The costs of a peak-load demand: an application to Gran Canaria airport *

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Abstract

Many airports around the world suffer from peak-load demand problems. To meet demand at the peak periods, airports need to over-invest in capacity. However, the costs associated with the peak-load problem are not only those related to the new investment but much more extensive affecting other economic agents. We use data from the airport in Gran Canaria where the peaks in capacity are associated with tourist arrivals and departures. We estimate the costs that demand peaks impose not only on agents located inside the airport, but also to the society in general. The aim of this paper is to provide a methodology for analyzing the costs imposed on those agents and to explore alternative airport policies.

Keywords: airports, peak-load demand, costs

JEL Classification: L13, L50, L93

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1 INTRODUCTION

Many airports around the world suffer from peak-load demand problems. In general, peak-load problems refer to the existence 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 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).

Peak-load pricing in transport has been traditionally linked to congestion problems. Congestion at airports occurs when there are "too many" users in the system (e.g. terminal or runways), 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 in order 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 internalization is conducted through peak-load pricing mechanisms. On the contrary, when congestion arises due to a suboptimal effort exerted by airports' managers, airports' agents or even airlines, (e.g. lack of personnel available to handle luggage), other type of congestion pricing mechanism should be applied (Nombela et al., 2004). Thus, peak-load pricing in air transport could be regarded as a particular type of congestion pricing.

There are some papers applying the peak-load pricing principles to the air transport industry. We can mainly distinguish the papers of Morrison (1983), Morrison and Winston (1989), Arnottt et al. (1993), Daniel (1995, 2001), Daniel and Pahwa (2000), Brueckner (2002 and 2005), Adler and Berechman (2003), and Janic (2005).

Although the economic literature concerning peak-load pricing is rather extensive, there is no paper in the literature estimating the real costs of the peak-load problem. While there is an incentive to spread services throughout the day because it lowers the costs of the land-side workforce and facilities and reduces airside congestion (Abeyrathne, 2000), 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. Few papers quantify the costs of peak periods for specific airlines (see Frank et al., 2005, and Kemppainen et al., 2007). However, in this paper we show that the costs of the peak-load problem might be much more extensive, affecting not only to agents inside the airport, but also to other related sectors of the economy. In particular, we use data from the airport in Gran Canaria in order to estimate the costs associated with the peak-load problem. The Gran Canaria airport is characterized for important peaks in arrivals and departures of tourists at given days of the week, which imposes important costs, not only to the airport itself, passengers and airport agents, but also to other sectors such as the bus industry or hotels. Thus, it is not only that the use of the airport capacity and facilities is exacerbated, but also the island accommodation and transport capacity. Our estimate of these costs for the Gran Canaria airport case is almost 12 million euros per year, which would undoubtedly justify a change in charging policies or the allocation of slots.[1] In this sense, another objective of the paper is to

[1] Button (2002) argues that for airport hubs the expected cost savings are more than off-set by the additional passenger benefits of having convenient concentrations of connecting services. However, this is clearly not the case of Gran Canaria airport.

explore alternative airport pricing schemes in order to induce a more efficient utilization of the airport capacity.

The peak-load problem is usually mitigated through peak-load pricing. 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 in practice. Indeed, although the use of airports' facilities is usually characterized by peaks, there are not many 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. 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 would be quite limited.

Schank (2005) also describes problems to be borne in mind when an airport is considering implementing this pricing mechanism. He analyzes 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, the elasticity of demand between peak and off-peak periods may be low. Second, there may be institutional barriers to peak pricing 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.[2] Finally, it might be extremely hard to calculate marginal costs in an accurate manner.

There are not many studies analyzing the elasticity of the demand for aeronautical services. Kanafani and Ghobrial (1985) estimated that the elasticity of demand for flights was between -0.148 and -0.38, while in Australia, it was estimated to fall in the range of -0.1 to -0.225 for interstate flights in the early 1990s (CC, 2002). Doganis (2002) points out two reasons explaining why demand for aeronautical services is so inelastic. First, aeronautical charges represent only a small part of an airline's total operating costs (generally less than 8% for intra-European routes and 4% for trans-Atlantic routes). However, the ratio of aeronautical charges to total operating costs varies from 7.8% to 13.2% for low-cost carriers. For this reason, using price mechanisms to allocate scarce capacity may more strongly affect low-cost carriers.

Therefore, though peak-load pricing is an efficient mechanism from a theoretical point of view, sometimes it may be difficult to be implemented. 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.

In this research we will make use of data from the airport in the island of Gran Canaria where the peaks in capacity are associated with tourist arrivals and departures

[2] 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.

as scheduled by tour-operators. In this case important investment resources are being allocated to the airport because of the peak nature of demand,[3] and without consideration of other possibilities to allocate existing capacity, as other alternatives for charging airlines at airports. The aim of this case study is 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.

The rest of the paper is organized as follows: in section 2 we focus on the Gran Canaria airport case, reviewing the main features of the demand, and identifying and quantifying the costs of the peak-load problem that are borne both by agents at the airport and by agents located outside the airport but directly related to the tourism. Finally, in section 3 we conclude and discuss some general policy recommendations.

2 THE GRAN CANARIA AIRPORT CASE

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, La Gomera, La Palma and El Hierro, all of them served by modern transport infrastructure including eight airports.[4] Five of these airports are international, and four of them (Gran Canaria, Tenerife South, Lanzarote and Fuerteventura) are ranked among the eleven busiest airports in Spain (AENA, 2006). Of course, the relevance of the tourist industry explains these figures.[5] 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, transport and accommodation.

[3] A total investment of 1,104 million euros has been devised for the period 2006-2020

[4] One in each island, excepting Tenerife, where there are two airports (North and South).

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

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 in the Canary Islands, though the selected peak days within the week usually differ across tour-operators and origins. It is important to note that tourists that made their own holiday arrangements (an increasing number, thanks to internet) can buy their flights to the same airlines that sell their seats to tour-operators, therefore creating the same problem.

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 airports, and it is 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 and consequently airlines face a quite uniform fare structure.

2.1 THE NATURE OF DEMAND AT THE AIRPORT

Gran Canaria airport is ranked the fifth among the Spanish airports, with almost 10 million passengers per year (see Figure 1).[6] More than a half of total traffic is Europe related (54 percent) whilst almost the other half (44 percent) are inter-island and other national flights.

[6] Madrid, Barcelona, Palma de Mallorca and Málaga occupy the previous positions.

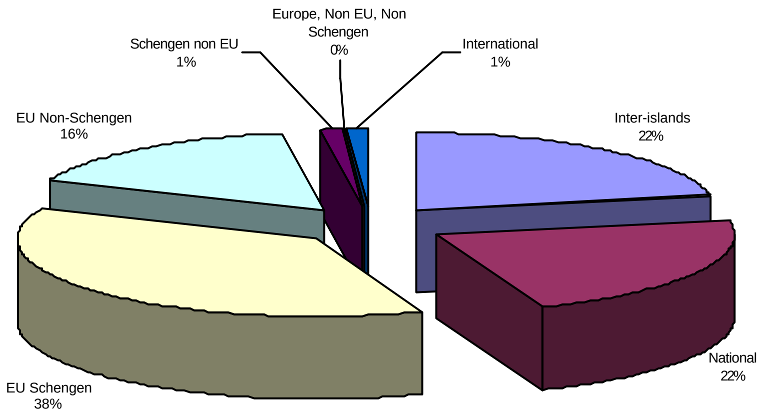

Figure 1: Distribution of passengers. Gran Canaria Airport in 2006

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 falling substantially in spring and summer. Three quarters of total non-national traffic comes from Germany, the United Kingdom and the Nordic countries, with German tourists being the most numerous with 28 percent of the total.

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 the number of passengers, were:[7] Amsterdam Schiphol (309,600), Manchester (303,929), London Gatwick (291,981), Oslo (238,460), Frankfurt (221,449), Dusseldörf (207,430) and Helsinki (173,178).

Concerning air carriers in the international market, 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 share (10.9 percent) with a traffic level of 0.58 million passengers each one. They were followed by MyTravel (6.8 percent, 0.36 million passengers), Transavia (4.8 percent, 0.25 million) and Thomas Cook (4.6

[7] 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.

percent, 0.24 million passengers). Nevertheless, at the beginning of 2007 there were several mergers and acquisitions within the sector. On the one hand, the tour-operators MyTravel and Thomas Cook merged, and so did First Choice and Thomson on the other hand. This concentration implies a reduction in competitors and, therefore, we should expect higher market shares of individual airlines in the future.

Due to the tourist origin 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 analyze daily peaks within a given week (e.g. Mondays, Wednesday and Saturdays); finally, the peaks may reappear by hours during a same day (e.g. midday or early afternoon hours).

In addition, the capacity of any airport is given by the capacity of its facilities (runways and terminals).[8] In the case of Gran Canaria airport terminals, 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 baggage area. The main problem arises at the departure area, due to the limits imposed by the checking and security controls, 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 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.

[8] Gran Canaria airport has two runways, though for security reasons and due to the small distance between them they can not be used simultaneously.

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 a representative week of January 2006.[9] Figure 2 shows all passengers at the airport during such a week at hourly intervals. Mondays, Wednesdays and Saturdays appear as the most important peak days, though the busiest hour is located in the selected Wednesday of January. In addition, most passengers arrive/leave at midday or early afternoon flights.[10] 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, the United Kingdom and Nordic Countries, 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 is their dynamics, which is also illustrated in the following figures. Since peaks can evolve over time, any pricing policy aimed to look for a more efficient use of the airport capacity should consider this fact. Even more, any pricing policy should take into account the whole network of airports within the Canary Islands, as Figure 3 shows. 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

[9] This is one of the "peak" months in terms of the tourist season.
[10] This fact has to do with the 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.

for coming to the Canaries on a given day, as the peak moves along the week from one airport to the other.[11]

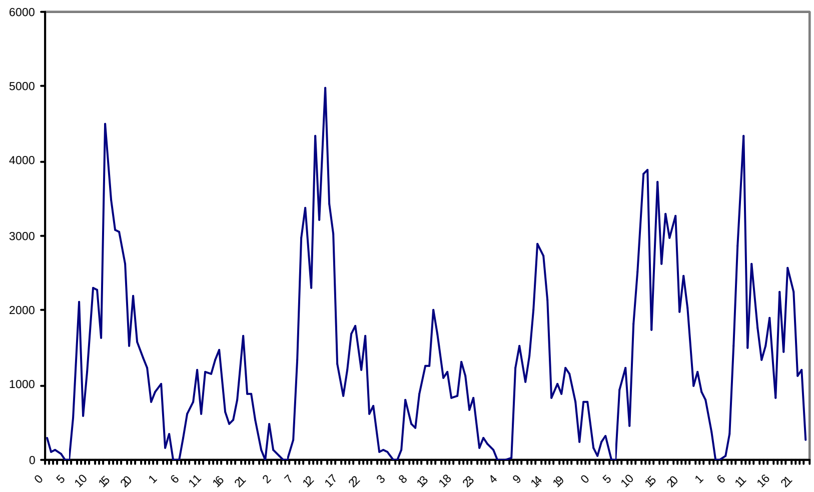

Figure 2: **Distribution of passengers per hour. Arrivals and departures. Gran Canaria airport. Week of January 2006.**

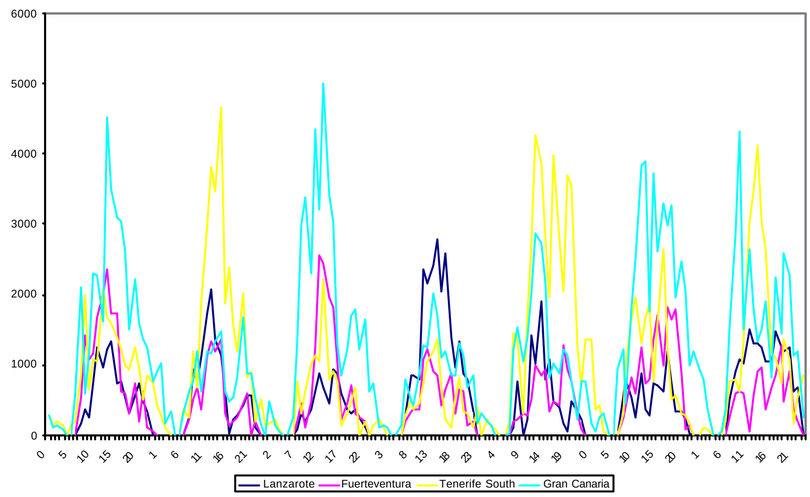

Figure 3: Distribution of passengers per hour. Lanzarote, Fuerteventura, Tenerife South and Gran Canaria airports. Week of January 2006

The question of how close is Gran Canaria airport to its capacity limit is answered by Figure 4 to 6. Regarding the runways capacity (maximum of 36 movements per hour), it can be seen that some peaks are already quite close to its maximum capacity. At the terminal, the capacity problem differs per area: as already mentioned, the arrivals

[11] This was also checked up 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.

area is not at all troublesome,[12] and even at the peak days and hours it remains below 50 percent of capacity usage. On the contrary, the departures area reaches its limits during some days in January.

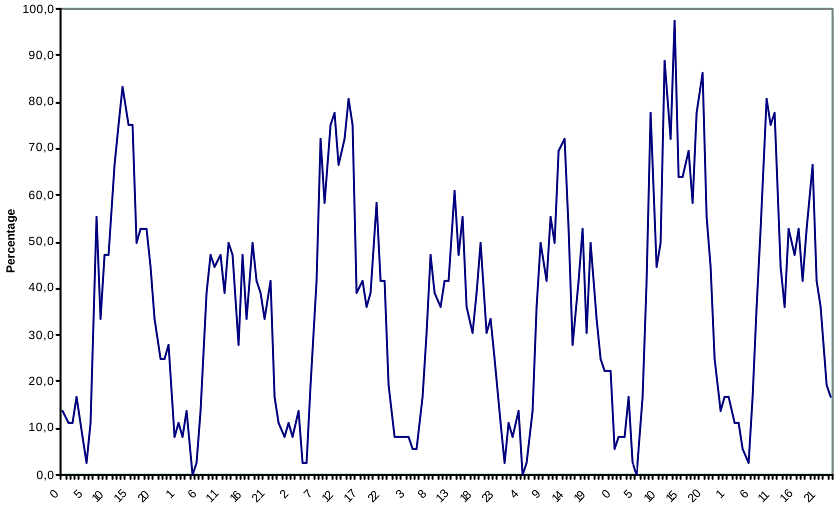

Figure 4: Percentage of runway capacity utilisation. Week of January 2006.

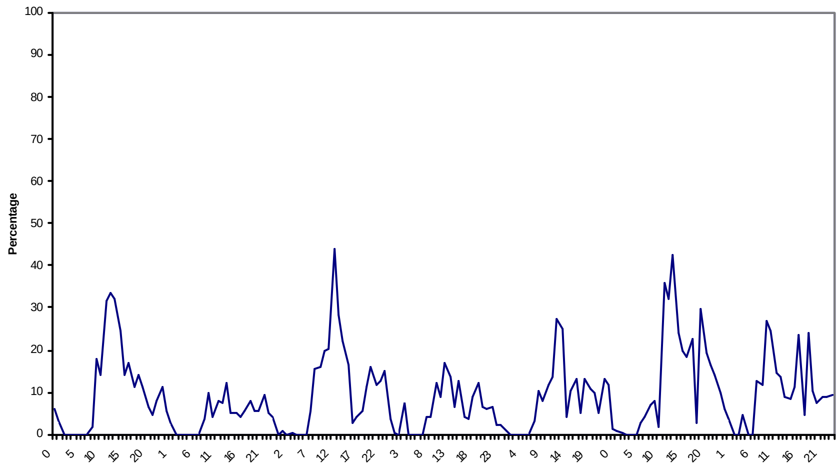

Figure 5: Percentage of terminal capacity utilisation. Arrivals area. Week of January 2006.

[12] The arrivals area capacity does not include the outside space where other people wait to meet passengers after they have collected their luggage, and which is under important capacity constraints at the moment.

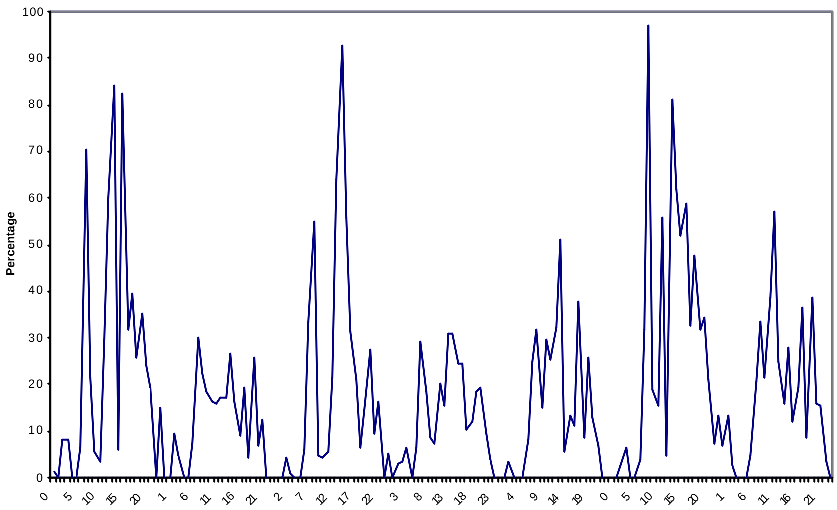

Figure 6: Percentage of terminal capacity utilisation. Departures area. Week of January 2006.

2.2 THE COSTS OF A PEAK- LOAD DEMAND

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 and cannot be discriminatory.

In general the main differentiation criteria found at airports are related to:

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

The current fare structure at Gran Canaria Airport does differentiate charges according to aircraft weight, which is just an international practice, and according to flight types (e.g. inter-island flights pay lowest charges). In spite of the clear peak and off-peak nature of demand, no further differentiation criterion is applied. Such a fare structure not only affects the behaviour of airlines and ultimately tour-operators (that do not mind to concentrate all their operations within the same day), 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 by the peak-load demand is detailed in Table 1.

At the airport
1. Passengers
2. Airport service providers:
2.1. Commercial services (restaurants, shops,etc)
2.2. Ramp and traffic handling
2.3. Fuel provision
2.4. Rent a car
Main agents outside the airport
3. Bus companies
4. Hotels and apartments

Table 1: Agents affected by the peak-load demand

All these agents are the costs bearers of the current extreme utilization of capacity. 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 or allocation of slots during the week. The costs for the tax-payers were not included in our estimates.[13]

In what follows we will present costs estimates and methodological procedures for each of the agent categories in Table 1.

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

2.2.1 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 later, we observed that passengers departing from the airport usually arrived at it 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 an off-peak one, though they are for sure experiencing quite different waiting conditions. The value (cost) of time for passengers is rather different depending on the waiting conditions. For instance, the value of time for a passenger that is waiting in a long queue, standing and carrying all his baggage is much higher than the value of the time for a passenger that is waiting in a seat while reading a book. Thus, in order to estimate passengers' costs, we identified two critical sections: checking and security.

The benchmark situation refers to the times spent by a theoretical passenger in checking and security assuming a uniform distribution of demand along the hours of a given week. During a peak day, passengers spend more time in the queue for checking and passing the security controls, and this affects their value of time. Consequently, the costs of the peak-load demand for passengers in the departure area are given by the difference in the value of time spent in the airport when we compare the benchmark situation, and the current case in which passengers have to wait under crowded and unpleasant conditions.

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

Actual times spent for checking 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. Only passengers from UK, Germany and Nordic Countries were considered, as these are the ones imposing the peak nature to the demand.[14] 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 in the case of departures, and the 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 whilst the remaining 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 quite high. In total we have covered around 60 percent of the total population either in terms of flights or passengers. We are aware that we have left out of our sample some of the flight of interests; 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 Figure 2).

Costs estimations for passengers are reported in Tables 2, 3 and 4. 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.[15] In our specific case study we need a value which would capture the willingness to pay of passengers to avoid waiting in unpleasant conditions, either at the checking or security sections or in the arrivals lounge. To our knowledge there is not enough evidence for airports in this regard, though the available evidence comes from other modes and situations. Hence, we have followed the general recommendation given by *HEATCO*, which advices to increase in-vehicle time values

[14] 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.
[15] For UK, Germany, Finland and Sweden. The weights were number of passengers.

by a factor of 2.5 for waiting or transferring times, 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.

	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 checking 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 2: Checking 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: Security 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**

Table 4: Arrivals area. Costs of time for a representative week

Our results show that the highest costs for passengers arise at the checking desk, being Saturday the worst day, followed by Monday. Interestingly, a peak day like

Wednesday seems to be under very efficient operating conditions,[16] and the passengers in that day would be slightly harmed by a change in the pricing policy or the allocation of slots. Also very interesting is the situation of Tuesday, which in spite of being an off-peak day, it has the highest cost per passenger, as the number of checking 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.

2.2.2 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. We found that all of them identify the tour-operators as the ultimate cause of demand peaks, stating that as a consequence they require to contract additional personnel, and hence the vast majority would rather prefer facing a uniform demand. Table 5 shows estimated costs for these agents. The costs are given by the additional personnel required in order to respond to the demand.

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

Table 5: Gran Canaria Airport services providers. Monthly costs

2.2.3 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

[16] The number of checking desks opened is the highest.

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, what worsens the capacity problem when the services overlap. Most of them identify the tour-operators or the airlines as the ultimate cause of demand peaks, reporting a strong preference for a demand that distributes uniformly. All companies are aware of the problem, and are able to quantify the number of additional personnel needed, although two of them subcontract services instead. Taking into account wages for the sector, the total monthly cost raises to 136,818 euros.

2.2.4 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 at the South of the island. Out of this total population we have selected a representative stratified sample of 18,4 percent. According to results from surveys all the establishments identify the tour-operators as the causation of demand peaks. Details for costs calculations are given at Table 6. As much as 41 percent of establishments state that as a consequence of tour-operators demand they require more personnel, though 61 percent of the sample declares a preference for a uniform demand.

	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	3926.93 3794.94 7589.88 3794.94
2 keys	205	89	0.15 reception 2.5 cleaning 0.15 maintenance	Reception: 912.85 Cleaning-maintenance: 893.27	12186.57 198752.57 11925.15
3 keys	8	4	3 cleaning	Cleaning: 927.57	11130.84
1 star	4	0	-	-	-
2 stars	11	7	0.5 reception	Reception: 912.85	3194.96
3 stars	38	12	0.67 reception	Reception: 979.49	7875.10
4 stars	35	15	4.5 reception 4.75 restaurant 3.25 cleaning	Reception: 1012.83 Restaurant-cleaning: 953.58	68366.03 67942.57 46487.03
5 stars	6	0	-	-	-
Data for total sample	**354**	**147**	**0.9 reception** **0.7 restaurant** **1.8 cleaning** **0.07 maintenance**		**446967**

Table 6: Hotels and apartments. Estimated monthly costs

2.2.5 Summary of costs

A total of around 1 million euros per month (see Table 7) is being borne by economic agents either at or outside the airport as a result of the peak-load demand, which is quite probably 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 checking previously to departures.

Agents	Monthly cost	Annual cost	Percentage
Passengers: Checking 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**

Table 7: The costs of a peak-load demand

3 CONCLUSIONS AND POLICY 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 is no paper 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 paper we show that the costs of the peak-load problem might be much more extensive, affecting not only to the agents inside the airport, but also to other related sectors of the economy.

With specific data for Gran Canaria airport we have illustrated 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 with 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 alternative policies like charging higher prices when capacity is scarcer. Fair to say, the current airport charging regime was established by law what 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. The group formed by tax payers 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 for the tax-payers of the over-investment in capacity. Such a 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 social marginal 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 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 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 in 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 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.

For the Gran Canaria airport case, we have 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 and 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 response to that will depend on the ability of air carriers to transmit them airport charges savings 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 tourist 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.

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