-commercial landing
- 25% reduction for positional flights.

The Airport services charging differentiation is based on two principles:

- Time dependent charging (night, time of request for services prior to landing)
- Service-dependent charging differentiation (technical and non-commercial landing, positional flights).

On the other hand, it may also be concluded that congestion charging has not yet been introduced at Ljubljana Airport.

Table 7-2 Ljubljana Airport Existing Charging Scheme (Ground Handling Services)

Services	Differentiation criteria	Categories	Reductions / Surcharges
Ground handling services (operational services and provision of services to the passengers)	MTOW	• 4 – 10 MTOW → 89.00 EUR • 10 – 16 MTOW → 170.00 EUR • 16 – 21 MTOW → 245.00 EUR • 21 – 40 MTOW → 282.00 EUR • 40 – 60 MTOW → 442.00 EUR • 60 – 79 MTOW → 601.00 EUR • 79 – 100 MTOW → 665.00 EUR • 100 – 130 MTOW → 799.00 EUR • 130 – 155 MTOW → 965.00 EUR • 155 – 200 MTOW → 1240.00 EUR • 200 – 270 MTOW → 1736.00 EUR • Above 270 MTOW → 2534.00 EUR	**Reductions:** • 50% for technical and non-commercial landing • 25% for positional flights **Surcharges:** • 25% for night time arrivals/departures (22.00 – 6.00) • 25% for provision of services announced less than 48 and more than 12 hours prior to landing • 50% for provision of services announced less than 12 hours prior to landing
Ground handling services (provision of services to the aircraft)	MTOW	• 4 – 10 MTOW → 70.00 EUR • 10 – 16 MTOW → 133.00 EUR • 16 – 21 MTOW → 191.00 EUR • 21 – 40 MTOW → 220.00 EUR • 40 – 60 MTOW → 345.00 EUR • 60 – 79 MTOW → 470.00 EUR • 79 – 100 MTOW → 521.00 EUR • 100 – 130 MTOW → 626.00 EUR • 130 – 155 MTOW → 755.00 EUR • 155 – 200 MTOW → 971.00 EUR • 200 – 270 MTOW → 1359.00 EUR • Above 270 MTOW → 1984.00 EUR	**Reductions:** • 50% for technical and non-commercial landing • 25% for positional flights **Surcharges:** • 25% for night time arrivals/departures (22.00 – 6.00) • 25% for provision of services announced less than 48 and more than 12 hours prior to landing • 50% for provision of services announced less than 12 hours prior to landing

Table 7-3 Ljubljana Airport Wholesale Charging Scheme for Use of Centralised Infrastructures

Services	Differentiation criteria	Categories	Reductions / Surcharges
Centralised infrastructures	Departing passengers	• → 0.71 EUR per passenger	
	MTOW	• 4 – 10 MTOW → 55.00 EUR • 10 – 16 MTOW → 106.00 EUR • 16 – 21 MTOW → 153.00 EUR • 21 – 40 MTOW → 176.00 EUR • 40 – 60 MTOW → 275.00 EUR • 60 – 79 MTOW → 375.00 EUR • 79 – 100 MTOW → 415.00 EUR • 100 – 130 MTOW → 499.00 EUR • 130 – 155 MTOW → 603.00 EUR • 155 – 200 MTOW → 775.00 EUR • 200 – 270 MTOW → 1085.00 EUR • Above 270 MTOW → 1584.00 EUR	**Reductions:** • 50% for technical and non-commercial landing • 25% for positional flights **Surcharges:** • 25% for night time arrivals/departures (22.00 – 6.00) • 25% for provision of services announced less than 48 and more than 12 hours prior to landing • 50% for provision of services announced less than 12 hours prior to landing

7.5 PRICE ELASTICITY OF DEMAND FOR AIRCRAFT LANDING

Any consideration about possible implementation of differentiated pricing schemes for the Airport infrastructure should also take into account the price elasticity of demand. Several studies and several authors e.g. Oum, Fu and Lijesen, (2005) argue that demand in the field of air transport is rather inelastic. In general this means that any change in price of Airport infrastructure charges will have a fairly low impact on demand for Airport services.

However, according to Oum, Fu and Lijesen, (2005), price elasticity of demand is higher for Charter and low-cost Carriers' flights as is symbolically demonstrated by Figure 7-16. One reason is the fact that these flights in general are not linked to the other connecting flights, and the second reason is that the Airport charges represent a significantly higher proportion of the total cost (price) structure for the low cost Carriers and charter flights than for the scheduled flights.

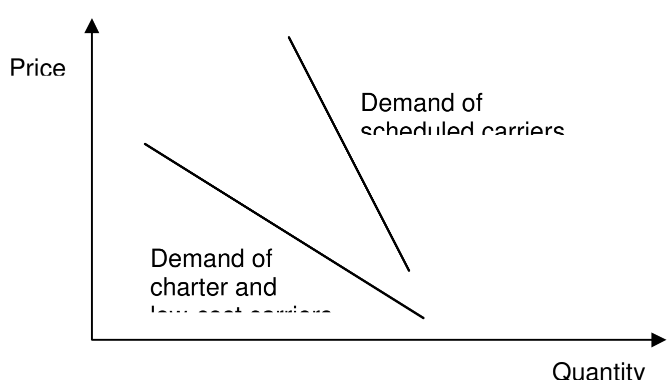


Figure 7-16 Price Elasticity of Demand by Carrier Type[52]

52 Utilized from Oum, Fu and Lijesen 2005

To be able to present the possible impact of differentiated landing charges on the behaviour of air carriers a rough quantitative assessment of the price elasticity of demand was performed.

The scientific literature and various research studies e.g. Oum, T. H., Waters, W.G. and Yong, J.-S. (1992), have determined that price elasticity of demand for aircraft landing ranges from – 0.075 to – 0.58. On the other hand, price elasticity of demand for air transport is found to be most likely between – 0.4 and – 1.2 for non-vacation between – 1.1 and – 2.7 for vacation, which is higher than that calculated for aircraft landings.

Nevertheless, demand for air travel drives demand for aircraft landings. In the short term, passengers can switch more easily to another service provider due to changed market conditions than can air carriers, which is one of the reasons for quite inelastic demand in the field of air Carriers.

Given the specific conditions at Ljubljana Airport, we assumed the price elasticity of demand for scheduled flights to be – 0.4 and charter as well as low-cost flights to be – 1.2 for a given price range.

In general it may be estimated that a price increase of 10% would lead to a 4% decrease in the number of scheduled flights and a 12% decrease in the number of charter and low-cost flights. The same analogy would also be applicable to any price cuts.

7.6 CONCLUSIONS

The existing Ljubljana Airport services charging system is based on two principles:

- Time-dependent charging (night, time of request for services prior to landing)
- Service dependent charging differentiation (technical and non-commercial landing, positional flights)

Nevertheless, the existing charging scheme does not differentiate between charges according to peak/off-peak time periods. The existing and anticipated growth of travel demand calls for the introduction of an additional, congestion-dependant differential charging system.

Besides several projects aiming to increase the capacity of the Ljubljana Airport facilities, differentiated airport user charges should be seriously considered in order to redistribute existing demand pattern and to provide more efficient utilisation of airport capacity. Differentiated pricing schemes could be a rational and efficient responses to such challenges.

The case study provides a thorough analysis of transport demand at Ljubljana Airport and has identified peak (congestion) periods on a daily, weekly and seasonal/annual basis

It may be concluded that there is a rather realistic potential option for the Ljubljana Airport to introduce an additional differential congestion charging scheme. According to the results of the analysis the Airport charging could be differentiated according to:

- time of day:
  - higher prices for the peak hours (between 7 and 9 in the morning, between 13 and 14 at noon and between18 and 20 in the evening)
- day of week:
  - higher prices for peak days (e.g. Wednesday)
- season:
  - higher prices in summer season (June to September).

The conclusions of the chapter dealing with price elasticity of demand also indicate that by introducing differentiated congestion pricing schemes, charter and low-cost carriers would be more affected. Although charter and low-cost flights currently represent a rather small share of the total passenger traffic at Ljubljana Airport, a differentiated charging scheme applied also to charter and low-cost carriers could perhaps shift their demand from peak periods towards off-peak periods. The expected positive consequence would be the achievement of lower congestion pressure during the identified peak periods and would smooth out the demand curve.

8 OVERALL RESULTS AND RECOMMENDATIONS

Many different services and activities are carried out at airports nowadays. These activities are usually grouped into *airside* and *landside*, and the fare structure of the airport tends to mimic this grouping. Consequently, when talking about differentiation of charges at airports we have to consider the whole set of charges susceptible of being differentiated and the criteria applied in this regard. For instance, when airports decide to deal with the noise problem through a pricing mechanism they may opt for the creation of a new charge (noise charge), for the differentiation of the landing charge based on this criterion or for introducing surcharges on the landing charge when noise is perceived as most annoying (i.e. night periods).

The degree of airport charges differentiation in Europe has been already presented in Deliverable 2.1 of this project. It was shown that the main differentiation criteria were:

- Aircraft weight
- Period of the day (e.g. day, night)
- Flight type (e.g. national or international)
- Traffic condition (peak/off peak)
- Aircraft noise
- Aircraft emission levels (pollutants)

In this deliverable we have analysed several cases of airport charges differentiation. Taking into account that in some instances the differentiation was already in place whilst in others was not, the methodological approach in each airport case study was necessarily different.

Perhaps the most important overall conclusion has to do with the effectiveness of market mechanisms in inducing a change in airlines' behaviour. The basic argument is as follows: the weight of airport charges on the whole costs structure of air carriers is minor, hence any modification in the level or even the structure of charges will cause only a small reaction on the airlines' side, if there is any reaction at all. This "low elasticity" argument appears to be confirmed at least in one of the case studies presented in this deliverable (Hamburg Airport), whilst in some others there might be caveats in this concern.

Hamburg airport was one of the first airports in Germany that sold a big part of its shares. It was the first German airport imposing price cap regulation and one of the first differentiating its charges according to noise emissions. The development of output figures in Hamburg shows that restructuring the charging regime was an important step for the airport. However, regarding the differentiation principles there are no considerable effects recognizable. In addition, the proportions of the two-part tariff became more variable after the reorganisation. This enables users (especially legacy carriers) to concentrate on their plans of expanding service frequency. The empirical findings combined with all heuristic findings provide safe evidences to argue, that the introduction of noise charges at Hamburg airport did not induce carriers to use less noisy aircrafts.

A very important aspect for the introduction of the differentiated noise charges was that no major interest group objected it. The policy was in favour of it; the users could live with it because at the same time they could achieve the introduction of their favoured price level and price structure; the airport could improve its environmental image and finally the environmental organisations were not really content with it, but they found the principles of the new charging scheme better than the old ones. Consequently the reasons for the current price structure are more detectable to the positive theory of regulation, as described in WP 2 and WP 3 (see hypothesis H8 and H9 in D3.2).

In any situation we would recommend to consider every particular case with care, thinking about all possibilities that may trigger a reaction on the airlines side. The Gran Canaria Airport case study illustrates this issue. During the preparation of this case study we were told many times that airlines were not sensitive to changes on airport charges. Nevertheless we contacted the representatives of some airlines and asked them about their willingness to move flights out to off peak hours and days.

Our feedback is that they are willing to move operations between peak and off peak days as far as they remain within the same hourly interval when they are compensated through lower airport charges. This initial response could be considered as evidence of demand sensitiveness at least on the airlines side.

The peak-load problem is usually mitigated through peak-load pricing, which would imply pricing at short-run social marginal cost. However, although peak-load pricing is an efficient mechanism from a theoretical point of view, sometimes it may be difficult to be implemented because of the following reasons: (i) it might be difficult to calculate the short-run marginal cost in an accurate manner, (ii) the existence of grandfather rights or institutional barriers and (iii) a low elasticity of demand between peak and off-peak periods. If the peak-load pricing can not be implemented for any of these reasons, other alternative policies may be considered, such as restricting the number of slots to be granted to the airlines during the peak days. However, the growing importance of low costs carriers in air transport markets, the possibility to extend the differentiated policy to other airport charges as those of handling operations, or even more important, the difficulty to fund huge airport investments based on peak capacity needs, are among the counter arguments to bear also in mind when implementing a new pricing policy aimed to redistribute demand.

Additionally, we have shown that peaks are dynamics, and for the case of airports in the Canaries, they appeared to be dynamic in time but also in space. Such a finding suggests that in order to design a new pricing policy we need to take into account the whole network of airports within the Canary Islands, as they are operated by the same institution and as the several destinations within the Archipelago seem to be close substitutes. In this concern, any pricing policy aimed to redistribute the peaks would have to be flexible enough to react to subsequent changes of demand. A situation in which airports announce new prices with few weeks or even days in advance would be much desirable as it would contribute to a more efficient utilization of the airport capacity.

We believe that the Gran Canaria Airport case study adds value to the existing literature on the peak-load problem at least in three aspects: (i) it concentrates on a particular airport, though the methodology used could be easily transferable to other airports with peak load demand problems; (ii) it should be able to contribute to the cost-benefit analysis of pricing policies at airports and other utilities and (iii) it illustrates a situation in which decisions on charges or the allocation of slots, and on infrastructure investments are taken at different instances, giving rise to inefficiencies that would have not appeared if both responsibilities were resting at the same institution.

Differentiation of airport charges by type of terminal is pretty much a new development that has been fostered by the high growth of low costs carriers. Even the European Commission recommends that different terminals with different characteristics should be subject to different airport charges (Proposal for a Directive of the European Parliament and of the Council on Airport Charges, article 8). In order to better understand the main insights of such a type of differentiation we have developed a theoretical model for the case of Madrid Barajas airport, that at the beginning of 2006 opened new facilities expanding its capacity substantially. Iberia and the Oneworld group were allocated to the new facilities while Spanair (main Iberia competitor in the domestic market) and the Star Alliance remained at the old terminals. Airport charges are the same irrespectively of type of terminal. Our theoretical model shows, in general, that if airlines are allocated to separate terminals, the lack of competition in transfer flights significantly affects the ticket prices of the whole network, the competition between airlines is reduced, the ticket prices are higher and the consumer surplus and the social welfare are lower. Only in some routes and under certain conditions on the market size, the ticket prices may be lower.

The allocation of airlines to terminals should promote the competition between airlines, and be non-discriminatory. We would like to highlight that the adverse network effects of allocating airlines to different terminals may be mitigated by using a differentiated scheme for airport charges or even if terminals were well connected, and shifts from one terminal to the other were not too costly in terms of time for transfer passengers (which is clearly not the case of Madrid/Barajas airport). All these considerations should be carefully taken into account when constructing new facilities at airports and deciding the reallocation of airlines to such new facilities.

Two important policy questions may be answered using the results of the analysis in the case of the London airports: do low-cost airlines operating from a secondary airport compete with full-service airlines serving a main airport in a multiple airport region, and do the estimated demand elasticities imply that price differentiation will be successful? The results show that the cross-elasticities of demand are rather low; there seems to be only a small effect of price change at one airport on the market share at another airport. This may indicate that competition is not as strong as expected, but one should realise that we look at the elasticity at the market-level. A price change in a market may well lead passengers to change their destination. This effect cannot be captured within our model due to data limitations (such data are simply not available). The same can be said for price differentiation. Changing prices to spread demand in a certain market over time or over different airports operated by the same airport operator may lead to the situation where passengers decide to change their destination. From the airport operator's perspective, this may not be a big issue, but for an airline it may be problematic. We have also find that the direct price elasticity of demand varies only little between business and leisure travellers, contrary to what was expected from the literature. One would expect that business travellers fly during peak hours, and are relatively inelastic. But because of the capacity constraints at London airports, airlines may operate on the elastic part of the demand curve during peak hours, even though the demand function for business travellers may be steeper for business travellers when compared to leisure travellers.

Finally, the case study of Ljubljana Airport, illustrates also the problem of congestion at peak periods. Although it is an airport with a moderate level of demand, the existing and anticipated growth of travel demand calls for introduction of additional, congestion depending differentiated charging system. Besides several projects aiming to increase the capacity of the Ljubljana Airport facilities, the differentiated airport user charges are to be seriously considered in order to reallocate the existing demand pattern and to provide more efficient utilisation of airport capacity. Differentiated pricing schemes could be rational and efficient responses to such challenges. This case study provides a thorough analysis of transport demand at the Ljubljana Airport and has identified peak periods during the time of a day, a day in a week and a season in the year. A preliminary analysis of price elasticity of demand also indicates that by introduction of differentiated congestion pricing schemes, charter and low-cost carriers would be more affected.

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APPENDIX 1

PROOFS FOR MADRID BARAJAS CASE STUDY

Proofs for Madrid Barajas case study

Proof of Proposition 2: *Taking into account that b>d and a>c, it can be easily proved that* $\overline{p_1^{AC}} > \overline{p_2^{AC}}$. *It can be also proved that if* $a > \dfrac{3cb^4 + 3cb^3 d}{6b^2 d - 3b^3 - d^3}$ *then* $\overline{p_1^{CB}} > \dfrac{a+bc}{2b}$, *that is, airline 1 charges a higher ticket price than the monopoly price in the CB market.* ■

Proof of Proposition 3: *Taking into account that b>d and a>c, it can be easily proved that* $\overline{\overline{p_1^{AC}}} > \overline{p_1^{AC}}$, $\overline{\overline{p_2^{AC}}} > \overline{p_2^{AC}}$, and $\overline{\overline{p_1^{AB}}} > \overline{p_1^{AB}}$. *Moreover, from the proof of Proposition 2 we have that if* $a > \dfrac{3cb^4 + 3cb^3 d}{6b^2 d - 3b^3 - d^3}$ *then* $\overline{p_1^{CB}} > \overline{\overline{p_1^{CB}}}$. *Since lower prices, higher quantities and more variety are always better for the consumer surplus and the social welfare, it is straight forward to prove that, if airlines operate within the same terminal, in the AC and AB market the consumer surplus and the social welfare are always higher, while in the CB market the consumer surplus and the social welfare are lower if the market size is large enough.* ■

Proof of Proposition 5: *If airlines operate in different terminals then* $\overline{\overline{p_1^{AC}}} = \overline{\overline{p_2^{AC}}} = \dfrac{a+bc}{2b-d}$. *Recall that* $a = \alpha/(\beta+\gamma)$, $b = \beta/(\beta^2 - \gamma^2)$, $d = \gamma/(\beta^2 - \gamma^2)$, *and* γ/β *expresses the degree of product differentiation, ranging from zero when the goods are independent to one when goods are perfect substitutes. Thus, the degree of product differentiation increases if* γ *decreases. We can rewrite ticket prices as* $\overline{\overline{p_i^{AC}}} = \dfrac{c\beta + \alpha\beta - \alpha\gamma}{2\beta - \gamma}$, *with* $\dfrac{\partial \overline{\overline{p_i^{AC}}}}{\partial \gamma} = -\beta \dfrac{\alpha - c}{(2\beta-\gamma)^2} < 0$. *Therefore, if the degree of product differentiation increases,* $\overline{\overline{p_1^{AC}}}$ and $\overline{\overline{p_2^{AC}}}$ *also increase. Since lower prices and higher quantities are always better for the consumer surplus and the social welfare, as the degree of product differentiation increases, the consumer surplus and the social welfare decrease.* ■

APPENDIX 2

PARAMETER ESTIMATES FOR LONDON AIRPORTS

Parameter Estimates for London airports

Below the parameters estimates underlying the elasticities reported in the main text are given. All parameters have the correct signs, but are difficult to interpret directly. The elasticities reported in the main text (and based on these parameter estimates) have a more intuitive interpretation.

Estimation results, business passengers

	November 2002			June 2003	
	parameter estimate	standard error		parameter estimate	standard error
airline choice variables					
ln(frequency)	1.15885	0.23398		0.53542	0.08610
fare	-0.00272	0.00167		-0.00276	0.00079
airport choice variables					
BHX	-	-		2.69228	0.34155
BRS	-	-		4.46337	0.56825
EMA	-	-		5.24191	0.54341
LCY	1.87374	0.91387		2.84274	0.36149
LGW	2.15382	0.27731		2.56111	0.57506
LHR	1.87415	0.49822		2.51715	0.33525
LTN	1.65507	0.51902		2.75045	0.28911
STN	2.06133	0.45675		0.46259	1.05697
road distance	-0.0211	0.00379		-0.03361	0.00304
inclusive value parameters					
μ_{BHX}	-	-		0.714165	0.074364
μ_{BRS}	-	-		0.714165	0.074364
μ_{EMA}	-	-		0.714165	0.074364
μ_{LCY}	0.76756	0.11128		0.714165	0.074364
μ_{LGW}	0.76756	0.11128		0.714165	0.074364
μ_{LHR}	0.76756	0.11128		0.714165	0.074364
μ_{LTN}	0.76756	0.11128		0.714165	0.074364
μ_{STN}	0.76756	0.11128		0.714165	0.074364
observations	794			3284	
log-likelihood	-722.08			-4669.74	

The inclusive value parameters are the parameters associated with the expected utility from all airlines at a given airport. For technical reasons they are required to fall in the interval [0,1].[53]

Estimation results, leisure passengers

	November 2002		June 2003	
	parameter estimate	standard error	parameter estimate	standard error
airline choice variables				
ln(frequency)	0.89159	0.10350	0.86958	0.05104
fare	-0.00232	0.00132	-0.00583	0.00050
airport choice variables				
BHX	-	-	-	-
BRS	-	-	-	-
EMA	-	-	-	-
LCY	-1.65079	1.03984	-	-
LGW	0.94715	0.32591	-	-
LHR	0.39833	0.24076	-	-
LTN	-0.65384	0.24011	-	-
STN	-0.93458	0.39939	-	-
road distance	-0.00678	0.00020	-0.00718	0.00059
inclusive value parameters				
μ_{BHX}	-	-	0.57441	0.03294
μ_{BRS}	-	-	0.57441	0.03294
μ_{EMA}	-	-	0.57441	0.03294
μ_{LCY}	0.64123	0.09920	0.40615	0.02284
μ_{LGW}	0.68402	0.07714	0.40615	0.02284
μ_{LHR}	0.69151	0.06620	0.40615	0.02284
μ_{LTN}	0.97320	0.09939	0.43957	0.02894
μ_{STN}	1	-	0.43957	0.02894
observations	1983		10813	
log-likelihood	-2699.576		-18912.06	

[53] If this is not the case the model is not consistent with utility maximization: there is no guarantee that the 'best' alternative is chosen.

APPENDIX 3

ESTIMATION RESULTS FOR HAMBURG AIRPORT

Estimation results for Hamburg Airport

Parameter	Value	Std. error	t-value
Aircraft related parameters (constants)			
A300-200	-4.28	2.14	-7.35
RJ85	-1.28	0.39	-3.30
RJ100	-1.06	0.50	-8.00
B727-200	-3.33	0.72	-16.99
B737-200	-5.38	3.68	-5.38
B737-300	+5.47	1.13	+8.06
B737-400	-1.12	0.51	-8.16
B737-500	-0.94	0.38	-2.49
B737-700	-3.32	0.46	-7.14
B737-800	+0.00	-	-
B747-400	-3.33	0.64	-19.16
A300-400	-3.33	0.64	-19,16
B757-200	-1.77	0.66	-9.94
B767-300	-4.68	2.61	-6.60
Canadair	+1.76	1.17	+5.53
FK70	-3.63	0.48	-7.57
FK100	-1.45	0.58	-9.30
DC9-200	-3.33	0.67	-18.46
DC9-300	-5.38	3.68	-5.38
FK28	-3.33	0.71	-17.37
MD8	-2.20	0.79	-2.76
TU34	-3.33	0.67	-18.37
A300-600	-3.50	0.47	-7.38
TU54	-2.16	0.78	-2.77
RJ70	-2.67	0.99	-2.71
B737-600	-2.89	1.09	-9.76
B757-300	-1.67	0.81	-9.78
A321-200	-2.24	0.81	-1.76
E145	-1.98	0.41	-4.79
YK42	-3.33	0.66	-18.48
YK40	-5.38	3.68	-5.38
C310	-1.17	0.51	-8.40
A318	-3.99	1.86	-7.91
A310-200	-2.89	1.09	-9.76
E170	-4.69	2.62	-6.60
A310-300	-2.98	1.14	-9.65
A319	-1.08	0.38	-2.81
A320-100	-3.59	1,53	-8.67
A320-200	+0.40	1.26	+1.08
A321-100	-2.78	0.44	-6.29
Airport related parameters			
Beta (Take-Off-Weight)	+0.24	0.44	+2.00
Beta (Price Cap)	+00001	+5.91	+0.00001
Beta (Noise Charge)	-0.0005	+1.93	-0.0003
Beta (Variabilisation)	+0.00008	+3.47	+0.00002
Beta (Life Cycle)	+0.00006	+3.98	+0.00001
Beta (Night Surcharge)	-0.0005	+5.64	-0.0003
Log-likelihood			-7,1618.69
Observations			2,680