Looking into the future:

Increasing the contribution of Girona Airport to the Catalan Airport System

Final Document

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Executive summary

This study provides an exploratory overview of the medium- and long-term strategic policy directions required to enhance the contribution of Girona Airport to the Catalan Airport System.

The analysis of air traffic and connectivity indicates that Catalonia is a large low-cost carrier (LCC) market dominated by short-haul origin-destination traffic. In a context of limited capacity at Barcelona Airport and knowing that the primary final destination of Girona Airport passengers is Barcelona, Girona Airport has the opportunity to increase its contribution to the Catalan Airport System in terms of origin-destination traffic.

In this regard, we consider that the conditions required to increase the contribution of Girona Airport to the Catalan Airport System are the following:

1. Likely capacity constraints at Barcelona Airport in the coming years, which could generate a traffic spill to Girona.
2. Improvement of accessibility, which has long been established as one of the crucial drivers of airport passenger choice.
3. Improvement of the airport charges scheme, which can facilitate attracting airlines. In particular, a higher differential in airport charges between the primary and secondary airports would facilitate the traffic spill.

The accessibility and catchment area analysis shows that by adding the high-speed train (HST) connection, the population in the 60-minute catchment area doubles from 2.5 million to over 5.1 million. It also allows Girona Airport and the airlines operating in it to tap into the Barcelona city and metropolitan markets, becoming a realistic and convenient travel option for the main Catalan market. In addition, the overlap between the Barcelona and Girona Airports catchment area increases significantly from 1.6 million residents to 4.3 million for the 60-minute catchment area. This is indeed a very positive improvement as more population can benefit from choosing between the two airports and their route networks.

The airport charges analysis shows that Girona Airport has a higher proportion of aircraft-related charges than Barcelona Airport. This is due to a very low difference in the unit rates for landing and aerodrome charges between the two airports, which can be explained by Girona Airport having slightly higher costs per passenger than Barcelona Airport. This adds to the fact that the differential between the average turnaround costs between Girona and Barcelona airports (47%) is lower than in other European airport systems. Furthermore, when considering the incentives to new routes, the airport charges differential decreases only to 21%. Hence, the incentives for new routes seems to be more advantageous to Barcelona in comparison to the cost savings attainable in Girona. The same incentive for new routes is offered across AENA's network; then, since the discount is offered only on passenger charges, airports moving large volumes of traffic stand to benefit the most.

Our analysis also shows the benefits of a higher integration of the Catalan Airport System from the perspective of network resilience and passenger recovery. We have simulated the closure of Barcelona Airport during 24 hours. The results indicate that, if Girona Airport

would be operating as in 2008 (better airport network overlap) and if HST would be available in both airports, the rate of passenger recovery (i.e. the proportion of passengers for which a new itinerary is found in less than 48 hours) at Barcelona Airport could increase from 38% to 49%. Also, Girona Airport would be the second most important surrogate airport, just after Madrid Airport.

Considering the results of the analysis carried out in this study, the following strategic directions are recommended to improve the contribution of Girona Airport to the Catalan Airport System:

1. Improve intermodal access at Girona with the addition of a HST station in the airport, which could significantly improve the catchment area, allowing airlines to easily access the Barcelona market from Girona, and also bringing benefits to passengers in terms of airport choice and service recovery in the event of a hypothetical airport closure.
2. Redesign the airport charges scheme and incentives for new routes, ensuring that: (a) there is a major airport charges differential between Barcelona and Girona Airports, and (b) discount schemes do not penalise small airports.
3. Improve marketing campaigns in the Barcelona market. The advent of the HST station in the airport and a possible service between Barcelona city and the Girona Airport brings an opportunity to promote Girona Airport as a realistic airport option for the Barcelona and metropolitan population.
4. Implement an airport management model that promotes airport competition. Although the analysis of the management model is outside of the scope of this study, the airport charges analysis demonstrates that the current airport management structure does not facilitate competition between airports. Limited competition in airport systems presents disadvantages to all parties, but mostly to passengers and consumers, which have to face higher prices and have less choice. Disregard of the particular model and ownership structure, a model allowing airport competition, would produce the right environment for each airport to design their own promotion and commercial strategy and focus in the right passenger segment.

Table of contents

1 Introduction

1.1 Background

Catalonia has four commercial airports (Bacelona, Girona, Reus and Lleida) and seven airfields (Empuriabrava, Sabadell, Igualada, Calaf, Manresa, La Seu-Andorra and La Cerdanya).

Airports of Catalonia, a public company of the Government of Catalonia, manages Lleida Airport and La Seu-Andorra Airfield. The other three commercial airports (i.e., Barcelona, Girona and Reus) are owned and managed by Aena, the Spanish airport company of which the Government of Spain owns 51% of its shares.

In January 2017, the Spanish Government published the DORA 2017-2021 (Document of Airport Regulation), which sets the regulatory requisites for the airports owned by Aena. The new regulatory framework puts forward significant changes that can influence the future development of smaller and regional airports. For example, it sets a dual till system[1], a cap in the airport charges and the strategic investment priorities for each airport.

Due to a wide range of reasons, among them the changing airline business models, the airport charges policy and changes in the markets served by the different airports, during the last few years traffic growth has been strong in Barcelona Airport, but has decreased in the regional airports (i.e., Girona and Reus Airports). Lleida Airport has also had significant problems to keep a steady number of operations.

Barcelona Airport handled 44.2 million passengers in 2016 and is approaching its capacity limit of 55 million annual passengers). The fast growth of Barcelona Airport is opening a debate about the future infrastructure needs of Catalonia. In this regard, some argue that regional Catalan airports can play a role in easing airport capacity congestion in Barcelona. Indeed, Girona Airport handled 1.7 million passengers and has a capacity of 7.2 million passengers.

In this context, different stakeholders are positioning themselves in the debate about the future airport infrastructure scenarios. In this vein, the Government of the Generalitat is currently working on the Aviation Strategic Plan of Catalonia to come up with different possible scenarios for the future development of airport infrastructure in Catalonia. In addition, Aena is planning to start in the near future the elaboration of the Master Plans for Barcelona and Girona Airports. Other stakeholders have also make public their position regarding the matter.

[1] Under the single till principle, all airport activities (including aeronautical and commercial) are taken into consideration when determining the level of airport charges. This contrasts with the dual till principle, where only aeronautical activities are taken into consideration when setting charges.

The current setting has also motivated Girona City Council to outline their technical and strategic views on the capacity of Girona Airport to support the further air traffic growth in Catalonia.

1.2 Objectives and structure

Considering the background presented above, this study provides an exploratory overview of the medium- and long-term strategic policy directions required to enhance the contribution of Girona Airport to the Catalan Airport System.

Whilst the scope of this study does not allow for a detailed analysis of each of the strategic policy areas, the overview will provide enough evidence to highlight the strengths of Girona Airport and the conditions required for its future growth.

The study is structured along four main analyses, namely, traffic and connectivity, accessibility and catchment areas, airport charges and resilience (Figure 1.1).

Figure 1.1 Thematic structure of the study.

1.3 Expert opinion

The authors of this study also sought advice from industry specialists when required. The following persons provided their views on specific aspects of the study:

- Salvador Montserrat, Associació per a la Promoció i el Desenvolupament de les Comarques Gironines
- Guillaume Burghouwt and Joost Zuidberg, SEO Amsterdam Aviation.

2 Traffic, connectivity and capacity

2.1 General traffic characteristics of the Catalan Airport System

2.1.1 Demand aspects: Catalonia, a massive OD market

Passenger traffic in the Catalan Airport System is highly concentrated in Barcelona Airport (Table 2.1) and it is characterised by a high proportion of origin-destination traffic. Indeed, 93% of the traffic are passengers that start or terminate their journeys in one of the four Catalan airports. The remaining 7% are connecting passengers that use Barcelona Airport as a transfer point (Table 2.2 and Figure 2.1).

Table 2.1 Passenger numbers, official statistics, 2016.

Airport	Passengers	Share
Barcelona (BCN)	44,154,693	94.6%
Girona (GRO)	1,664,763	3.6%
Reus (REU)	817,611	1.8%
Lleida (ILD)	34,754	0.1%

Source: Aena, Aeroport de Lleida-Alguaire.

Table 2.2 Commercial departing passengers (no double counting) from Catalan commercial airports, 2016.

Airport	Direct	Onward connecting	Transfer at airport	Total
BCN	15,513,542	2,881,973	1,547,780	19,943,295
GRO	765,767	-	16,509	782,276
ILD	6,151	-	55	6,206
REU	250,520	-	19,481	270,001
Total	16,535,980	2,881,973	1,583,825	21,001,778

Source: Cranfield-Edinburgh analysis, MIDT-OAG Traffic Analyser.

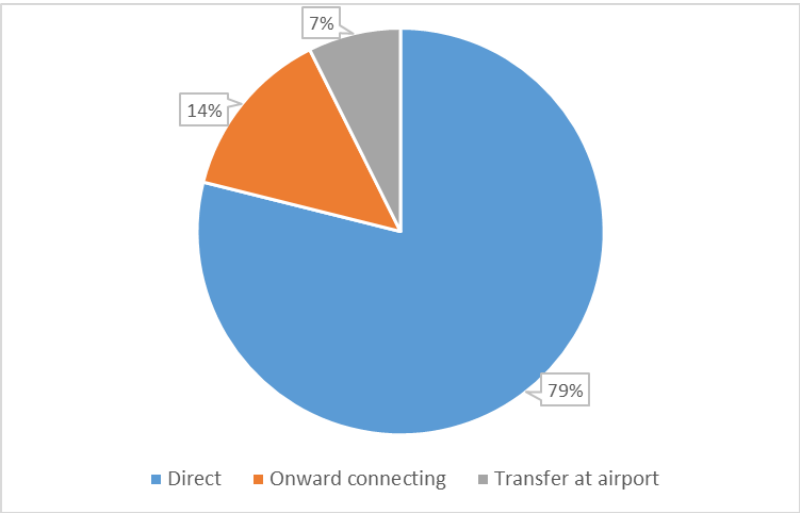


Figure 2.1 Share of departing passenger traffic from Catalan commercial airports, 2016.

Source: Cranfield-Edinburgh analysis, MIDT-OAG Traffic Analyser.

By breaking down the results above by destination region (Table 2.3) we can observe that, overall, the main destinations are the major European markets, mainly Western Europe (79.2% of the passengers). Beyond the European region, the only markets standing out are North America (3.3%), South America (2.4%), North Africa (2.3%), and North East Asia (2%). Hence, not only is the traffic in Catalonia mainly dominated by OD passengers, but also most of those passengers have Europe as their destination.

It is important to highlight that this is not only a characteristic of the overall Catalan market, but it is also a feature of Barcelona Airport. The main airport of Catalonia has indeed a higher proportion of intercontinental passengers, but almost 85% of the passengers departing from Barcelona Airport have Europe as their final destination.

Table 2.3 Departing OD passengers (direct and onward, excluding transfer passengers) by originating airport and destination region, 2016.

	Barcelona		Girona		Lleida		Reus		Total	
Region	**Pax**	**%**	**Pax**	**%**	**Pax**	**%**	**Pax**	**%**	**Pax**	**%**
Africa : Central/Western Africa	59,869	0.3%	1	0.0%		0.0%		0.0%	59,870	0.3%
Africa : Eastern Africa	21,301	0.1%		0.0%		0.0%		0.0%	21,301	0.1%
Africa : North Africa	421,555	2.3%	25,035	3.2%		0.0%		0.0%	446,590	2.3%
Africa : Southern Africa	24,712	0.1%		0.0%		0.0%		0.0%	24,712	0.1%
Asia : Central Asia	13,259	0.1%		0.0%		0.0%		0.0%	13,259	0.1%
Asia : North East Asia	381,408	2.1%	14	0.0%		0.0%		0.0%	381,422	2.0%
Asia : South Asia	113,256	0.6%		0.0%		0.0%		0.0%	113,256	0.6%
Asia : South East Asia	138,584	0.8%	10	0.0%		0.0%		0.0%	138,594	0.7%
Europe : Eastern/Central Europe	1,101,649	6.0%	88,801	11.4%		0.0%		0.0%	1,190,450	6.1%
Europe : Western Europe	14,472,432	78.7%	668,189	85.4%	6,201	99.9%	270,001	100.0%	15,416,823	79.2%
Latin America : Caribbean	77,404	0.4%	5	0.0%		0.0%		0.0%	77,409	0.4%
Latin America : Central America	104,108	0.6%	181	0.0%	5	0.1%		0.0%	104,294	0.5%
Latin America : Lower South America	284,286	1.5%	5	0.0%		0.0%		0.0%	284,291	1.5%
Latin America : Upper South America	169,093	0.9%	25	0.0%		0.0%		0.0%	169,118	0.9%
Middle East	325,678	1.8%		0.0%		0.0%		0.0%	325,678	1.7%
North America	641,241	3.5%	10	0.0%		0.0%		0.0%	641,251	3.3%
Southwest Pacific	45,680	0.2%		0.0%		0.0%		0.0%	45,680	0.2%
Total	**18,395,515**	**100.0%**	**782,276**	**100.0%**	**6,206**	**100.0%**	**270,001**	**100.0%**	**19,453,998**	**100.0%**

Source: Cranfield-Edinburgh analysis, MIDT-OAG Traffic Analyser.

2.1.2 Supply aspects: Catalonia, a low-cost market

In this section, we focus the attention on the supply provided by the airlines in the Catalan Airport System.

Figure 2.2 presents the evolution in the supply of airline seats from January 2000 to April 2017. Overall, a positive trend is observed. The contribution in the supply from the regional

airports was higher during the 2008 peak year. There has been a significant change in the supply dynamic since the post-2008 contraction.

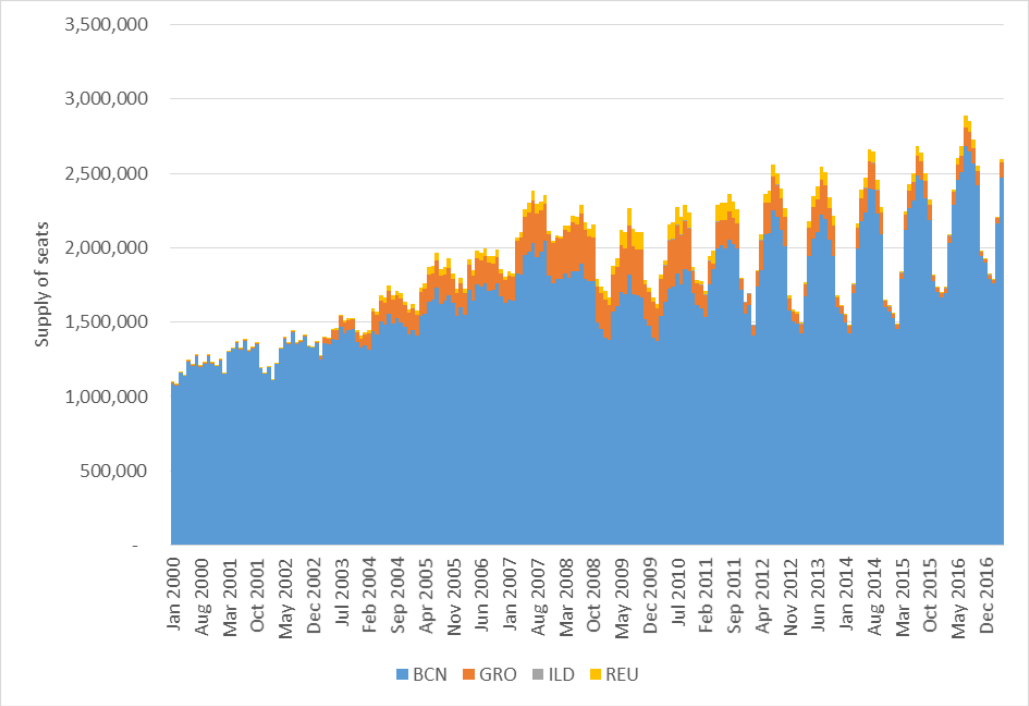


Figure 2.2 Evolution of the seat supply in the Catalan Airport System, January 2010 – April 2017. Source: Cranfield-Edinburgh analysis, OAG Schedules.

This new period is characterised basically by two aspects. Firstly, a lower supply in the regional airports due to a change in the Ryanair's behaviour (the reasons behind this change are detailed in Section 2.2). Secondly, a significantly higher level of seasonality in all the airports of the system, which may be linked to an overall lower business activity across the year and the increased importance of inbound tourism during the summer period.

Another important characteristic of the supply of seats is that most of it has Western Europe (86%) as destination (Figure 2.3). This result is in line with the demand data presented in the previous section.

Figure 2.4 and Figure 2.5 show the share of seat supply by airline type in Barcelona Airport and Girona Airport respectively. As expected, the supply in Girona Airport is dominated by Low-Cost Carriers (LCCs). In the case of Barcelona Airport, the evolution in the share of the seat supply between LCCs and full service carriers follows the usual evolution for an airport that mainly serves short haul routes. Between the last quarter of 2016 and the first quarter of 2017, the share of LCC seats fluctuates between 64% and 68%. The Catalan Airport System seems to be a massive low-cost market.

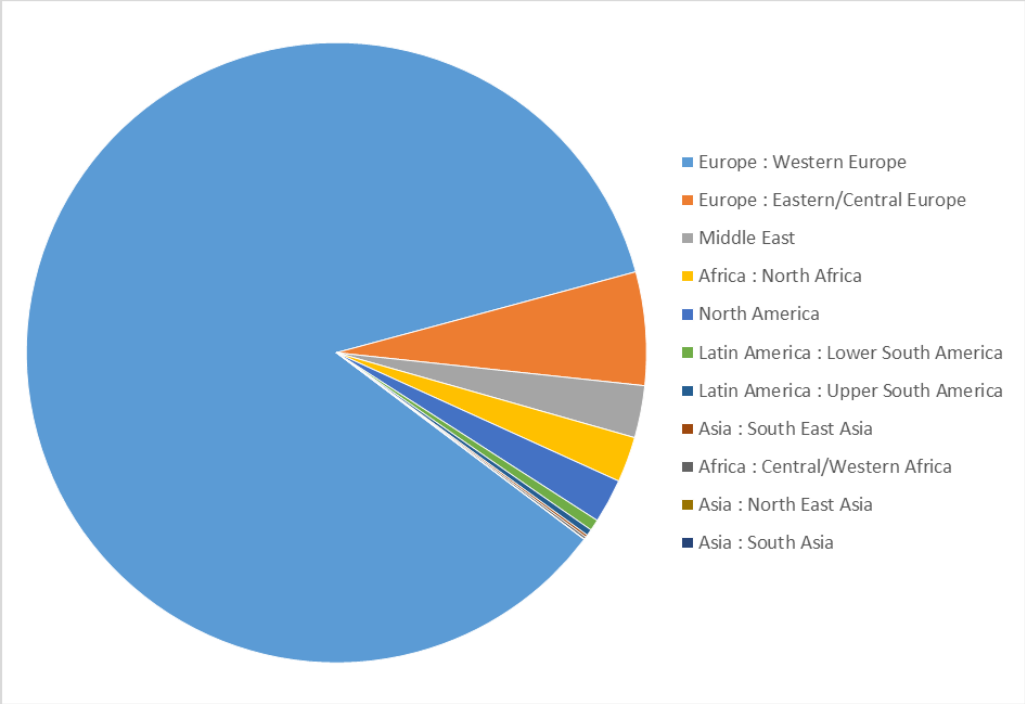


Figure 2.3 Share of seat supply by destination market in the Catalan Airport System, 2016

Source: Cranfield-Edinburgh analysis, OAG Schedules.

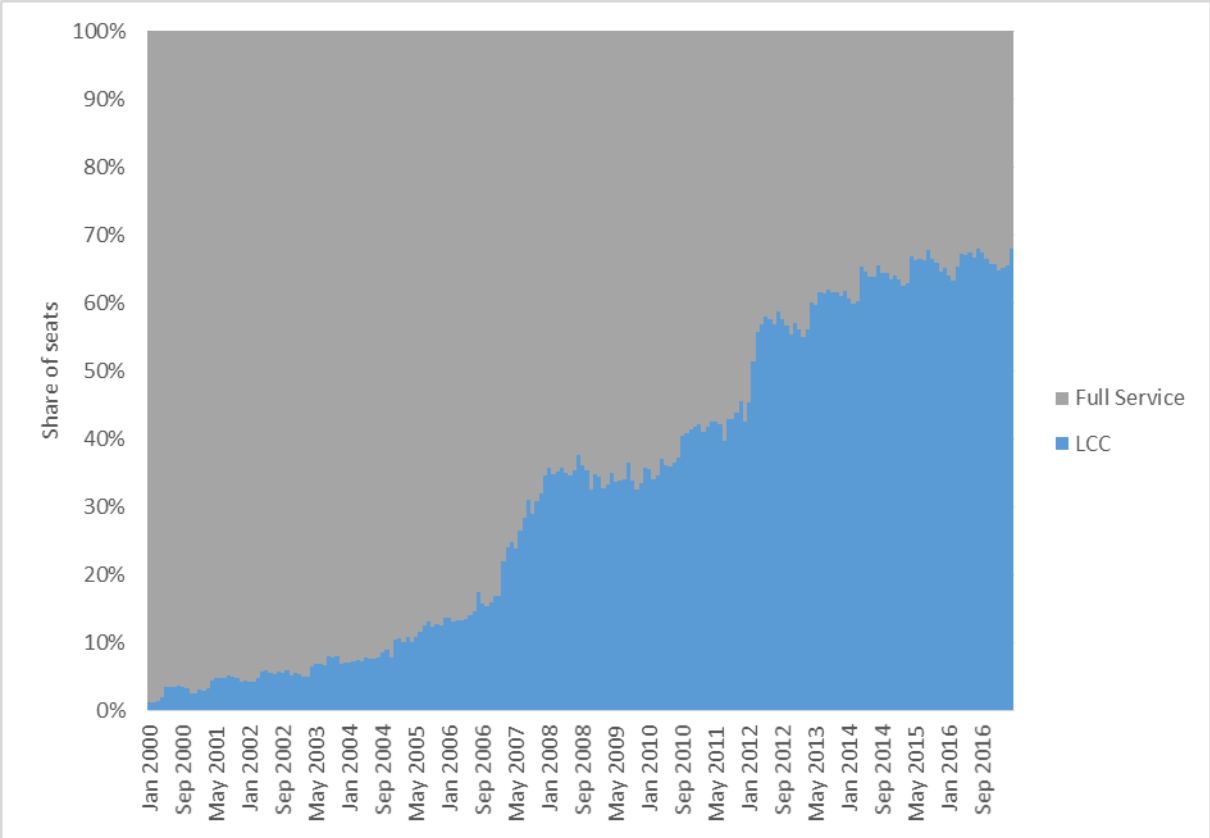


Figure 2.4 Share of seat supply by airline type, Barcelona Airport, January 2000 – April 2017.

Source: Cranfield-Edinburgh analysis, OAG Schedules.

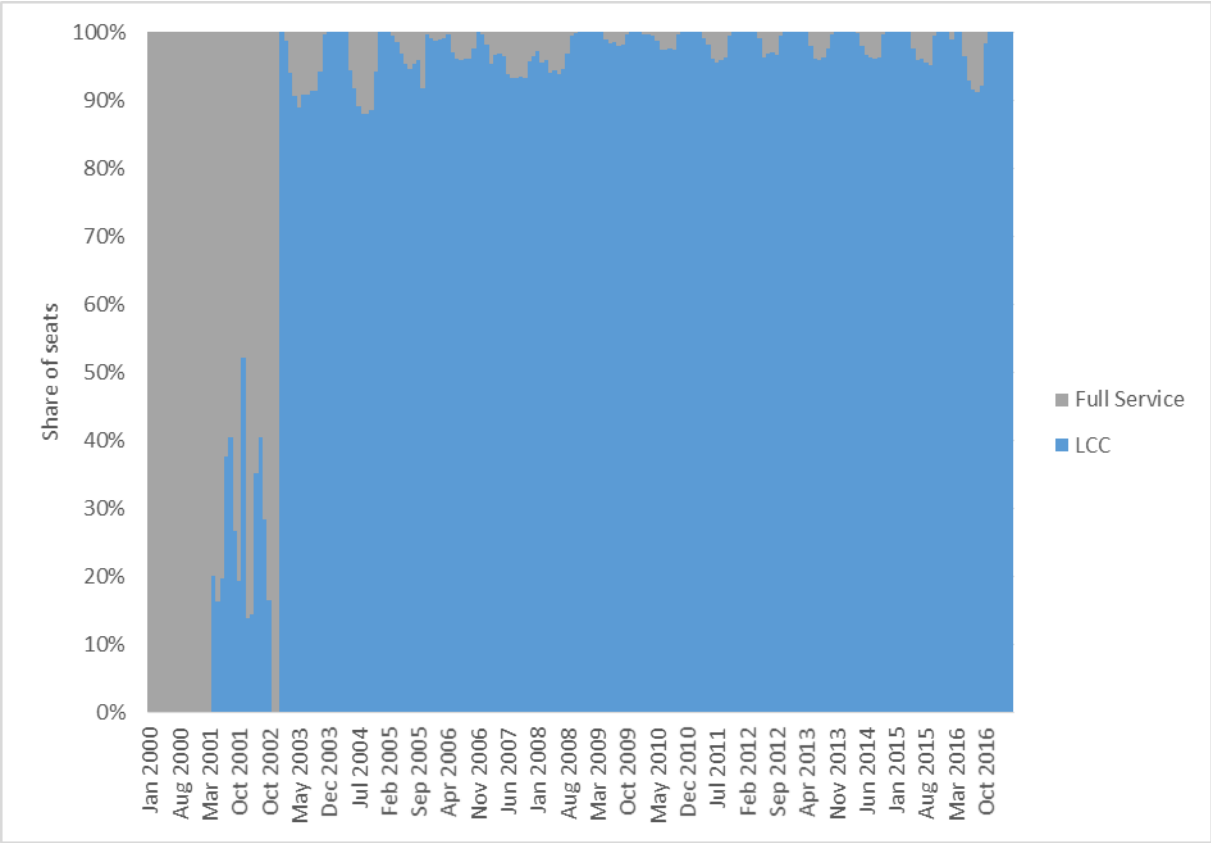


Figure 2.5 Share of seat supply by airline type, Girona Airport, January 2000 – April 2017.

Source: Cranfield-Edinburgh analysis, OAG Schedules.

2.2 Girona Airport traffic trends

2.2.1 Evolution of traffic and supply at Girona Airport

Having provided an overview of the demand and supply of the Catalan Airport System, we now turn the attention to Girona Airport.

Figure 2.6 and Figure 2.7 show the evolution of passenger numbers at Girona Airport from January 2004 to December 2016. Annual passenger numbers peaked in 2008 with 5.5 million passengers. On a monthly basis, passenger numbers peaked in August for the years 2008, 2009 and 2010 with 603,059, 617,736 and 617,546 passengers respectively. Passenger numbers dropped dramatically from 4.8 million in 2011 to 3 million passengers in 2010 when Ryanair decided to withdraw a significant number of services. It is important to note as well that in the summer seasons of 2015 and 2016 passenger numbers were lower than in the winter season of 2008, 2009 and 2010.

As Figure 2.7 demonstrates, the airport has always been characterised by a significant level of seasonality linked to the tourism activity fluctuations. A more detailed analysis of the intensity of seasonal variations is provided by the cycle plots in Figure 2.8 and Figure 2.9, which reveal that the busiest years of 2008, 2009 and 2010 were also the years with the highest level of seasonality, alongside the years 2012, 2013 and 2014. This clearly indicates that the airport's volumes are largely driven by tourism.

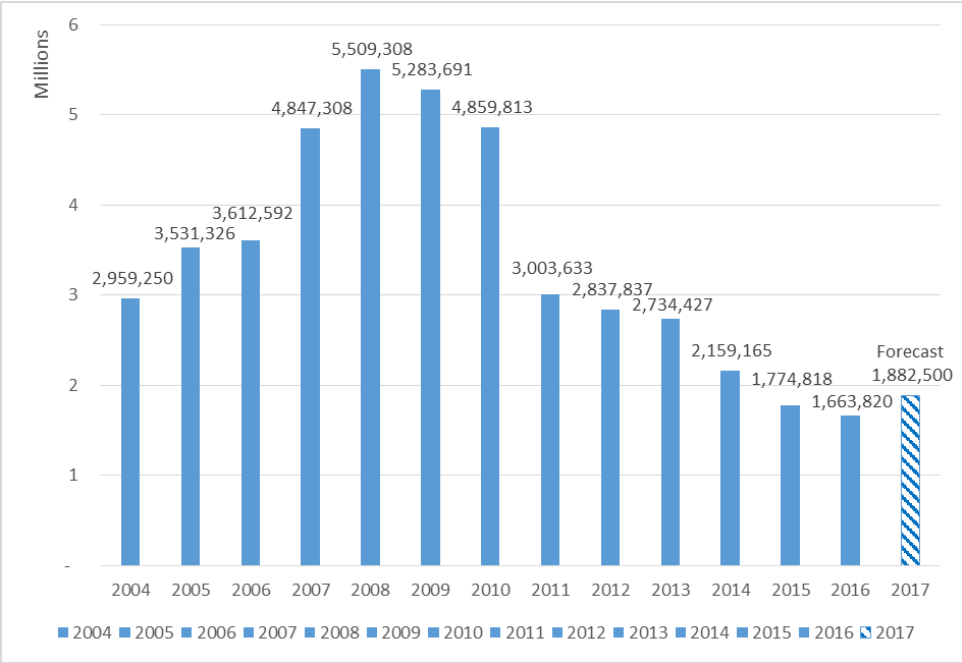


Figure 2.6 Evolution of passenger numbers at Girona Airport, 2004 – 2016 and 2017 forecast.

Source: Aena Statistics.

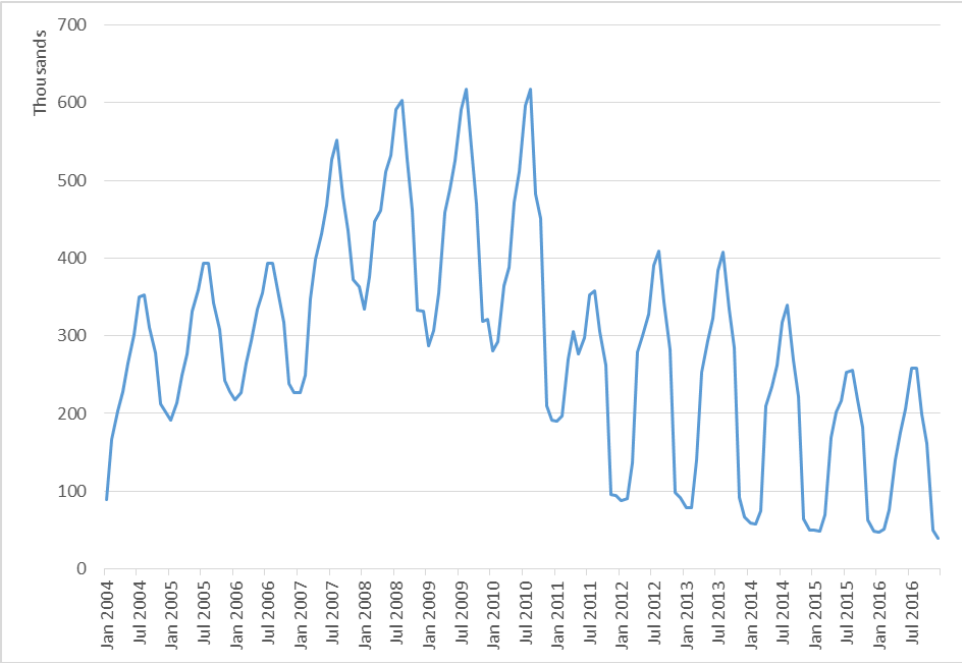


Figure 2.7 Monthly evolution of passenger numbers at Girona Airport, January 2004 – December 2016.

Source: Aena Statistics.

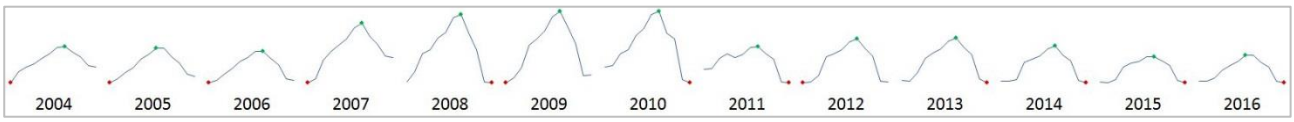


Figure 2.8 Cycle plot, annual passenger traffic trend over the twelve months.

Note: vertical axis is consistent across sparklines.

Source: Cranfield-Edinburgh analysis, Aena Statistics.

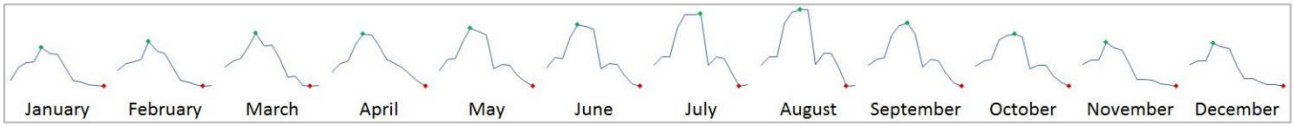


Figure 2.9 Cycle plot, monthly passenger traffic over the 2004-2016 period.

Note: vertical axis is consistent across sparklines.

Source: Cranfield-Edinburgh analysis, Aena Statistics.

The evolution of seat supply at Girona Airport (Figure 2.10) presents a very similar picture to the passenger numbers. Although the airport has been served by a long list of carriers, the supply has been principally provided by Ryanair. However, the supply of seats by Ryanair has plunged significantly. Whilst in the summer season of 2010 the airline supplied 1,771,308 seats, in the summer season of 2016 it only provided 525,420 seats, which represents a reduction of almost 1.25 million seats. Similarly, whilst in the winter season of 2008-2009 the Irish carrier supplied 1,507,275 seats, in the winter season of 2016-2017 the airline only provided 208,089 seats, a reduction of almost 1.3 million seats.[2]

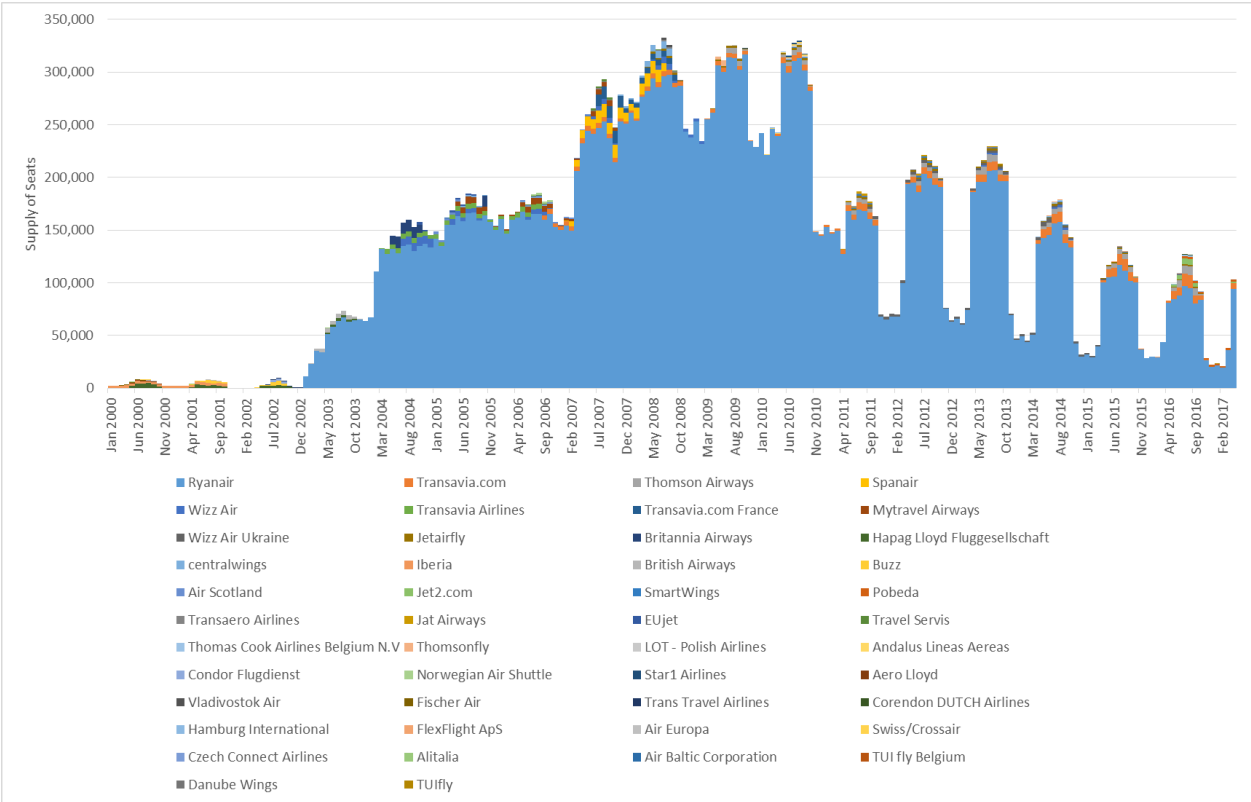


Figure 2.10 Evolution of the seat supply at Girona Airport by airline, January 2000 – April 2017.

Source: Cranfield-Edinburgh analysis, OAG Schedules.

[2] Summer season: April to September.
Winter season: October to March.

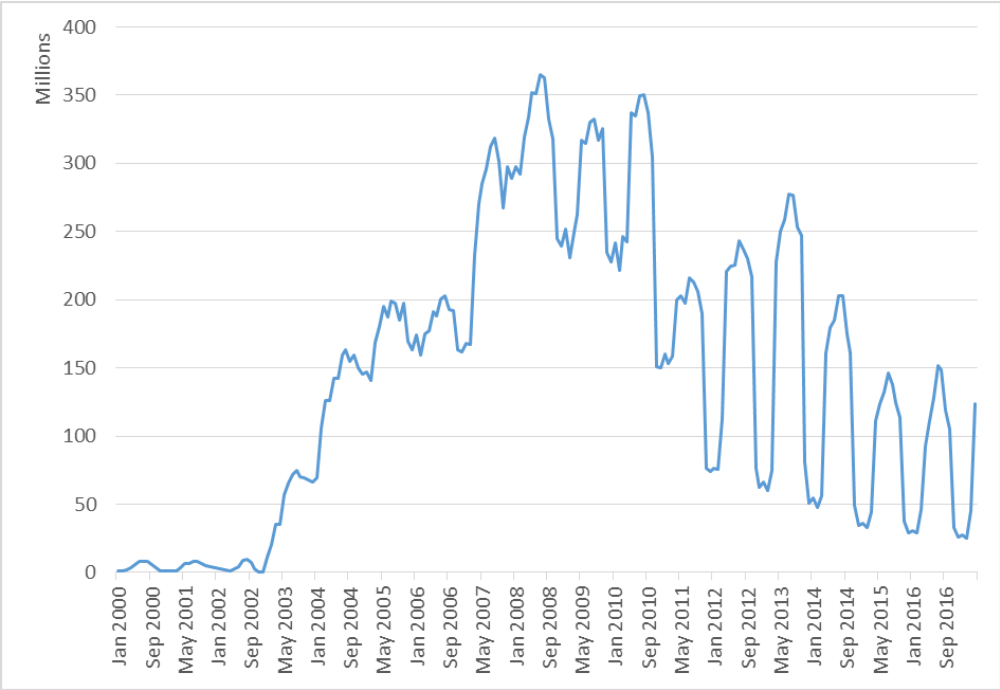


Figure 2.11 Evolution of the available seat kilometres at Girona Airport, January 2000 – April 2017. Source: Cranfield-Edinburgh analysis, OAG Schedules.

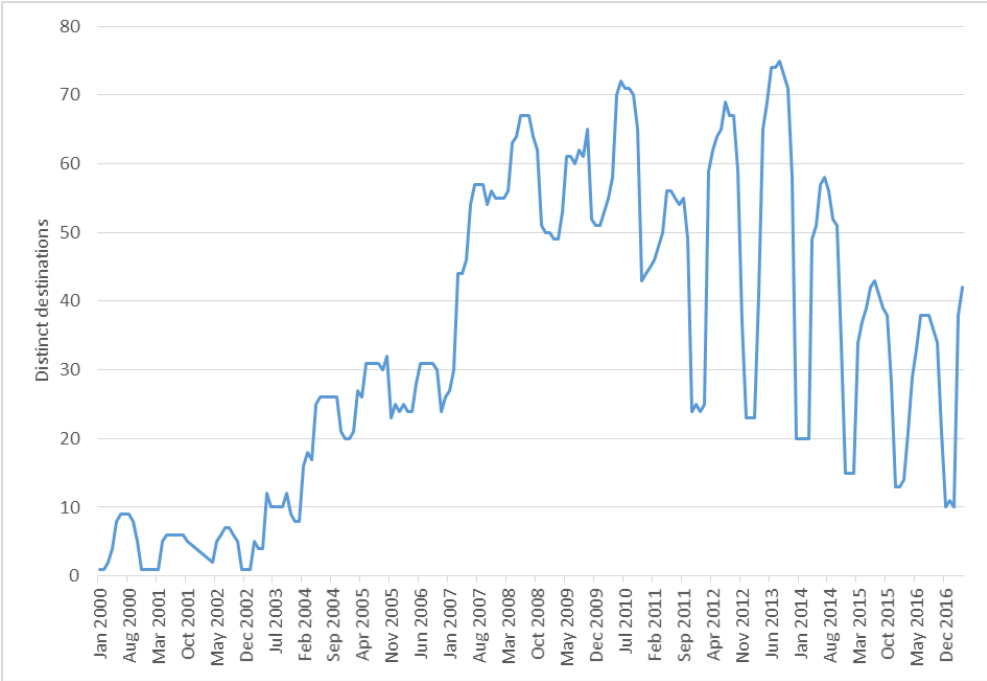


Figure 2.12 Number of distinct destinations from Girona Airport, January 2000 – April 2017. Source: Cranfield-Edinburgh analysis, OAG Schedules.

The evolution of the available seat kilometres (ASKs) (Figure 2.11) and the number of distinct destinations shows a similar evolution as the seats supply (Figure 2.12). The latter, however, seems to have withstood better the recession period and there has not been such a significant drop in the number of destinations. This translates, however, to lower average weekly frequency values, as shown by Figure 2.13.

The withdrawal of such a large number of operations from Girona Airport by Ryanair coincides with the entry of the airline in Barcelona Airport. The movement towards larger, more central airports is due to a major change in the airline's business model, which tries to react to the problems they were facing with regard to density economies across their European network. De Wit and Zuidberg (2012) present a detailed analysis of the density economies issues that Ryanair was facing. These issues were related to need of Ryanair to keep on opening new markets to seek for new demand. In 2010, the airline was operating 70% of their frequencies in airports of less than 5 million passengers. Whilst the airport was enjoying a monopoly position in many routes, these low density markets could not support high frequencies and were dependent on stimulating demand with very low fares. Indeed, Figure 2.13 shows progressive decrease of frequency as the number of destinations increases. Moreover, in its seek for new demand, from 2001 to 2010, Ryanair increased the average stage-length of their routes by 75% (De Wit and Zuidberg, 2012). This is very relevant, as yield (operation revenue / revenue passenger kilometres) tends to decrease as the stage-length increases.

On top the density economies issue, the financial crisis of 2008 damaged passenger demand from secondary cities. Generally, Ryanair came under pressure to move towards larger markets and airports where demand was stronger and the market could sustain slightly higher frequencies. Also, the airline's service product was improved to attract to the new higher-yield customers. A detailed explanation on the business model changes of Ryanair is available in De Wit and Zuidberg (2010) and Fageda et al. (2015).

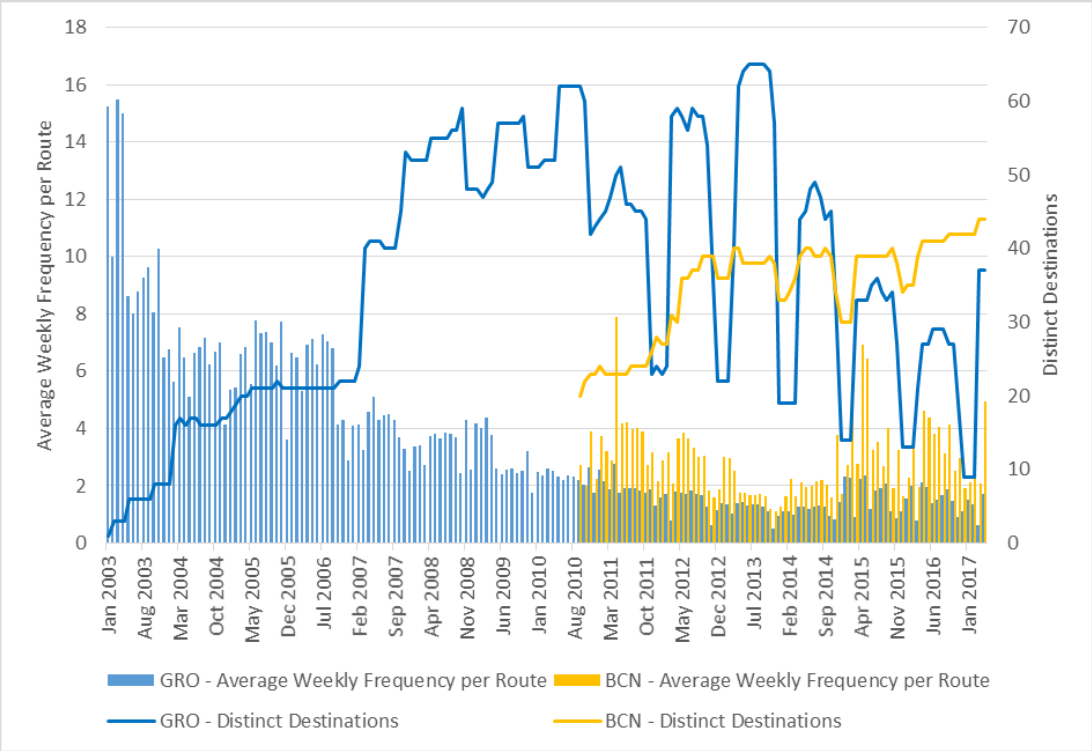


Figure 2.13 Ryanair's average weekly frequency per route versus distinct destinations from Girona Airport and Barcelona Airport, January 2003 – April 2017.

Source: Cranfield-Edinburgh analysis, OAG Schedules.

Currently, Ryanair offers a higher average frequency and more destinations from Barcelona Airport than from Girona Airport. Also, most of the top destinations from Barcelona are primary airports (Table 2.4 to Table 2.7) (e.g., Rome Fiumicino, Palma de Mallorca, Brussels, Ibiza, Sevilla, and Berlin Schönefeld), whilst the destinations from Girona Airport tend to be secondary or regional airports (e.g., Karlsruhe, Pisa, and Weeze).

There is very little route overlap between Girona and Barcelona Airports (Table 2.5 and Table 2.7). It only takes place in the routes to the main Ryanair bases (i.e., London Stansted, Dublin and Bergamo) and in routes to main tourism outbound markets (i.e., Manchester).

Table 2.4 to Table 2.7 also provide information on route competition. As expected, the Herfindahl-Hirschman Index (HHI)[3] confirms that the airline enjoys a monopoly position in the routes served from Girona, whilst in most of the routes served from Barcelona the airline faces significant levels of competition. Although the airline is dependent on stimulating the demand in Girona's thin routes by providing low fares, the monopoly position in those routes could potentially imply higher fares in Girona. Unfortunately, there is no available fare data for low-cost carriers and this cannot be verified.

However, we have extracted offered fare data for two destinations (London Stansted and Dublin) that are served from both Girona and Barcelona airports (Table 2.8). We have also considered two types of trip lengths. Long stays, which would be more appealing to holiday-makers having coastal destinations as final destination; and short-stays, which would be more typical of city-breakers. While we need to be careful when interpreting offered fare data, as we do not have information on the number of seats sold at each price, we could infer the following conclusions for the selected routes:

- For longer stays, Girona Airport is a more expensive option than Barcelona Airport.
- For shorter stays, Barcelona Airport is a more expensive option than Girona Airport for London Stansted, in which the airline enjoys monopoly power in both airports, but not for Dublin, in which the airline faces competition in Barcelona (HHI = 0.40 in summer season)

Hence, this basic assessment could indicate, on the one hand, that limited route competition could push prices up in Girona Airport and, on the other hand and more importantly, that the duration of the stay and the final destination (Costa Brava and Girona region vs Barcelona) could have a major influence on the offered price, since passengers would tend to choose the closest airport to their final destination. Nevertheless, this assessment needs to be taken with caution given the limited data available on prices.[4]

[3] This is a well-established indicator of market concentration that is also used as a proxy for the degree of competition. It is calculated as the sum of the airlines' squared market shares. It ranges from 1 (monopoly) to 0 (perfect competition).

[4] This is just a preliminary assessment, further detailed and in-depth analyses are suggested to confirm this hypothesis.

Table 2.4 Ryanair routes only served at either Girona or Barcelona Airport. Winter season 2016-2017.

Only served by Girona					Only served by Barcelona			
Dest	**Freq**	**Seats**	**HHI**		**Dest**	**Freq**	**Seats**	**HHI**
PSA	187	35,343	1		FCO	643	121,527	0.34
FKB	63	11,907	1		BGY	546	103,194	1
BTS	52	9,828	1		PMI	538	101,682	0.28
MLA	52	9,828	1		BRU	537	101,493	0.34
RBA	52	9,828	1		IBZ	417	78,813	0.52
WRO	51	9,639	1		OPO	414	78,246	0.57
KRK	50	9,450	1		SVQ	363	68,607	0.53
NRN	45	8,505	1		SXF	289	54,621	0.49
BRS	28	5,292	1		SCQ	288	54,432	0.47
BOH	22	4,158	1		TSF	241	45,549	1
LTN	22	4,158	1		BLQ	201	37,989	0.51
FMM	18	3,402	1		AGP	184	34,776	0.61
BLL	15	2,835	1		MAH	180	34,020	0.51
BRE	15	2,835	1		VGO	180	34,020	0.49
MST	11	2,079	1		CGN	171	32,319	0.50
POZ	10	1,890	1		HAM	171	32,319	0.35
PSR	10	1,890	1		VLL	138	26,082	0.55
SKG	10	1,890	1		BUD	133	25,137	0.46
TLL	10	1,890	1		WMI	132	24,948	1
TPS	10	1,890	1		TRN	130	24,570	0.51
CAG	3	567	1		LPA	109	20,601	0.44
BFS	2	378	1		FUE	106	20,034	0.51
LBA	2	378	1		RAK	106	20,034	0.51
OMR	2	378	1		TFN	104	19,656	0.30
NCL	1	189	1		SDR	99	18,711	0.51
Total	**743**	**140,427**			XRY	91	17,199	0.51
					TFS	84	15,876	0.50
					ACE	82	15,498	0.56
					SOF	82	15,498	0.39
					FEZ	76	14,364	1
					NYO	71	13,419	1
					VNO	58	10,962	0.48
					NDR	57	10,773	0.50
					NAP	6	1,134	0.58
					Total	**7,027**	**1,328,103**	

Source: Cranfield-Edinburgh analysis, OAG Schedules.

Table 2.5 Ryanair route overlap of Girona, Barcelona and Reus Airports. Winter season 2016-2017.

	GRO			BCN			REU			Total	
Dest	**Freq**	**Seats**	**HHI**	**Freq**	**Seats**	**HHI**	**Freq**	**Seats**	**HHI**	**Freq**	**Seats**
STN	28	5,292	1	769	145,341	1	58	10,962	0.96	855	161,595
DUB	13	2,457	1	464	87,696	0.45	37	6,993	1	514	97,146
MAN	16	3,024	0.79	259	48,951	0.31				275	51,975
BVA	31	5,859	1	209	39,501	1				240	45,360
BHX	3	567	0.63	192	36,288	0.37	2	378	0.72	197	37,233
EDI	2	378	1	144	27,216	0.51				146	27,594
LPL	2	378	1	119	22,491	0.49	2	378	1	123	23,247
EMA	2	378	1	112	21,168	1	2	378	0.45	116	21,924
PIK	1	189	1	97	18,333	1				98	18,522
CRL	53	10,017	1	6	1,134	1	20	3,780	1	79	14,931
EIN	135	25,515	1				64	12,096	1	199	37,611
HHN	72	13,608	1				11	2,079	1	83	15,687
Total	**358**	**67,662**		**2,371**	**448,119**		**196**	**37,044**		**3,112**	**588,168**

Source: Cranfield-Edinburgh analysis, OAG Schedules.

Table 2.6 Ryanair routes only served at either Girona or Barcelona Airport. Summer season 2016.

Only served by Girona					Only served by Barcelona			
Dest	**Freq**	**Seats**	**HHI**		**Dest**	**Freq**	**Seats**	**HHI**
PSA	236	44,604	1		FCO	915	172,935	0.35
NRN	219	41,391	1		BRU	670	126,630	0.34
LTN	131	24,759	1		IBZ	608	114,912	0.59
FKB	108	20,412	1		BGY	549	103,761	1
BOH	105	19,845	1		PMI	549	103,761	0.34
BLL	87	16,443	1		SVQ	366	69,174	0.58
FMM	79	14,931	1		SXF	366	69,174	0.46
BRE	78	14,742	1		OPO	296	55,944	0.52
TPS	75	14,175	1		BLQ	292	55,188	0.53
BTS	62	11,718	1		TSF	262	49,518	1
TLL	60	11,340	1		MAH	245	46,305	0.56
MST	59	11,151	1		BHX	235	44,415	0.29
MLA	57	10,773	1		SCQ	235	44,415	0.50
KRK	53	10,017	1		EMA	188	35,532	1
RBA	53	10,017	1		TRN	183	34,587	0.50
SKG	53	10,017	1		VGO	183	34,587	0.50
POZ	52	9,828	1		VLL	183	34,587	0.53
PSR	52	9,828	1		AGP	183	34,587	0.68
WRO	52	9,828	1		CGN	183	34,587	0.50
NOC	26	4,914	1		EDI	183	34,587	0.44
Total	**1,697**	**320,733**			HAM	183	34,587	0.31
					XRY	157	29,673	0.50
					BUD	136	25,704	0.39
					NYO	136	25,704	1
					WMI	130	24,570	1
					SDR	126	23,814	0.47
					RAK	118	22,302	0.50
					ACE	114	21,546	0.54
					LPA	105	19,845	0.46
					TFS	87	16,443	0.50
					FUE	82	15,498	0.50
					VNO	79	14,931	0.39
					FEZ	78	14,742	0.53
					NDR	78	14,742	0.35
					TFN	78	14,742	0.33
					SOF	11	2,079	0.40
					Total	**8,572**	**1,620,108**	

Source: Cranfield-Edinburgh analysis, OAG Schedules.

Table 2.7 Ryanair route overlapping of Girona, Barcelona and Reus Airports. Summer season 2016.

	GRO			BCN			REU			Total	
Dest	**Freq**	**Seats**	**HHI**	**Freq**	**Seats**	**HHI**	**Freq**	**Seats**	**HHI**	**Freq**	**Seats**
STN	140	26,460	1	705	133,245	1	87	16,443	1	932	176,148
DUB	78	14,742	1	471	89,019	0.40	219	41,391	0.99	768	145,152
MAN	78	14,742	0.37	366	69,174	0.29				444	83,916
BVA	131	24,759	1	340	64,260	1				471	89,019
LPL				183	34,587	0.39	35	6,615	1	218	41,202
PIK				183	34,587	1	34	6,426	1	217	41,013
CRL	212	40,068	1				96	18,144	1	308	58,212
BRS	144	27,216	1				38	7,182	0.53	182	34,398
EIN	141	26,649	1				119	22,491	1	260	49,140
HHN	133	25,137	1				52	9,828	1	185	34,965
ORK	26	4,914	1				40	7,560	1	66	12,474
Total	**1,083**	**204,687**		**2,248**	**424,872**		**720**	**136,080**		**4,051**	**765,639**

Source: Cranfield-Edinburgh analysis, OAG Schedules.

Table 2.8 Average offered fares by Ryanair in a selection of routes.

Outbound return flight from London Stansted				
	Week (7 days) 31 July to 6 August 2017 Lowest fare available		Weekend (3 days) 30 June to 2 July 2017 Latest flight of the day	
Airport	**BCN**	**GRO**	**BCN**	**GRO**
Average offered return fare	£132.15	£192.01	£220.86	£192.68
Yield (operation revenue/RPK) Average offered fare per Km	£0.056	£0.085	£0.093	£0.086
Outbound return flight from Dublin				
	Long stay (5 days) 2 to 6 August 2017 Lowest fare available		Long weekend (4 days) 29 June to 2 July 2017 Latest flight of the day	
Airport	**BCN**	**GRO**	**BCN**	**GRO**
Average offered return fare	£221.82	£318.88	£341.98	£335.02
Average offered fare per Km	£0.075	£0.110	£0.115	£0.116

Note/Source: Daily fare collection from Ryanair.com from 5 May to 2 June 2017 at 9am. The exact trip days were selected depending on flight schedules.

2.2.2 Passenger profile and final destination

There is limited available information on the nature of the passenger at Girona Airport. Aena's surveys on passenger ground transport accessibility and profile (EMMA surveys) are not available to the public. The only publicly available EMMA survey for Girona Airport is from 2005 (EMMA, 2005).[5] The second available study dates of 2010 and was commissioned by AGi (*Associació per la Promoció i el Desenvolupament de les Comarques Gironines*) and conducted by the University of Girona (Insetur, 2010).

Table 2.9 Final destination of inbound passengers at Girona Airport, 2010 and 2011.

Area	Winter 2010/2011	Summer 2010
Barcelona	57.1%	35.9%
Costa Brava	10.5%	37.9%
Maresme North	1.4%	10.5%
South of France	9.8%	4.5%
Girona	7.4%	4.3%
Country side	8.4%	4.7%
Figures	2.2%	-
Other	2.2%	2.2%

Source: Insetur, 2010.

Table 2.10 Origin/destination of passengers at Girona Airport, 2005.

Province	%		Municipality	%
Barcelona	50%		Barcelona	36.8%
Girona	42.1%		Girona	12.5%
Tarragona	1.7%		Lloret de Mar	7.3%
Lleida	0.8%		L'Escala	2.5%
France	3.5%		Calella	2.3%
Other	1.6%		Begur	1.8%
			Other	36.7%

Source: EMMA, 2005.

The passenger profile found by both studies is very similar. The dominant passenger is a woman between 18 and 35 years old with holidays as the reason of travel. Overall, around 52% of the passengers are inbound (Insetur, 2010). Both studies also reach very similar results in terms of the final destination of the passengers (Table 2.9, Table 2.10 and Figure

[5] The authors of this study requested access to the last EMMA survey for Girona Airport, but the access was denied.

2.14). Barcelona is the main final destination and the Girona and Costa Brava areas are the second main destinations. In this line, ground transport access is dominated by coach –especially for inbound passengers–, which supports the idea that the main final destination is Barcelona (Table 2.11).

Table 2.11 Ground transport access modal split.

	Inbound		Outbound	
	Winter 2010/2011	**Summer 2010**	**Winter 2010/2011**	**Summer 2010**
Coach	62%	47.3%	45.2%	36.3%
Total public transport	*62%*	*47.3%*	*45.2%*	*36.3%*
Drop off (Kiss&Fly)	23.6%	22.7%	27.1%	36.3%
Car Hire	10.6%	10.8%	1%	0.4%
Own vehicle	0.9%	1.3%	25%	23.7%
Taxi	2.2%	7.5%	1.2%	2.5%
Transfer service	0.5%	10.4%	0.2%	0.6%
Total private vehicle	*37.8%*	*52.7%*	*54.5%*	*63.5%*
Plane	0.2%	-	0.2%	-

Source: Insetur, 2010.

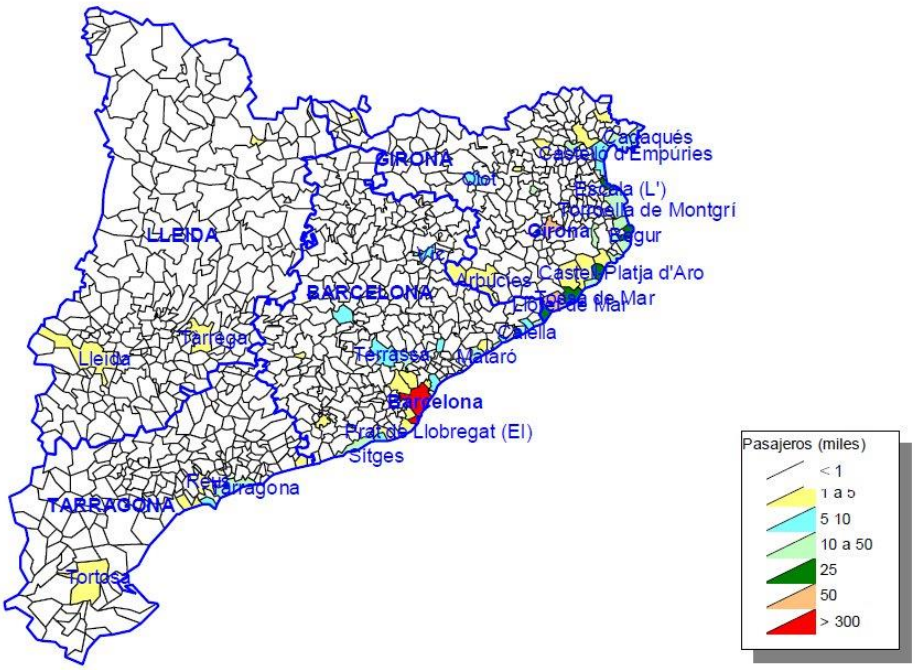


Figure 2.14 Final destination or initial origin of passengers at Girona Airport by municipality, 2005.

Source: Estudios de Movilidad del Modo Aéreo, AENA.

2.3 Capacity of the Catalan Airport System

The DORA (*Documento de Regulación Aeroportuaria*) document, published in January 2017 by the Spanish Government, stablishes the conditions that Aena, the airport manager, will have to comply with in terms of airport infrastructure, investment, quality and conditions of service.

Table 2.12 presents the passenger numbers for 2016, the DORA forecast for 2021 and the declared capacity of the Barcelona, Girona and Reus Airports. According to DORA's data, Barcelona Airport is approaching full capacity. Moreover, considering the high year-on-year increases of 2016-2015, 2015-2014, and 2014-2013 (11.2%, 5.7% and 6.7% respectively), the DORA forecast for 2021 seems to fall short and passenger numbers could be higher. The DORA considers some investments in the Catalan airports for the 2017-2021, but they do not lead to an increase of capacity. Considering the large timescales required for major airport capacity expansions, it is quite likely that Barcelona Airport will face capacity limitations in the coming years. On the other hand, Girona Airport still has considerable spare capacity (Table 2.12), which could be useful in a scenario of congestion in Barcelona Airport.

Table 2.12 Passengers, forecast and declared capacity of Aena airports in Catalonia according to DORA 2017-2021.

	Passengers 2016	DORA forecast for 2021	Declared Capacity 2016	Available Capacity 2016
Barcelona	44,154,693	47,216,864	55,000,000	14%
Girona	1,664,763	1,658,686	7,200,000	77%
Reus	817,611	778,278	1,600,000	51%
Total	46,637,067	49,653,828	63,800,000	22%

Source: DORA (2017).

2.4 Initial strategic assessment

The initial air traffic and connectivity analysis pictures Catalonia as a large LCC market dominated by short-haul origin-destination traffic. In a context of limited capacity at Barcelona Airport and knowing that the primary final destination of Girona Airport passengers is Barcelona, Girona Airport has the opportunity to increase its contribution to the Catalan Airport System regarding the origin-destination traffic.

Hence, we will now look into (a) accessibility, which has long been established as one of the crucial drivers for airport passenger choice, (b) the airport charges scheme, which can facilitate attracting airline, and (c) the possible support that Girona could provide in terms of network resilience.

3 Accessibility and catchment area analysis

3.1 Introduction

This section provides an analysis of the accessibility and catchment area of Girona Airport. The analysis is performed for the current conditions and for a future scenario that considers a High Speed Train (HST / TAV) station close to the airport. The analysis also looks into the area of presumed competition with Barcelona Airport and the population benefiting from the increase in the airport's catchment area and competition.

3.2 Methodology

The analysis of accessibility and catchment areas based on driving distances and TAV travel times was carried out for Girona and Barcelona Airports using the ArcGIS Online platform. This is a common approach in the literature of airport catchment area analysis, as access times have long been established as one of the crucial drivers of air passenger choice (Hess, 2007; Hess and Polak, 2005). Hence, it follows that airports with good accessibility tend to have a natural competitive advantage in capturing passengers from their closest population centres, all other things being equal.

Since Girona and Barcelona Airports are far from being "equal" airports, one cannot conclude that Girona Airports "captures" the local residents within its catchment area. However, this analysis does indeed illustrate the benefits brought by the new TAV connection in terms of reaching valuable centres of population in shorter times, thus expanding the extent of convenient accessibility and improving its currently weak competitive prospects with respect to Barcelona Airport. This is an aspect that new airlines operating at Girona Airport will definitely appreciate when making their decision to open routes.

In order to carry out this analysis, the following location points were set (Table 3.1).

Table 3.1 Location points for the catchment area analysis.

Type	Name	Latitude	Longitude
Airport	Barcelona–El Prat (BCN)	41.3027941	2.0714806
Airport	Girona–Costa Brava Airport (GRO)	41.8977620	2.7678757
Train Station	Girona	41.9779668	2.8152213
Train Station	Girona–Aeroport[6]	41.8833770	2.7642740
Train Station	Figueres–Vilafant	42.2647710	2.9413583
Train Station	Barcelona–Sants	41.3790928	2.1379441
Train Station	Barcelona–La Sagrera	41.4216670	2.1936110

Around the airport points, three driving time areas were calculated, representing 30, 60, and 90-minute access times. The ArcGIS platform has a built-in worldwide road network and uses data from live traffic servers to determine average/typical driving speeds for each road,

[6] The new Girona-Aeroport station is located in the intersection with the GIV-5341 road, as indicated by Departament de Territori i Sostenibilitat.

which was the assumption employed in our calculations. Thus, the size of a catchment area based on driving times will change significantly depending on the airport's location with respect to the major populations centres it serves, as driving within cities and dense urban areas is substantially slower than in inter-urban roads. As a proxy for the extent of potential competition between Girona and Barcelona Airports, we calculate the intersection of both airports' catchment areas for different driving times.

The results are always presented as shaded areas over a map, which are later enriched with socio-economic variables provided by the software company Esri and built-in into the GIS platform (See details in Esri, 2015[7]). This is achieved by overlaying the drive time layers over the data layers and intersecting them. The following three variables were calculated:

1. Total surface area.
2. Total population: projected for the year 2015 based on official INE statistics.
3. Purchasing Power per Capita for 2015: according to Esri's methodological notes, this variable refers to disposable income (i.e. income after taxes) and it was calculated using national and regional tax and income statistics from official sources.

Two scenarios were run:

1. The baseline scenario takes into account current standard driving times to determine accessibility to Girona and Barcelona Airports.
2. The high-speed scenario (TAV) augments the baseline catchment areas with the new accessibility brought by the high-speed rail connections originating at Girona Airport and terminating at the stations in La Sagrera, Sants, and Figueres-Vilafant, with travel times of 30, 35, and 20 minutes, respectively, plus a 5-minute transfer to/from the new TAV station at Girona Airport. The time-space compression brought by increased travel speeds to Barcelona and Figueres allows covering more area in 60 and 90 minutes from Girona Airport.[8]

3.3 Results

Table 3.2 provides a summary of the results and Maps 3.1 to 3.7 show their graphical representation.

Overall, in the baseline scenario, we could say that Girona Airport has a very small 30-minute catchment area of just 265,000 people; most of the population is within 60 to 90 minutes. On the other hand, Barcelona Airport has a very strong 30-minute catchment area. Also, the purchasing power of the population is higher in the Barcelona area, so Girona Airport can only capture it when driving time is above 60 minutes.

The TAV connection greatly expands the population count for Girona Airport within the 60-minute catchment area, whilst the 90-minute catchment area remains pretty much the same. More to the point, by adding the TAV connection, the population in the 60-minute catchment

[7] http://downloads.esri.com/esri_content_doc/dbl/int/mb-research_notes.pdf
[8] Note that we did not consider the faster passenger processing times at Girona Airport, which could potentially improve the results for this airport.

area population from 2.5 million to over 5.1 million, which is almost the value for Barcelona Airport in the baseline scenario (Table 3.2, Figure 3.1, Maps 3.4 and 3.5). As shown in Map 3.4, the TAV connection allows Girona Airport and the airlines operating in it to tap into the Barcelona city and metropolitan markets. Also, it is important to highlight that the increase of the 60-minute catchment of Girona Airport has a consequence a substantial increase in the average purchasing power per capita, so Girona Airport get access to a bigger and richer pie.

In addition, the overlap between the Barcelona and Girona Airports increases significantly from 1.6 million to 4.3 million residents for the 60-minute catchment area (Figure 3.2). This is indeed a very positive improvement as more population can benefit from choosing between the two airports and their route networks, thus increasing airport competition.

Table 3.2 Summary results of the catchment area analysis.

Airport/s	Scenario	Driving Time (min)	Area in Square Kilometres	2015 Total Population	2015 Purchasing Power p.c. (EUR)
Barcelona (BCN)	Baseline	30	649	3,225,290	16,851
Barcelona (BCN)	Baseline	60	3,664	5,266,920	16,124
Barcelona (BCN)	Baseline	90	12,206	6,471,382	15,979
Girona (GRO)	Baseline	30	838	265,875	16,269
Girona (GRO)	Baseline	60	5,935	2,521,485	15,095
Girona (GRO)	Baseline	90	12,304	5,942,223	15,994
Girona (GRO)	TAV	60	6,636	5,179,368	16,192
Girona (GRO)	TAV	90	13,058	6,208,243	15,974
Overlap GRO/BCN	Baseline	60	909	1,676,436	14,837
Overlap GRO/BCN	Baseline	90	6,721	5,575,829	16,023
Overlap GRO/BCN	TAV	60	1,382	4,334,063	16,306
Overlap GRO/BCN	TAV	90	7,090	5,819,011	15,998

Source: Cranfield-Edinburgh Analysis, ArcGIS Online, INE.

In this regard, the current catchment area overlap between Barcelona and Girona Airport is the smallest overlap between the main airport and a secondary airport in comparison with other European airport systems (Table 3.3). In all international case studies, more than 80% of the residents in the 60-minute catchment area of the primary airport can also reach the secondary airport within the same time. This would indeed point out the need to improve the accessibility to Girona Airport.

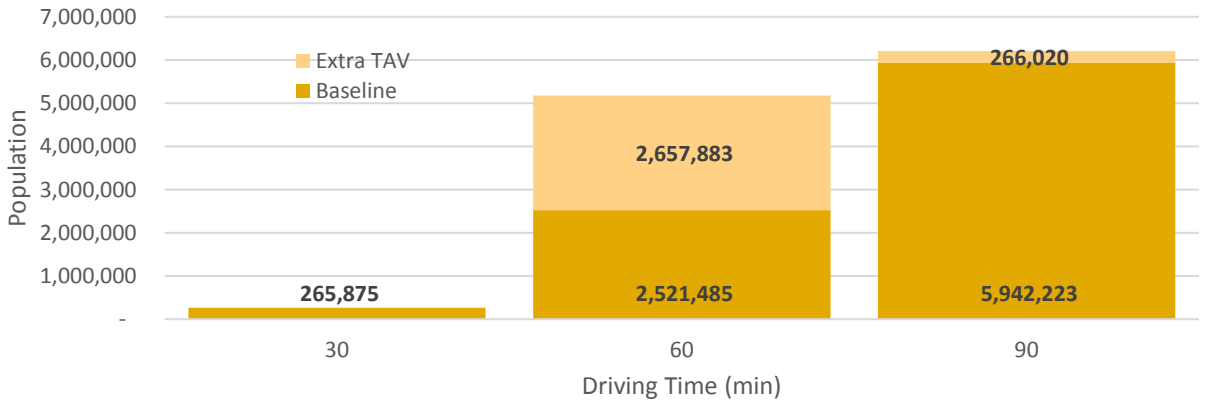


Figure 3.1 Population within Girona Airport catchment areas under different scenarios: 30, 60, and 90 min.

Source: Cranfield-Edinburgh Analysis, ArcGIS Online, INE.

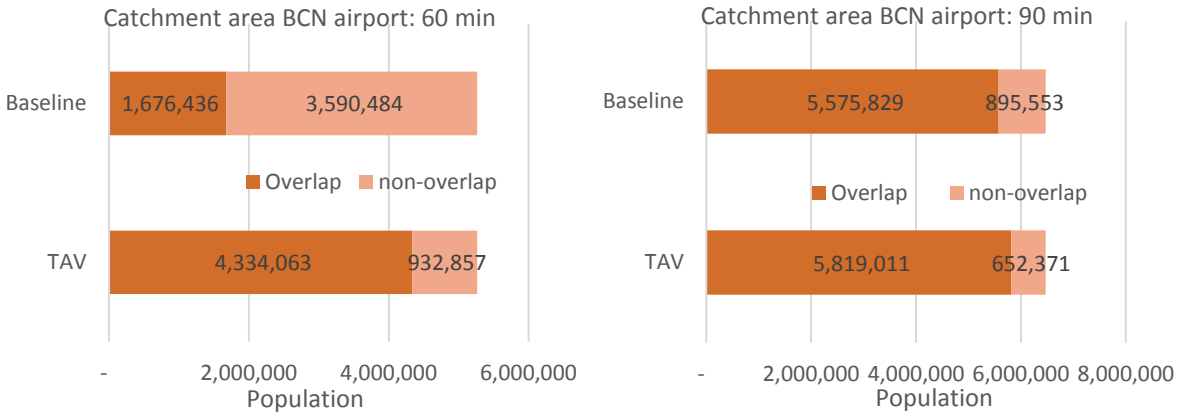


Figure 3.2 Girona Airport's coverage of BCN airport's catchment area: overlap 60 and 90 min.

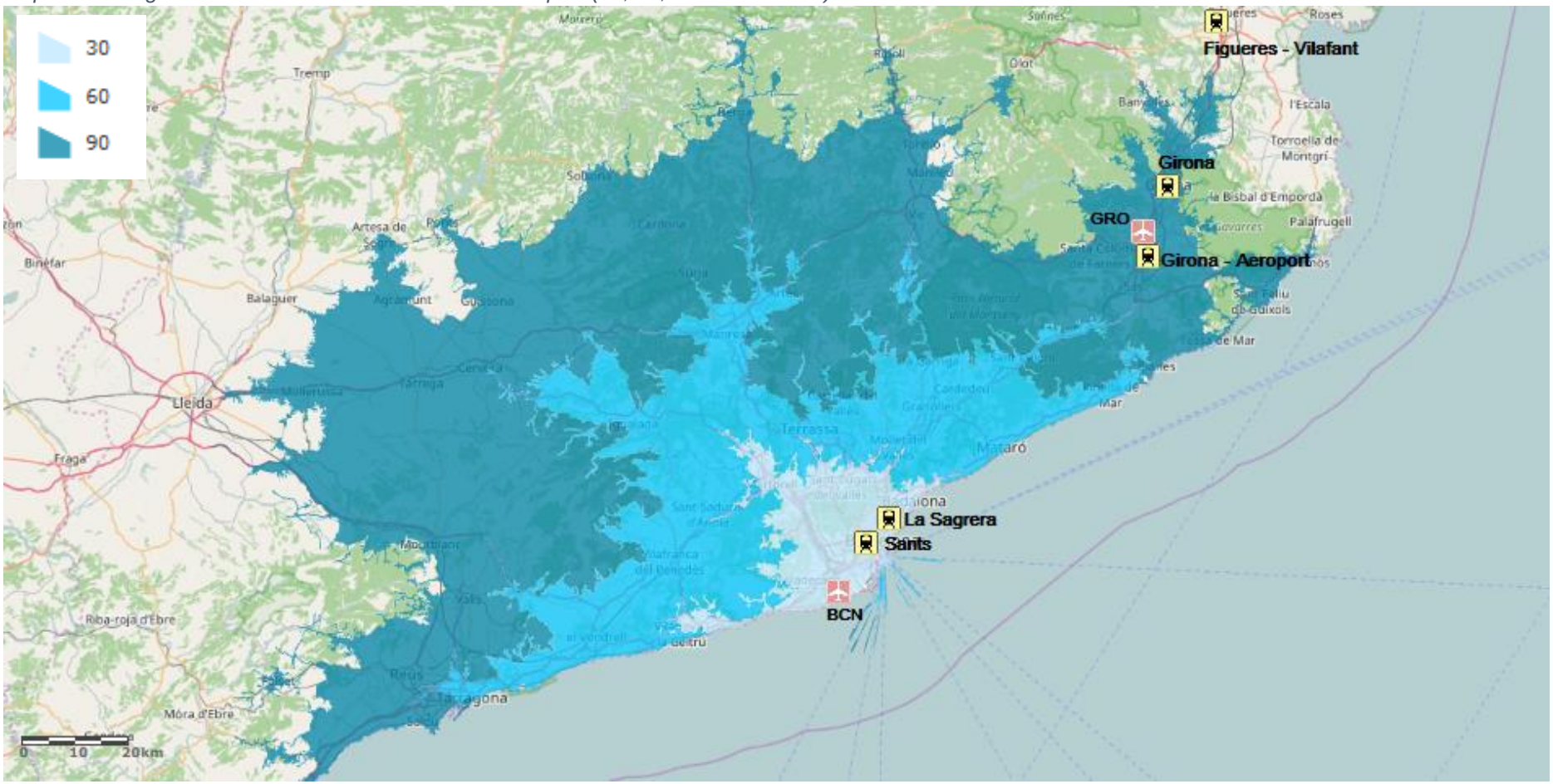
Source: Cranfield-Edinburgh Analysis, ArcGIS Online, INE.

Table 3.3 Catchment area analysis for a selection of airport systems.

Airport/s	Driving Time (min)	Area in Square Kilometres	% area primary	2015 Total Population	% population primary	2015 Purchasing Power p.c.
Barcelona (BCN)	60	3,664		5,266,920		16,124
Overlap with Girona (GRO)	60	909	24.8%	1,676,436	31.8%	14,837
Paris - Charles-de-Gaulle (CDG)	60	11,005		12,023,995		24,395
Overlap with secondary airports (Orly, Beauvais)	60	9,178	83.4%	11,863,862	98.7%	24,466
Milano Malpensa (MXP)	60	5,920		6,110,586		20,520
Overlap with secondary airports (Linate, Orio al Serio)	60	2,979	50.3%	5,204,582	85.2%	20,962
Amsterdam Schiphol (AMS)	60	9,756		8,589,928		19,065
Overlap with secondary airport (Rotterdam)	60	6,033	61.8%	7,277,399	84.7%	19,235
London Heathrow (LHR)	60	8,911		11,245,280		21,407
Overlap with secondary airports (Gatwick, Luton, Stansted)	60	6,009	67.4%	9,549,647	84.9%	21,723

Source: Cranfield-Edinburgh Analysis, ArcGIS Online.

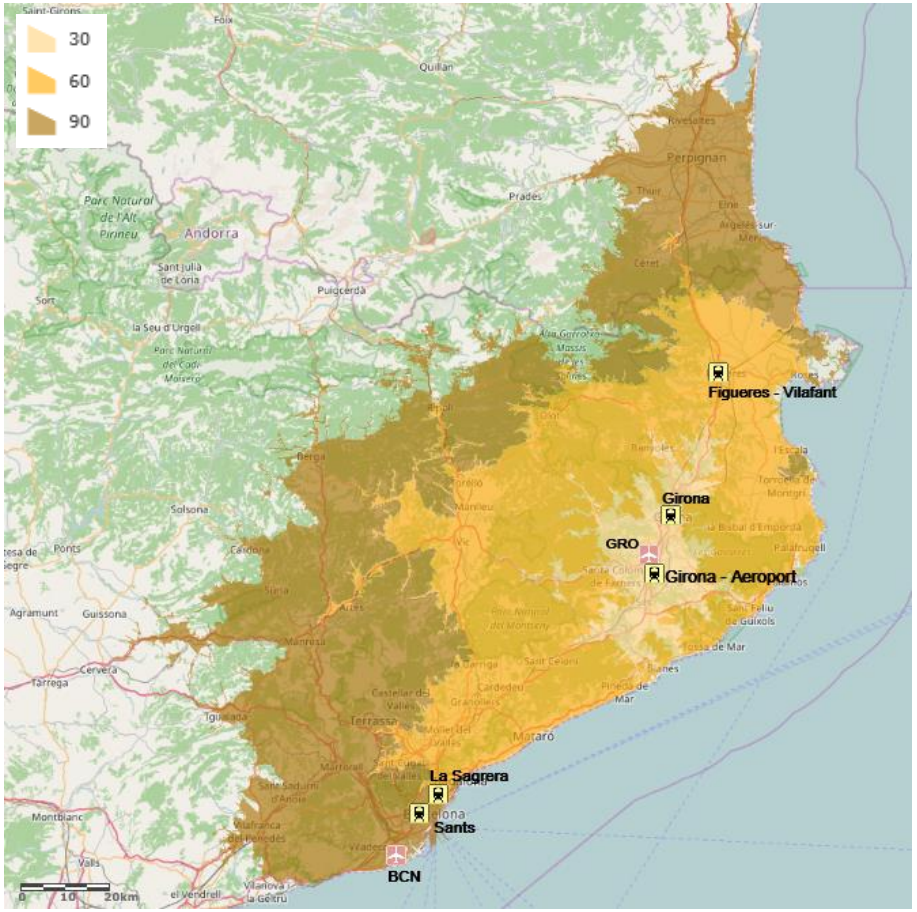
Map 3.1 Driving time catchment areas for Barcelona Airport (30, 60, and 90 minutes)



Driving time (min)	30	60	90
Area in Square Kilometres	649	3,664	12,206
2015 Total Population	3,225,290	5,266,920	6,471,382
2015 Purchasing Power: Per Capita (EUR)	16,851	16,124	15,979

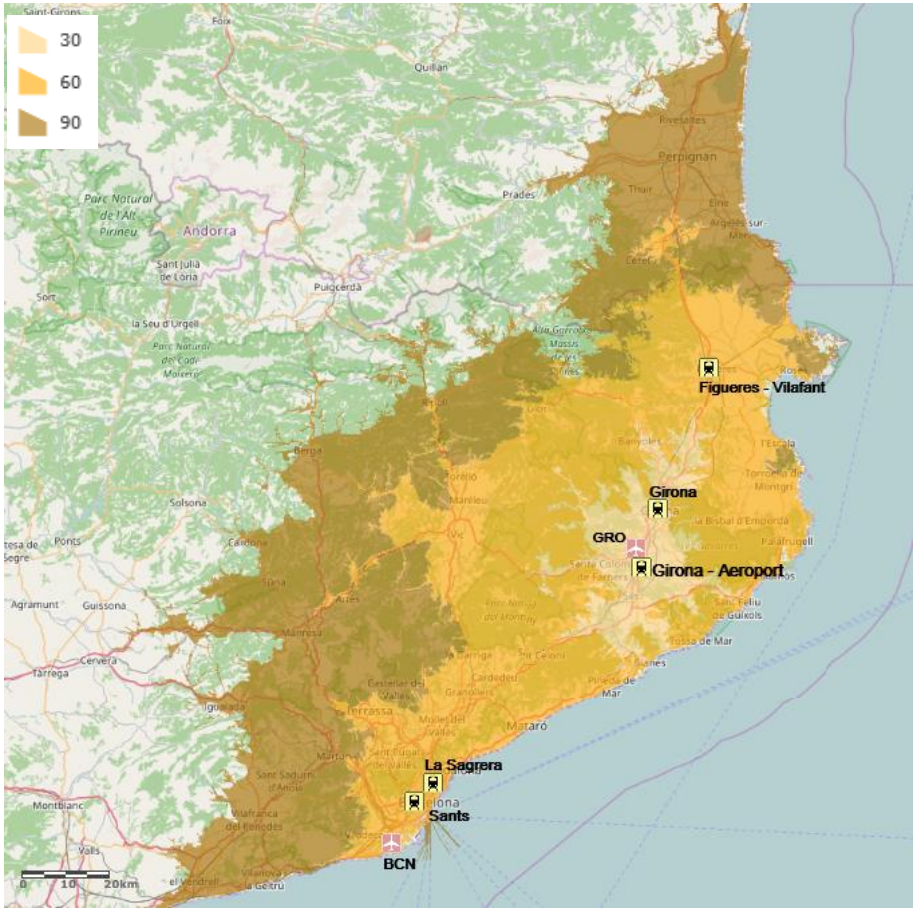
Source: Cranfield-Edinburgh Analysis, ArcGIS Online, ESRI data, INE.

Map 3.2 Driving time catchment areas for Girona Airport (30, 60, 90 min): Baseline scenario



Driving time (min)	30	60	90
Area in Square Kilometres	838	5,935	12,304
2015 Total Population	265,875	2,521,485	5,942,223
2015 Purchasing Power Per Capita (EUR)	16,269	15,095	15,994

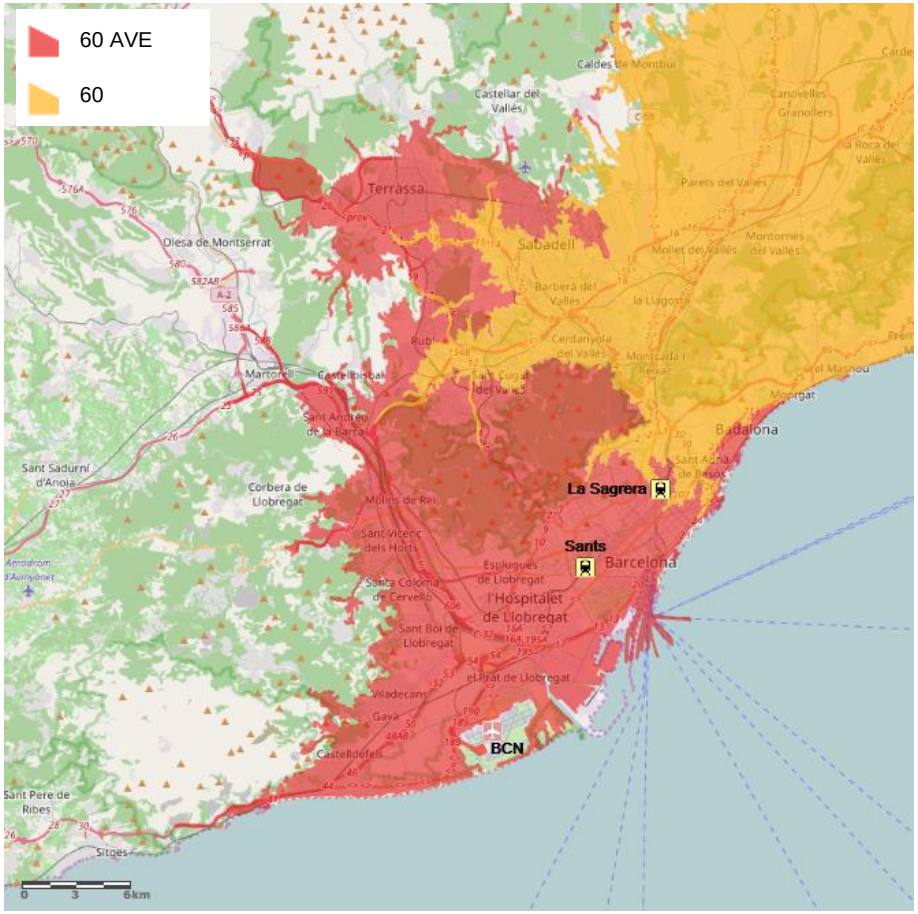
Map 3.3 Driving time catchment areas for Girona Airport (30, 60, 90 min): TAV scenario



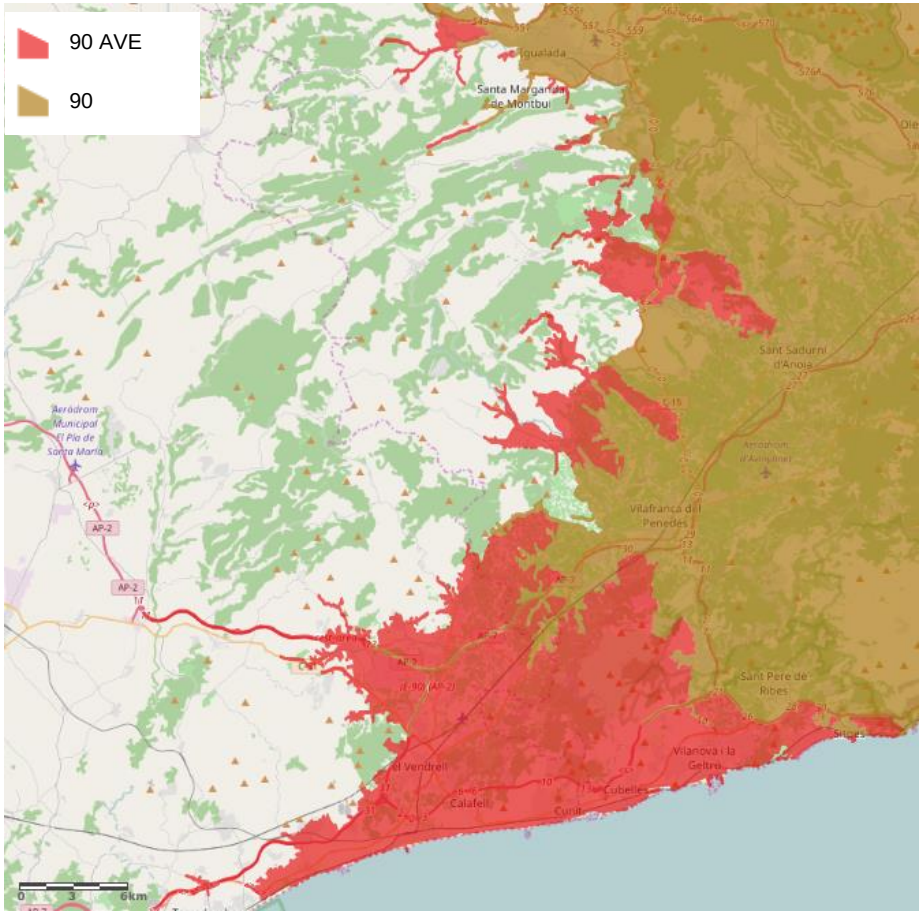
Driving time (min)	30	60	90
Area in Square Kilometres	838	6,636 (+12%)	13,058 (+6%)
2015 Total Population	265,875	5,179,368 (105%)	6,208,243 (+4%)
2015 Purchasing Power Per Capita (EUR)	16,269	16,192 (7%)	15,974 (-0.1%)

Source: Cranfield-Edinburgh Analysis, ArcGIS Online, ESRI data, INE.

Map 3.4. Extension in 60-minute catchment area for Girona Airport: TAV Scenario.



Map 3.5 Extension in 90-minute catchment area for Girona Airport: TAV Scenario

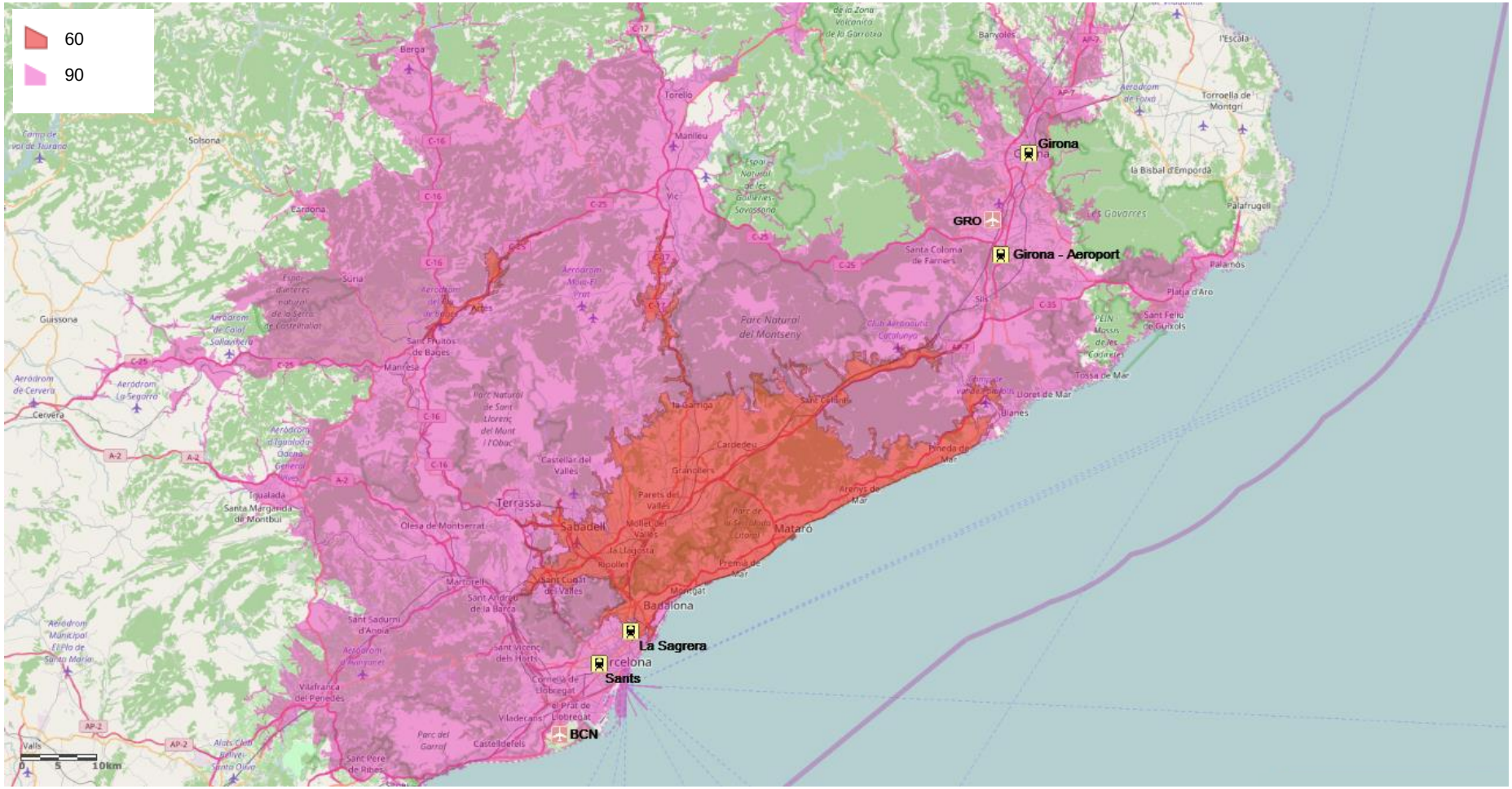


Driving time (min)	60 base	60 TAV	Increase
Area in Square Kilometres	5,935	6,636	701 (+12%)
2015 Total Population	2,521,485	5,179,368	2,657,883 (+105%)
2015 Purchasing Power Per Capita (EUR)	15,095	16,192	1,097 (7%)

Driving time (min)	90 base	90 TAV	Increase
Area in Square Kilometres	12,304	13,058	754 (6%)
2015 Total Population	5,942,223	6,208,243	266,020 (4%)
2015 Purchasing Power Per Capita (EUR)	15,994	15,974	-20 (-0.1%)

Source: Cranfield-Edinburgh Analysis, ArcGIS Online, ESRI data, INE.

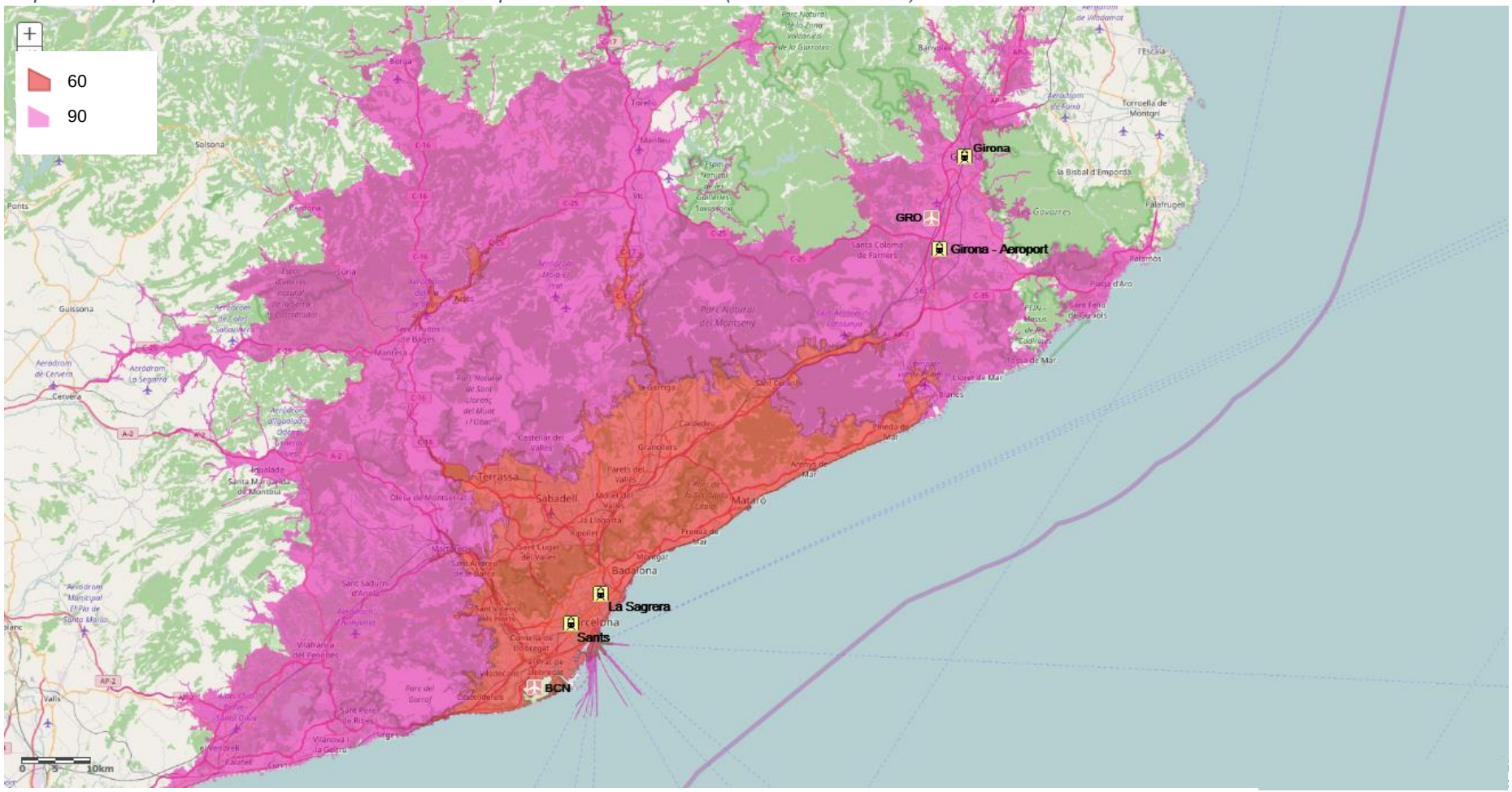
Map 3.6 Overlap between Girona and Barcelona airports' catchment areas (60 and 90 minutes): Baseline scenario



Driving time (min)	60	90
Area in Square Kilometres	909	6,721
2015 Total Population	1,676,436	5,575,829
2015 Purchasing Power Per Capita (EUR)	14,837	16,023

Source: Cranfield-Edinburgh Analysis, ArcGIS Online, ESRI data, INE.

Map 3.7 Overlap between Girona and Barcelona airports' catchment areas (60 and 90 minutes): TAV scenario



Driving time (min)	60	90
Area in Square Kilometres	1,382 (+52%)	7,090 (+5%)
2015 Total Population	4,334,063 (+158%)	5,819,011 (+4.3%)
2015 Purchasing Power Per Capita (EUR)	16,306 (+10%)	15,998 (-0.1%)

Source: Cranfield-Edinburgh Analysis, ArcGIS Online, ESRI data, INE

4 Airport charges analysis

4.1 Introduction and methodology

In this section, we provide a comparative analysis of the airport charges in several European airport systems. Airport charges are an essential factor for airlines when assessing the viability of the operation in a specific airport. In addition, they crucial in defining the airport competitive environment and regulatory framework.

In this analysis, we have calculated the turnaround costs of a Boeing 737-800, the aircraft used by Ryanair, following the assumptions described in Table 4.1. Regarding the parking stand, a bridge or an apron has been considered depending on the airport.

Table 4.1 Assumptions considered for the airport charges calculation.

Aircraft characteristic	Value
Aircraft Type	B737-800
MTOW (metric tons)	79.02
Body type	Narrow
Cumulative noise margin (dB)	13.7
Total NOx emissions (kg/LTO)	10.03
Flight Type	International EEA
Seat Capacity	189
Load Factor	90%
Total Passengers	170
Origin / Destination Passengers	170
Transfer Passengers	0
Number of bags	85
Parking Time (h)	1
Check-in Usage (h)	2
Boarding bridge time (h)	1
Arrival Time	10:00
Cargo (kg)	0
Parking Stand	Apron or bridge

Source: Cranfield-Edinburgh Analysis, IATA Airport Charges, Boeing.

The calculations are made using the IATA Airport Charges database and the airport charges documents published by each individual airport or airport manager. It is important to note that the calculations do not include any potential bilateral discounts or marketing agreements between the airport and the airline that are not public. Nonetheless, for Barcelona and Girona Airports, the calculations also include the value of the reduced charges when applying the incentive for new routes. According to the Aena Price Guide 2017, the incentive to start new routes to new destinations consists of a 75% discount on the first year of the average passenger charge. A further 25% discount is given in the second

year if passenger numbers are maintained or increased. This discount applies equally to all airports and all types of routes.[9]

Results distinguish as well between aircraft-related and passenger-related.

4.2 Airport charges benchmarking

Overall, the results (Figure 4.1) show that the primary airport of the region has generally higher airport charges. There are, however, two exceptions. Milan-Linate is more expensive that Milan-Malpensa, which was traditionally considered the main airport in the region, but lost importance after the de-hubbing of Alitalia. Linate is also more centrally located and suffers from substantial congestion. Amsterdam-Schiphol is also cheaper than Rotterdam Airport. Indeed, the charges at Amsterdam were reduced significantly from 2016 to 2017, probably to facilitate traffic growth and help in the intense hub competition in the top-end of the airport market. Also, Rotterdam is highly congested and slots are limited.

Having said that, the following observations can be highlighted for Girona Airport:

- **General assessment on the composition of airport charges** (Figure 4.3): Airport charges are composed by passenger-related charges and aircraft-related charges (e.g., landing charges). Compared to other European airports, Barcelona and Girona Airports have, overall, a higher proportion of aircraft-related charges than passenger-related charges. However, airlines' decisions would generally favour airports with a high proportion of passenger-related charges, since these are linked to traffic volume, rather than the operation. Aircraft-related charges have a negative impact on the airline bottom-line in case passenger numbers or load factors decrease. Therefore, we could argue that the composition of airport charges is not as attractive at it could be.

- **Composition of airport charges, little difference between Girona and Barcelona** (Figure 4.3): There is relatively little difference between the aircraft-related charges of Barcelona and Girona Airports. This could be due to the similar infrastructure costs per passenger the two airports have. In fact, looking at the airport financials released by Aena for 2014, the total costs per passenger were 9.50 EUR for Barcelona Airport and 10.41 EUR for Girona. It seems then that scale economies allow Barcelona Airport to have lower costs per passenger. This could be one of the reasons explaining the relatively low difference between the aircraft-related charges of the two airports (Landing: Barcelona (7.15 EUR per Tm), Girona (5.69 EUR per Tm). Aerodrome Service: Barcelona (3.38 EUR per Tm), Girona (3.04 EUR per Tm)).

- **Airport charges differential between primary and secondary airports** (Figure 4.2): The differential of the turnaround costs between Girona and Barcelona airports

[9] There are also discounts for increasing passenger numbers on routes with less than 3 million passengers. Nevertheless, we have not computed these discounts as our analysis is cross-sectional and only focuses on a specific moment in time.

(47%) is lower than in other European airport systems. For example, the differential between Milan-Malpensa and Bergamo is 48%, between Paris-CDG and Beauvais is 88% and between London-Heathrow and Luton and Stansted is 55% and 66% respectively. The airport charges differential is a key incentive for airlines to consider the operation from a secondary airport. It is important to highlight that when considering the new routes incentive the airport charges differential decreases only to 21% (see next point).

- **Incentives for new routes provide an advantage to Barcelona Airport** (Figure 4.1, Figure 4.2, Figure 4.3): As detailed above, the same incentive for new routes is offered across the network of Aena's airports. Since the discount is offered on the passenger charge, airports moving larger volumes of passengers benefit the most. As seen in Figure 4.1, the resulting airport charge is proportionally much lower for Barcelona than for Girona Airport and the airport charge differential (Figure 4.2), is reduced to only 27%. As a result, the incentive for new routes benefits more larger airports than smaller regional airports as Girona.

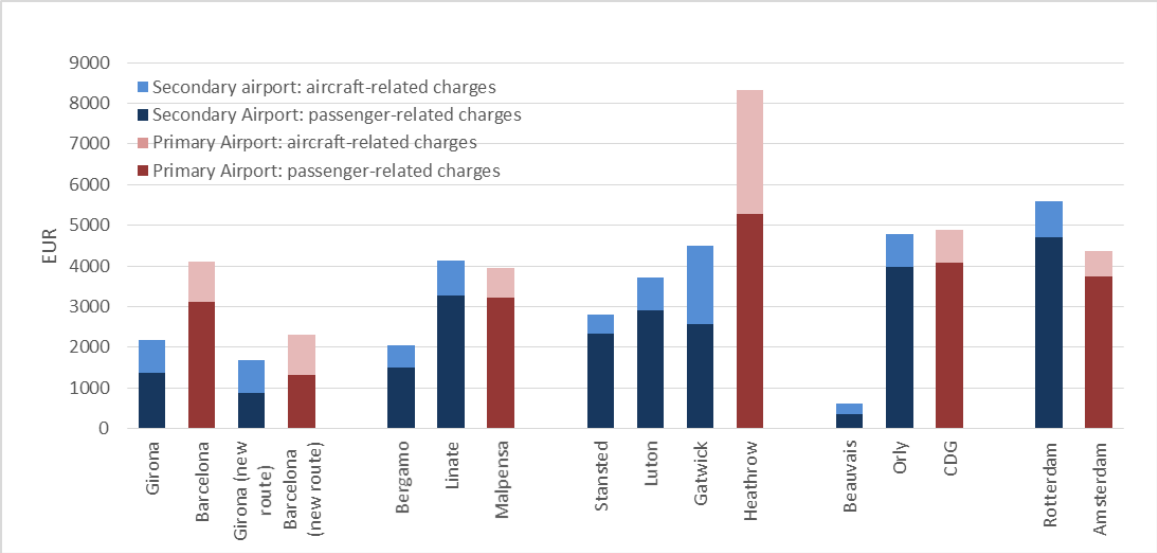


Figure 4.1 Turnaround airport charges for a Boeing 737-800 by airport system.
Source: Cranfield-Edinburgh Analysis.

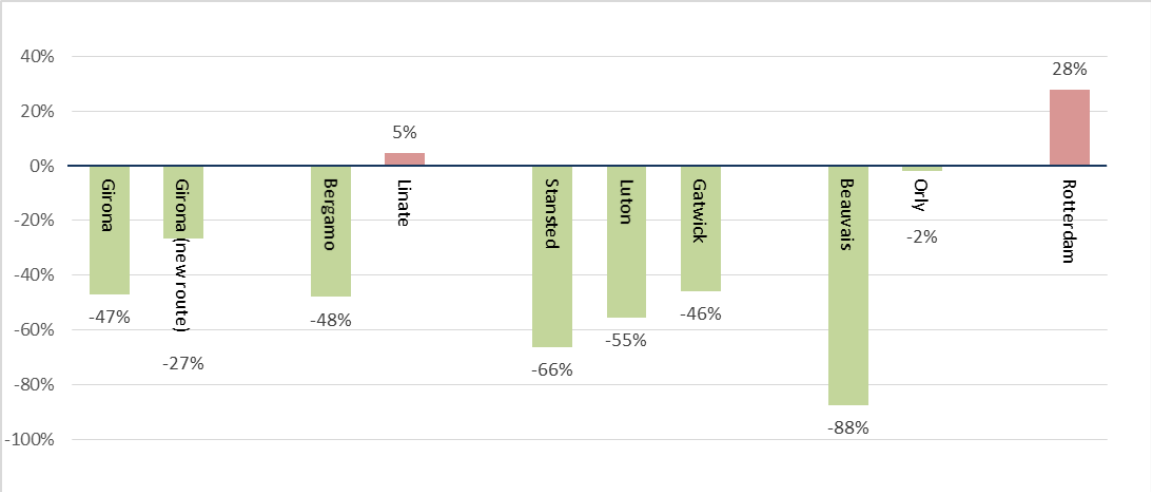


Figure 4.2 Difference in turnaround airport charges with respect to the primary airport in the airport system.
Source: Cranfield-Edinburgh Analysis.

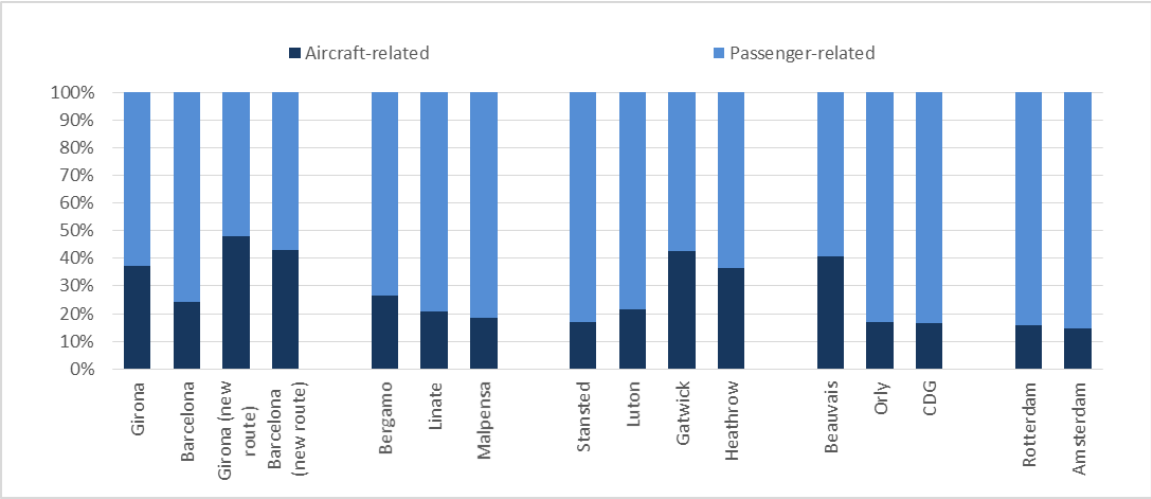


Figure 4.3 Composition of airport charges.

Source: Cranfield-Edinburgh Analysis.

5 Resilience and passenger relocation

5.1 Introduction

In this section, we simulate the closure of Barcelona Airport during 24 hours and measure its vulnerability from the perspective of the delays imposed on passengers. We then analyse the support that Girona Airport could provide as a surrogate airport to reduce passenger delays by serving as an alternative point for arrival of departure for the passenger stranded at Barcelona Airport.

5.2 Methodology

Our method assumes that all flights at Barcelona Airport are cancelled (for an unspecified reason) for a period of 24 hours. This period starts on the first Monday of June 2016 at 00:00 UTC. Secondly, a shortest-path-length passenger relocation algorithm simulates the airlines' process to find the fastest alternative itinerary for each disrupted passenger using the seat capacity available in its own remaining flights or the flights of partner airlines, all within a recovery window of 48 hours since the beginning of the disruption (Figure 5.1). In order to facilitate the relocation of stranded passengers, we also allow for ground transfers to nearby airports (e.g. Girona). After simulating this relocation process, the damage caused to the passenger (and hence the network vulnerability) is measured by the aggregated travel delays experienced by the passengers.[10]

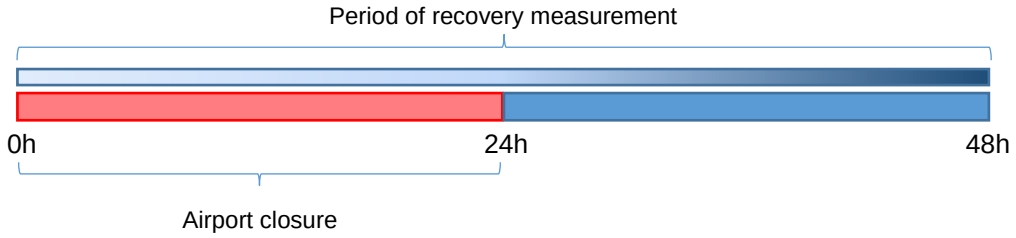


Figure 5.1 Airport closure and recovery periods scheme.

5.2.1 Measures and vulnerability indicators

The following indicators have been defined to measure the capacity of the airport to recover from a closure.

Indicators for all passengers:

- Dpax: Number of disrupted passengers that had to start or finish their trip, or connect, at the closed airport.

[10] The complexity of the method does not allow for a detailed explanation in this study. More information is available in Voltes-Dorta et al., 2017.

Indicators for the relocated passengers:

- Reloc: Number of relocated passengers at the end of the relocation window (48h).
- %reloc: Percentage of relocated passengers with respect to the total number of disrupted passengers.
- Ddel: Average departure delay for each relocated passenger (departure of their new flight or HST trip).
- Avt0: Average original travel time in the reference scenario.
- Avt1: Average travel time of the alternative itinerary provided by the airline to the relocated passengers.

Indicators for the passengers that could not be relocated:

- Non-reloc: Number of passengers that could not be relocated after the 48h window.

5.2.2 Scenarios

We define the following scenarios:

1. Closure of Barcelona Airport: airlines can only recover passengers within their alliance and in collaboration with other airlines with which they may have agreements. The HST is not considered an alternative travel option.
2. The same as the previous, but we consider the HST to Madrid as an alternative option. A HST load factor of 80% is considered.
3. The same as the previous, but we consider the new HST connection to Girona Airport as well an alternative option. A HST load factor of 80% and the Girona Airport flight schedules from 2008 are considered. We consider the 2008 schedule because this is when the airport was operating at its maximum.

5.3 Results

Table 5.1 presents the results of the closure simulation of Barcelona Airport for the first Monday of June 2016, which would affect 108,853 passengers. In scenario 1 (no HST) only 37.7% of the passengers would be relocated during the considered 48-hour window. This is an indication of the limitations of the surrogate airports (i.e. Girona and Reus) to support Barcelona Airport in a closure situation. As described above, Barcelona Airport has a high proportion of origin-destination traffic, a characteristic that increases the pressure on the airport, as passengers are stuck at the airport until it can be reopened. These are the principal reasons behind the high level of delays experienced by passengers.

Table 5.1 Results summary for the simulation of the closure and recovery of Barcelona Airport. Closure for the first Monday of June 2016.

Markets and scenarios		Disrupted passengers	Relocated passengers						Main alternative or surrogate airport/station		
Markets	**Scenario**	**dpax**	**reloc**	**% reloc**	**ddel (min)**	**avt0 (min)**	**avt1 (min)**	**Increase avt**	**alt**	**alt. pax.**	**% reloc**
All	(1) NO AVE	108,853	41,072	37.7%	1,016	185	773	317.9%	LHR	4,400	10.7%
All	(2) AVE 80%	108,853	48,788	44.8%	973	183	759	315.6%	MAD	8,922	18.3%
All	(3) AVE 80% + GRO 2008	108,853	52,764	48.5%	949	178	790	343.1%	MAD	7,085	13.4%

Source: Cranfield-Edinburgh Analysis.

Having said that, the number of relocated passengers increases if the HST is considered as an alternative method of travel. Considering a 20% of capacity available in the scheduled HST services between Barcelona and Madrid, the number of relocated passengers during the 48-hour window increases to 44.8% (scenario 2) and up to 45.5% if we add the possibility of reaching Girona Airport with the HST (scenario 3).

The detailed analysis of the delays for the passengers that can be relocated makes clear the limitations of Barcelona Airport to deal with critical situation. The average delay in the departure time of the relocated passengers is of 1,016 minutes, in other words, almost 17 hours. Moreover, we need to add the increase in the travel time, which is of 317.9%. These values are very far from the best performing European airports (Voltes-Dorta et al., 2017). Adding the support of Girona Airport and the HST (Scenario 3), improves the departure delay, but increases the travel times as the itinerary requires of a ground transport leg.

Table 5.2 Top-25 surrogates airports to Barcelona Airport for the AVE 80% + GRO 2008 scenario. Closure for the first Monday of June 2016.

Airport	Reference scenario before the relocation (passengers)	AVE 80% + GRO Scenario (passengers)	Passenger increase (passengers)
GRO	0	5,064	5,064
MAD	2,117	7,085	4,968
LHR	615	4,578	3,963
DUS	326	2,634	2,308
AMS	665	2,965	2,300
TXL	222	2,447	2,225
LGW	376	2,333	1,957
CDG	683	2,617	1,934
MUC	514	2,248	1,734
FRA	635	2,287	1,652
PMI	1,548	3,035	1,487
DUB	436	1,911	1,475
VIE	394	1,853	1,459
FCO	637	1,926	1,289
ZRH	350	1,418	1,068
ARN	252	1,238	986
CPH	155	1,069	914
IST	245	1,146	901
HEL	372	1,251	879
JFK	5	791	786
STN	178	959	781
IBZ	916	1,688	772
BRU	597	1,334	737

Source: Cranfield-Edinburgh Analysis.

Table 5.2 provides information on the top-25 airports and stations that provide support channelling disrupted passengers either as an alternative transit point or as a surrogate airport. The results show the importance of connecting the airports to the HST network. In

Scenario 3, Madrid Airport and Girona Airport are the most important alternative nodes. In this regard, in Figure 5.2, the detailed analysis of the departure delay distribution over timeFigure 5.2 Distribution of relocated passengers during the first 48 hours at Barcelona Airport. Scenarios 1 and 3. Closure of the first Monday of June 2016. (in colours) and the times of departure of the alternative flight (horizontal axis) reveals the importance of the HST connection in both airports. As the figure shows, the number of passengers relocated during the first 24 hours increases between scenario 1 and 3. Yet, the values are small, and without airline collaboration, it is very limited what the almost exclusively Ryanair flights at Girona Airport could do to relocate more passengers from other airlines at Barcelona Airport.

We can conclude this section by saying that, although the Barcelona Airport surrogate airports, including Girona, do not sufficiently support the airport in case of closure, the analysis has revealed the importance having healthy traffic numbers at Girona Airport and the significance of HST to relocate passengers. Indeed, the results indicate that inter-modality between airports and HST would need to be improved, as well as points towards the idea of establishing emergency protocols to ensure the quick availability of the HST option and additional capacity.

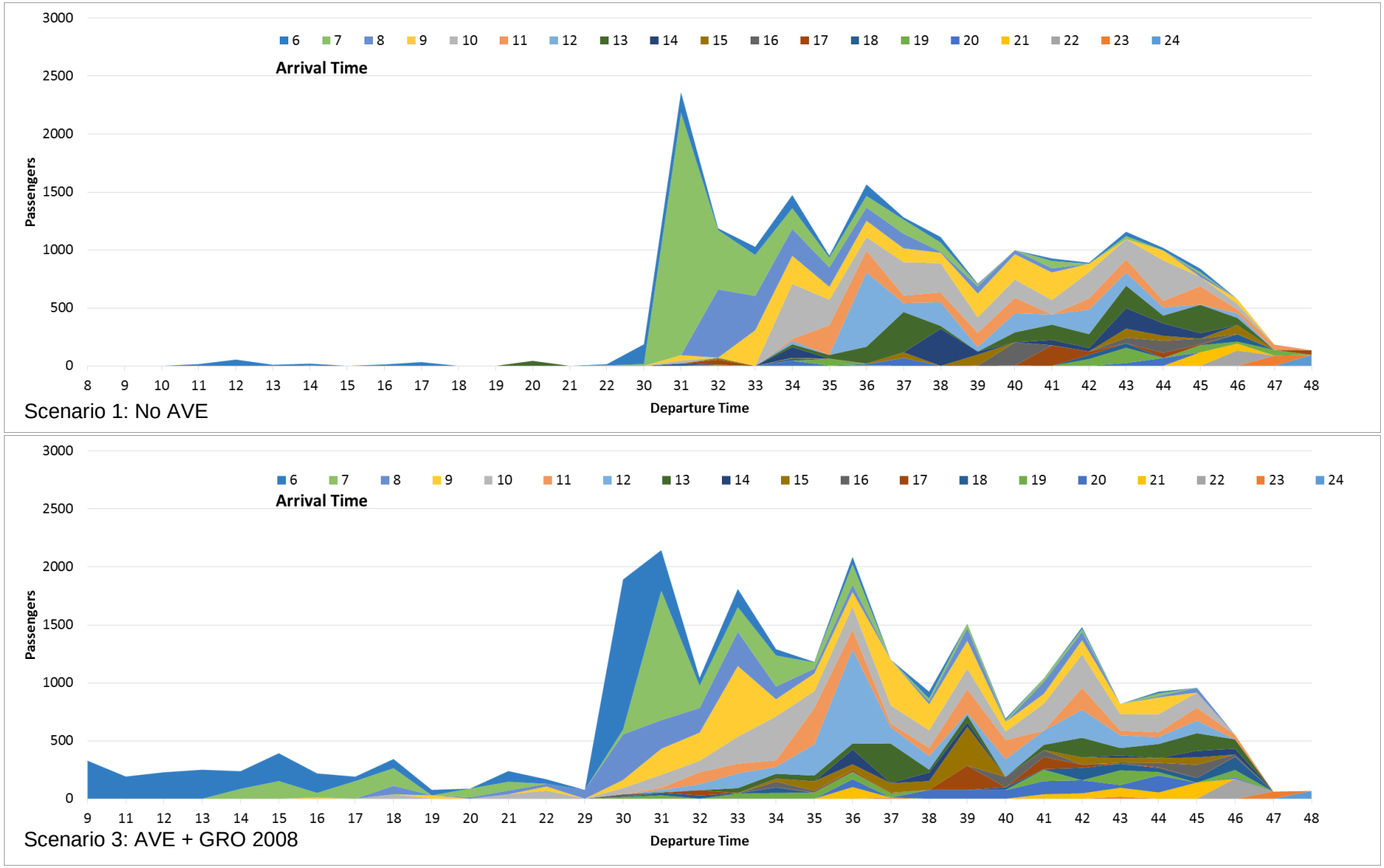


Figure 5.2 Distribution of relocated passengers during the first 48 hours at Barcelona Airport. Scenarios 1 and 3. Closure of the first Monday of June 2016. Source: Cranfield-Edinburgh Analysis.

6 Summary and strategic recommendations

6.1 Summary of the air traffic and connectivity analysis results

This study has provided an exploratory overview of the medium- and long-term strategic policy directions required to enhance the contribution of Girona Airport to the Catalan Airport System.

The traffic and connectivity analysis has provided the market context to understand the air transport supply and demand aspects of the Catalan Airport System.
We can conclude that the traffic characteristics of the Catalan Airport System are:

- In Catalonia, the air traffic market is dominated by origin-destination passengers. In other words, 93% of the total number of passengers start or finish their trip in Catalonia. Only 7% of the passengers are connecting passengers that use Barcelona Airport as a transfer point.
- The main origin and destination markets are in Europe. This is not only valid for the regional airports, but also for Barcelona Airport, in which almost 85% of the departing passengers have Europe as their destination.
- The supply dynamics has significantly changed since 2009. The new period is characterised by a higher level of seasonality in all airports of the system and by Ryanair's change of behaviour and focus in larger airports.
- The Catalan Airport System seems to be a massive low-cost market. Particularly, in Girona Airport supply is dominated by LCCs; and in Barcelona Airport the LCC seat supply is between 64% and 68%.
- Regarding airport capacity, according to DORA's data, Barcelona Airport is approaching full capacity. Moreover, considering the high year-on-year increases of 2016-2015, 2015-2014, and 2014-2013 (11.2%, 5.7% and 6.7% respectively), the DORA forecast for 2021 seems to fall short and passenger numbers could be higher. Considering the large time scales required for large airport capacity expansions, it is quite likely that Barcelona Airport will face capacity limitations in the coming years. On the other hand, Girona Airport still has considerable spare capacity.

Additionally to the points above and focusing on Girona Airport, we have observed the following air traffic characteristics:

- The drop of Ryanair traffic numbers between 2010 and 2011 was related to a change in the business model of the airline.
- The current supply of Ryanair at Girona and Barcelona Airports targets different markets. Most of the top destinations from Barcelona are primary airports, whilst the destinations from Girona tend to be secondary or regional airports. The airline also offers higher average frequencies and more destinations in Barcelona.
- The HHI confirms that Ryanair enjoys a monopoly position in most of the routes served from Girona, whilst in most of the routes served from Barcelona the airline faces significant levels of competition.

- A basic assessment of offered fare data suggests, on the one hand, that limited route competition could push prices up in Girona Airport. On the other hand, the duration of the stay and the final destination (Costa Brava and Girona region vs Barcelona) could have a major influence on the offered price, since passengers would tend to choose the closest airport to their final destination. Nevertheless, this assessment needs to be taken with caution given the limited data available on prices.
- Previous studies (EMMA, 2005 and Insetur, 2010), show that Barcelona is the main final destination and the Girona and Costa Brava areas are the second main destinations of the passengers arriving at Girona Airport.

6.2 Conditions to increase the contribution of Girona Airport to the Catalan Airport System and resilience benefits

The initial air traffic and connectivity analysis pictures Catalonia as a large LCC market dominated by short-haul origin-destination traffic. In a context of limited capacity of at Barcelona Airport and knowing that the primary final destination of Girona Airport passengers is Barcelona, Girona Airport has the opportunity to increase its contribution to the Catalan Airport System regarding the origin-destination traffic.

In this regard, we consider that the conditions required to increase the contribution of Girona Airport to the Catalan Airport System are the following:

1. Capacity constraints in Barcelona Airport, which would generate a traffic spill. As mentioned above, it is quite likely that Barcelona Airport will face capacity limitations in the coming years.
2. Improvement of accessibility, which has long been established as one of the crucial drivers for airport passenger choice.
3. Improvement of the airport charges scheme, which can facilitate attracting airlines. Also, in a context of limited capacity in the main airport of the system, a higher airport charges differential between the primary and secondary airports would facilitate the spill dynamics.

Moreover, our analysis has looked into the impact of improving accessibility, the limitations of the current airport charges scheme and the contribution that Girona Airport could potentially do from a network resilience point of view.

The accessibility and catchment area analysis shows that:

- By adding the HST connection, the population in the 60 minutes catchment area doubles from 2.5 million to over 5.1 million. It also allows Girona Airport and the airlines operating in it to tap into the Barcelona city and Barcelona metropolitan markets, becoming a realistic and convenient travel option for the main Catalan market (i.e. Barcelona).
- The potential increase of supply and services by airlines at Girona Airport, associated to the convenient access to the Barcelona market, can also be considered a direct benefit to the population of the Girona region, since the airport could potentially have

a level of supply and service that otherwise could not be sustained just with the demand generated locally.

- In addition, the overlap between the Barcelona and Girona Airports catchment area increases significantly from 1.6 million to 4.3 million for the 60 minutes catchment area. This is indeed a very positive improvement as more population can benefit from a choosing between the two airports and their route networks.

The airport charges analysis the following aspects can be highlighted:

- Barcelona and Girona Airports have, overall, a high proportion of aircraft-related charges than passenger-related charges. However, Airlines' decisions would generally favour airports with a high proportion of passenger-related charges, since these are linked to traffic volume, rather than the operation.
- Girona Airport has a higher proportion of aircraft-related charges than Barcelona Airport. This is due to a very low difference in the unit rates for landing and aerodrome charges between the two airports, which can be explained by Girona Airport having slightly higher costs per passenger than Barcelona Airport.
- The differential of the turnaround costs between Girona and Barcelona airports (47%) is lower than in other European airport systems. When considering the new routes incentive, the airport charges differential decreases only to 21%.
- Incentives for new routes provide an advantage to Barcelona Airport. The same incentive for new routes is offered across the network of Aena's airports; then, since the discount is offered on the passenger charge, airports moving larger volumes of passengers benefit the most.

Our analysis has also shown the benefits of a higher integration of the Catalan Airport System from the perspective of network resilience and passenger recovery:

- In case of the closure of Barcelona Airport, the surrogate airports provide very limited support to the airport. This is partly due to the limited network overlap between the airports' networks.
- The rate of passenger recovery could increase from 38% to 49% if Girona Airport would be operating as in 2008 (better airport network overlap) and if HST would be available in both airports. Girona Airport would be the second most important surrogate network node, just after Madrid Airport.

6.3 Strategic recommendations

Considering the results of the analysis carried out in this study that are summarised above, the following strategic direction are recommended to improve the contribution of Girona Airport to the Catalan Airport System:

1. Improve the intermodal accessibility of Girona Airport with the addition of a HST station in the airport. The specific details of level of service and who has to deliver it is a matter outside of the scope of this study. However, we have shown that the addition of a HST station at Girona Airport could significantly improve the catchment area of the airport, allowing airlines to easily access the Barcelona market, bringing benefits to passengers in terms of airport choice, and contributing to the overall

network resilience of the Catalan Airport System. The potential increase of supply and services by airlines at Girona Airport, associated to the convenient access to the Barcelona market, can also be considered a direct benefit to the population of the Girona region, since the airport could potentially have a level of supply and service that otherwise could not be sustained just with the demand generated locally.

2. Redesign the airport charges scheme and incentives for new routes, ensuring that: (a) there is a larger differential in airport charges between Barcelona and Girona Airports, and (b) setting discount schemes that do not penalise small airports.
3. Improve marketing campaigns in the Barcelona market. Whilst different stakeholders have focused in the past in providing marketing support to airlines and promoting Girona Airport in the foreign markets, a higher commercial focus in the main destination market (i.e. Barcelona) would be recommended. The advent of the HST station in the airport and a possible service between Barcelona city and the Girona Airport brings an opportunity to promote Girona Airport as a realistic option for the Barcelona metropolitan population.
4. Implement a management model that promotes airport competition. Although the analysis of the management model is outside of the scope of this study, the airport charges analysis demonstrates that the current airport management structure does not facilitate competition between airports. Limited competition in airport systems presents disadvantages to all parties, but mostly to passengers and consumers, which have to face higher prices and have less choice. Regardless of the actual ownership structure, a model allowing airport competition would produce the right environment for each airport to design their own promotion and commercial strategy and focus in the right passenger segment.

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