

VOLUME III | Issue 4 | 2015 | CIEO

Guest-Editors: Cláudia Ribeiro de Almeida and Vânia Costa
Editor-in-Chief: Patrícia Pinto

Journal of Spatial and Organizational Dynamics

Air Transport

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TECHNICAL INFORMATION

Volume III, Issue 4, 2015

JOURNAL OF SPATIAL AND ORGANIZATIONAL DYNAMICS

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Authors:

Ana Ramón
Andrés Pedreño
Cláudia Almeida
David Ramos-Pérez
João Pedro Fernandes Jardim
Jorge Miguel dos Reis Silva
José Ignacio Izquierdo-Misiego
Luis Moreno
Margarida Maria Fidalgo Costa Vaz
Maria Emília da Silva Baltazar
Vânia Costa

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Publisher:

Research Centre for Spatial and Organizational Dynamics - CIEO
Campus de Gambelas, Faculdade de Economia, Edifício 9
8005-139, Faro
cieo@ualg.pt
www.cieo.pt

Editorial Board:

Teresa de Noronha, Faculty of Economics, University of Algarve, Portugal (mtvaz@ualg.pt)
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Eric Vaz, Department of Geography, Ryerson University, Canada (evaz@GEOGRAPHY.Ryerson.Ca)
Helen Lawton Smith, Department of Management - Birkbeck, University of London, U.K (helen.lawtonsmith@ouce.ox.ac.uk)
Jafar Jafari, School of Hospitality Leadership, University of Wisconsin-Stout, USA (jafari@uwstout.edu)
Purificación Galindo, Department of Statistics, University of Salamanca, Spain (purivic@yahoo.com)
Rafael Alberto Peres, Universidad Complutense de Madrid, Spain (estrategia@rafaelalbertoperez.com)
Saul Neves de Jesus, Faculty of Human and Social Sciences, University of Algarve, Portugal (snjesus@ualg.pt)
Thomas Panagopoulos, Faculty of Sciences and Technology, University of Algarve, Portugal (tpanago@ualg.pt)

Open Access Policy:

This is a blind peer-reviewed journal.

Articles submitted to this journal should not have been published before in their current or substantially similar form.

The JSOD is diffused by all links related to the Research Center for Spatial and Organizational Dynamics and is continually online (http://www.cieo.pt/discussion_papers_editions.php)

This journal is supported by the Portuguese Foundation for Science and Technology (FCT).

Indexation:

RePec-Ideas
Directory of Open Access Journals
Emerging Sources Citation Index (ESCI) - Thomson Reuters

Networking and Indexing:

Silvia Fernandes

Page Layout:

Marlene Fernandes

Design and Cover Concept:

Bloco D, Design e Comunicação

Quarterly Edition
ISSN: 2183-1912
CIEO, Faro, Portugal

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LOW-COST CARRIERS, LOCAL ECONOMY AND TOURISM DEVELOPMENT AT FOUR PORTUGUESE AIRPORTS. A MODEL OF COST–BENEFIT ANALYSIS

Vânia Costa
Cláudia Almeida

ABSTRACT

The liberalisation of air transport created a new era in the sector. The entry of low-cost carriers triggered dynamism and consequently changed the behaviours of the demand and supply of air transport services. The volume of traffic at Portuguese airports increased from 17 million passengers in 2002 to more than 30 million in 2012, representing cumulative growth of 75%. The commitment to low-cost carriers (LCCs) was a determining factor for this growth in that, in 2012, these carriers recorded a market share of 33%. This study aims to analyse the evolution of LCC air traffic in Portugal and its impact on regional economic development. Through a model of cost–benefit analysis, we determine the costs, benefits and net welfare in the development of the region driven by the LCC routes of 4 Portuguese airports, Faro, Lisbon, Funchal and Porto, between 2005 and 2012. The methodology proves the existence of a positive net impact driven by LCCs on the local economy, directly through job creation and increased consumption in the tourism sector and indirectly by the increased demand from other sectors.

Keywords: Air Transport, Airport, Cost–Benefit Analysis, Low-Cost Carrier, Regional Development, Economic Impact

JEL Classification: L91, L93, D61, R11, F63

1. INTRODUCTION

The air transport industry boosts economic and social progress and increases the connection between people, countries, cultures and markets as well as developed and developing countries. The exponential growth of this sector required new regulation, which was implemented in 1987 and resulted in the liberalisation of European airspace. This process lasted for a decade and began a new era of air transport services, with a new transportation infrastructure based on a competitive market mechanism whereby decisions result from the mutual interaction between supply and demand. Airlines emerged that offered shuttle services at reduced rates, known as low-cost carriers (LCCs). These airlines introduced a new management model based on a higher level of operational efficiency combined with low fares (Donzelli, 2010). In addition to low fares, LCCs are typically characterised by short- and medium-term point-to-point traffic with a minimum service offer (Wittmer and Bieger, 2011). According to Han (2013), passengers readily accept the offer of a minimum service in exchange for lower prices (Francis *et al.*, 2004; Mikulic and Prebeac, 2011; Ryan and Birks, 2005; Zhang *et al.*, 2008).¹ Han (2013) asserts that in this business model, the practice of low-cost management

¹ Authors cited in Han (2013).

combines various measures, including the kind of aeroplane used, high utilisation of crews, sales made directly to the customer and the exclusion of additional services, such as food and drink.

The market share of these airlines has doubled over the last decade, reaching around 26% of the total seats offered on the world market in 2012 (OAG Aviation, 2012). In Portugal, these airlines have gained a 33% market share and have contributed greatly to the growth in the volume of traffic at Portuguese airports, which have experienced average annual growth of 6% over the last decade (ANA, 2013).

This study aims to analyse the effect of LCC air traffic on Portuguese airports. To compare the LCCs' effect on the Portuguese airport infrastructure, we analysed the evolution of LCC air traffic at all the airports where these airlines are present – in particular the airports of Faro, Lisbon, Funchal and Oporto – and LCCs' impact on regional economic development. Through a model of cost–benefit analysis (CBA), we sought to determine the cost, benefit and net impact of low-cost routes on the development of the areas surrounding these Portuguese airports from 2005 to 2012.

The structure of this article is as follows. After the introduction, Section Two focuses on the relationship between air transport and economic development. Section Three concentrates on the Portuguese airport system. Section Four details the methodology applied in the case study. Section Five presents and analyses the results of the cost–benefit analysis of low-cost carriers operating at the Faro, Lisbon, Funchal and Oporto airports, and, finally, Section Six contains the general conclusions of this study.

2. THE IMPACT OF AIR TRANSPORT ON LOCAL ECONOMIES

Over the past 50 years, air transport has played a pivotal role in economic development, with a resulting strong increase in demand. From 1970 to 2012, the total number of passengers carried by airline companies all over the world multiplied more than 10 times, from 310 million to 2.9 billion passengers (IATA, 2012; ICAO, 2013). This sector employs 32 million people worldwide and contributes greatly to the world's wealth, with an estimated total impact of US\$3.56 trillion, which corresponds to about 7.5% of the world gross domestic product (GDP) (ATAG, 2008). Within the European context, approximately 744 million passengers were transported in 2011 (Eurostat, 2011), and, taking into consideration the total number of jobs generated (direct, indirect and induced), there are about 5.1 million jobs in this sector. These jobs contribute more than US\$485 billion to the European GDP (ATAG, 2012).

In Portugal, air transport generates a number of economic benefits, in 2009 contributing approximately €2.3 billion, which corresponds to 1.4% of the Portuguese GDP (Oxford Economics, 2011). In addition, an effect of €3.3 billion is estimated in the tourism sector and the air transport sector employs about 59,000 workers in Portugal, 24,000 of which are direct jobs, 20,000 indirect jobs and 15,000 are jobs arising from the expenditures of workers in the air transport sector. On average, the annual salary of the workers in this sector is around €72,000, which, according to the study cited above, corresponds to an average increase in all the earnings in Portugal. In a catalytic effect, about 124,000 jobs have emerged in the tourism sector. The total contribution in taxes, aviation fees and other support sectors is around €264 million. In addition to its contribution to the GDP, employment and tax revenues, by creating multiple connections between cities and markets, air transport increases foreign investment and, therefore, Portugal's productivity.

Despite the economic crisis experienced in recent years, the Portuguese air traffic market has shown a strong capacity for recovery. From 2005 to 2012, the number of

passengers carried grew by about 50% and, according to ANA (2013), the development in the international segment contributed fundamentally to this growth, as it recorded average annual growth exceeding 6%. In 2012, 30.5 million passengers and 137,000 tons of cargo were transported in a total of 280,000 aircraft movements. In the same year, Portuguese airports received 12.6 million passengers on international flights, mainly from the UK, France, Spain, Germany and Brazil (64% being international passengers), of whom about 37% travelled using LCC flights (Turismo de Portugal, 2013). These air links represent the connectivity between Portuguese cities and major towns and markets around the world, reflecting the economic importance of these destinations. Over time, air links have grown in both frequency and destinations, reducing the waiting time and improving the service quality (Oxford Economics, 2011). By the end of 2012, Portuguese airports regularly offered flights to around 140 cities along 161 different routes (ANA, 2013). This improved connectivity has been accompanied by a reduced cost of air transportation, a decrease of about 1% in real terms over the past 40 years, contributing to the growth and competitiveness of the sector compared with other means of transport (Oxford Economics, 2011). In addition to the benefits for passengers, the study cited argues that the greatest economic benefit of the increased links between countries and regions appears in their impact on the long-term performance of the economy as a whole, by increasing the overall level of productivity and generating greater access to foreign markets and freer movement of investment in capital and workers. This study describes some research studies (Oxford Economics Forecasting, 2005 and 2006) that conclude that a 10% increase in connectivity associated with the GDP generates a long-term impact of about 0.5% at the level of economic productivity.

The exponential growth of this sector has generated the need to adjust its structure to cope better with this higher demand. Thus, a process of airspace liberalisation has begun, which has resulted in the adaptation of a free-market mechanism, whereby decisions result from the mutual interaction between supply and demand. This process of deregulation has offered new opportunities to airlines, increased competition and allowed the entry of new airlines into the sector, using a business model based on low cost (Graham, 2013). The new low-cost airlines have primarily fuelled substantial changes in the spatial distribution of short-distance air transport networks and in the servicing of airport infrastructures.

In particular, airports have been affected because LCCs present a business model of demand for services that are different from those usually offered by traditional airlines (Hanaoka and Saraswati, 2011). According to the authors cited, several airports have built low-cost terminals to meet LCCs' specific requests, including the reduction of cost and time. Because of these investments, many of these airports have registered dramatic growth rates in their passenger traffic (Graham, 2013). According to Abrantes (2010), LCCs boosted their provision of services primarily in three market segments: i) clients with greater price sensitivity, ii) clients with leisure motivations and iii) business customers with flexible schedules and frequency of travel. An estimated 59% of LCC traffic carries new passengers (ELFAA, 2004). Thus, LCCs have provided a new segment of demand by creating their own market. According to OAG Aviation (2012), the supply of these airlines in 2012 was twice their 2003 share, with about 25% of the total seats offered worldwide. In Europe, in 2011, 40 LCC airlines operated on 3,173 destination routes with 29,330 workers² – accounting for a 35% share of the LCC seats worldwide – reflecting average annual growth of 4.2% in the last decade.

This enlargement of the LCC network has been beneficial to various regions, especially to the most disadvantaged areas, such as southwest Europe. According to the findings of an ELFAA (2004) study, the effects of European LCCs on tourism, regional development and

² According to data from LCC airline websites.

other sectors are clearly positive. These airlines have changed travel and leisure habits and, according to this study, can play a key role in stimulating business transport.

Over the past few years, several studies aiming to evaluate and quantify the effects of airports and the airport system on economies have appeared in the literature. These studies have sought to examine, in particular, the role of low-cost airlines (see Table 1). Overall, the findings of these studies have revealed a positive effect, in particular through creating a new demand, increasing the income tax revenue and developing activity sectors that are related, directly and indirectly, to air transport, resulting in a leverage effect on regional economic development.

According to most of the literature, the emergence of LCCs has resulted in the growth of several sectors of activity in various regions, contributing positively to the economic and social development of the regions influenced by airports, especially in the tourism sector.

Table 1. Impact of LCCs on regional economies

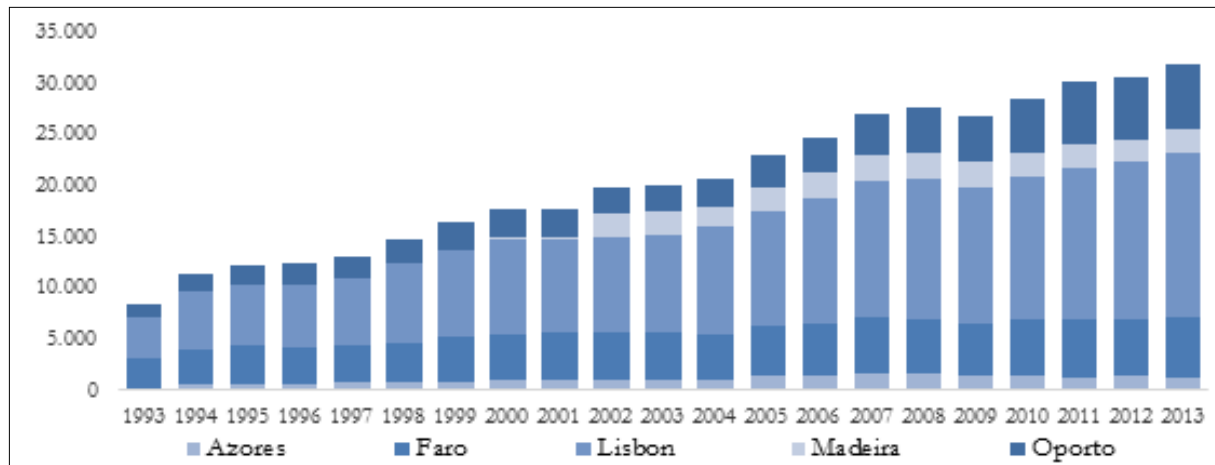
Study	Country, airport	Impact of LCCs
Macário <i>et al.</i> (2007)	France, Carcassonne Airport	- generated new demand of about 230,000 passengers (2003); - total increase in revenue of €584 million (direct effect: €8.4 million; indirect: €253 million; and induced income: €272.4 million).
	Italy, Pisa Airport	- creation of new demand of 316,000 passengers (in 2003); - average spending per business passenger landed: €431.40; - average spending per tourism and leisure passenger landed: €496.52; - total economic impact of €149.2 million on the regional economy.
	Germany, Cologne Bonn Airport	- paid total taxes of €91 million (2004); - cost and productivity advantage for businesses in the region: €147.6 million; - average spending per passenger disembarking: €285.42.
Huderek (2008)	Poland, Gdańsk Airport	64.4% of total airport traffic: 1.589 million passengers were transported by LCCs; - passengers stayed, on average, for 4.6 days per visit; - average daily spending per passenger landed: €82; - indirect impact on the local revenue of €114 million.
	Poland, Wrocław Airport	59.1% of total airport traffic: 1.137 million passengers were transported by LCCs; - passengers disembarking remained in the region, on average, for 3.7 days; - average daily spending in the region: €109; - total stimulus in the regional economy of €95 million.
	Poland, Katowice Airport	81.9% of total airport traffic: 1.529 million passengers were transported by LCCs; - passengers disembarking remained, on average, in the region for 2.6 days; - average daily spending in the region: €140; - total stimulus in the regional economy of €123 million.
Donzelli (2010)	Italy, Campino Airport, Bergamo Treviso Airport, Algher Airport, Brindisi and Lamezia Terme Airport	- LCC airlines reduced the rates for seasonal air traffic; - concluded an average net impact of €88 per passenger generated by each LCC in Italy.

Source: Macário *et al.* (2007), Huderek (2008) and Donzelli (2010)

3. THE EVIDENCE FROM THE CASE OF PORTUGAL

Portugal has a peripheral geographical position in Europe. This position means that, within air transport, the country has emerged as a region at the confluence of several international routes and with large-scale entry and exit for the main European markets and for other continents. The Portuguese airport system consists of 5 main airports, located in Lisbon, Oporto, Faro, Funchal and Ponta Delgada, which, in 2013, recorded a total volume of traffic of more than 31 million passengers (see Figure 1).

Figure 1. Evolution of passenger traffic in Portugal from 1993 to 2012 (in thousands)



Source: Eurostat (2012), ANA (2013), ANA (2014a), ANA (2014b), ANA (2014c), ANAM (2013) and ANAM (2014)

Lisbon Airport is located in Lisbon and, in 2013, represented about 50.4% of the total air traffic in Portugal, with over 16 million passengers. Oporto Airport, located in Oporto and the north, received about 20% (6.4 million passengers), while Faro Airport, located in the Algarve's capital, received about 19% (5.9 million passengers). Funchal Airport, located in the archipelago of Madeira, recorded 2.4 million passengers, which represented about 7.5% of the national traffic. The airport of Ponta Delgada, in the city of that name on the Azores island of São Miguel, carried about 1 million passengers, representing about 3% of the total traffic.

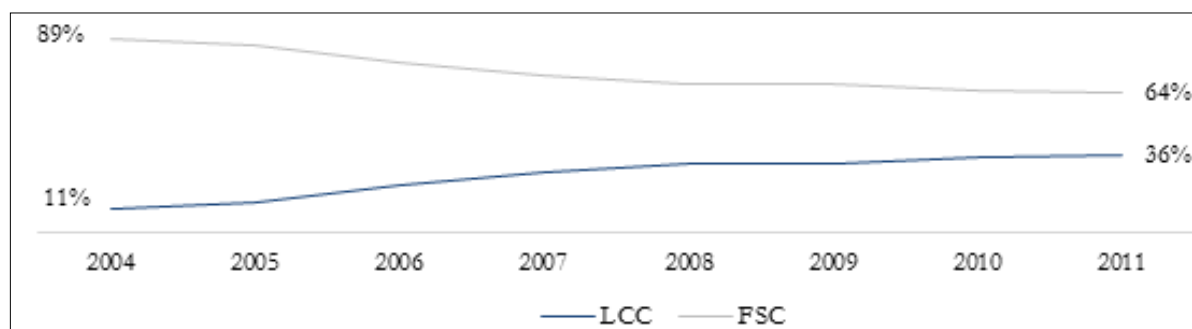
These 5 airports reveal large differences in the passenger volume of traffic. Upon analysis, we determined a Gini index of concentration³ between the traffic at these airports of 0.6546 in 2000 and a slightly lower one in 2012 of 0.6112, which allowed us to prove the existence of relative inequality between the traffic volumes of the 5 airports under study. Low-cost airlines began operating in Portugal in 1995, with the non-regular business operators Air Berlin and Ryanair; however, the process of liberalisation in the air transport sector did not occur simultaneously throughout Portugal (INAC, 2012). Initially, low-cost airlines began operating from the Algarve airport, then Lisbon Airport, most recently Oporto and, finally, Funchal.⁴ According to the study cited above, the initial strategy of these airlines was to gain a market share of the routes already serviced by regular and charter airlines. From 2003 to 2012, these airlines captured a significant portion of passengers, about 25% of the regular market and 33% of the non-regular segment. In the regular segment, according to this study, the routes that stand out are operated by Ryanair from the Faro Airport and Funchal Airport to the United Kingdom and from Oporto Airport to the Spanish market and to Madeira. A milestone in the growth of LCCs in Portugal was passed in 2003, when they doubled

³ The Gini index is a method for measuring concentration ranging from 0 to 1, according to which the higher the value, the higher the level of concentration of the observed values.

⁴ The airport of Ponta Delgada, in the Azores, was not included as a case study since this airport's traffic has not been deregulated.

the number of passengers carried. Subsequently, these airlines gained representation within each airport's infrastructure, and their market share has continued to increase, practically doubling from 2004 to 2011. In 2011, 20 LCC companies operated throughout the country, which together carried about 36% of passengers and represented 23% of the total trade movements (see Figure 2).

Figure 2. Evolution of market share of regular passengers



Source: INAC (2012)

According to the INAC (2012), Faro Airport recorded a large market share of LCCs. In 2011, 13 airlines accounted for approximately 83% of all the aircraft movements recorded at the airport, having transported 87% of the passengers who travelled in the regular segment, of which 72% were disembarking (see Table 2). Oporto Airport is the second-largest airport with LCC representation. In 2011, 4 LCC airlines performed 20,000 movements at this airport, which corresponded to 33% of the total movements, and carried about 50% of the passengers in the regular traffic. At Funchal Airport, 6 LCC airlines accounted for 25% of the total movements and transported 37% of the regular passenger segment and around 15% of the total passengers who disembarked. At Lisbon Airport, 8 LCC companies operated in 2011, carrying out 2 million movements and transporting about 14% of the regular passenger segment.

Table 2. Passenger arrivals and total LCC by airport

	Total disembarking		Passengers disembarking at LCC			
	2005	2011	2005	LCC %	2011	LCC %
Faro	2,317,593	2,775,373	1,117,589	48%	2,010,247	72%
Lisbon	5,511,918	7,383,666	303,483	6%	1,017,268	14%
Funchal	1,223,301	1,192,545	0	0%	181,945	15%
Oporto	1,504,663	2,963,476	162,771	11%	1,613,675	54%
Portugal	10,986,411	14,763,865	1,583,843	11%	4,823,135	33%

Source: Adapted from INAC (2012)

In Oporto Airport and Faro Airport, Ryanair has emerged as a prominent carrier among the LCCs and, in 2011, it held, for each airport respectively, approximately a 39% and a 31% market share of the regular segment of these airport infrastructures. At Funchal Airport, easyJet accounted for approximately 20% of this segment and, at Lisbon Airport, which has a lower presence of these airlines, easyJet is among the most important, with a 9% share of the market. Concerning the routes with the most passengers in the same year, Madrid stands

out for Oporto Airport, Barcelona for Lisbon Airport, Madrid for Faro Airport and Lisbon for Funchal Airport.

Table 3. Top routes and airlines by airports and LCC

	Passengers disembarking at LCC			
	2005	LCC%	2011	LCC%
Faro	London – Stansted (Ryanair)	100%	Madrid – Barajas (Ryanair)	58%
	Palma – S.S. Joan (Air Berlin)	95%	Beauvais – Tille (Ryanair)	100%
	Frankfurt (Ryanair)	100%	Barcelona (Ryanair)	77%
Lisbon	Brussels (Virgin Express)	41%	Barcelona (Vueling: 34% and EasyJet: 15%)	48%
	Palma – S.S. Joan (Air Berlin: 86% and Niki: 11%)	97%	Madrid – Barajas (EasyJet)	20%
	Colonia – Koln (Germanwings)	100%	Funchal (EasyJet)	25%
Funchal	Nuremberg (Air Berlin)	93%	Lisboa (EasyJet)	25%
	Munich (Condor)	42%	London – Gatwick (EasyJet)	53%
	Hamburg (Condor)	98%	London – Stansted (EasyJet)	100%
Oporto	London – Stansted (Ryanair)	100%	Madrid – Barajas (Ryanair)	58%
	Palma – S.S. Joan (Air Berlin)	95%	Beauvais – Tille (Ryanair)	100%
	Frankfurt (Ryanair)	100%	Barcelona (Ryanair)	77%

Source: INAC (2012)

According to Oxford Economics (2011), at least one-third of tourists arrive in Portugal by air. Thus, the growth of the tourism sector has accompanied the dynamic expansion of low-cost air travel in Portugal. Over the past five years, the income from tourism has shown a positive growth tendency, indicating a recovery of the revenues lost in previous years (INE, 2012). The revenues from tourism increased in 2011, by about 7.2%, and the expenses only increased slightly, by 0.7%. Therefore, according to this study, the Portuguese tourism income shows a positive growth trend and attained a balance of €2.974 million in 2011, slightly higher than the balance for 2010 (€2.953 million). According to the same study, the main markets, as in previous years, were the United Kingdom (18%), France (17.8%), Spain (13.8%) and Germany (10%). However, some countries recorded even greater increases in tourism revenue, such as Poland (+24.1%), the USA (+21%) and the Czech Republic (+19.9%). Tourism revenues are usually derived primarily from leisure travel, which contributed €15 billion to the global GDP in 2011. In the same year, the investment volume in the sector was approximately €3.6 billion, corresponding to 11.5% of the total investment in Portugal. From 2006 to 2010, the number of passengers disembarking from LCCs nearly doubled, resulting in an increase in foreign guests and in a direct contribution of the tourism sector to employment and the Portuguese GDP of 3.5% and 11.5%, respectively (see Table 4).

Table 4. Evolution of indicators of transport and tourism in Portugal from 2006 to 2010

	2006	2010	Δ %
Foreign guests (million)	6.5	6.9	6.2%
Total disembarking passengers (millions)	11.9	13.9	16.8%
LCC disembarking passengers (million)	2.4	4.7	95.8%
Share of LCC (disembarking) (%)	20%	34%	14pp
Direct contribution of travel and tourism to GDP (€ billion)	7.8	8.7	11.5%
Total contribution of travel and tourism to GDP (€ billion)	20.8	23.9	14.9%
Direct contribution of travel and tourism employment (thousands)	316.8	328	3.5%
Total contribution of travel and tourism employment (thousands)	792.2	841.3	6.2%

Source: MEID (2011) and WTTC (2011)

4. METHODOLOGY

To evaluate the investments from a socioeconomic point of view, thereby assessing the net economic impact of the project, we applied the cost–benefit analysis methodology (CBA). This analysis evaluates the economic or social effects of a particular investment, allowing an assessment of the viability of public or private investment projects from the perspective of the social welfare of a country or region through the sum of the monetary values of the costs and benefits to society. The methodology applied in this study is the same as the methodology applied by Costa (2014), with a similar aim. According to Macário *et al.* (2007), the assessment of the impact on a regional economy can be subdivided into three effects: direct, indirect and induced. Direct effects are caused by the employment and income that are generated directly by the construction and operation of an airport. The indirect impact is caused by the employment and income that derive from the suppliers of goods and the service chain. The induced impact is the employment and income generated by the spending of income from direct and indirect employment. This impact is induced by the direct and indirect effects derived from the multiplier effect of the direct and indirect impacts. To quantify these three effects on the economy – as driven by LCCs operating from the airports of Faro, Lisbon, Funchal and Oporto – two perspectives were considered: supply and demand. To calculate the benefit of added employment, we quantified the direct, indirect and induced employment generated by an increase in LCC traffic at the airports of Faro, Lisbon, Funchal and Oporto. In accordance with Costa (2014), to quantify the tourism revenue, we assessed the expenses of tourists disembarking from LCCs during their stay according to the following functions:

$$NT = PD_{LCC} \times \% NT_{LCC} \quad (1)$$

$$D = NT \times TE_{LCC} \quad (2)$$

$$I = \gamma D \quad (3)$$

$$N = \alpha(D + \gamma D) \quad (4)$$

$$E = D + I + N \quad (5)$$

$$E = D + \gamma D + \alpha(D + \gamma D) \quad (6)$$

$$E = (1 + \gamma + \alpha + \alpha\gamma)D \quad (7)$$

assuming the term $(1 + \gamma + \alpha + \alpha\gamma)$ as:

$$E = \beta D \quad (8)$$

$$R = E \times W \quad (9)$$

with NT denoting the new air traffic, PD_{LCC} being the passengers landed by LCCs and $\%NT_{LCC}$ being the percentage of new traffic generated by LCCs. TE_{LCC} represents the rate of employment by LCC operators. D is the direct effect on employment, I the indirect effect, N the induced effect and E the total effect on employment. γ is the multiplier direct effect on employment and α the multiplier induced effect on employment. R denotes the income earned by the employment generated. β is the multiplier of the liberalisation of air transport, and W is the average annual wage.

Following the same study, to determine the increase in turnover in the tourism sector, we evaluated the amount spent by LCC tourists who landed and stayed according to the following functions:

$$T = PD_{LCC} \times \%T_{LCC} \quad (10)$$

$$TUR = g \times n \times T \quad (11)$$

$$B = R + TUR \quad (12)$$

with T representing the total number of tourists landed by LCCs and $\%T_{LCC}$ the percentage of new traffic generated by LCCs motivated by tourism. While g is the average spending of tourists per stay, n is the number of nights per stay. TUR denotes the effect on tourism, and B represents the benefit generated by LCCs for the regional economy.

To quantify the negative effects of LCCs operating at the Faro, Lisbon, Funchal and Oporto airports, according to Costa (2014), we must consider the following as negative externalities: accidents, air pollution, climate change, noise, upstream and downstream effects, and effects on nature and the landscape, expressed by:

$$C = c(PD_{LCC} \times Km_{LCC}) \quad (13)$$

where c denotes the cost by passengers transported per kilometre and Km_{LCC} the length of a trip on an LCC.

Finally, the net impacts result from the difference between the LCCs' benefits and their costs for the airports, which reflect the social welfare generated by carriers, in turn translating into the economic impact on the region influenced by the airport. We considered the following:

$$BE = B - C \quad (14)$$

with BE representing the welfare generated by LCCs.

5. COST-BENEFIT ANALYSIS OF LOW-COST CARRIERS FOR PORTUGUESE AIRPORTS

To assess the effects of low-cost routes on the local economy, we assessed the net economic impact of LCCs for 2005–2012. We adopted a CBA methodology to assess the overall economic well-being generated by LCC routes in the areas that are economically influenced by four Portuguese airports, namely the airports of Faro, Lisbon, Funchal and Oporto.

The airlines easyJet and Ryanair have the largest share of the low-cost market in Portugal. In 2012, they together accounted for about 78% of the total traffic on LCCs, which translates into about 7.6 million passengers (ANA, 2013). easyJet carried approximately 3.8 million passengers (39.2% of the LCC traffic) and Ryanair about 3.7 million passengers (38.8% of the LCC traffic). Therefore, we assumed the details for these airlines as the reference LCC details for our study and considered their weighted average traffic as being representative of all LCC airlines.

The total revenue generated by low-cost airlines can be calculated as the sum of the income from the employment created plus the growth in tourism income, which we considered to be equivalent to tourist spending. To quantify these benefits, we considered only passengers disembarking from LCCs, from which we recorded an increased induced yield through job creation and an increased turnover in the tourism sector. We subdivided the impact on employment into three types of effects: direct, indirect and induced. For the direct impact, we considered the employment generated by the induced increase in passengers, given the employment rate per 1,000 passengers carried by Ryanair and easyJet: 0.11 workers in 2005 and 0.13 in 2012. For the indirect effect, we assumed a multiplier effect on direct employment, while the induced employment emerges from the multiplier effect of the direct and indirect employment generated. These multipliers were estimated in the study by the ACI and York Aviation (2004).⁵ The increase in revenue from job creation comes from the average annual salary⁶ earned by registered workers in Portugal each year, with positions reflecting employment supported by LCC services.

To quantify the impact of LCCs in the tourism sector, we considered only 59% of new traffic (ELFAA, 2004). We further considered only those travelling for tourism and leisure: about 79% of the Faro Airport traffic (ANA, 2008 and 2011), 79.5% of the passengers in Lisbon (Observatório Turismo de Lisboa, 2013), 81% of the passengers at Funchal Airport (ESTRATUR/ACIF, 2008) and 72.03% of the passengers at Oporto Airport. Given the average number of nights⁷ and the average spending of the tourists per stay and per region,⁸ we calculated the amount of money generated in the tourism sector.

In 2005, the total benefit gained from LCCs was approximately €307 million. The highest proportion of benefits (82.9%) was concentrated in Faro Airport, and Funchal Airport recorded no value, since the low-cost airline companies only began operating at this airport in 2007. In 2012, the total revenue generated by LCCs in Portugal stood at €1.377 billion (Table 5). The Algarve was the region that showed the greatest benefits from LCCs, with 40% of the total benefits for Portugal, which amounted to approximately €556 million. The north recorded total benefits of €436 million (32% of the total benefits) and the Lisbon

⁵ Since the ACI and York Aviation (2004) study does not determine the multiplier effects for the airports under study, we used as our reference points similarities in features, size and traffic, comparing these four airports' infrastructure. For the airports of Oporto and Faro, we assumed the values estimated in the study for Valencia Airport. For the airport of Lisbon, we assumed the estimated multipliers for Malaga Airport. Finally, for Funchal Airport, we took as a comparison Cardiff Airport, given the similarity in the volume of traffic.

⁶ We considered the average annual salary of €10,910.40 in 2005 and €13,711.08 in 2012, according to data from the GEP/MSSS (2011 and 2013) studies.

⁷ Source: Faro Airport (ANA, 2008 and 2011), Lisbon Airport (Lisbon Tourism Observatory, 2013), Funchal Airport (ESTRATUR/ACIF, 2008) and Oporto Airport (IPDT 2012a, 2012b, 2012c and 2012d).

⁸ These data were obtained from the available values and, for the remaining years, we updated the average daily expenditure using an upgrade rate of 6%. This rate was estimated according to the general criteria recommended by the European Commission for cohesion countries (European Commission, 2008). Source: Faro Airport (Pimpão *et al.*, 2009); Lisbon Airport (Observatório Turismo de Lisboa, 2013); Funchal Airport (ESTRATUR/ACIF, 2008); and Oporto Airport (IPDT 2009, 2010a, 2010b, 2010c, 2010d, 2011a, 2011b, 2011c, 2011d, 2012a, 2012b, 2012c and 2012d).

region €345 million (25% of the total benefits). Finally, in the region of Madeira, LCCs provided benefits of approximately €40 million (3% of the total benefits).

In addition to the benefits, we quantified the negative externalities, accounting for the negative effects generated by LCC airlines as a result of accidents, air pollution, climate change, noise pollution, urbanisation effects, loss of biodiversity, soil and water pollution and upstream and downstream effects. Our assessment was based on the estimates in Delft and Infrass's (2011) study for the year 2008,⁹ taking into consideration the possibility of higher estimated costs, adjusted to a total average recorded for Portugal of €51.3 per 1,000 passengers per kilometre (see Table 5).

Table 5. Negative externalities of air transport in 2008

Cost category	Cost p/1000 passenger-kilometre	Cost category	Cost p/1000 passenger-kilometre
1. Accidents	€0.5	6. Nature and landscape	€0.6
2. Air pollution	€0.9	7. Biodiversity losses	€0.1
3. Climate change	€44.3	8. Soil and water pollution	€0.0
4. Noise	€1.0	9. Urban effects	€0.0
5. Upstream and downstream	€3.9	Total	€51.3

Source: Adapted from Delft and Infrass (2011)

The number of passengers transported per kilometre for each airport were obtained by multiplying the passengers disembarking from LCCs by the weighted average length in kilometres of each low-cost flight.¹⁰ Over the years under study, the negative externalities of the LCC flights at Oporto Airport increased by about 300%, around €107 million in 2005 and €430 million in 2012.

The total net benefit of LCC companies proved to be positive and increased throughout the period studied, translating into greater economic well-being generated by these airlines in the local economy. The total economic welfare generated by LCCs in Portugal amounted to approximately €200 million in 2005 and €948 million in 2012, for a net benefit per passenger of €126.03 in 2005 and €186.52 in 2012 (see Tables 6, 7).

Table 6. Cost-benefit analysis of LCC for Portuguese airports in 2005

BENEFIT					
	Faro	Lisbon	Funchal	Oporto	Total
Increase in passengers (PD_{LCC})	1,117,589	303,483	0	162,771	1,583,843
Employment created					
Direct effect (D)	105	29	0	15	149
Indirect effect (I)	46	57	0	7	110
Induced effect (N)	740		0		740
[8] Total jobs created (E)	892	86	0	108	1,086
[9] Increase in income (R)	9,731,179.54	937,463.46	0	1,417,295.47	12,085,938.47

⁹ We considered the average cost for 2008 as the base year. For the remaining years, we updated the value of the cost at a rate of 6%. This rate was estimated according to the general criteria recommended by the European Commission for cohesion countries (European Commission, 2008).

¹⁰ Faro Airport (1,778 km), Lisbon Airport (1,007 km), Funchal Airport (1,199 km) and Oporto Airport (1,030 km).

BENEFIT					
[1] New traffic (<i>NT</i>)	659,377.51	179,054.97	0	96,035	934,467
[10] Tourists (<i>T</i>)	567,065	142,348.70	0	69,169	778,583
Average expenditure per day (<i>g</i>) (€)	€47.95 47.95 €	€33.53	€0	€45.99 €45.99	€51.20
Average overnight stay (<i>n</i>)	9	5.21	0	8	7.4
[11] Increase in turnover of tourism (<i>TUR</i>)	€244,695,570	€24,866,311	€0	€25,447,046	€295,008,927
[12] Total Benefits	€254,426,750€	€25,803,774	€0	€26,864,341	€307,094,864
%	82.9%	8.4%	0%	8.7%	100%
Cost					
	Faro	Lisbon	Funchal	Oporto	Total
Accidents	846,019.68	130,148.22	0	71,388.27	1,047,556.17
Air pollution	1,522,835.42	234,266.80	0	128,498.89	1,885,601.11
Climate change	74,957,343.67	11,531,132.41	0	6,325,001.07	92,813,477.15
Noise	1,692,039.36	260,296.44	0	142,776.55	2,095,112.35
Upstream and downstream	6,598,953.51	1,015,156.13	0	556,828.54	8,170,938.18
Nature and landscape	1,015,223.62	156,177.87	0	85,665.93	1,257,067.42
Biodiversity losses	169,203.94	26,029.64	0	14,277.65	209,511.23
[13] Total Cost	€86,801,620	€13,353,208	0	€7,324,437	€107,479,264
%	80.8%	12.4%	0%	6.8%	100%
[14] Economic welfare generated by LCC (<i>BE</i>)	€167,625,130	€12,450,567	0	€19,820,385	€199,896,082
%	84.0%	6.2%		9.8%	100%
Economic welfare generated in local economy by each passenger	€149.99	€41.03	€0	€121.8	€126.21

Source: Authors

Table 7. Cost-benefit analysis of LCC for Portuguese airports in 2012

BENEFIT					
	Faro	Lisbon	Funchal	Oporto	Total
Increase in passengers (PD_{LCC})	2,032,834	1,173,883	209,252	1,664,079	5,080,048
Employment created					
Direct effect (<i>D</i>)	294	131	30	210	665
Indirect effect (<i>I</i>)	128		2	91	222
Induced effect (<i>N</i>)	2,064	261	2	1,472	3,799
[8] Total jobs created (<i>E</i>)	2,486	392	35	1,773	4,686
[9] Increase in income (<i>R</i>)	€27,065,065	€5,544,579	€378,415	€19,297,445	€42,445,825

[1] New traffic (<i>NT</i>)	1,199,372	692,591	123,459	981,807	2,997,229
[10] Tourists (<i>T</i>)	947,504	550,610	100,002	707,146	2,305,228
Average expenditure per day (<i>g</i>) (€)	€69.75	€118.32	€61.56	€84.20	€83
Average overnight stay (<i>n</i>)	8	5	6,5	7	7
[11] Increase in turnover of tourism (<i>TUR</i>)	€528,675,566	€339,421,883	€40,013,193	€416,800,296	€1,324,910,938
[12] Total Benefits	€555,740,631	€344,966,462	€40,391,608	€436,097,741	€1,377,196,443
%	40%	25%	3%	32%	100%
Cost					
	Faro	Lisbon	Funchal	Oporto	Total
Accidents	2,238,554	732,312	155,386	1,061,674	4,187,924
Air pollution	4,029,396	1,318,161	279,694	1,911,012	7,538,264
Climate change	198,335,841	64,882,806	13,767,182	94,064,279	371,050,108
Noise	4,477,107	1,464,623	310,772	2,123,347	8,375,849
Upstream and downstream	17,460,717	5,712,030	1,212,009	8,281,054	32,665,811
Nature and landscape	2,686,264	878,774	186,463	1,274,008	5,025,509
Biodiversity losses	447,711	146,462	31,077	212,335	837,585
[13] Total Cost	€229,675,590	€75,135,168	€15,942,583	€108,927,709	€429,681,050
%	53%	17%	4%	25%	100%
[14] Economic welfare generated by LCC (<i>BE</i>)	€326,065,041	€269,831,294	€24,449,025	€327,170,033	€ 947,515,392
%	34%	28%	3%	35%	100%
Economic welfare generated in local economy by each passenger	€160.40	€229.86	€116.84	€196.61	€186.52

Source: Authors

6. CONCLUSION

This study aimed to analyse and quantify the effect of low-cost airlines in Portugal, specifically in the regions of the Algarve, Lisbon, Madeira and northern Portugal, where the airports of Faro, Lisbon, Funchal and Oporto are located. In 2005, the economic welfare generated by LCCs totalled almost €200 million, corresponding to €126 per new passenger disembarking from LCCs. Faro Airport shows higher values than the other airports, since this was the first airport to receive these airlines. In 2005, this airport attracted 84% of the total economic welfare generated by LCCs in Portugal. The airports of Lisbon and Oporto accounted for 8.4% and 8.7%, respectively. The LCCs operating from Faro Airport generated net economic welfare per passenger of approximately €150, those operating from Oporto €122 and those operating from Lisbon Airport €41.

From 2005 to 2012, the airports in this study increased their low-cost flights, which resulted in a positive effect on each region. In 2005, traditional airlines (FSC) controlled 86% of the market share of the volume of air traffic, while LCCs only held 14%. However, in 2011, FSC's share decreased by 22% points, dropping to 64%. That market share transferred

to low-cost airlines, which increased their share to 36%. As a result, the economic welfare generated by low-cost airlines in the Portuguese economy gradually increased over the study period, representing cumulative growth of 78.9% from 2005 to 2012. By 2012, the average impact of LCCs per passenger at each airport was €186.5.

Lisbon Airport, in particular, recorded tremendous growth in the benefits of LCCs. Throughout the study period, the total LCC benefits grew by 96.2% and the benefits per passenger increased from €41 to €230 (+461%). This growth stems from the fact that this region is where tourists show the highest average daily spending per day of their stay (€118). In addition, the economic costs of flights are relatively lower, since the distance in kilometres of low-cost routes, weighted by the most representative routes of this airport, is lower than that of the other airports in the study. The distance for Lisbon is 1,007 kilometres, while at Faro Airport it is 1,778, at Funchal Airport it is 1,199 and at Oporto Airport it is 1,030. In 2011, 8 LCC airlines operated from Lisbon Airport, with a market share of 14% in the regular traffic segment.

Faro Airport, the first Portuguese airport to offer flights on low-cost airlines, reveals an especially large market share of LCC airlines. In 2011, 13 LCC airlines carried out 83% of all the aircraft movements recorded at this airport, having transported 87% of the passengers who travelled in the regular traffic. In 2012, the LCC traffic resulted in a benefit of €326 million for the Algarve region and €160 per passenger, reflecting growth of 7% over 2005.

Oporto Airport is the second-largest airport in terms of LCC traffic. In 2011, 4 LCC airlines performed 20,000 movements at this airport, corresponding to 33% of the total movements, and LCCs carried about 50% of the passengers in the regular traffic. In 2012, the economic welfare generated by LCCs totalled €327 million and €197 per passenger, reflecting growth of almost 64% compared with the benefits generated in 2005.

This study supports the conclusion reached in other studies in the literature on the economic impact of low-cost airline companies: the entry of these airlines has resulted in significant economic benefits for the regions influenced by these four airports. Specifically, this study demonstrated a positive net impact generated directly by LCCs through job creation and increased consumption in the tourism sector and indirectly through the increased demand in other sectors. However, it is evident that the LCCs' effect is distinct in each region under study. In some cases, the entry of LCCs clearly created a new demand, as seen in the airports of Lisbon and Oporto. Regarding Faro Airport, although the LCCs' entry has generated a new demand, it has also generated widespread transfer of demand, in which passengers who usually travel with traditional airlines fly on low-cost airlines. Funchal Airport benefited the least, which can be explained by the special characteristics of the Madeira archipelago. This is a region with a mature and consolidated tourism industry, so the airport does not function as the main engine of regional economic growth.

Based on these results, and as advocated by most of the literature, it can be concluded that low-cost carriers play a key role in regional economic development and tourism in particular in countries with a lower gross domestic product (GDP) and the potential for tourism development.

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THE DEVELOPMENT OF LOW-COST AIRLINES AND TOURISM AS A COMPETITIVENESS COMPLEMENTOR: EFFECTS, EVOLUTION AND STRATEGIES

Luis Moreno

Ana Ramon

Andrés Pedreño

ABSTRACT

This paper addresses the relationship between the development of the airline industry and tourism. On the one hand, air transport has triggered the growth of tourism throughout the world, while, on the other hand, tourism has acted as a complementary product for developing new flight routes. This process has intensified with the emergence of low-cost carriers. A profound change has been observed in companies' strategy to adapt to the demands of this type of market.

To conduct this study, a review of the existing literature related to tourism and low-cost carriers was carried out. To conclude, an analysis of the positioning and price-fixing strategies of low-cost airlines operating on some of the most important tourist routes in Europe was performed. The results indicate different level of fares among the five companies in the sample, especially between Ryanair and easyJet, but similar pricing behaviour on the routes studied.

Keywords: Low-Cost Carriers, Pricing, Tourism, Airline Industry

JEL Classification: L93, Z32, L11

1. INTRODUCTION. GLOBALISATION, TOURISM AND AIR TRANSPORT DEVELOPMENT

In recent decades, commercial air transport growth has been closely linked to different parameters, such as higher incomes, lower average costs per flight and the global economy phenomenon (Ishutkina and Hansman, 2009). Airlines have given rise to a socioeconomic interconnection between different countries worldwide, especially in those activities with a high international component, such as tourism (in fact, tourism seems to be the most important effect in the international movement of people). It is well known that there is reciprocity between airlines and globalisation: both traditional and low-cost airlines foster global economic development, and at the same time, the globalisation phenomenon can explain the exponential development of airlines (Button and Taylor, 2000; Williams and Baláž, 2009).

The adjustment of airlines to the global market was no coincidence. Airlines have been constantly adapting to the ever-changing air transport environment (Zhang and Round, 2009), which has included a concentration process, the formation of international alliances and the inclusion of ICTs in airlines' business models (Goetz, 2002). The emergence of low-cost airlines is explained by these and other political changes, particularly the deregulation

processes in the US and Europe (Mason and Alamdari, 2007).¹ Since the US deregulation in 1978, many authors have studied which variables determine the number of operations and passengers per route. For instance, Gillen (2009) showed that *distance, population, industry liberalisation* and particularly *the kind of economic activities developed in a place* explain the air transport demand. Therefore, tourism is one of the activities that increase the air transport development in a region.

Tourism and air transport have been studied as complementary products for many decades. For instance, Graham (1995), Abeyratne (2000), Bieger and Wittmer (2006) or Rey *et al.* (2011), among many others, studied the air transport evolution effect in different countries, observing that it has led to a more sophisticated tourism supply. In the future, air transport will have a greater impact on tourism, according to some authors, like Poon (1993), Buhalis (2003) or Buhalis and Law (2008). These and other authors have defined *new tourism* as being dependent on low-cost airlines, without intermediaries, and based on travelling longer distances.

However, air transport is needed for the whole globalisation process, not just that in tourism. According to Zhang and Round (2009), and based on the experiences of Europe and the US, over the next few years, the BRICS countries will have to create efficient air transport systems to facilitate their economic growth based on deregulation, privatisation and modernisation. All of the major countries have followed these steps in terms of economy and finance.

These changes have given rise to important analyses related to air transport and how airlines respond to the new globalised panorama. The main areas of study are the relationship between airlines and airports (Barbot, 2008; D'Alfonso and Nsatasi, 2012; Graham, 2013), competition between airlines and with other means of transport (Pitfield, 2008; Jiménez and Betancor, 2012), the international expansion of airlines (Ramón-Rodríguez *et al.*, 2011) and, particularly, changes in pricing strategies and the emergence of low-cost airlines (Malighetti *et al.*, 2010; Salanti *et al.*, 2012). Some authors, such as Vera and Ivars (2009), have even promoted political and infrastructural changes to increase air transport's impact.

Our aim in this paper is to focus on how tourism is affecting the competitive strategies of the European low-cost carriers. Accordingly, first, we reviewed several previous papers to study the impact of tourism on air transport strategies. Then, we described how some variables related to tourism affect pricing in five different European low-cost carriers, including Ryanair and easyJet.

2. COMPLEMENTORS, NEW TOURISM AND LOW-COST CARRIERS

Over the last fifty years, the air transport industry has been the principal driving force behind international leisure travel (Dwyer *et al.*, 2010). The number of airline users has increased thanks to the decrease in fares (especially because of the low-cost effect) and the existence of new tourism destinations worldwide. At the same time, airlines are taking tourism into account to determine their strategies, both in pricing and in positioning, according to Graham (2000).

Moreno-Izquierdo *et al.* (2015) began a debate on the role of tourism in airline pricing, pointing out that it could perhaps be understood as a new *strategy force* in a revised Porter's five forces model. Complementary products have been considered as a sixth force in previous works, such as Bandenburger and Nalebuff (1996) and Grove (1996). The first of these authors introduced the term *co-opetition*, referring to a double relationship between

¹ Air transport has always been considered as a strategic industry, even before it was deregulated in the US in 1978. The European liberalisation process started in the mid-1990s. Air transport deregulation underwent "significant changes in industry structure, profitability, employment, volume, and patterns of service and fares, among other characteristics" (Goetz and Vowles, 2009, p. 1).

companies in one industry. Complementors play a main role in the diagrams of both *six forces models*. In the airline industry, complementors could be those businesses that are fostering or supporting the international movement of people, such as hotels, airports or leisure supply.

The emergence of the LCCs has generated a change in the behaviour of users, together with an interest in secondary destinations, which, according to Forsyth (2003), will have an impact in the next few years similar to that exerted by the tourism destinations consolidated in the 1960s. Different authors, such as Poon (1993) or, more recently, Mills and Law (2004), have discussed the configuration of a new type of tourism with preferences that differ widely from those observed until now. Buhalis and Law (2008) explained that new tourists are changing their interests within the destination, transforming themselves from visitors to citizens, fully integrated into the local society. These tourists use online channels to manage and buy their entire tourist package, which benefits those airlines that are well positioned on the Web and foster ecommerce, such as Ryanair or easyJet.

Vera and Ivars (2009) observed strong dependence between intra-European tourism and low-cost airlines, which require many concessions to guarantee a high flow of tourism. For instance, Papatheodorou and Lei (2006) explained that the creation of a multiple-airport system, with a main airport and secondary/regional ones around it, responds to low-cost demands. During the first decade of the twenty-first century, to adapt to the evolving low-cost tourism market, it seemed necessary to create new infrastructure and provide good conditions to attract airlines such as Ryanair. In fact, Barrett (2004), Tinard (2004) and Bel and Fageda (2008) documented the different kinds of subsidies granted to low-cost airlines by local and regional governments to boost the tourism industry.

According to some predictions, it seemed that the new kind of tourists would eliminate traditional tourism in the near future. This would change the tourism industry's parameters, fostering new destinations to the detriment of traditional tourist centres (Morgan, 1991; Knowles and Curtis, 1999). For example, Knowles and Curtis (1999) understood that newly developed areas would substitute the traditional Mediterranean sun and sand destinations. Low-cost carriers would be one of the most important factors in this change.

However, Tretheway (2004) disagreed with the assertion that LCCs will cause such a radical change. This author strongly felt that there are two elements that will maintain the traditional airlines in spite of the advancing low-cost companies: (1) the existence of a segment of people who find traditional transport more useful; and (2) the limited low-cost expansion on long-haul routes. We should also point out that the traditional airlines are taking steps to improve the efficiency of their flights, having partly counteracted the low-cost effect experienced in the first decade of the 2000s (Ramón-Rodríguez *et al.*, 2011).

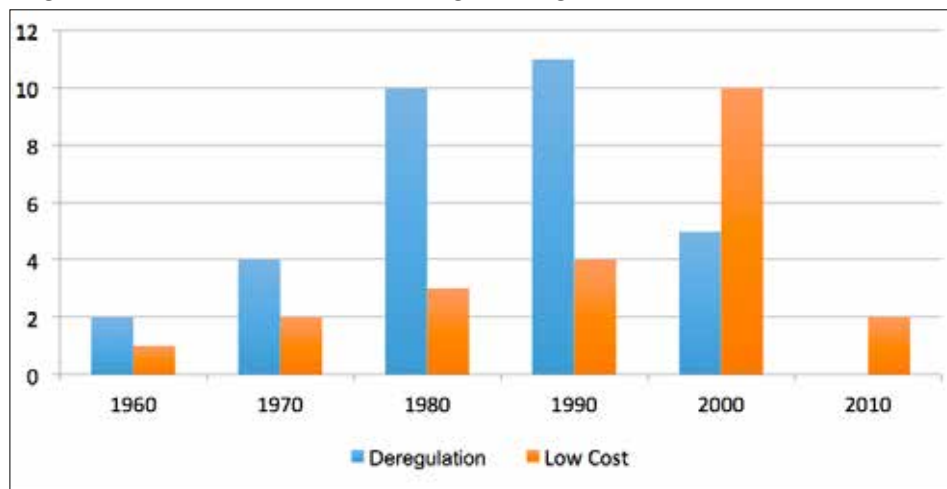
Supporting this idea, the studies by Marrero Rodríguez and Santana Turégano (2008) and Foronda Robles and García López (2009) observed that the decline of traditional tourist destinations would be neither radical nor quick. Today, there is a higher demand for the traditional offer than for emerging destinations with more appeal or social life. The occupancy capacity and the distance between receiving and issuing countries could explain why traditional tourism patterns are even increasing. In fact, European low-cost carriers have grown due to the regional leisure market. It is because of this that Vera and Ivars (2009) suggested that traditional tourism cities should be interested in increasing the number of low-cost flights so as not to lose competitiveness against developing destinations.

2.1. Literature on tourism in airline strategies

Throughout the existing literature, for example Moreno Izquierdo (2013), we can observe that tourism is one of the key factors determining airline strategy. Based on a study of more than 100 articles, it is apparent that there has been an increase in the number of studies

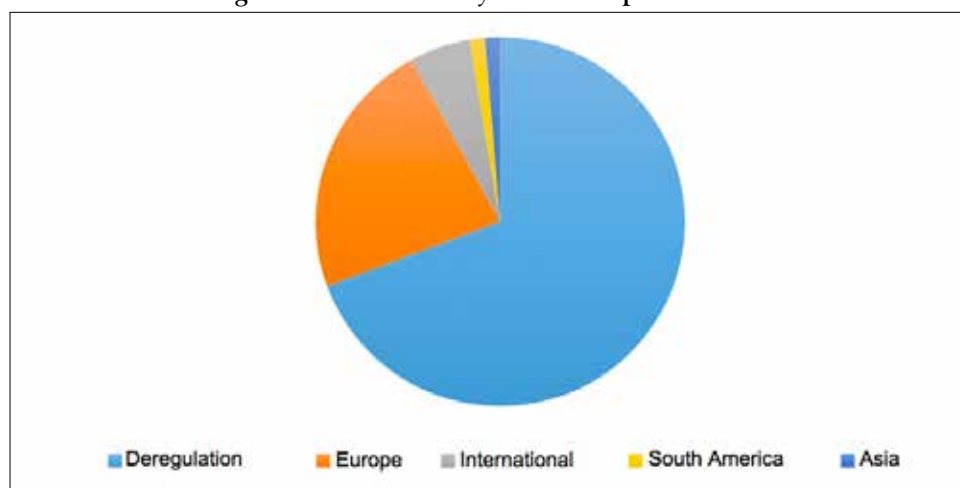
analysing the air transport industry since the 1970s for two main reasons: the effects of the deregulation process and, subsequently, the emergence of the low-cost airlines (Figure 1).

Figure 1. Evolution of studies relating to deregulation and the low cost carriers



To gain an idea of the impact of the low-cost carriers, we can refer to Porter (2008), who made a brief application of his five forces model to the American air transport sector. He concluded that it was one of the least profitable industries due to the strength of the forces of his model. The emergence of the low-cost airlines - particularly in Europe - has changed the make-up of the sector, especially for the traditional companies. In fact, previous authors, such as Lawton (2002), Francis *et al.* (2006) and Graham and Shaw (2008), have considered the emergence of the LCCs to be the principal repercussion of the deregulation of the European air transport market, and others, such as Alderighi *et al.* (2012), have pointed out that the *low-cost revolution* has transformed the airline industry's environment. According to Moreno Izquierdo (2013), the role played by the low-cost companies in Europe has shifted the interest of researchers from the United States to Europe (Figure 2).

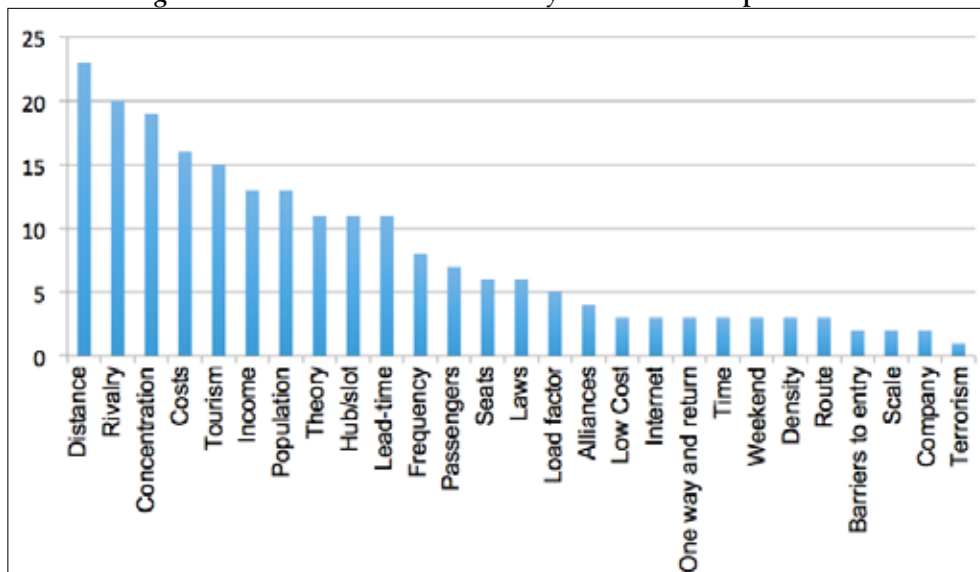
Figure 2. Areas of study in the sample observed



Within the strategic analysis of the air transport sector, and more specifically the case of price fixing, tourism has been a recurrent variable for segmenting the different products. Together with objective data such as distance, the number of rivals, income, the population

or the concentration on routes, tourism in any of its dimensions is understood as an element that can lead to alterations in companies' strategies (Figure 3).

Figure 3. Variables used in the study of the air transport sector



In the case of air transport, in most cases, the idiosyncrasy of the demand and the routes has been reduced to two typologies: *business* and *leisure*. According to the literature, the *leisure* routes show greater elasticity in terms of the average price than the *business* routes, as indicated by Oum *et al.* (1986), Windle and Dresner (1995) or Graham (2000); therefore, price alterations seem to affect the business demand to a lesser extent, as highlighted by Salanti *et al.* (2012). Similarly, Brons *et al.* (2002) stated that “overall, business travelers are less elastic to rates changes than leisure passengers”, since the former value a series of determinants even more than the cost of transportation (p. 167); hence, the *tourism* factor often shows a negative sign with respect to airfares (Figure 4).

Figure 4. Effect of tourist demand on pricing strategies

	YEARS	MARKET	RESULT
Bailey <i>et al.</i> (1985)	1976-1981	United States	(-)
Borenstein (1989)	1987	United States	(-)
Windle and Dresner (1999)	1993-1996	United States	(-)
Richards (1996)	1995	United States	(-)
Dresner, Lin and Windle (1996)	1991-1994	United States	(-)
Park and Zhang (2000)	2000	US and Europe	(-)

3. CASE STUDY OF PRICE-FIXING STRATEGIES IN TOURIST DESTINATIONS

To carry out the analysis, it was decided to select a series of tourist routes in Europe, using a sample of more than 2,600 direct international flights from the Mediterranean region of Spain to England or Ireland and vice versa. The time frame used for the study covered a total of four months, between June and September 2011, in line with the current trend of

studies that analyse price dispersion, in which the samples rarely exceed twelve months, such as Giaume and Guillou (2004), Escobari and Jindapon (2008), Alderighi *et al.* (2011) or Salanti *et al.* (2012), to name some examples.

Each flight was observed 60, 30, 25, 20, 15, 10, 5 and 1 day(s) in advance. The observed sample falls entirely within the direct low-cost European flight category, assuming that the trips are independent (not round trips). Only those low-cost companies (LCCs) that operated flights for the whole period were included: *Ryanair* (FR), *easyJet* (U2), *Jet2* (LS), *BMI Baby* (WW) and *Monarch Airlines* (ZB) (Figure 5). A total of 17,664 observations were finally included in the analysis.

We divided the airports in the sample into five zones: Zone A (Alicante, Valencia, Murcia and Almería), Zone B (Barcelona, Girona and Reus), Zone C (London, Stansted, Luton, Bournemouth and Gatwick), Zone D (Manchester, Liverpool, Leeds, Birmingham, Sheffield, Nottingham and Blackpool) and Zone D (Dublin). The information was collected from websites that integrate flights (principally trabber.com, kayak.com and liligo.com). These types of websites have been used by other authors, such as McAfee and te Velde (2006), Law *et al.* (2011), Puller and Taylor (2012) and Domínguez-Menchero *et al.* (2014), to obtain their respective samples, as they provide fast and reliable information. Other authors, for instance Pels and Rietveld (2004), Piga and Bachi (2007), Malighetti *et al.* (2009) and Alderighi *et al.* (2012), use the airlines' own websites, although this method is only recommended when only one airline is being analysed.

Figure 5. Low cost carriers in the sample

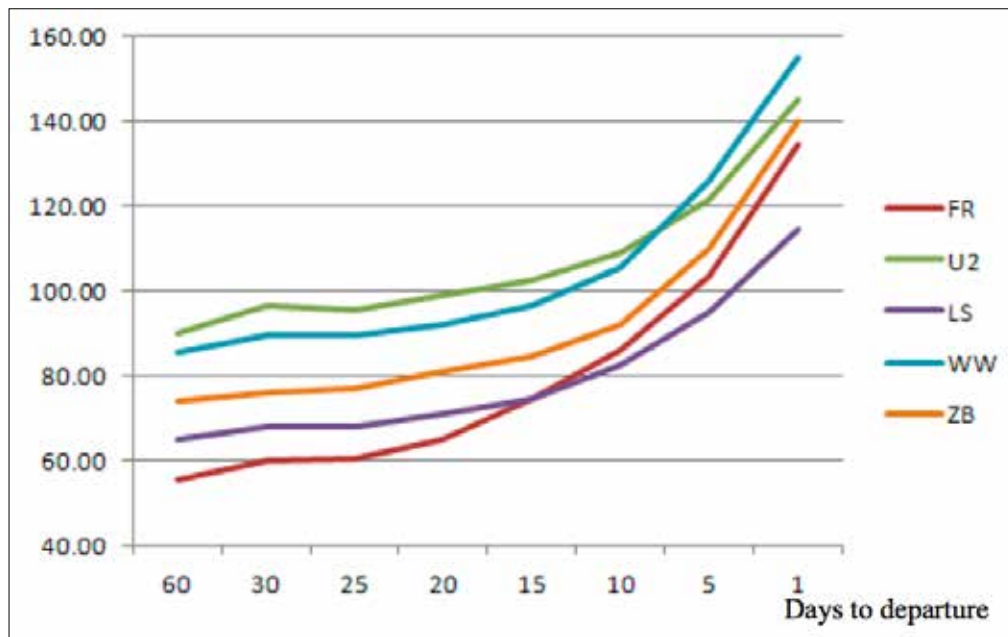
AIRLINE	CODE	COUNTRY	NO. OF FLIGHTS OBSERVED	MOST FREQUENT ROUTE	AVERAGE DISTANCE
Ryanair	FR	Ireland	1,098	ALC - LGW	1482.76
easyJet	U2	UK	798	BCN - LGW	1365.82
Jet2	LS	UK	116	ALC- MAN	1607.12
Bmi Baby	WW	UK	72	ALC - EMA	1567.73
Monarch	ZB	UK	188	ALC - LGW	1509.69

The reasons for selecting the routes forming the sample include:

- their importance within the European area since the movements between Spain and the British Isles are very significant in terms of international tourism in Europe, especially during the summer season.
- Spain and the United Kingdom's special idiosyncrasy in terms of airport policy, which combines a high number of airports with different management strategies,
- The low-cost airlines' support in exploiting the westernmost European routes, with easyJet and Ryanair as references, the results of which are carefully observed by the rest of the industry worldwide.

There is a vast amount of information pertaining to the five airlines included in the sample that may be considered as highly relevant. It is worth noting, for example, how they set their prices according to the days prior to take-off. According to our database, we can identify two chief elements: overall stability in all the companies' prices set between 60 and 25 days prior to take-off and a marked increase in the last 10 days (figure 6).

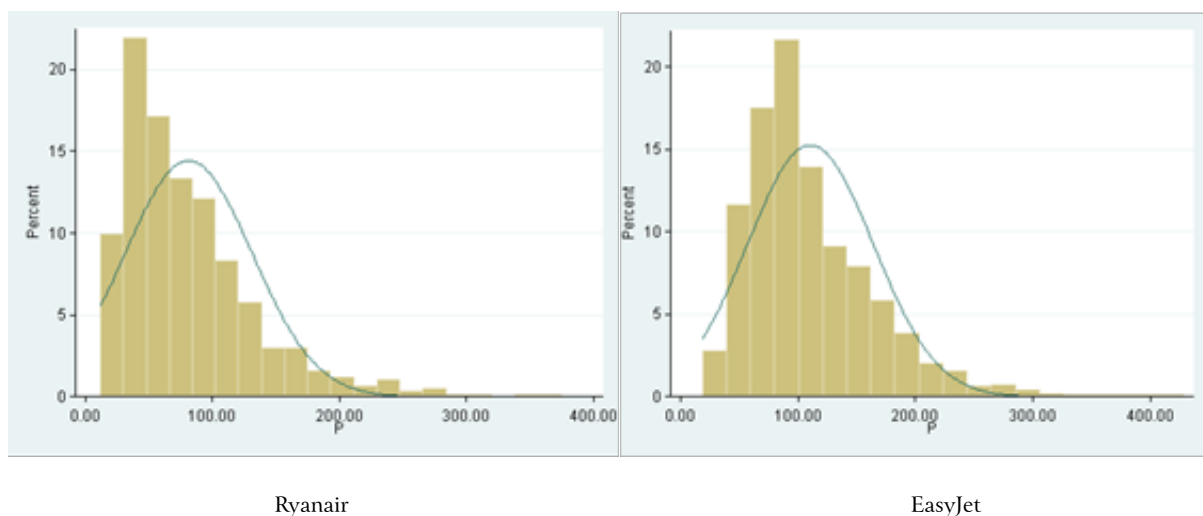
Figure 6. Evolution of pricing by days to departure



By breaking down the data by company, we can see that Ryanair is the cheapest airline for almost the whole period, but this company also shows the most variance. In fact, in the last 10 days, its price increase is greater than that of any other company (Button and Vega, 2007). On the other hand, easyJet is the company that, on average, shows the highest prices, although it maintains more stable prices than its principal rival Ryanair during the 60- and 15-day periods prior to take-off. This strategy is also used by Monarch and Jet2, while BMI Baby seems to employ a pricing strategy that is more similar to Ryanair's.

Both strategies can be observed in greater detail in the histograms shown in figure 7 for the segment's two leading companies. The result shows that the minimum and maximum prices of easyJet and Ryanair are very close, although the difference lies in easyJet's greater emphasis on average prices and Ryanair's tendency to make numerous discounts on its fares.

Figure 7. Pricing histogram: Ryanair and EasyJet



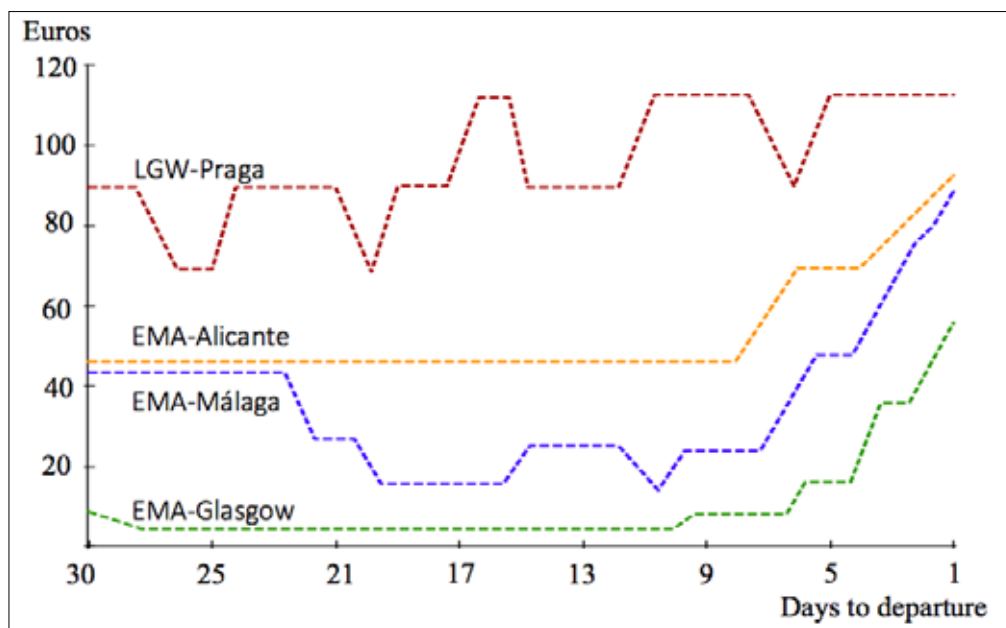
Nevertheless, as users, we must be careful not to assume that these trends with respect to advance purchase are true for all markets. Although some authors, such as Pels and Rietveld

(2004) and Salanti *et al.* (2012), claim that companies seem to behave as described in our sample, Pitfield (2005) clearly clarified that this is not always the case. His work shows that airlines can implement completely different strategies depending on the market, which is the case of easyJet. This company uses very different strategies for the “East Midland-Alicante” and “East Midland-Málaga” routes, for instance (figure 8). Button and Vega (2007) reached the same conclusion after reviewing some of the articles referring to different markets both in the United States and in Europe: there is no behavioural pattern for pricing in terms of time or advance purchasing. The authors continued by observing that prices adopt this rising trend merely due to the nature of the market’s structure. We can therefore state that airlines set their prices according to the environment in which they operate.

Another relevant observation is how prices evolve in terms of the season. As we can see in figure 9, the average prices of the airlines in our sample increase up to mid-August, coinciding with the peak tourism season on the Spanish coasts; they then decrease abruptly in the month of September, returning to similar levels to those observed in June. Additionally, a clear increase in the Monday, Saturday and Sunday rates can be appreciated since these days are considered to have the highest number of passengers using low-cost airlines.

The very same results were observed by Salanti *et al.* (2012) in their study of European tourism routes, which highlights an increase, particularly in April and August, coinciding with Easter and the summer holidays. The same results can be obtained if we observe the difference between prices on Fridays, Saturdays and Sundays in comparison with the rest of the weekdays.

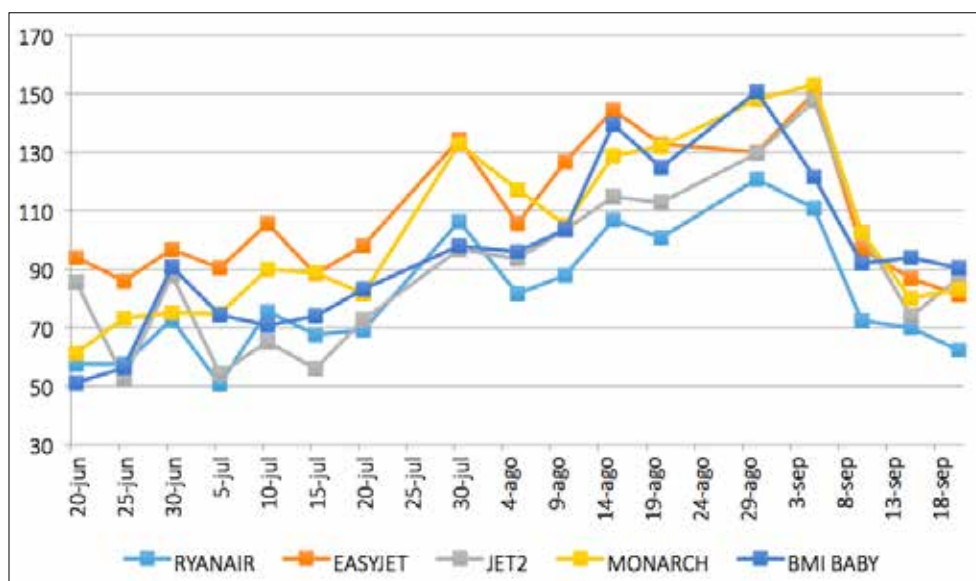
Figure 8. Different EasyJet pricing strategies



Resource: Pitfield (2005)

Therefore, we can conclude that there is a clear trend in pricing that is consistent with the proposal of dynamic prices defined within yield management (in the higher-demand periods, such as at weekends or during the month of August, the price increase is inevitable, as well as the abrupt decline during the summer season). However, beyond this seasonal variation, no common strategy has been found that enables us to define the behaviour in different markets; therefore, it is necessary to perform a thorough route analysis to comprehend companies’ tactical decisions.

Figure 9. Average airline prices by day of departure



4. CONCLUSIONS

Throughout this article, we have observed the close relationship between the development of the air transport sector and the tourism industry. Without the existence of one, we cannot explain the current situation of the other, and vice versa. On some occasions, the airline sector has been observed as an element integrating the tourism sector of a region or at least as having a complementary role.

However, the development of the low-cost carriers, particularly in Europe, has given rise to a whole range of studies in which tourism has become an element of airlines' strategies. In fact, as we have seen, low-cost carriers have the capacity to modify, in part, the flow of tourists to new markets; in this way, we can understand that tourism is a complementary element of the development of the air transport sector.

In studies referring to pricing strategy, tourism has been seen as a "negative" element for airlines. On the one hand, prices are usually higher in regions where tourism is not the principal economic activity, which is the case of large cities. On the other hand, tourists usually pay less than business passengers. This does not mean that *tourism per se* is negative. The airlines take advantage of the demand in consolidated and emerging tourist regions to generate new routes and, within them, use the fluctuations in demand to modify their prices.

Based on the data collected for this article, we can observe this strategy with two very clear examples: first, the number of days prior to departure and, second, the seasonality of sun and beach tourism. According to our observations, users should purchase their seats between 60 and 30 days in advance. In the 30-day period prior to the flight, prices gradually rise until the day of departure, which could represent an increase of up to 300% compared with 1 month beforehand.

However, there are significant differences between the companies. When comparing Ryanair and easyJet, we can observe different strategies in the markets studied. We can see that Ryanair generally has lower prices than its rival but penalises those users who do not know how to optimise their purchase. However, the variability of easyJet's prices is much lower, providing a different package of services to users. The two companies also use different strategies with respect to the markets in which they operate, with easyJet being more oriented towards the large airports than Ryanair.

However, despite this difference in strategies, both airlines display the typical inertia of low-cost carriers with respect to the days before departure and an adjustment to demand. Future studies should continue to analyse the behaviour of low-cost carriers in tourist markets, particularly in comparison with traditional airlines. On the other hand, it would also be interesting to analyse whether this pattern exists on non-tourist routes or on those with a different seasonality.

The success enjoyed by the low-cost airlines, with growth that was impossible to imagine a few decades ago, invites us to continue to study their strategies, particularly now that more mature sectors in European economies are having to reinvent themselves.

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FLYING FROM EUROPE TO THE ALGARVE: THE GEOGRAPHICAL IMPACTS OF THE GROWTH OF LOW-COST CARRIERS (1996–2013)¹

David Ramos-Pérez

José Ignacio Izquierdo-Misiego

ABSTRACT

The replacement of non-scheduled traffic by scheduled services is one of the main impacts that the liberalisation of the European Common Aviation Area has had on tourist airports. In the case of Faro, between 1996 and 2013, this shift led to both fewer routes served and reduced catchment areas in the source markets for tourists visiting the Algarve. The strategy pursued by Ryanair, the airport's main carrier, focuses on connections that already channelled a greater volume of traffic when charter airlines dominated. Therefore, the impact of low-cost carriers on diversifying the number of airports of origin and source markets is limited. Moreover, using the spatial analysis functions of GIS software, we verified that the population linked to the theoretical catchment areas of airports with a non-stop flight to Faro in 2013 was smaller than that of the airports with such connections in 2000. The decision-making process involved in the policy incentives for introducing new routes could benefit greatly from this type of analysis.

Keywords: Low Cost, Airports, Tourism, Algarve

JEL Classification: L93, L83, R12

1. INTRODUCTION

Since the end of the 1990s, numerous studies have detected significant changes in tourist behaviour, including those related to mobility patterns. As regards this latter aspect, the emergence of low-cost carriers is considered to be one of the more salient vectors of this transformation, as they have reduced fares independently of the package tours that had channelled the bulk of the demand since the 1960s.

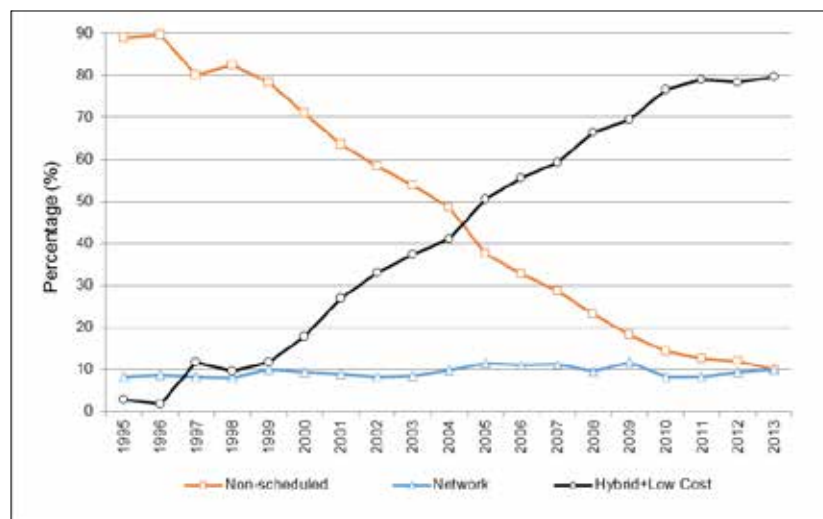
The levels of intensity and stability reached by the demand for transport on a considerable number of tourist routes and the changes in habits affecting the demand itself, increasingly more prone within a post-Fordist context to the individual organisation of holidays, shorter stays and a higher number of trips, explain the interest that low-cost carriers have shown in these routes (Ioannides and Debbage, 1997; Graham, 2008). It is no wonder, therefore, that the business model of low-cost carriers seems to suit the demands for flexibility associated with this new tourist profile better. Furthermore, the introduction of the European Single Market in 1993, reducing the restrictions on the purchase of property in other EU countries by EU citizens, has boosted the purchase of holiday homes in mature tourist destinations along Europe's Mediterranean coastline, driving an increase in international residential

¹ The paper presents some of the findings arising from a period of research that David Ramos-Pérez spent at the University of Algarve during June and July 2014, funded by the University of Salamanca Researcher Mobility Programme – Action 1a.

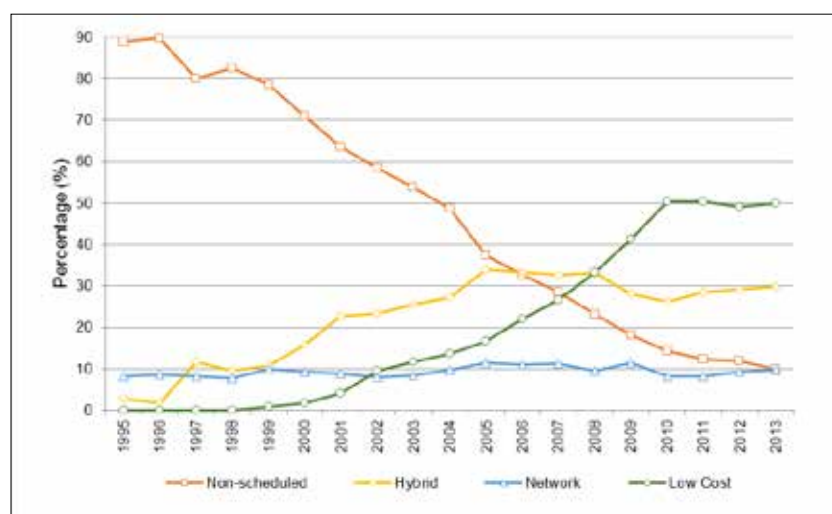
tourism (Mantecón, 2008). The Algarve is clearly part of this dynamic, as repeatedly shown in different studies (Williams and Patterson, 1998; Baron-Yellès, 2006).

Foreign residents along the Mediterranean seaboard are no longer mostly retired migrants, as they now respond to a complex mosaic of profiles, ranging from people who are actively looking for new career opportunities to those working from home for their companies in the United Kingdom, including those who distribute their lives between two countries or those who simply buy a property for short getaways that are taken with a variable frequency (fortnightly, monthly, etc.) (King *et al.*, 1998; O'Reilly, 2000). This has therefore given rise to the appearance of new segments of consumers in the demand for air transport, for whom the purchase of a package tour is pointless and the availability of a scheduled supply, such as that provided by low-cost carriers, significantly improves their possibility of reaching their destination.

Figure 1. Trend in international passenger traffic (1995-2013).
Comparison of two segmentations



A) Segmentation of traffic according to ANA



B) Segmentation of traffic according to Ramos and Almeida (2015)

Source: Unpublished Official statistics sourced by ANA

Although there are discrepancies when matching the different air carriers to specific business models, an analysis of Faro Airport's recent trend in traffic reveals a sharp drop in its non-scheduled operations, as can be seen in figure 1, which compares the results of methodologies that apply different criteria to the segmentation of traffic. Figure 1B, based on the method formulated by Ramos-Pérez and Almeida (2015), helps to qualify the widely held notion that charter operators have simply been replaced by low-cost carriers, showing that the latter's dominance is not as obvious as is commonly assumed. What is more, the so-called hybrid operators – those carriers that have moved from the charter segment to scheduled flights – have managed to retain a significant market share of 30% of the overall international traffic.

Nevertheless, over and above the prevalence of one or other business model, there are only a handful of studies on the changes that these transformations have introduced into the supply and demand for flights at airports located in mature tourist areas, defined mainly by their product offer of sun and sand. One of the lacunas detected involves the need to look beyond the overall aggregate figures and proceed to a detailed geographical segmentation, which places the routes and the catchment areas of the airports of origin at the heart of the analysis. Only in this way can we discover the extent to which the progressive replacement of charter operators by other low-cost or hybrid ones can be linked to the diversification of the airports of origin or to a simple replacement of some airports by others. The only study published on this topic, drawn up by the INAC (2011), is based on a relatively short time frame (2000–2009) and does not cater for a breakdown by types of operators or by markets. On the other hand, an analysis should also be made of the catchment areas of those airports located in source markets, with the aim of assessing the impacts that the appearance and disappearance of routes have on the volume of population served in those countries. In the summers of 2010 and 2011, Turismo de Portugal issued a series of reports that linked the supply of scheduled flights to the socio-economic conditions of the regions that they served, albeit without providing a detailed analysis of the catchment areas. Both these lacunas are even more significant when we take into account the substantial financial aid that Portugal's public authorities give to low-cost carriers at Faro Airport, which are considered vital for avoiding the stagnation of tourism in the Algarve.

The research presented here constitutes an initial approach to the issues raised. This theoretical discussion is followed by a brief presentation of the methodology and sources used. This is followed by a yearly record of the routes opened and closed, which includes an analysis of the airport's routes supplied over the 1996–2013 period using two different methodologies for the calculation, as well as a more detailed study of the two main source markets for tourists travelling to the Algarve. The fourth section quantifies the volume of population served in the source markets according to the network of routes available in 2000 and 2013, the aim being to gauge the possible impact of the appearance of low-cost carriers and the transition of charter operators to hybrid models. The fifth section examines Ryanair's route network, the dynamics of which have conditioned the airport as a whole following the opening of the operating base there in 2010. The paper ends with a discussion of its findings, and mention is made of certain aspects that should be addressed by further research.

2. METHOD AND SOURCES

This paper is based on the case-study method; in other words, it conducts an in-depth analysis of an example that may be considered representative of others of its kind. Such is the case of Faro with regard to all the other airports along Europe's Mediterranean seaboard. We adopt

a diachronic perspective to process the statistical data available by routes, characterising their dynamics over the 1996–2013 period.

Portugal does not have any official publications that cover the demand for flights broken down by routes and airlines. Nevertheless, some summary information can be found in the yearbooks issued by the airport management company (ANA) and by the civil aviation institute – the Instituto Nacional de Aviação Civil (INAC), the country's highest authority in civil aviation. We therefore submitted a direct request for data to both these organisations, although in certain specific cases we also used data provided by the UK's Civil Aviation Authority (CAA) and the EUROSTAT statistics server. All this enabled us to work with detailed data at the route level for the 1996–2013 period, each route being broken down by carrier for the 2000–2013 period.

The annual figures for the appearance and disappearance of routes need to be identified accurately. For our purposes, we consider a route to be one that records at least 1,280 passengers per year. This figure is obtained by applying a coefficient of 85% occupancy to the operation of at least four 4 flights in a 189-seat aircraft. This threshold allows the discarding of flights operated on an occasional basis at some times during the year, while at the same time it includes seasonal flights to destinations such as Reykjavik that only operate on a weekly basis in August. We only consider intra-EU international routes, as they are the ones that are affected by the liberalisation process and for which it is meaningful to study the decline in non-scheduled flights and the emergence of low-cost carriers. Accordingly, the calculation does not consider domestic flights (Lisbon, Porto and Funchal), flights to Canada (Toronto) and Russia (Moscow and St. Petersburg), and scheduled routes with a triangular structure that largely involve Spanish airports.

Our analysis also distinguishes between the routes involving the pairing of airports and those involving the pairing of cities. This is not a minor difference given the profusion of multi-airport systems in Europe following the emergence of low-cost carriers and their choice of secondary or alternative airports. Furthermore, this distinction permits an initial approach to the fact that although there is no scholarly consensus on the thresholds of distance and time that allow a decision on whether an airport belongs to a specific metropolitan area, here we combined two criteria: a maximum distance of 100 km from the centre of the city in question and/or its marketing by a low-cost carrier under the name of that city. The 100 km threshold is based on an analysis conducted by the European Commission prior to a decision on the proposed merger between the companies Ryanair and Aer Lingus (European Commission, 2007; Copenhagen Economics, 2012), whereby it is reasonable to consider that all those airports that are less than 100 km away from a given city provide it with a service. Nevertheless, the Commission itself admitted that this might be a conservative threshold in some cases, as some case studies have shown (Pantazis and Liefner, 2006). We therefore apply a second criterion based on the airport's marketing, which enables us to associate Hahn with Frankfurt, Torp Sandefjord with Oslo, Västerås with Stockholm and Reus with Barcelona. The multi-airport systems considered are listed in annex 1.

The calculation of the potential population living in the theoretical catchment area of the airports of origin studied is a simple exercise of combining spatial analysis functions, which we performed using the Geographic Information System ArcGIS (v. 9.3) from ESRI. This analysis uses a previously prepared database that links the administrative level LAU2, corresponding to the maximum breakdown in the gathering of census data in most European countries, with population data from censuses held from 1961 to 2011. A catchment area is considered to fall within a radius of 100 kilometres around the airports involved at each date, a threshold that is commonly used in the existing academic literature, as mentioned earlier. Regarding other proposed methods, such as the one using the population data arising

from the CORINE project (Suau-Sánchez et al., 2014), in this case the calculation of the population is more accurate, as it uses census data rather than estimates.

In short, the following sequence of operations was followed:

- The generation of circular buffers with a radius of 100 km from the airports of interest on two reference dates (2000 and 2013).
- The merging of the resulting circles and calculation of the overall population associated with the centroids of the centres of population included in each one of the two major areas, which represent the joint catchment area of all the airports, by means of a spatial aggregation and superimposition function.
- The calculation of the differences in the population affected between the dates by applying an intersection and subtraction function to the geometries of the general catchment areas and associated centroids.
- Additional detailed calculations by countries for the final comparative result between the two dates.

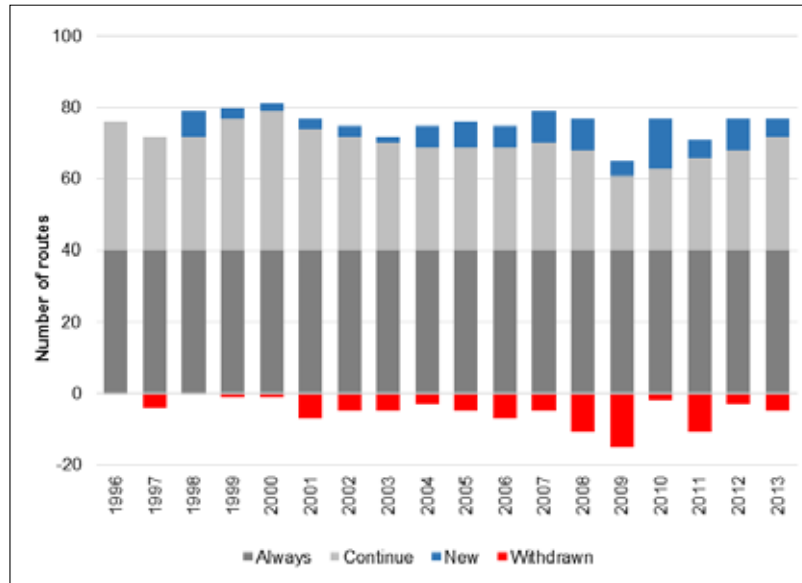
These operations ultimately enabled us to identify certain regional effects of the changes in the supply of direct flights to Faro; in other words, they allowed us to discover not only which areas cease to fall within the supply's catchment area and which ones are incorporated, but also to estimate the volume of the population that has also fallen outside the catchment area and the corresponding volume that has been incorporated.

3. THE TREND IN THE SUPPLY OF INTRA-EU INTERNATIONAL ROUTES

3.1. General outcome

Although the headlines in the press and official statements on the deployment of low-cost carriers at any airport always mention the introduction of new routes, only rarely is reference made to those routes that are withdrawn. Nevertheless, the final result between the two is the factor that determines whether the supply of routes is expanding or shrinking (figure 2). In Faro's case, an analysis of the data provided by the official sources mentioned earlier reveals that the deployment of low-cost carriers has not brought about any significant changes regarding the number of intra-EU international routes operated between 1996 and 2013. The average for this period, 75.3 annual routes, provides a useful snapshot of the airport's reality, as the graph clearly shows few variations, except for the minimal one in 2009. Indeed, the standard deviation recorded is 3.7, and the coefficient of variation does not reach 5%. This stability is also apparent when computing the opening and closing of routes during this time frame, as it enables us to confirm that 40 routes have operated on an uninterrupted basis for over 14 years. Moreover, a considerable number of routes are operated over at least two consecutive years, so the changes in the arrangement of the supply of routes have been minimal and highly influenced by a carrier's appearance on the scene, as was the case with Ryanair's new base in 2010. Furthermore, the network adjustments made by Ryanair are the ones that have had the biggest impact on the yearly results in terms of the number of routes.

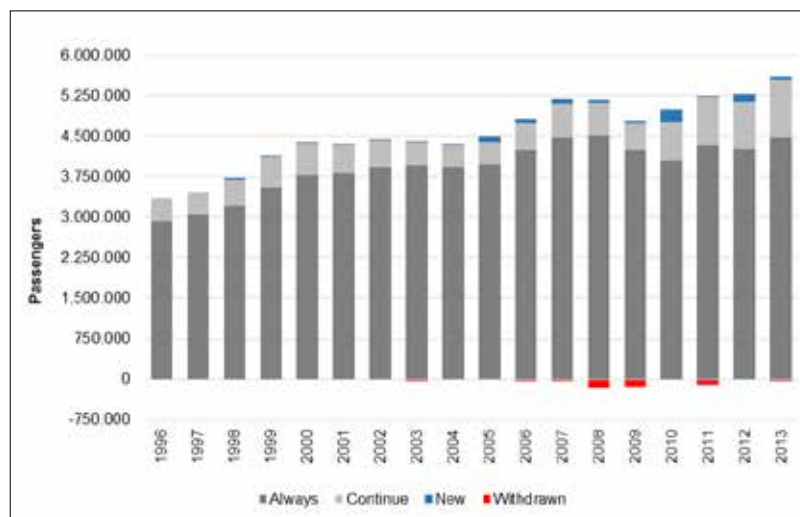
Figure 2. General dynamics of Faro Airport's routes (1996-2013)



Source: Authors' own work based on unpublished data from ANA and EUROSTAT (2003)

On the other hand, these 40 routes are extremely important for the airport in terms of the flow of traffic that they record: in 2013, they channelled 79.8% of intra-EU international passengers (figure 3). Between 2009 and 2010, however, that market share fell suddenly from 88.4% to 81.1%, coinciding with the aforementioned opening of Ryanair's base. The carrier's decision to create a network of links that incorporated airports that had not hitherto had any flights to Faro largely helps to explain this situation. As of that moment, there are no significant variations in the weight of the traditional routes, so only the coming years will tell whether new links will corner a bigger market share.

Figure 3. Passengers transported in Faro by types of routes according to their dynamics (1996-2013)

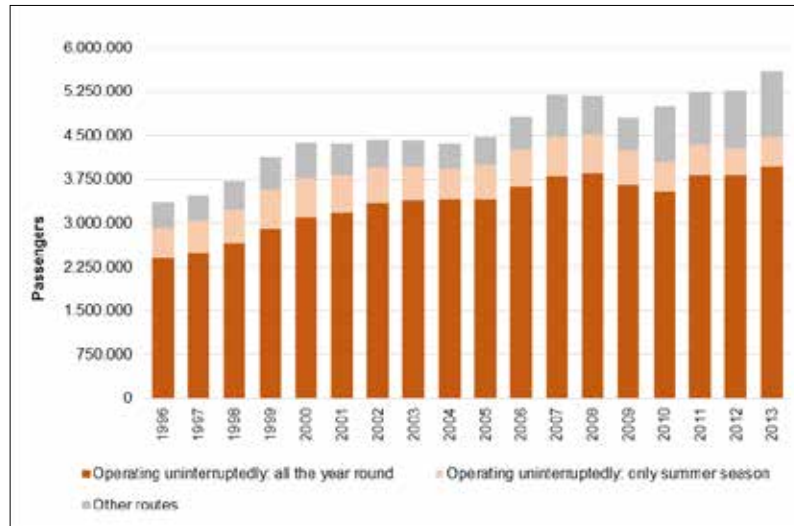


Source: Authors' own work based on unpublished data from ANA and EUROSTAT (2003)

Given the airport's markedly seasonal nature, there is obviously a significant fluctuation in routes between summer and winter. While the number of routes peaks in August, which coincides with the figure shown in the graph, the lowest figure is recorded in January, with 29 connections in the last winter season. Out of these 29 links, a total of 23 were part of the

group of 40 connections that have remained stable throughout the entire period analysed, being operated all the year round, albeit adapting their frequencies and seating capacity to the fluctuations in demand. In 2013, they accounted for almost 71% of the airport's intra-EU international traffic (figure 4), which gives a good idea of their importance in terms of the tourist demand that they channel: the 17 remaining routes in this group of 40, which have a much more seasonal profile, account for only 9% of the airport's traffic. Although that proportion varied over the period under study, peaking at 78.1% in 2004, it never fell below 70%.

Figure 4. Segmentation according to the seasonality of the routes operating in Faro (1996-2013)

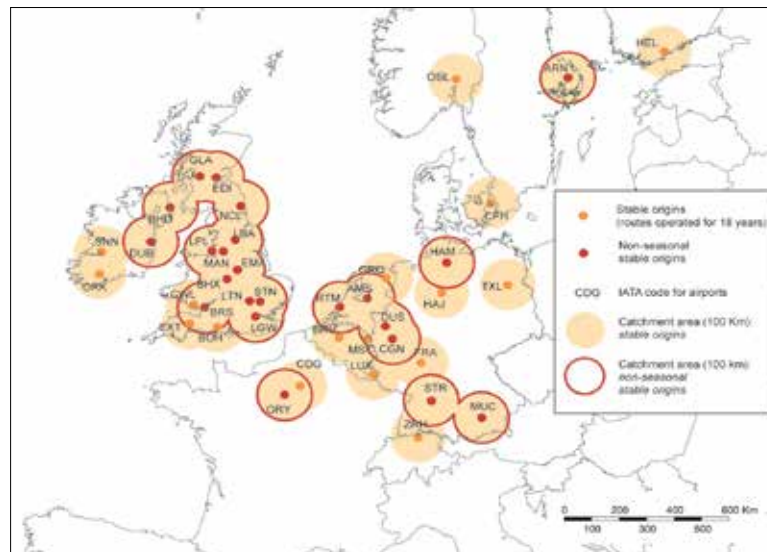


Source: Authors' own work based on unpublished data from ANA and EUROSTAT (2003)

Besides reflecting changes in the airlines' business model, this shows that the routes always prioritise a well-defined set of tourist source locations that can be considered crucial for the Algarve (map 1). Thus, the 40 stable routes cover a potential population of 184.4 million people within the catchment area of the airports of origin, which in terms of the route network operated in 2013 means 76.1%. However, the fact is that the 23 connections that are not of a seasonal nature provide a service for 132 million people, and they alone covered 54.5% of the population served in 2013. Furthermore, these figures have risen since 2000, when they stood at 67.2% and 48.1%, respectively, confirming the trend towards polarisation of the supply from this perspective as well.

Finally, a handful of routes are defined by their ongoing intermittent nature: in other words, they appear and disappear frequently. The connection with Madrid is possibly the most unstable of all, as it was withdrawn and then reinstated 3 times over the 18-month period considered. What is more, when we consider the years 2014 and 2015, we note there is even a fourth reinstatement, which is quite a remarkable development for a route that is considered to be strategic for increasing the number of Spanish tourists visiting the region. The links with Lyon, Rome and Verona record three withdrawals and two reinstatements, clear examples of the difficulties in consolidating the tourist flow from the French and Italian markets. The links with the German cities of Dortmund and Karlsruhe were also withdrawn twice, but have since been reinstated for a third time, remaining on the airport's schedule of routes. A further thirteen routes, among which those with the UK prevail, were withdrawn twice during these years.

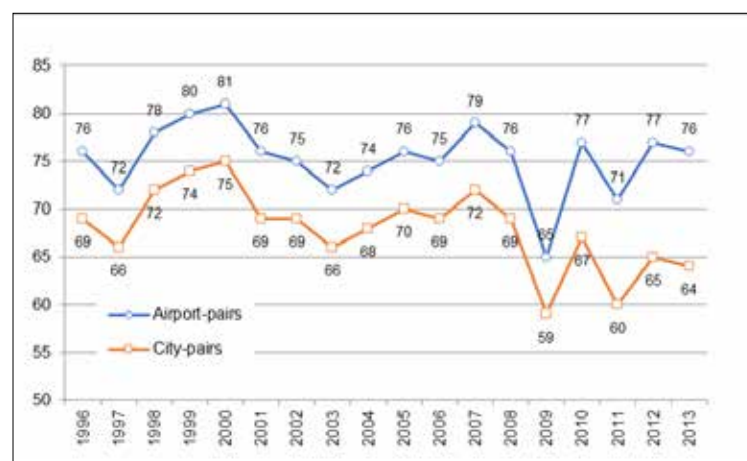
MAP 1. Origin and catchment area of the routes operating on a stable basis with Faro between 1996 and 2013



Source: Authors' own work based on unpublished data from ANA and EUROSTAT (2003)

As regards the origin of the intra-EU international routes operated between 1996 and 2013, it is also noted that the launch of low-cost carriers has not led to any particularly significant changes. A report drafted by the INAC (2012) on the impact of low-cost carriers in Portugal reached much the same conclusion, indicating that their strategy was based not so much on the opening up of new routes, but instead on doubling up the already-existing ones through secondary and/or alternative airports. Indeed, if instead of quantifying the routes as links between pairings of airports, we do so as pairings of cities, considering all the facilities that provide a service for an urban area as a single one, following the criteria described earlier in the method section, the resulting number of links would be 64 in 2013 (figure 5). Furthermore, since 2009, the gap has widened between the results provided by these two calculation methods, indicating that the connections with Faro are now provided by a higher number of secondary and/or alternative airports. This process is linked to the opening of Ryanair's base, which until recently has shown a clear preference for these kinds of airports due to their lower operating costs compared with the more traditional hubs.

Figure 5. Difference in the number of routes operated in Faro (1996-2013) depending on the method of calculation



Source: Authors' own work based on unpublished data from ANA and EUROSTAT (2003)

In sum, it is clear that within the new scenario dominated by low-cost carriers and hybrid operators, the connections between city pairings are far from recording the figures that they attained towards the end of the 1990s. At that time, when the supply provided by non-scheduled flights and charter companies accounted for between 80% and 90% of the airport's international traffic, the highest figure was recorded for the period analysed, with a total of 75 links in 2000.

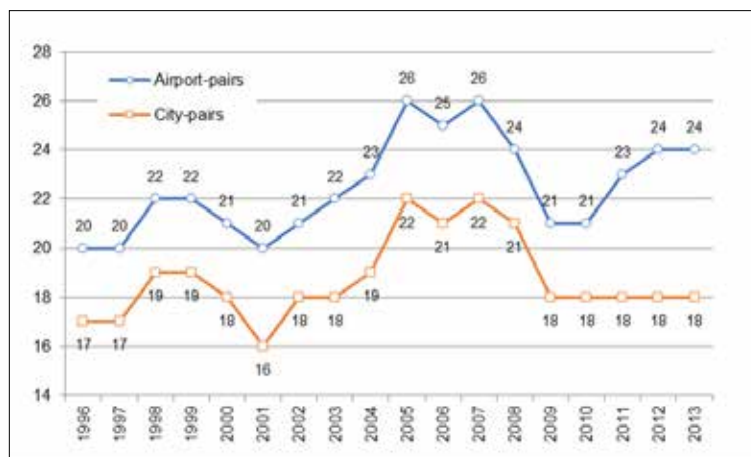
3.2. Results by markets

The overall assessment made of the airport's supply of routes should be complemented by a scale analysis of the source markets, with the aim of detecting specific patterns of behaviour over this period in which low-cost carriers have consolidated their positioning. We present individual analyses for the two main source markets, the UK and Germany, as in 2013 they originated 51% of the airport's connections and accounted for almost 70% of its traffic.

3.2.1. The UK market

In the UK's case, by 1996, Faro was already connected with 18 UK airports serving 15 cities. By 2013, the number of airports had risen to 24 and the number of cities to 18, although the diversification of cities peaked in 2005 (figure 6). Nevertheless, the shift from non-scheduled to scheduled operations and the emergence of low-cost carriers are marked by remarkable stability in the routes operated, as the 16 connections between airport pairings operating uninterruptedly throughout all the years in the period under study only saw a slight reduction in their market share: whereas in 1996 they accounted for 95% of the traffic between Faro and the UK, in 2013 they slightly exceeded 90%. Nevertheless, the traffic records a more balanced distribution across the routes operated (the Gini coefficient fell from 0.65 in 1998 to 0.52 in 2013), a situation that has been reached following a highly heterogeneous trend in the volume of passengers that each of them channelled as of 1996.

Figure 6. Difference in the number of UK-Faro routes (1996-2013) depending on the method of calculation



Source: Authors' own work based on unpublished data from ANA and EUROSTAT (2003)

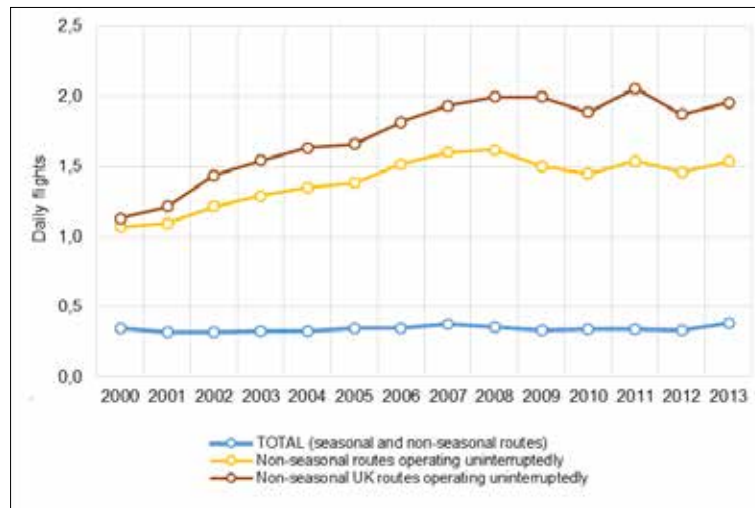
Certain routes have proven to be remarkably unstable, being withdrawn only shortly after opening (Coventry, Humberside, Norwich and Kent), even though in some cases they managed to attract high volumes of traffic (Coventry exceeded 50,000 passengers in 2006). Following an initial stage of sharp growth, other airports, such as Bournemouth, Exeter, Doncaster and Cardiff, in 2007–2008 began a steady downturn that in some cases led to the loss of almost half of their traffic. In fact, only in the cases of Bristol, Liverpool, Leeds,

Belfast International and Glasgow Prestwick can it be stated that there was a clear process of growth and consolidation of routes that was secondary back in 1996. In Belfast's case, the trend is also linked to the general strengthening of the flows between Faro and Northern Ireland following the opening of Ryanair's base in 2010, including the diversification of the routes operated, with flights to Londonderry and Belfast's second airport. On the other hand, the growth recorded by Prestwick and Liverpool is linked to the lower figures for Manchester and Glasgow, reflecting a clear redistribution of the air traffic between airports with a significant overlap in their catchment areas. The same applies to Greater London, where Gatwick lost ground to Luton and Stansted, while for the time being Heathrow has dropped off the map, with the incorporation of London City and the refurbished airport in Southend. In short, a redistribution of traffic occurred that nonetheless has not stopped a loss in London's overall market share with Faro; while by 2013 it accounted for barely 34.1% of the traffic between the Algarve and the UK, in 1996 the figure was close to 49%. This fits the pattern posited by Pearce (1987) for mature tourist destinations, where ground is steadily gained by connections with regional airports in the more consolidated source markets at the expense of the links with the capital.

Therefore, low-cost carriers have adapted their operations to the pattern of routes built up over decades by the non-scheduled supply, with the instability noted in certain connections being related to the process of adjusting those routes to the operating bases of the foremost low-cost carriers (Luton and Stansted are the main bases for easyJet and Ryanair), to the opening of new bases by carriers that have made the move from charter flights to scheduled services (Monarch in Leeds Bradford) or to the specific strategy at certain airports (Liverpool has awarded generous incentives to low-cost carriers, while Manchester has been more inclined to favour network operators). The replacement process has almost concluded, which means that by 2013 the only links provided solely on a non-regular basis were those with Cardiff and Doncaster, with a further eleven airports providing both types of supply and the remaining eleven now only marketing scheduled flights.

On the other hand, the 40% difference noted between the number of UK visitors that officially stay in the region and the number arriving at the airport is a clear indication of the surge in residential tourism from the UK. This phenomenon helps to explain the consolidation of a more stable and frequent supply of flights on some of the busiest routes. Indeed, out of the 23 intra-EU international routes that over the past 18 years have been available from January to December, a total of 13 involve UK airports, being those in which, together with Dublin, the weekly supply of flights has grown more quickly, rising on average from 1 to 2 daily flights, while the figure for the overall number of routes involving the airport has hardly varied between 2 and 3 weekly flights, the traditional pattern of non-scheduled operations (figure 7).

Figure 7. Daily flights depending on the type of routes operated in Faro (2000-2013)



Source: Authors' own work based on unpublished data from ANA

3.2.2. The German market

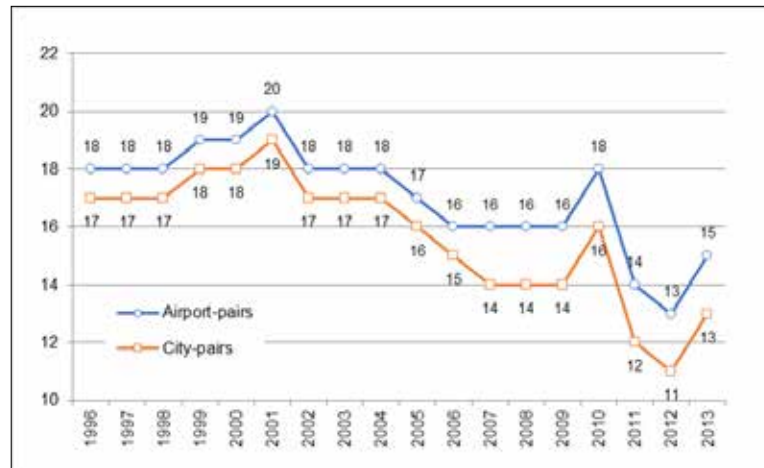
Turning to Germany, the drop in the number of tourist arrivals recorded since the mid-1990s has not led to a significant reduction in the number of routes operated: 17 airports had a direct connection to Faro in 1995, while the figure was 15 in 2012, which in terms of cities served means a drop from 16 to 13. The number of routes operated peaked in 2001, coinciding with the culminating point in a 3-year period of growth for incoming German passengers (figure 8). As regards the distribution of passengers across the different routes, there is less stability than that observed for the UK: the eight routes operated uninterruptedly between 1995 and 2013 lost more than 20 points of market share over that period, accounting on the last date for 61% of the traffic between Germany and Faro. What is important is that this drop materialised as of 2005, and at that time it accounted for 81% of the demand.

Ryanair's appearance on the scene in 2010, following the opening of its Faro base, simply reduced the dominance of those 8 main routes, as the Irish carrier operated in Germany from a significant number of secondary airports, at which the presence of charter companies and/or connections with Faro had been scarce or non-existent (which explains the upturn in the number of routes in 2010). The growth of Weeze, Hahn, Karlsruhe and Memmingen are clear examples of this. Quite the opposite applies to the airports at Dresden, Erfurt, Münster, Nuremberg, Paderborn and Saarbrücken, where after a period of stable connections with Faro that had lasted for over 10 years, and even as long as 15, recording as many as 20,000 passengers, by 2013 there were longer any direct flights to the Algarve. Although there appears to be a balanced outcome between the withdrawn routes and the new connections, there are two significant implications: on the one hand, a tendency towards an increase in the supply at secondary airports close to the country's main urban centres, as Hahn and Weeze operate largely as alternatives to Frankfurt and Düsseldorf, and on the other, the instability observed on certain routes, basically those operated by Ryanair on its own, as revealed by the prompt withdrawal of Faro's connections with Lübeck, Leipzig and Karlsruhe, which in the first two cases were restricted to a single summer season (2010 and 2013, respectively). The addition of Dortmund, and especially of Cologne, to Ryanair's network seems to suggest a change in its strategy that prioritises those cities that were traditionally active in the charter era.

It is still too early to say whether the upturn in the number of German tourists arriving in the Algarve between 2012 and 2013 is purely circumstantial, as had already been the

case in 2009 and 2010, or whether it is related to the consolidation of hybrid and low-cost operators. It is, nonetheless, a fact that 80% of the increase in the influx of German visitors to Faro originated from airports at which Ryanair operates, especially Cologne, Dortmund and Leipzig.

Figure 8. Difference in the number of Germany-Faro routes (1996-2013) depending on the method of calculation



Source: Authors' own work based on unpublished data from ANA and EUROSTAT (2003)

Although the residential behaviour of German passengers is not as extended as that of the British, the difference between tourists accommodated and passengers disembarking even exceeds 20% in some years. There are, moreover, several routes on which the proportion of passengers that report owning a home exceeds 15%, such as Dusseldorf, Hamburg, Stuttgart, Munich, Niederrhein/Weeze, Hahn and Lübeck (Almeida, 2009; Pimpão *et al.*, 2012). Nevertheless, this has not led to a general increase in the weekly flights on the different routes operated, as is indeed the case in the UK. In fact, there are few connections involving a daily flight in the summer months, with the winter simply involving the flight to Dusseldorf.

4. THE POPULATION LIVING IN THE CATCHMENT AREAS OF THE AIRPORTS OF ORIGIN: WHAT CHANGES BETWEEN THE CHARTER AND THE LOW-COST ERA?

The variation in the number of routes supplied by Faro Airport over the 1996–2013 period also permits a more complex spatial reading that is crucial for assessing the impact that these changes exert on the coverage of the population living in the regions that send tourists to the Algarve. Although an analysis of the dynamics of the opening and closing of routes may provide important data from a geographical perspective, they do not cater for the inclusion of certain major qualifications. For example, the new connections with secondary airports involve not only an overlap with catchment areas already covered by routes originating at other airports, but also the incorporation of regions that had hitherto been over 100 km away from a direct flight to Faro.

A simple cartographic analysis enables us to compare the changes taking place between 2000 and 2013. We chose these two years because they are representative of two different traffic structures: the non-scheduled supply still prevailed in 2000 and the airport recorded

the highest number of routes operated; and in 2013 the regularisation of the traffic had almost concluded, with low-cost carriers prevailing over their so-called hybrid counterparts.

Maps 2 and 3 show the catchment areas extending 100 km around the airports that in 2000 and 2013 had a direct flight with Faro. Using the latest population data (2011 censuses) and the methodology described earlier, we find that in 2000 those catchment areas covered a population of 274.3 million people, while in 2013 that figure stood at 242.3 million (table 1).

Table 1. Population covered by the network of routes operating with Faro in 2000 and 2013

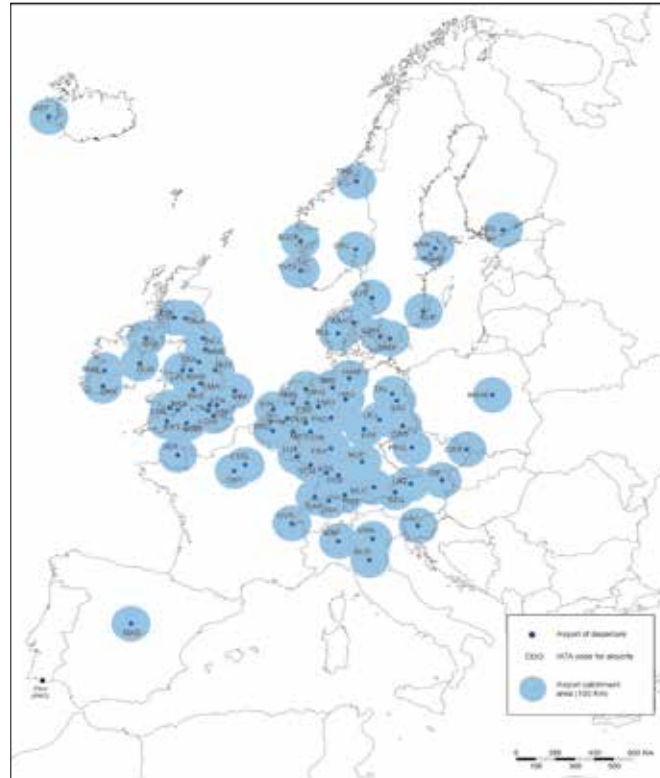
Code	Country	2000			2013		
		Population served	TOTAL Population	Coverage	Population served	TOTAL Population	Coverage
AT	Austria	6.844.922	8.404.252	81,4	972.032	8.404.252	11,6
BE	Belgium	10.508.309	10.951.266	96,0	10.951.266	10.951.266	100,0
CH	Switzerland	7.679.185	7.938.877	96,7	7.232.809	7.938.877	91,1
CZ	Czech Republic	7.639.742	10.479.469	72,9	8.804.775	10.479.469	84,0
DE	Germany	78.894.974	81.752.483	96,5	70.432.595	81.752.483	86,2
DK	Denmark	4.929.674	5.557.201	88,7	4.516.290	5.557.201	81,3
EE	Estonia	43.870	1.298.814	3,4	43.870	1.298.814	3,4
ES	Spain	7.263.942	46.234.392	15,7	844.503	46.234.392	1,8
FI	Finland	1.925.415	5.375.276	35,8	1.925.415	5.375.276	35,8
FR	France	23.176.706	65.131.082	35,6	29.314.853	65.131.082	45,0
HR	Croatia	213.352	4.287.700	5,0	0	4.287.700	0,0
HU	Hungary	564.750	9.952.571	5,7	0	9.952.571	0,0
IE	Ireland	3.840.298	4.555.978	84,3	4.319.619	4.555.978	94,8
IS	Iceland	243.913	318.452	76,6	243.913	318.452	76,6
IT	Italy	21.445.048	59.227.871	36,2	10.439	59.227.871	0,0
LI	Liechtenstein	36.149	36.149	100,0	36.149	36.149	100,0
LT	Lithuania		3.053.338	0,0	1.440.619	3.053.338	47,2
LU	Luxembourg	511.840	511.840	100,0	511.840	511.840	100,0
NL	Netherlands	16.573.829	16.574.989	100,0	16.573.829	16.574.989	100,0
NO	Norway	3.086.387	4.920.305	62,7	2.283.876	4.920.305	46,4
PL	Poland	9.425.680	38.501.195	24,5	16.417.452	38.501.195	42,6
SE	Sweden	5.905.055	9.415.570	62,7	4.454.710	9.415.570	47,3
SI	Slovenia	1.371.925	2.050.189	66,9	0	2.050.189	0,0
SK	Slovakia	1.907.480	5.395.469	35,4	1.059.210	5.395.469	19,6
UK	United Kingdom	60.294.075	63.121.595	95,5	59.897.633	63.121.595	94,9
	TOTAL	274.326.520	465.046.324	59,0	242.287.697	465.046.324	52,1

Note: Population data always refers to year 2011.

Source: Results of the GIS analysis

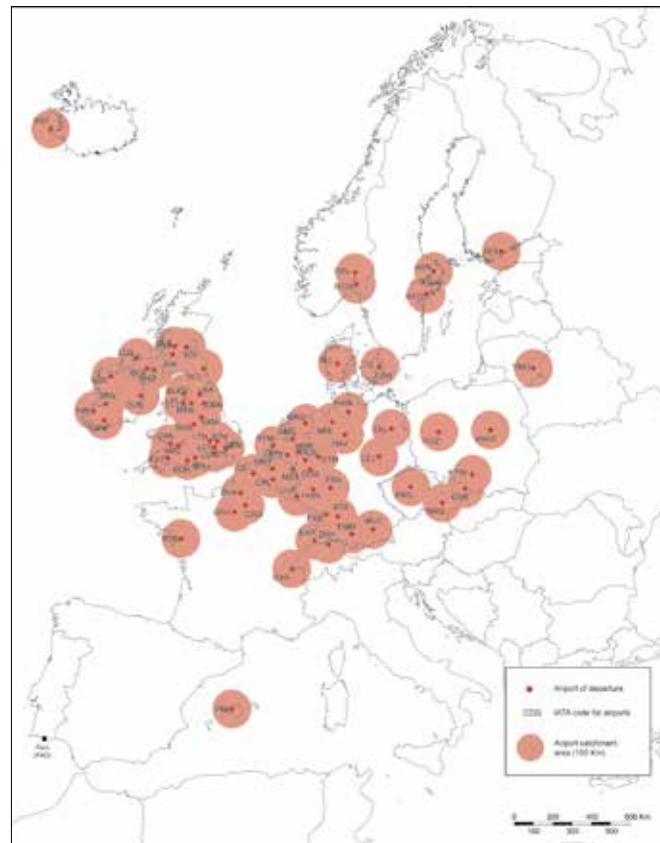
This reduction of 32 million may seem small, as it is no more than 12%, yet it is indicative of a process: following the transition from a model dominated by non-scheduled operators to one in which hybrid carriers prevail, and especially low-cost airlines, the network of connections with Faro has ended up catering for a smaller population volume.

MAP 2. Origin and catchment area of the routes operated with Faro in 2000



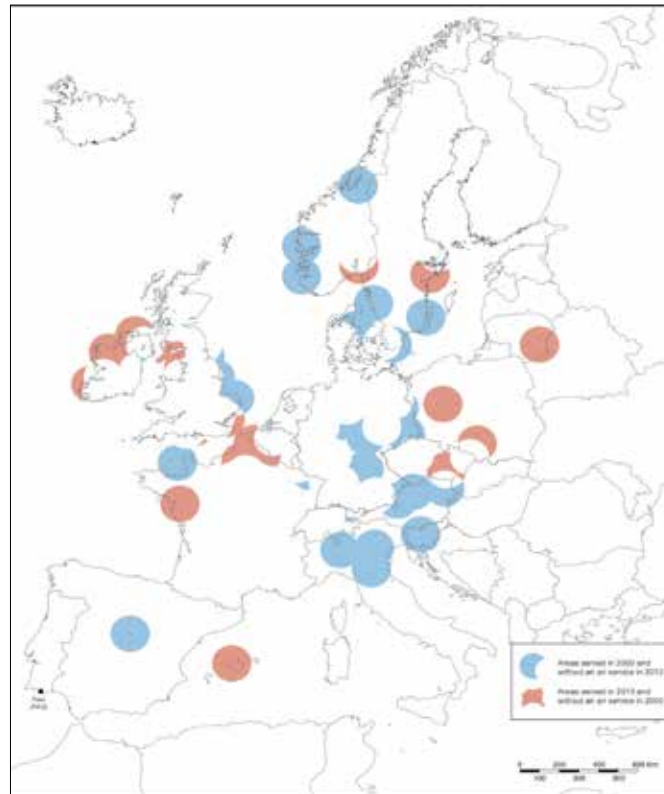
Source: Authors' own work based on unpublished data from ANA

MAP 3. Origin and catchment area of the routes operated with Faro in 2013



Source: Authors' own work based on unpublished data from ANA

MAP 4. Difference between the regions served by the network of routes operated with Faro:
2000 vs. 2013



Source: Authors' own work based on unpublished data from ANA

Table 2 shows that the regions encompassing the new routes' catchment areas have 21 million inhabitants, a figure that far from compensates for the 53 million people now living in areas that are no longer served by the supply of direct flights to Faro. Therefore, the scheduling of routes with airports that previously did not have a direct connection with Faro does not always imply better regional coverage of the source markets or stimulate an increase in demand. If those airports have significantly overlapping catchment areas with others that already have direct links with the Algarve, the final outcome may be a simple sharing of the demand across several infrastructures, as occurs within the backbone of Europe, in the Ruhr Basin and South-East England. Therefore, to gauge the impact of these new routes, it is important to focus on more peripheral areas in geographical terms. Map 4 shows that the connections with Eastern Europe (mostly non-scheduled services) and with the French region of Nord-Pas-de-Calais (through the airports Paris-Beauvais and Brussels-Charleroi) are those that account for the biggest gains. The most significant losses are recorded by Scandinavia and Southern Europe.

Table 2. Difference in the population coverage of the network of routes operated in 2000 and 2013

Country	Population in unserved areas	Population in served areas	Difference
Poland	-189.764	7.181.536	6.991.772
France	-1.478.209	7.616.356	6.138.147
Lithuania		1.440.619	1.440.619
Czech Republic	-325.245	1.490.278	1.165.033
Ireland		479.321	479.321
Belgium		442.957	442.957
Croatia	-213.352		-213.352
United Kingdom	-704.344	307.902	-396.442
Denmark	-413.384		-413.384
Switzerland	-446.376		-446.376
Hungary	-564.750		-564.750
Norway	-1.306.779	504.268	-802.511
Slovakia	-933.308	85.038	-848.270
Slovenia	-1.371.925		-1.371.925
Sweden	-1.970.169	519.824	-1.450.345
Austria	-5.933.238	60.348	-5.872.890
Spain	-7.263.942	844.503	-6.419.439
Germany	-8.512.244	49.865	-8.462.379
Italy	-21.434.609		-21.434.609
TOTAL	-53.061.638	21.022.815	-32.038.823

Note: Population data from 2011.

Source: Results of the GIS analysis

5. THE CASE OF RYANAIR

When we discussed the overall outcome of the dynamics of the routes operated at Faro Airport, we mentioned the significant impact that the opening of Ryanair's new base had on that result in 2010, given the high number of routes that the Irish carrier has operated and the constant opening and closing of destinations within its network. Although in 2010 Ryanair was no stranger to the airport, it significantly reinforced its presence there: its supply jumped from 11 to 31 intra-EU international routes, which in terms of the supply of seats meant multiplying the prior year's figures by 2.3. This gave the airport such a boost that it managed to close its business in 2010 with a sharp increase in the volume of passengers carried that more than made up for the sharp drop recorded in 2009. Furthermore, between 1996 and 2015, the Irish airline operated as many as 39 different international routes, although at the same time it recorded a peak of 31 during the 2010 summer season, a figure that to date it has yet to exceed. Ryanair has therefore been the main beneficiary of several programmes of public subsidies designed to introduce new air routes, and it ended 2014 as

the airport's leading operator in terms of passenger numbers. Accordingly, a more detailed analysis of the regional impact associated with the network of routes operated by Ryanair in Faro will help us to gauge better the impact linked to the prevalence of low-cost carriers at tourist airports.

Although the figures presented in the previous paragraph are considered exceptional by the leading tourist agents in the region, an objective appraisal of the impact of Ryanair's base should not ignore the fact that out of the 20 new routes opened, only 10 were not provided by another operator, and in only three cases (Madrid, Marseille and Milan-Bergamo), there was no significant overlap with the routes operated by other carriers from nearby airports (map 5). In fact, those 10 links operated solely by Ryanair incorporated 22.6 million people into the population served with direct flights in 2010, barely 8.4% of the 270 million included in the catchment areas of the airports of origin in that year. What is more, when we consider that the route with Madrid affects 7.2 million people, the case of Milan-Bergamo 7.7 million and Marseille 5 million, the contribution made by all the other connections is wholly irrelevant from that perspective. This confirms that Ryanair has focused on a direct concurrence in those corridors in which there was a significant traffic potential, rather than in the real opening of new routes. In addition, however, it reveals that in terms of the population served, there are few variations besides those of the three genuinely new routes, which on the other hand were also withdrawn shortly after being opened (Marseille and Milan-Bergamo the following year and Madrid in 2013).

On the other hand, although Ryanair is frequently opening and closing routes, the phenomenon in Faro is no way near to being on a par with the rate recorded in the overall network operated by the Irish carrier (de Wit and Zuidberg, 2012). Further still, it might easily be said that Ryanair has been highly selective when defining the routes that it operates from its Faro base. Of the 31 routes operated at the start of 2010, a total of 22 are still operating in 2015, with 11 of them being part of the small group of connections that have operated uninterruptedly over the past 18 years, while 3 have been operating for more than 12 years at Faro, since 1996. A further 4 links are operations with alternative airports in large metropolitan areas (Charleroi, Weeze, Hahn and Beauvais). We are therefore dealing with a majority of origins with a proven capacity to send tourists to the Algarve, in terms of both their track record and the size of their populations. The 4 remaining routes have very specific characteristics: 3 Irish airports (Kerry, Knock and Derry) are peripheral and have little capacity for sending tourists, but Ryanair's low fares manage to generate a significant amount of traffic, and Memmingen, in the south of Germany, is at the midway point between several large cities, such as Munich, Stuttgart and Zurich, which means a high potential demand. Over this period of time, Ryanair has also ended up withdrawing several routes, with the more noticeable cases being the few months that the links lasted with Lübeck, Marseille and Bergamo. These are the cases that reflect Ryanair's trademark approach to opening new routes that has been identified by Wit and Zuidberg (2012): rather than prior market studies, the process appears to follow a simple strategy of trial and error, whereby if the route does not generate enough income, it is automatically removed during the next scheduling.

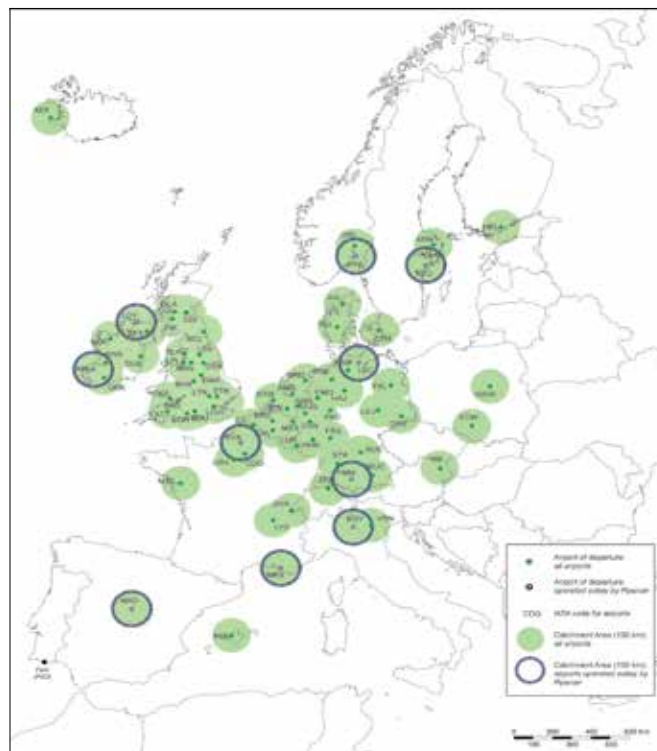
Nevertheless, following the withdrawal of all the links to Scandinavian countries in the summer of 2015, it is obvious that the network operated by Ryanair at Faro tends towards greater spatial concentration, reinforcing as noted the traditional source regions for tourists.

6. CONCLUSIONS

The reduction in the population served by airports with direct flights to Faro has not led to a decrease in the arrival of tourists staying in the Algarve or a reduction in the airport's traffic over the time frame considered, with the exception of 2009. This permits a double-sided reading: a positive one, as it shows how appealing the Algarve is as a tourist destination, especially in a series of significant tourist source markets (United Kingdom, Germany and the Netherlands); and a negative one, as it shows that the region is somewhat incapable not only of diversifying its source markets, but even also of ensuring a certain variety of airports of origin within these very heartlands. This overdependence on a handful of markets within the current context of intense competition among destinations is a major weakness that may have a bearing on the trend in demand over the medium term.

The path followed by low-cost carriers leads to a situation of shadows and light from the perspective considered in this paper. Although it is clear that their presence allows a better adjustment of the supply to the changes detected in the behaviour of tourist demand – the individual organisation of holidays – and new routes being opened with airports that previously had no direct flights with Faro, the analyses conducted reveal that the regional coverage of the network currently operated caters for a smaller population volume than in 2000. The quality of the service has largely been improved (number of weekly flights, range of carriers) in those regions that already had a significant supply, while all the other areas have seen their supply reduced or even cancelled completely.

MAP 5. Catchment areas of Ryanair's new routes at Faro in 2010. A limited regional impact?



Source: Authors' own work based on unpublished data from ANA

Elsewhere, the analysis presented here shows the potential of the Geographic Information System (GIS) as an instrument for supporting the decision-making process in tourism-related and airport management matters. It is clear that one of the criteria to be considered in the incentive-based opening of new routes is better coverage of those areas with a greater

potential for sending tourists to the Algarve, especially when the quality of the flight supply with consolidated markets, such as the UK and Germany, is already very high. A spatial analysis of the data is therefore extremely valuable. Furthermore, this paper has linked the regional coverage of the catchment areas of airports of origin with a single variable, namely population, but others of great significance from a tourism perspective could also be included, such as level of income, or by giving different weightings to air links depending on the weekly flights operated.

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ANNEX 1. Multi-airport systems considered for the calculation of routes between city pairings

Metropolitan Area	Airports	Code	Distance from centre (Km)	Metropolitan Area	Airports	Code	Distance from centre (Km)
Barcelona	Barcelona	BCN	19	Hamburg	Hamburg	HAM	14
	Girona	GRO	93				
	Reus	REU	103		Lübeck	LBC	69
Berlin	Tempelhof	THF	6,5	Katowice-Cracovia	Katowice	KTW	10
	Tegel	TXL	12				
	Schönefeld	SXF	20		Cracovia	KRK	79
Belfast	City	BHD	10	London	City	LCY	11
					Heathrow	LHR	29
					Gatwick	LGW	45
	International	BFS	27		Stansted	STN	52
					Luton	LTN	52
					Southend	SEN	67
Brussels	Brussels	BRU	13	Lyon	Lyon	LYS	29
					Saint Etienne	EBU	77
	Charleroi	CRL	50		Grenoble	GNB	86
Düsseldorf	Düsseldorf	DUS	8,5	Milan	Linate	LIN	13
	Mönchengladbach	MGL	21		Malpensa	MXP	48
	Niederrhein	NRN	67		Bergamo	BGY	51
Stockholm	Bromma	BMA	10	Oslo	Gardemoen	OSL	56
	Arlanda	ARN	40		Rygge/Moss	RYG	69
	Skavsta	NYO	99		Sandfjord/Torp	TRF	103
	Västerås	VST	104				
Strasbourg	Strasbourg	SXB	12	Paris	Orly	ORY	16
					Charles de Gaulle	CDG	26
	Karsruhe	FKB	41		Beauvais	BVA	79
Frankfurt	Frankfurt	FRA	13	Rome	Ciampino	CIA	15
	Hahn	HHN	121		Fiumicino	FCO	30
Glasgow	Glasgow	GLA	14	Vienna	Vienna	VIE	20
	Prestwick	PIK	48		Bratislava	BTS	76
Gothenburg	Säve	GSE	15				
	Gothenburg	GOT	24				

Source: Authors' own work. Distances by road calculated using the application www.viamichelin.com

AIRPORTS' OPERATIONAL PERFORMANCE AND EFFICIENCY EVALUATION BASED ON MULTICRITERIA DECISION ANALYSIS (MCDA) AND DATA ENVELOPMENT ANALYSIS (DEA) TOOLS

João Jardim
Maria Emília Baltazar
Jorge Silva
Margarida Vaz

ABSTRACT

Airport benchmarking depends on airports' operational performance and efficiency indicators, which are important for business agents, operational managers, regulatory agencies, airlines and passengers. There are several sets of single and complex indicators to evaluate airports' performance and efficiency as well as several techniques to benchmark such infrastructures. The general aim of this work is twofold: to balance the data envelopment analysis (DEA) and multicriteria decision analysis (MCDA) tools and to show that airport benchmarking is also possible using a multicriteria decision analysis tool called Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH). Whilst DEA measures the relative performance in the presence of multiple inputs and outputs, MCDA/MACBETH uses performance and efficiency indicators to support benchmark results, being useful for evaluating the real importance and weight of the selected indicators. The work is structured as follows: first, a state-of-the-art review concerning either airport benchmarking and performance indicators or DEA and MCDA tool techniques; second, an overview of the impacts on airports' operational performance and efficiency of emergent operational factors (sudden meteorological/natural phenomena); third, two case studies on a set of worldwide airports and Madeira (FNC) Airport; and fourth, some insights into and challenges for future research that are still under development.

Keywords: Airport Performance and Efficiency, MCDA, DEA, Benchmarking

JEL Classification: L93, O18, R41

1. INTRODUCTION

This work is a part of two MSc theses and one PhD thesis in Aeronautical Engineering – developed under the Business Models for Airport Development and Management (AIRDEV) Project within the MIT-Portugal Program – the aims of which are twofold: to balance the DEA and MCDA tools and to show that airport benchmarking is also possible using a multicriteria decision analysis tool called Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH).

The collected data were related to airports' facilities, considered as inputs – in particular runways, aircraft parking stands, both passenger and cargo terminal areas, check-in desks, baggage carousels and boarding gates – and to airport statistics, namely passengers, aircraft

movements and cargo, which were considered as outputs. An emergent operational factor related to sudden meteorological/natural phenomena was also taken into account as input for a self-benchmarking study within Madeira Airport (FNC).

This work is organised as follows: first, a state-of-the-art review concerning airport benchmarking and performance indicators and DEA and MCDA tools and techniques; second, the impacts on airports' operational performance and efficiency of emergent operational factors (sudden meteorological/natural phenomena); third, two case studies concerning a set of worldwide airports and Madeira (FNC) Airport; and fourth, some insights into and challenges for future research that are still under development.

2. AIRPORT BENCHMARKING AND PERFORMANCE INDICATORS

Duarte and Ventura (2013) advocate a systemic approach that helps any organisation to optimise the sequence of activities so that it may improve its results. Benchmarking is a self-improvement tool for any organisation: it allows it to identify its own strengths and weaknesses, to compare itself with others and to learn more about how to improve its efficiency. Benchmarking is an easy way to find and adopt the best practices to achieve the desired results (Spendolini, 1992; Bogan and English, 1994).

Graham (2005) underlines that benchmarking within the airport industry began to be accepted as an important management achievement just fifteen to twenty years ago, mainly because in the past the commercial and business pressures within the airport sector were less pronounced and airports were almost under governmental ownership; nowadays, among several strategies aiming to achieve economic development, the weight that large infrastructures such as airports (and their related performance and efficiency) represent for attracting investment stands out (Prada-Trigo, 2014). Airport benchmarking is a key component of airports' planning procedure (Adler *et al.*, 2013). It is a process that, being statistical, is an accounting one too, used to monitor airports' performance indicators. Benchmarking is a key feature in the implementation of an airport's strategic plan and its importance extends so far as to identify the best practices to increase efficiency and quality (Oum and Yu, 2004). The ACI (2012) summarises the benchmarking process as follows:

- It is about management and organisational change first and measurement and technology second;
- It provides a diagnostic tool to check whether all systems are in alignment and working properly;
- On a self-benchmarking basis, it is an excellent management tool to monitor performance improvements;
- External benchmarking is an effective way to identify best practices to determine whether they can be incorporated into an organisation and to identify faulty practices with the aim of eliminating them;
- A tool to link strategic goals, employee involvement and productivity.

Humphreys (2002) identifies the entities that are particularly relevant to airports' benchmarking process:

- State/government, for economic and environmental regulation reasons;
- Airlines, to compare costs and performance across airports;
- Managers, to run the business;
- Passengers, to evaluate the service that they receive;
- Owners, to understand business performance and how to return the investment.

There are several works on airport benchmarking, each using different performance indicators. Some of them use single indicators, for example the number of aircraft parking

positions (ATRS, 2009; Ferreira *et al.*, 2010; ACI, 2012), while others consider complex indicators such as the number of passengers per area of the passenger terminal (Braz, 2011; Braz *et al.*, 2011; Jardim, 2012; Baltazar *et al.*, 2013). The indicators can be divided into two major groups, single and complex, for which we used the DEA and MACBETH tools, respectively. The indicators included in our analysis are shown in Table 1.

Table 1. Single and Complex Indicators

Single indicators	DEA	Inputs	Number of Runways Number of Aircraft Parking Stands Passenger Terminal Area Cargo Terminal Area Number of Boarding Gates Number of Check-In Counters Number of Baggage Carousels
		Outputs	Natural Phenomenon Aircraft Movements Processed Passengers Processed Cargo (Ton.)
Complex indicators	MACBETH	PAX/PAX TA	Processed Passengers / Passenger Terminal Area
		CARGO/CARGO TA	Processed Cargo (ton.) / Cargo Terminal Area
		MOVS/STANDS	Aircraft Movements / Number of Aircraft Parking Stands
		MOVS/RWS	Aircraft Movements / Number of Runways
		PAX/GATES	Number of Passengers Processed / Number of Boarding Gates
		PAX/CHK-IN	Number of Passengers Processed / Number of Check-In Counters
		MOVS/GATES	Number of Movements / Number of Boarding Gates
		MOVS/BELTS	Number of Movements / Number of Baggage Belts (arrivals)
		OP TIME/TOTAL T	Natural Phenomenon: Operational Time / (24 h 365 days)

Source: Authors

This work tries to demonstrate that it is possible to achieve airport rankings by following a (new) multicriteria approach allowing the proper choice of both the indicators and the related weights. This enables all the interested parties (including passengers) to produce their own ranking, which may be compared at the end of the entire process. Another interesting feature of this method is the ability to compare the performance/efficiency either of the airport with other similar infrastructures or of the airport in different years, thus offering airport managers the possibility to remain in touch with the evolution of the infrastructure.

3. DEA AND MACBETH METHODOLOGIES AND TOOLS

As mentioned, the aims of this study are twofold: to balance the DEA and MCDA tools and to show that airport benchmarking is also possible using a multicriteria decision analysis tool called Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH). Whilst DEA is a linear programming-based technique for measuring the relative performance of organisational units in the presence of multiple inputs and outputs (Lai *et al.*, 2012, 2015), MCDA/MACBETH uses performance and efficiency indicators to support benchmark results, being useful for evaluating not only the real importance of the selected indicators but also their correct weight.

3.1 DEA – Data Envelopment Analysis

DEA is a non-parametric method designed to measure, in our case, the performance of an airport using a decision-making unit (DMU). It has several models, and the one chosen for this study was the basic analysis, CCR. The name (CCR) comes from its creators (Charnes, Cooper and Rhodes), and it is also known as CRS (Constant Return to Scale) (Ferreira *et al.*, 2010). The CCR is related to constant returns, and the improvement obtained in the output is proportional to that observed in the inputs. The DEA software used was SIAD (Integrated Decision Support System) (Meza *et al.*, 2005), a CCR model with input-oriented analysis (minimising inputs while keeping output values fixed).

As Meza *et al.* (2005) describe, each k^{th} DMU, $k = 1, \dots, n$, is considered to be a production unit that uses r inputs x_{ik} , $i = 1, \dots, r$ to produce s outputs y_{jk} , $j = 1, \dots, s$. The CCR model described by equation (1) maximises the ratio between the linear combination of outputs and the linear combination of inputs, with the constraint that for each DMU that ratio cannot be greater than one (equation 2). Therefore, for a particular DMU o , h_o is its efficiency, x_{io} and y_{jo} are its inputs and outputs, and v_i and u_j are the calculated weights for the inputs and outputs, respectively. After some mathematical manipulations, the model can be rewritten, yielding a linear programming problem (LPP) (equations 3 and 4).

$$\text{Max } h_k = \frac{\sum_{r=1}^m u_r t_r^{j0}}{\sum_{i=1}^n v_i w_i^{j0}} \quad (1)$$

subject to:

$$\frac{\sum_{r=1}^m u_r t_r^j}{\sum_{i=1}^n v_i w_i^j} \leq 1, \quad j = 1, 2, \dots, s \quad (2)$$

$$\text{max } h_o = \sum_{j=1}^s u_j y_{jo} \quad (3)$$

subject to,

$$\begin{aligned}
 \sum_{i=1}^r v_i x_{io} &= 1 \\
 \sum_{j=1}^s u_j y_{jk} - \sum_{i=1}^r v_i x_{ik} &\leq 0, \quad k = 1, \dots, n \\
 u_j, v_i &\geq 0 \quad \forall i, j
 \end{aligned}
 \tag{4}$$

As an LPP is solved for each DMU, if we have n DMUs, n LPPs must be solved, with $r + s$ decision variables. The model just presented is the basis for all other DEA models (Meza *et al.*, 2005).

As Ferreira *et al.* (2010) highlight, DEA tries to maximise the relationship between the goods produced (outputs) and the material spent on their production (inputs) by defining the weight of each output/input. The only constraint of the model is that the efficiency of all DMUs cannot be greater than the unit if using the weight assigned to the analysed DMU. The DEA tool is also useful for defining benchmark units, which are determined by the projection of the inefficient DMUs on the efficient frontier. The way in which this projection is made defines the input/output orientation model: the input-oriented model used to minimise inputs while keeping the values of the output constant or the output-oriented model used to maximise the results without decreasing the assets.

3.2 Multicriteria Decision Analysis Approach and the MACBETH Tool

Since the beginning of history, humans have taken decisions. This is probably one of the most common human tasks. Every day one finds a set of problems and related decisions that are neither easy nor linear to solve. When making a decision, one generally takes into account several criteria that are more or less conflictive. In a stressful situation, if one must consider just one factor, usually the option is the most relevant. Thus, conflicts could exist between several criteria and therefore the decision maker has to consider the pros and cons of each one to reach the final (optimal) solution. This is the basis of a multicriteria decision problem.

As Bana e Costa *et al.* (2012) assert, MACBETH is a user-friendly multicriteria decision analysis approach that requires only qualitative judgements about differences in value to help a decision maker, or a decision advisory group, to quantify the relative attractiveness among several options.

As presented by Bana e Costa *et al.* (2012), MACBETH has a complex formulation, and Gómez *et al.* (2007) describe the basics of this tool's mathematical foundations. Consider X (with $\#X = n \geq 2$) as a finite set of elements (alternatives, choice options, courses of action) for which a group or an individual, J , wants to compare their relative attractiveness (desirability, value).

X defines ordinal value scales, which are quantitative representations of preferences, reflecting numerically the order of attractiveness of the elements of X for J . An ordinal value scale is constructed following a straightforward process; J is able to rank the elements of X by order of attractiveness – either directly or through pairwise comparisons – to determine the elements' relative attractiveness.

When the ranking is defined, it is necessary to assign a real number $v(x)$ to each element x of X , in such a way that:

1. $v(x) = v(y)$ if and only if J judges equal attractiveness between the elements x and y ;
2. $v(x) > v(y)$ if and only if J judges x to be more attractive than y .

Equally, a value difference scale is defined for X as the preferences' quantitative representation, to be used to reflect not only the order of attractiveness of the elements

of X for J , but also the differences in their relative attractiveness, that is, the strength of J 's preferences for one element over another. J provides preferential information about two elements of X at a time, firstly by ordinal judgement (of their relative attractiveness) and secondly, if the two elements are not considered to be equally attractive, by expressing a qualitative judgement about the difference in attractiveness between the most attractive of the two elements and the other one.

To ease the judgemental process, six semantic categories of differences in attractiveness are offered to J as possible answers: "very weak", "weak", "moderate", "strong", "very strong" or "extreme" or a succession of these (in the case that hesitation or disagreement arises).

By comparing the elements of X pairwise, a matrix of qualitative judgements is filled in, either with only a few pairs of elements or with all of them (in which case $n \cdot (n - 1) / 2$ comparisons would be made by J).

Thus, before developing any model, it is necessary to obtain as large an amount of data as possible. The next step is to create a decision tree with nodes, that is, a decision model; the nodes correspond to the indicators that will be taken into account, so the choice of nodes is one of the key issues in the development phase.

Subsequently, data need to be obtained to fill the performance table of each indicator; this is a crucial step that even influences the node choice because only if the data collection fills the performance table for each indicator is it possible to use that indicator within the work.

Within the next step, each decider defines the attractiveness of each indicator in the tree; after considering the attractiveness of each node, the decision maker must define the attractiveness difference between each pair of indicators in the model too. Following the introduction of these values for each node, it is possible to produce a robustness table, still giving the opportunity to the decider to adjust the sensibility of the model (Braz *et al.*, 2011).

4. THE IMPACTS OF NATURAL (WEATHER) PHENOMENA ON AIRPORTS' OPERATIONAL PERFORMANCE AND EFFICIENCY

It is well known that aviation presents a high level of sensitivity to the weather, involving major impacts on the safety, efficiency and capacity of aviation operations. Consequently, under those conditions, the capacity of airports is highly reduced by the need to increase the separation between aircraft, the need for additional holdings or the closure of one or even all of the runways, thus affecting their operational performance. Such weather phenomena, from the point of view of airport operations, include thunderstorms, turbulence and gusts, heavy snowfall (Figure 1) and runway icing, low visibility due to fog and, most recently, volcanic ash in the airspace due to volcanic eruptions. As a result, the operational capacity of a region's entire airspace is reduced through delays, diversions and flight cancellations, all of which have severe effects on travellers.

Figure 1. Heavy Rain at Cancun Airport



Source: Morales, 2012

An airport has a number of basic characteristics, all of which are considered to be combined with specific weather hazards, such as local weather phenomena and climatic conditions, the topography of the region, the orientation of the runways and so on. However, due to (sudden) climate changes, these phenomena will each become more common and produce growing negative impacts; therefore, in our opinion, an individual self-benchmarking study has to be performed for each airport – or the most vulnerable ones – to investigate its susceptibility to adverse weather conditions, since the conclusions reached for one airport of course do not automatically hold for others (Sasse and Hauf, 2003).

5. CASE STUDIES

In the first case study, we use the same airport data as Ferreira *et al.* (2010) but add some more, not only airport but also performance indicators, both chosen from the ATRS's (2009) publication, to produce an efficiency ranking of a set of worldwide airports using both the DEA and the MACBETH tool. In the second case study, we use data collected from a Portuguese airport, Madeira (FNC), on Madeira Island, from 2007 to 2011, to self-benchmark such an infrastructure using both the DEA and the MACBETH tool using the same performance indicators as in the previous case but also adding the number of closure hours per year due to natural (weather) effects.

5.1 Efficiency of a Set of Worldwide Airports

Ferreira *et al.* (2010) obtained an efficiency ranking of some worldwide airports, especially focused on Brazilian infrastructures, using a DEA approach. The authors used seven individual performance indicators to produce their ranking: four inputs (number of runways (RWS), number of aircraft parking positions (STANDS), passenger terminal area, m^2 (PAX TA), and cargo terminal area, m^2 (CARGO TA)) and three outputs (number of aircraft operations (MOVS), number of processed passengers (PAX) and cargo volumes, *tons* (CARGO)). After a review of the state-of-the-art literature as well as taking into account the opinions of some

experts on airport benchmarking, we decided to add other inputs, namely the number of check-in desks (CHK-IN), number of boarding gates (GATES) and number of baggage belts (BELTS). Equally, we used some new airports, with a number of processed passengers higher than 19,000,000, as presented in the ATRS (2009) report. Thus, it was necessary to obtain the appropriate data, as presented in Table 2.

We used all these data to obtain an efficiency ranking based on the DEA and MACBETH approaches; note that if we had introduced these indicators as single ones within MACBETH, as mentioned, we would produce not an efficiency ranking but a performance one. Then, it was necessary to obtain new indicators, which we called complex ones, combining the above inputs and outputs, as suggested in Table 1. In that table, “movements” includes the number of aircraft landing at/taking off from the airport; “passengers” includes the number of passengers who arrive at and depart from the airport; and “cargo” includes the number of cargo tons that arrive at and depart from the airport, being domestic or international, freight or mail flights. Afterwards, we divided the work into two different parts to verify any position changes in the ranking due to the addition of new performance indicators: a) the DEA and MACBETH cases, which include the same inputs and outputs as those used by Ferreira *et al.* (2010); and the DEA+ and MACBETH+ cases, including all the performance indicators presented in Table 2, (Table 3).

Table 2. Airports Data

			Statistics 2011										
			INPUTS								OUTPUTS		
			IATA	RWS	STANDS	PAX TA	CARGO TA	CHK-IN	GATES	BELTS	MOVS	PAX	CARGO
South America	Brazil	Guarulhos	GRU	2	66	179790	64752	320	61	23	270600	30003428	515175
	Brazil	Galeão	GIG	2	53	280681	41800	150	50	15	139443	14952830	114097
	Brazil	Viracopos	VCP	1	11	8720	67458	70	9	4	99982	7568384	283267
	Brazil	Manaus	MAO	1	15	46266	9300	53	5	4	56298	3019426	179082
	Argentina	Aeroparque ¹	AEP	1	68	30000	10000	55	16	9	81675	5320292	13741
	Argentina	Ezeiza ²	EZE	2	42	71000	203827	143	23	11	93346	8786807	248692
North America	Canada	Calgary	YYC	3	45	123000	54812	118	50	9	162000	12844523	116000
	Canada	Vancouver	YVR	3	108	255000	96200	250	95	14	296942	17032780	223878
	Canada	Toronto	YYZ	5	141	251054	84575	370	108	24	428477	33400000	492171
	Canada	Montreal ²	YUL	3	64	72720	135000	208	60	13	217545	13660862	112000
	EUA	Tampa	TPA	3	75	174374	22300	116	59	14	191315	16732051	81822
	EUA	Atlanta	ATL	5	172	340955	130846	124	207	17	923991	84962851	638127
Asia - Pacific	Japan	Tokyo	NRT	2	141	783600	815580	584	67	28	183451	28068714	1898885
	Japan	Central Japan	NGO	1	66	220000	260000	180	28	9	82137	8890683	143134
	Singapore	Changi	SIN	2	85	650000	510000	444	92	15	301711	46543845	1865252
	Australia	Sydney	SYD	3	93	354000	53850	258	56	23	280910	35630549	249159
	China	Hong Kong	HKG	2	120	710000	351600	377	75	12	334000	53904000	3938000
	Dubai	Dubai	DXB	2	144	1444474	78600	400	82	31	326317	50980000	2190000
Europe	Germany	Munich	MUC	2	135	469400	58250	310	200	28	409956	37782256	303655
	Germany	Frankfurt	FRA	4	189	800000	90000	381	120	31	487162	56443657	2169304
	UK	Gatwick	LGW	1	115	258000	20300	348	94	16	244741	33639900	88214
	Serbia	Belgrade	BEG	1	22	40000	7300	47	16	4	44923	3124633	8025
	Italy	Milan	MXP	2	139	142000	45000	313	93	15	186780	19291427	440258
	Spain	Barcelona	BCN	3	168	674759	43692	258	149	28	303054	34398226	96572

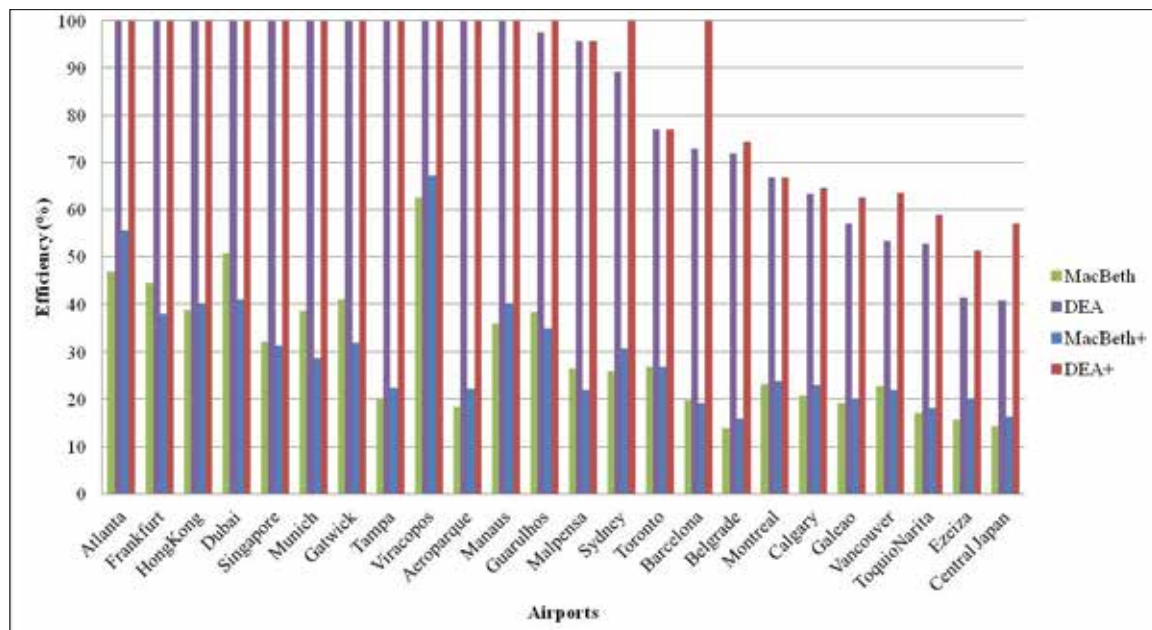
¹ Statistics data for 2006, ² Statistics data for 2010

Table 3. Airports Position in the Efficiency Ranking for all the Case Studies

DMU	DEA efficiency (%)	DEA Rank	DEA+ efficiency (%)	DEA+ Rank	MACBETH efficiency (%)	MACBETH Rank	MACBETH+ efficiency (%)	MACBETH+ Rank
Atlanta	1	1	1	1	46,83	3	55,63	3
Frankfurt	1	1	1	1	44,32	4	37,80	5
Hong Kong	1	1	1	1	38,75	6	39,90	8
Dubai	1	1	1	1	50,61	2	40,95	2
Singapore	1	1	1	1	32,29	10	31,42	4
Munich	1	1	1	1	38,6	7	28,74	12
Gatwick	1	1	1	1	41,03	5	31,99	7
Tampa	1	1	1	1	20,15	17	22,42	17
Viracopos	1	1	1	1	62,51	1	67,19	1
Aeroparque	1	1	1	1	18,35	20	22,15	14
Manaus	1	1	1	1	35,77	9	40,14	6
Guarulhos	97,44	12	1	1	38,26	8	34,83	11
Malpensa	95,67	13	95,67	15	26,5	12	21,95	21
Sydney	89,05	14	1	1	25,85	13	30,76	9
Toronto	76,91	15	77,00	16	26,85	11	26,98	18
Barcelona	72,83	16	1	1	19,86	18	19,08	22
Belgrade	71,87	17	74,38	17	13,83	24	15,87	24
Montreal	66,87	18	66,87	18	23,32	14	23,93	10
Calgary	63,28	19	64,45	19	20,85	16	23,12	13
Galeao	57,05	20	62,53	21	19,16	19	19,91	16
Vancouver	53,29	21	63,48	20	22,81	15	22,09	15
Tokyo Narita	52,72	22	58,93	22	17,1	21	18,19	19
Ezeiza	41,38	23	51,39	24	15,79	22	20,05	20
Central Japan	40,68	24	56,95	23	14,39	23	16,26	23

Source: Authors

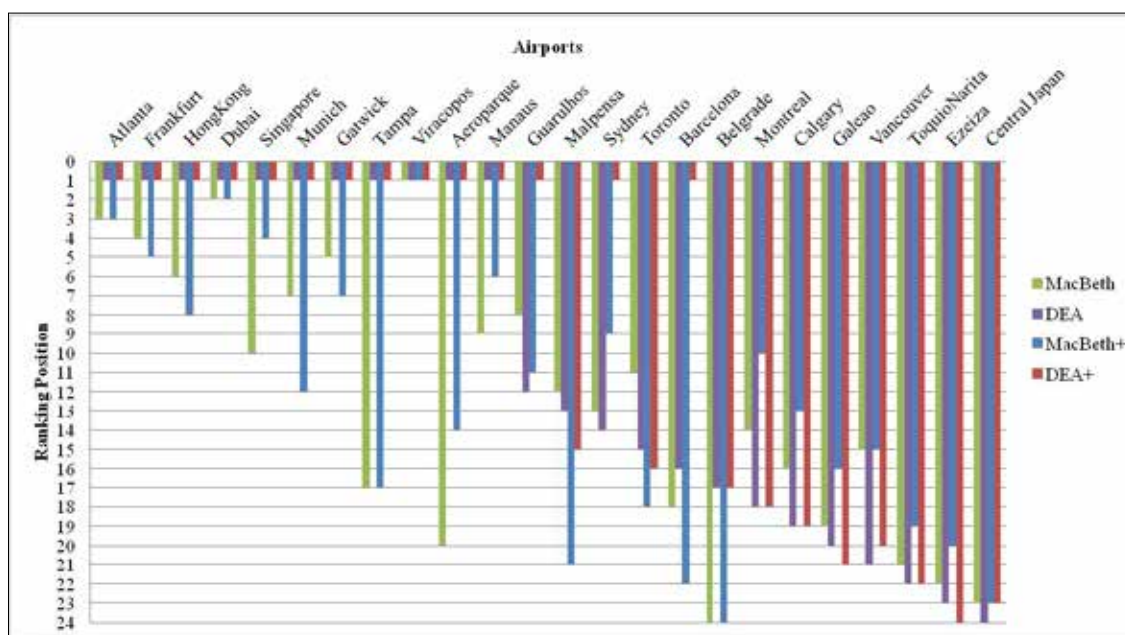
Figure 2. Comparative Efficiency for all Case Studies



Source: Authors

The efficiency rankings obtained following the DEA and MACBETH approaches are quite different. From Figure 2, it is possible to observe the variation in the efficiency rankings due to the use of the two tools. Indeed, the values of some airports differ between the approaches, since MACBETH follows a thinner approach (and presents a non-convergence one) and DEA presents more than one airport in the first place. Comparing the transition from DEA to DEA+, which represents the addition of new indicators, it is possible to observe that there are some similarities, such as for Atlanta, Dubai, Tampa, Viracopos and Frankfurt, but there are also great discrepancies, such as for Sidney and Barcelona. Comparing the transition from MACBETH to MACBETH+, which again represents the addition of new indicators, it is possible to observe that there are some similarities, such as for Atlanta, Dubai, Tampa, Viracopos, Belgrade, Vancouver and Central Japan, but also that there are great discrepancies, for example Singapore, Munich, Aeroparque, Malpensa and Toronto.

Figure 3. Comparative Ranking Positions for all Case Studies



Source: Authors

Figure 3 shows the comparisons between rankings, before and after the addition of new indicators, using either each tool with the same set of indicators (DEA and DEA+, and MACBETH and MACBETH+) or each set of indicators with each tool (DEA and MACBETH, and DEA+ and MACBETH+). It is possible not only to reach conclusions on the impact on some airports – such as Singapore and Malpensa – of the use of the MACBETH tool and on others – such as Guarulhos, Sidney and Barcelona – of the use of the DEA one, but also to determine that the addition of other, non-traditional indicators to the benchmarking study – such as check-in desks, boarding gates and baggage belts – has an important, non-negligible influence for some airports.

5.2 Self-Benchmarking for Madeira (FNC) Airport

An interesting improvement for benchmarking studies is the possibility of using both the DEA and the MACBETH tool to compare the efficiency values of a given airport over several years. This feature is particularly interesting when observing the answer given by the airport whenever there are investments in such infrastructure. If there are no investments, it is always possible to see how effective the airport has become over the years. Thus, this case

study specifically undertakes the self-benchmarking of a Portuguese airport, Madeira (IATA code: FNC), on Madeira Island. We used the data from Table 4 as the input and output indicators.

Table 4. Madeira Airport Data 2007-2011

INPUTS									OUTPUTS		
DMU	RWS	STANDS	PAX TA	C TA	CHK-IN	GATES	BELTS	OP TIME	PAX	MOVS	CARGO
FNC2007	1	16	44590	4800	40	16	4	- ¹	2418489	21954	6774,6
FNC2008	1	16	44590	4800	40	16	4	-	2446924	22799	6637,6
FNC2009	1	16	44590	4800	40	16	4	-	2346649	21955	6228,4
FNC2010	1	16	44590	4800	40	16	4	-	2233524	22094	6069,5
FNC2011	1	16	44590	4800	40	16	4	-	2311380	21346	5095

¹ Data not available to be shown as requested by the airport authority.

Source: ANAM, 2007-2011

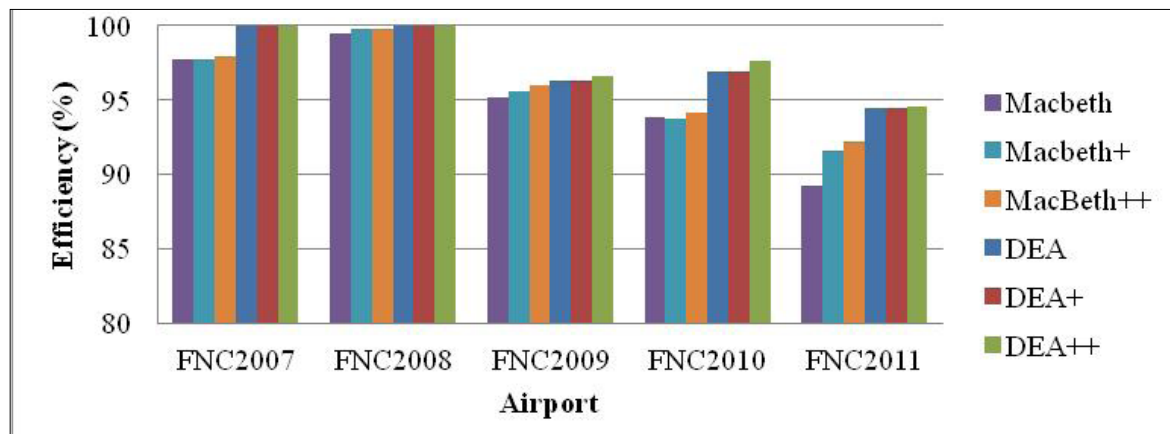
This case study is divided into three parts: in the first and second parts, the indicator structure is the same as that of the previous case study, as presented in Table 3, and the third one, which we called MACBETH++ and DEA++, corresponds to the inclusion of a new indicator related to the number of closure hours per year due to natural (weather) effects. As such **information is confidential**, as requested by the airport authority, the related data **cannot be displayed**; nevertheless, they were included in the case study. The purpose of these investigations was (again) to verify possible changes in the rankings, using both tools/methodologies, due to the addition of other performance indicators than the traditional ones. Thus, we used the MACBETH and DEA tools to rank Madeira Airport during a set of years, between 2007 and 2011. The weights for MACBETH and MACBETH+ are the same as those used previously, and for MACBETH++ they are (in accordance (again) with the opinion of the same 30 national and international aeronautical experts): MOVS/STANDS (15.63%), MOVS/RWS (11.80%), PAX/PAX TA (17.03%), CARGO/CARGO TA (11.96%), PAX/CHK-IN (9.96%), PAX/GATES (9.07%), MOVS/GATES (8.57%), MOVS/BELTS (8.11%) and OP TIME/TOTAL T (7.88%). The results are displayed in the following Table 5 and in Figures 4 and 5.

Table 5. Madeira Airport Positions in the Efficiency Rankings for the Five Case Studies/Years

DMU	DEA efficiency (%)	DEA Rank	DEA+ efficiency (%)	DEA+ Rank	DEA++ efficiency (%)	DEA++ Rank	McB efficiency (%)	McB Rank	McB+ efficiency (%)	McB+ Rank	McB++ efficiency (%)	McB++ Rank
FNC2007	1	1	1	1	1	1	97,76	2	97,77	2	97,95	2
FNC2008	1	1	1	1	1	1	99,47	1	99,73	1	99,74	1
FNC2009	96,29	4	96,29	4	96,64	4	95,19	3	95,61	3	95,92	3
FNC2010	96,90	3	96,90	3	97,60	3	93,81	4	93,73	4	94,15	4
FNC2011	94,46	5	94,46	5	94,50	5	89,21	5	91,54	5	92,20	5

Source: Authors

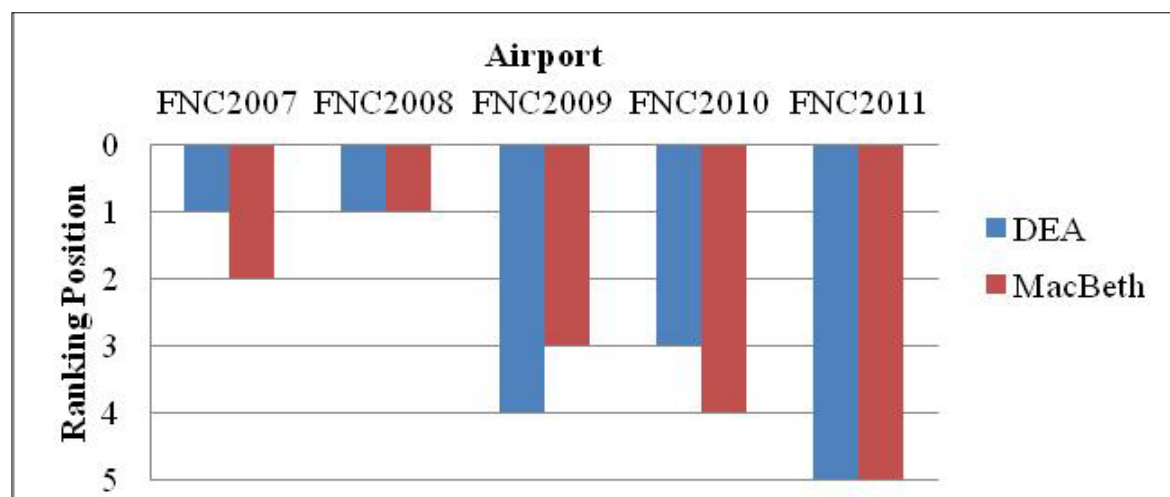
Figure 4. Comparative efficiency for all case studies



Source: Authors

Comparing on one hand MACBETH, MACBETH+ and MACBETH++ and on the other hand DEA, DEA+ and DEA++ (Figure 4), it is possible to observe that some differences exist in the efficiency values due to the successive addition of new indicators, despite no change existing in the rankings in each year and for each method (Figure 5). With the addition of new indicators, the efficiency values show a slight increase (Table 4), mainly with the inclusion of the closure time (even with the small weight/importance of 7.88% given by our experts). This fact is due to small changes in the closure times, each year, at the airport; however, we believe it to be an important indicator for measuring the airport's efficiency, mainly in some particular cases.

Figure 5. Balance between MACBETH and DEA Rankings



Source: Authors

As evidenced in Figure 5, the results obtained with the MACBETH and DEA approaches are quite different for 2007, 2009 and 2010. For both MACBETH and DEA, 2008 was the most efficient year for Madeira Airport and 2011 was the least efficient year.

6. FINAL REMARKS

MACBETH and DEA have the ability to compare either the airport with other similar infrastructures or the airport in different years, offering to all stakeholders the possibility to remain in touch with the evolution of the performance and efficiency of the infrastructure. The results obtained using the MACBETH tool are quite different from those obtained following the DEA approach, since MACBETH is a thinner approach and presents a non-convergence approach, as opposed to the DEA solutions. The natural/meteorological conditions under which airports are working seem to be, for our experts, not a relevant indicator to rank the infrastructure, either with others or with itself over time.

7. CONCLUSIONS

Benchmarking is a self-improvement tool for any organisation as it allows it to identify its own strengths and weaknesses, to compare itself with others and to learn more about how to improve its efficiency. There are several works on airport benchmarking, each using different performance indicators; some of them use single indicators, for example the number of aircraft parking positions, while others consider complex indicators, such as the number of passengers per area of the passenger terminal. It is easy to understand how important an MCDA approach is for airports' stakeholders to support the decision-making process. The main goal of this work is not only to balance the DEA and MCDA tools in general, but also to achieve airport rankings using a (new) multicriteria approach allowing a proper choice of both the indicators and the related weights. Therefore, we used MACBETH to rank airports in two ways, thus underlining the versatility of such a tool: the efficiency of a set of worldwide airports and the self-benchmarking of a Portuguese one (Madeira). The disadvantage of MACBETH in benchmarking airports is the subjectivity needed to determine the indicator weights, which can be mitigated in two ways: using the opinions of specialists in the appropriate fields of knowledge and obtaining as many answers as possible so that the related average (and variance) values are as close as possible to reality (Braz, 2011). The DEA analysis gives the indicator weighting by a mathematical approach, leading to some airports achieving the maximum efficiency simply because one indicator exists for that airport that is much better than the other ones. For this reason, this approach sometimes does not facilitate a clear understanding of the desired efficiency ranking.

The next research steps will be focused on using both the DEA and the MACBETH model, and the same efficiency indicators as used in the previous (+) cases, in benchmarking studies for: (a) the closest airports to the European Union capitals; (b) the most important Iberian airports (Portugal and Spain); and (c) the most important Portuguese ones. A further target is the self-benchmarking of some Iberian airports, including particular natural (weather) effects and ramp occurrences.

ACKNOWLEDGEMENTS

To FCT (Foundation for Science and Technology, Portugal) by the MSc grant of João Jardim, under AIRDEV (Business Models for Airport Development and Management) Project in partnership with MIT-Portugal Program (Reference: MIT-Pt-TSAs/0046/2008).

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DYNAMIC PROCESSES OF AN AIRPORT'S SYSTEM. APPLYING VALUE NETWORK ANALYSIS (VNA) TO THE AIR TRAVELLER EXPERIENCE

*Margarida Vaz
Maria Emília Baltazar
Jorge Silva*

ABSTRACT

In this paper, we argue that networks are fundamental instruments for the development of the business system of airports' landside area. We propose value network analysis (VNA) to gain a better understanding of how processes and people create value in airports' network ecosystem. This methodology makes it possible to understand and visualise the internal and external value networks, mapping the players and their interrelationships and thus capturing the dynamics of the airports' entire system. Applying value network analysis (VNA) to the air traveller experience, we conclude that this approach provides a network ecosystem perspective on how processes and people create value within the air traveller experience network. For the validation of this scenario, several interviews were conducted with experts.

Keywords: Airports' Landside Areas, Air Traveller Experience, Social Network Analysis, Value Network Analysis

JEL Classification: R42, Y10

1. INTRODUCTION

In accordance with the results of the fifth task of the Airdev Project¹ related to hinterland effects, **two main outcomes** were expected: 1) a system dynamics model; and 2) a model for the evolution of an airport into a city airport, which derives from the first outcome.

The first outcome will clarify the mechanisms responsible for the generation of economic and social benefits. It must identify the key variables and their relationships that allow the evaluation of the impacts resulting from the existence of an airport. The second outcome will provide the framework for evolution from an airport into a city airport, being sufficiently flexible to handle different sizes of airports. The model will include all the relevant activities that may be located in an airport city as well as the relevant vectors of development: economic, financial, strategic, marketing and processes.

Common to both outcomes is the concept of a system, which relies on networks and dynamic interrelations.

Jimenez *et al.* (2012, p. 24) argued that the studies applying network analysis to airport or airline systems can be divided into two broad categories, which "either take a strict network theory point of view or have an air transportation field perspective". The first group of studies is normally "interested in analysing the topology of the networks and their performance according to graph statistics". The "second group uses some network-related

¹ R&D Project "AIRDEV – Business Models for Airport Development and Management" financed by the FCT/MIT Programme (MIT-Pt/TS-AAS/0046/2008) (rating of "very good").

parameters to classify business strategies of airports and airlines, to perform economic analysis or to evaluate technical features of the systems”.

In line with both perspectives of analysis, we propose to use value network analysis (VNA) to gain a better understanding of how processes and people create value in airports’ network ecosystem. This methodology makes it possible to understand and visualise the internal and external value networks, mapping the players and their interrelationships and thus capturing the dynamics of the airports’ entire system.

Our study maps the players and their interrelationships in **four different scenarios**: the air traveller experience, the supply chain, the infrastructure development and the air cargo experience. For the validation of each scenario, several interviews were conducted with experts.

In the context of this paper, only the air traveller scenario will be presented.

2. THEORETICAL FRAMEWORK

Much of the relevant literature refers to the huge economic impact of airports on local, national and international economies. Indeed, some airports contribute to national and/or international economies, but the mechanisms by which the regions benefit from the existence of an airport remain fairly unknown.

A number of limitations in the practice of airport economic impact studies have been identified (TRB, 2008), which raise the question of whether the metrics of the impacts are adequate and even whether the focus on metrics is more important than increasing the opportunities associated with airports.

The adequacy of any method (traditional or otherwise) to measure net benefits or impacts or even to identify relevant vectors of development depends on the understanding of the complex roles and spatial interactions actually associated with a given system. The same is true when the goal is not the metric of the impacts but instead increasing the opportunities associated with that system. These facts call for refreshed conceptual frameworks to provide a better understanding of the regional opportunities and constraints associated with airports and, at the same time, for integrative models that allow the recognition and understanding of the nature and importance of international, national, regional and local airports’ sustainable growth.

In this context, quantification alone is not enough to understand such complex systems. Matters of pattern, structure and value conversion must be considered along with several levels of analysis. The network approach is viewed as one strategy for cross-level analysis and has been used to understand the conversion of the value of financial and non-financial assets into other forms of value.

2.1 Networks and social network analysis (SNA)

The concept of a network is used in the scientific literature in two directions (Romeiro, 2007), which are particularly relevant in the context of this paper: 1) a fundamental architecture for the economic, social and institutional organisation: in this context, a network represents an organisational structure comprised of independent elements that establish relations between them for the medium-long term, based on the will of the elements to work together towards common objectives, which could not be achieved in the same way through individual work (Vernon, 2005); and 2) an explanatory principle of the structure of complex realities: in this sense, the concept of a network refers to a set of actors (individuals, institutions or organisations) bound by a set of social relations of a certain type (friendship, business or other) (Gulati, 1998). Therefore, a social network can be viewed as a series of links that are

established between a defined set of social actors (Requena, 1989; Powell and Smith-Doer, 1994).

Both perspectives of analysis are important for this research. Unlike the organisational structure, the concept of a network is understood as a structure between the market and the hierarchy, formed by more than two organisations (corporate, public organisation, association, university and airport, among others) that decide, formally or informally, to initiate cooperation in the medium term involving the exchange of resources (material or immaterial). The network is established under the premise that all the organisations within a network are interdependent, meaning that the behaviour of one organisation affects and is affected by the behaviour of the other organisations. This design points out explicitly the components of a network – a set of actors and a set of relations – the structure of which can be systematised and analysed through social network analysis (SNA).

Applications of social network analysis (SNA) have increasingly been expanding to the business world, at the level of organisational performance and/or strategic alliances (Cross and Parker, 2003; Dawson, 2003; Iansiti and Levien, 2004; Anklam, 2007; Basol and Rouse, 2008; all cited by Allee, 2009, p. 2). However, some inherent limitations of SNA have limited that progress (Allee, 2009):

- Although SNA provides a structural analysis of the network linkages, it does not directly address economic or social value creation and outputs;
- The empirical link between the organisational structure and the performance of companies remains to be demonstrated adequately;
- The links defined in a social network are of the same nature and only one link is represented among actors. When there are multiple variables and unique features, it becomes necessary to build separate networks for each different type of social or economic exchange between players, which turns the analysis very weighty;
- Due to the high level of technical expertise needed to analyse and interpret the patterns of the network, the use of SNA as a management tool is limited.

2.2 Value network analysis (VNA)

To overcome these limitations, Allee (2008)² proposed a network methodology that allows the measurement of networks' value creation. According to this author (op. cit., 2008, p. 2) (...) "because the network is the primary economic mechanism for value conversion, network analysis can be used to describe the value creation dynamics of work groups, organizations, business webs, and purposeful networks engaging in both tangible and intangible value exchanges to support the achievement of specific outcomes and to generate economic and social good".

According to Allee (2008), a **value network** is any set of roles and interactions in which people engage in both tangible and intangible exchanges to achieve economic or social value. This definition allows the application of the value network perspective a) to the **internal** value networks focused on the sets of relationships between individuals, within and among work groups and between and among the various work groups that make up the organisation; and b) to the **external**-facing value networks, which comprise those between the organisation and its suppliers, its investors, its strategic business partners and its customers.

Another related concept is **value conversion**, which refers to the act of converting or transforming financial into non-financial value or transforming an intangible input or asset into a financial value or asset. When considering value conversion, it is necessary to assess the inputs and outputs for each role in the network to determine whether value conversion opportunities are being overlooked. In addition, the network is a value conversion mechanism

² This section is largely based on Allee's work since it was that author who developed the VNA methodology.

that achieves not only positive goods and outcomes, but nefarious and negatives ones as well, according to the values and intent of those who serve the network.

The emergent purpose and value dynamics of the network are revealed through the particular pattern of **roles** (contributing individuals or organisations) and their unique negotiated **value exchanges** in service fulfilling an economic or social goal or output. Shared purposes and values may be either tacit or explicit but can be deduced from the network patterns and the nature of the exchanges. Value is continually being negotiated in this context of both individual and overall purposes and values.

Based on these concepts, Allee (2008) proposed a methodology called value network analysis (VNA), which provides a network ecosystem perspective on how processes and people create value.

This methodology presents several advantages in comparison with the traditional SNA (Allee, 2008):

- It shows both the structured relationships and the informal yet essential flow paths of knowledge sharing and support;
- It provides a perspective for understanding the value-creating roles and relationships, both internal and external, upon which an organisation depends;
- It offers dynamic views of how both financial and non-financial assets can be converted into negotiable forms of value that have a positive impact on those relationships;
- It explains how to realise value more effectively for each role and how to utilise tangible and intangible assets for value creation;
- It provides a systematic analysis of how one type of value is converted into another.

The ability of VNA to describe effective work networks better has been demonstrated in many organisations addressing a wide range of business issues. The number of published case studies and academic articles referencing and applying value network analysis is multiplying rapidly, with more than 50 relevant academic articles published in 2007, more than double those published in 2006. Companies' adoption of VNA, especially the Allee method, has been growing rapidly in global companies, government agencies and civil society organisations and networks (Verna, 2009).

This is the case, for example, of Cisco's Global Call Center. Value networks and VNA were fundamental and highly instrumental in achieving advancements in Cisco's Global Call Center strategy. According to LaVeta Gibbs, former Director of Global Contact Center Strategies for Cisco, "Value Network Mapping of an organization, or even better, multiple organizations is the most unbiased and necessary view into what really goes on in business interactions. If done successfully, it changes the way job roles and the value of interactions are perceived and measured."

Mayo Clinic, one of the largest medical clinics in the US, adopted VNA to solve problems related to the time that patients had to wait (six months) to receive a confirmed appointment for a critical medical procedure. ValueNet Works analysts identified a key bottleneck that other management tools, including Lean analysis, could not identify and reduced the waiting time to four weeks.

AgResearch, New Zealand's largest crown research institute, identified through the VNA method how a twelve-year innovation process was being disadvantaged by differences between scientific research and commercialisation networks. The time to market was reduced and employee morale improved by creating new roles, enabling the scientists to focus on research. Furthermore, value network evaluation was performed in the Skåne region in Sweden to explore the regional innovation system.

The Boeing Company is another example of the successful implementation of VNA. It launched a complex new product that significantly expanded the daily product testing without a corresponding increase in resources. The flight test team completely changed the

business unit model and increased the number of tests that could be performed through the use of VNA in combination with process engineering. VNA is now being used to achieve similar gains in productivity for other business units within the company.

3. DYNAMIC PROCESSES OF AN AIRPORT'S SYSTEM. AN EMPIRICAL STUDY

According to Macário and Reis (2012, p. 7), airports have traditionally viewed airlines as their primary customers and airlines, in turn, have considered passengers as their primary clients. However, “today, in a more commercial and private environment, with an increased pressure on the awareness of the relevance of a business model for airports, these complex infrastructures are increasingly dependent on non-aeronautical revenues (business centres, health care, etc.), and thus perceiving passengers as another segment of their primary customers”.

As mentioned in the previous section, several studies have applied value network analysis to different business and organisational areas, but no research concerning the application of this methodology to the business system of airports' landside areas has been undertaken as far as we know. Since we argue that networks are fundamental instruments for the development of this domain of activity, in this section, we explore how this methodology can be adopted to achieve “more economically efficient, aesthetically pleasing and socially and environmentally sustainable” (Kasarda, 2010, p. 31) development. Considering that business systems for airport landside areas have to be considered on a global base, we agree with Stevens *et al.* (2007) that the list of system impacts beyond the system boundaries has grown through time, but treatments have remained highly specialised and contained within disciplinary paradigms. Even the empirical analysis has been generally limited to the evaluation of the isolated components of a complex system.

These facts call for refreshed conceptual frameworks to enable a better understanding of the business opportunities and constraints related to airports' landside and at the same time for integrative models that allow the recognition and understanding of the nature and importance of international, national, regional and local airport industry growth and the need for sustainable balanced development.

To gain a better understanding of how processes and people create value in an airport network ecosystem, value network analysis (VNA), a methodology proposed by Allee and colleagues (Allee, 1998, 2000, 2002, 2008; Allee and Taug, 2006; Venezia *et al.*, 2007; Allee and Schwabe, 2009), was used for this research.

3.1 Methodology

The analysis begins with a **visual map** or diagram that shows the essential contractual, **tangible** revenue or business funding-related transactions and exchanges that occur between each node of the network.

The nodes represent individuals or groups of individuals, such as a business unit, or aggregate groups as a type of business in an industry network and each node is analysed from the perspective of the **role that** it plays within the system.

People generate **value** by assuming or creating **roles** to **convert** tangible and intangible assets into **deliverables** that can be conveyed to other roles through the execution of a **transaction**. In turn, value is **realised** by companies when they convert inputs into gains.

Furthermore, the critical **intangible** exchanges (informal knowledge exchanges and benefits or supports that build relationships) are also made visible by a value network analysis. These intangible exchanges, traditionally ignored by business practices, are a fundamental key to creating trust and opening ways for innovation.

The various visualisations and diagrams link to a variety of **assessments** (usually using Excel spreadsheets) enabling an increase in value outputs, the leveraging of knowledge and intangibles for improving financial and organisational performance and the detection of new value opportunities. Through this analysis, it is possible to gain insights into what is happening in the ecosystem, where more value can be realised and what is required to achieve the maximum value benefit across the entire business activity or ecosystem that is the focus of the analysis.

Our study maps the interrelationships between the airport's players and the hinterland's players in four different scenarios, considering the related impacts in the form of tertiary effects and perpetual effects, as follows:

- The air traveller experience scenario;
- The cargo experience scenario;
- The supply chain scenario;
- The infrastructure development scenario.

The first scenario results from the existence of air transport services for the use of individuals. The second is related to those companies that need a high-speed and high-quality transport service. The third scenario considers the supply of goods and services that contribute to the operations of an airport. The fourth scenario considers the perpetual effects associated with the regional economy considering that an infrastructure investment will raise the level of activity and stimulate productivity, setting in progress a bigger and longer-lasting cross-regional economic development leading to profitable scale economies. For the validation of each scenario, **several interviews were conducted with experts**.

The air traveller experience scenario is the only subject of analysis in the context of this paper.

3.2 A Value network analysis of air traveller experience. Research approach and main findings

3.2.1 Research approach

People travel for many reasons. However, regardless of the reason, there is a set of procedures that is more or less common to travellers. Particularly those who travel by plane need to make the necessary travel arrangements (e.g. air travel, ground travel, accommodation), directly or through a travel agency (virtual or real), and follow specific air travel rules and regulations (eg. security, handling, customs).

To apply the VNA methodology, the air traveller scenario needs to identify the main steps that an air traveller needs to undertake before and during the journey and to understand how the “bubble” around the traveller works at the airports. This procedure will allow easy identification of the different roles involved in the process.

First step: Marketing advertisement and customer reservation

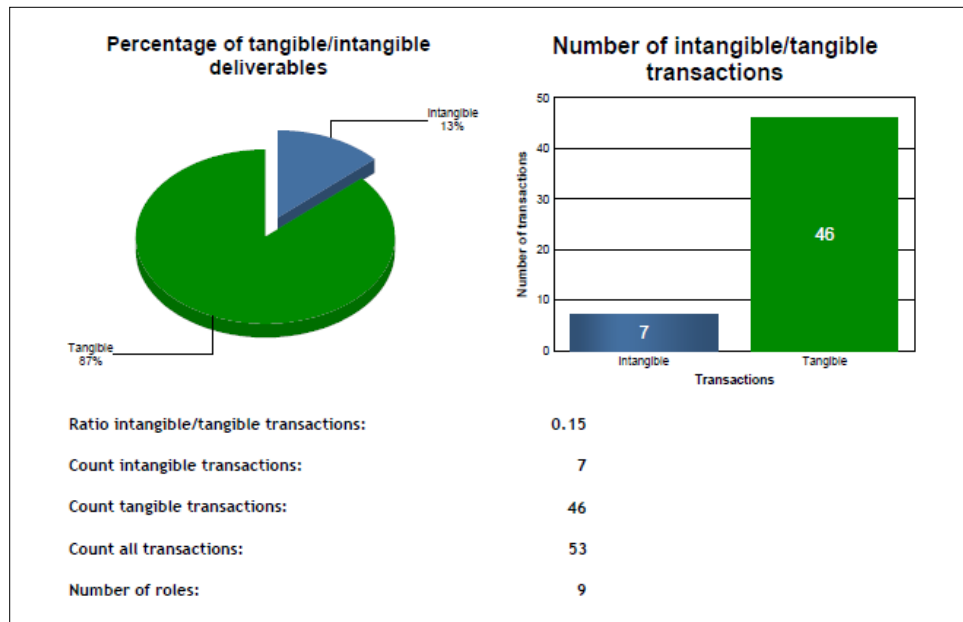
First, there is some marketing advice from **airlines** and **travel agents** that needs to be disseminated to capture the attention of the customers (in this case, **air travellers**). The travellers will then contact the travel agents to set up a reservation, which provides vouchers and payment transfers among the elements of the chain.

Second step: Travellers go to the origin airport

Once this has been completed, the travellers go to the **airport**, where they are subject to the check-in and security processes common to all airports. Many **airport services** provide information about flights, food services, duty free shops and so on. If the flight is not

trip. Nevertheless, all the roles engaged in contributing to his/her (good) experience while travelling have to work efficiently. This fact may explain why the scenario of the air traveller experience presents a higher level of tangible than intangible transactions, meaning that it is a **process-focused operational network characterised by a formal structure**.

Figure 2. Resilience of the Air Traveler Network

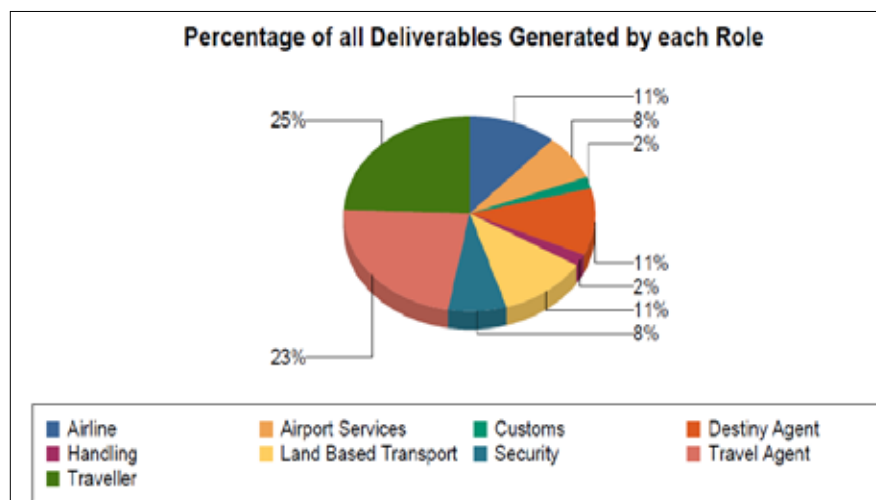


Source: Own elaboration

Value creation

The active agents for value creation are the roles in the network. The capacity of each role to generate both tangible and intangible value determines the ability of the network to generate value. The **traveller** and the **travel agent** roles are the ones that **create more value** within the traveller experience network, followed by the roles of **land-based transport, airlines and destination agents** (see Figure 3). They are indeed the key roles for the materialisation of travel.

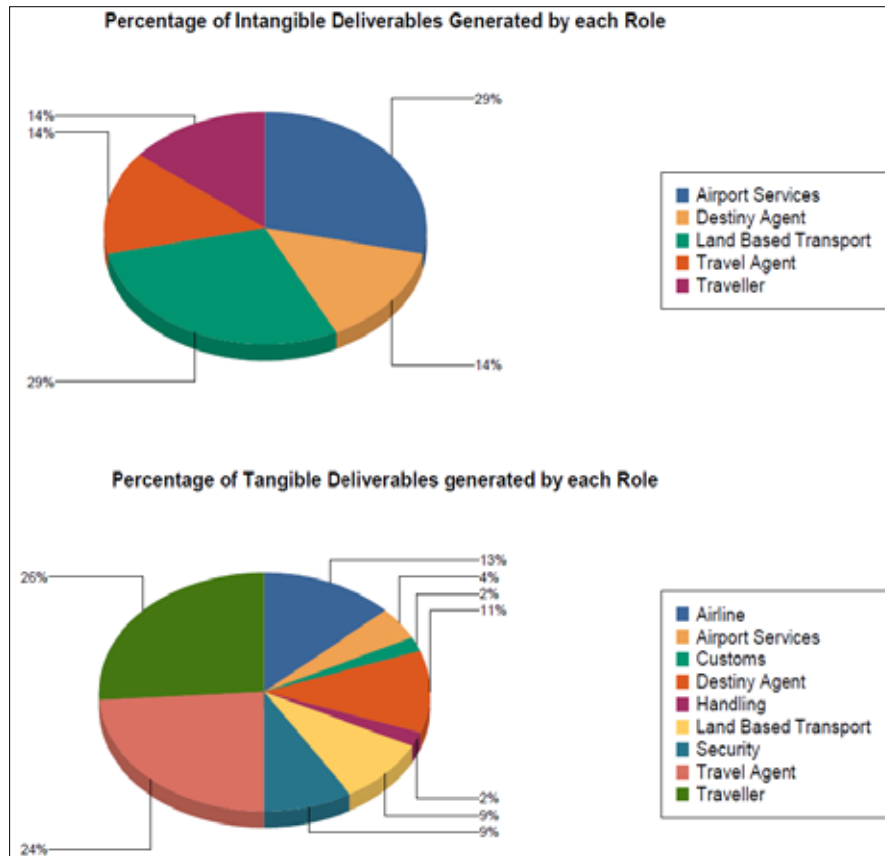
Figure 3. Value Creation by Air Traveler Network's Roles



Source: Own elaboration

Either on the demand side or on the supply side, tourism demands large amounts of information (intangibles) (Benabdallah and Ben Soltane, 1996). The **airport services** and the **land-based transport** are the roles that **generate more intangible deliverables** (Figure 4). Notably, the **traveller is the role that generates more tangible value, followed by the travel agent** (see Figure 4). Indeed, the traveller is the one for whom all the other roles converge.

Figure 4. Percentage of Tangible and Intangible Deliverables by each role

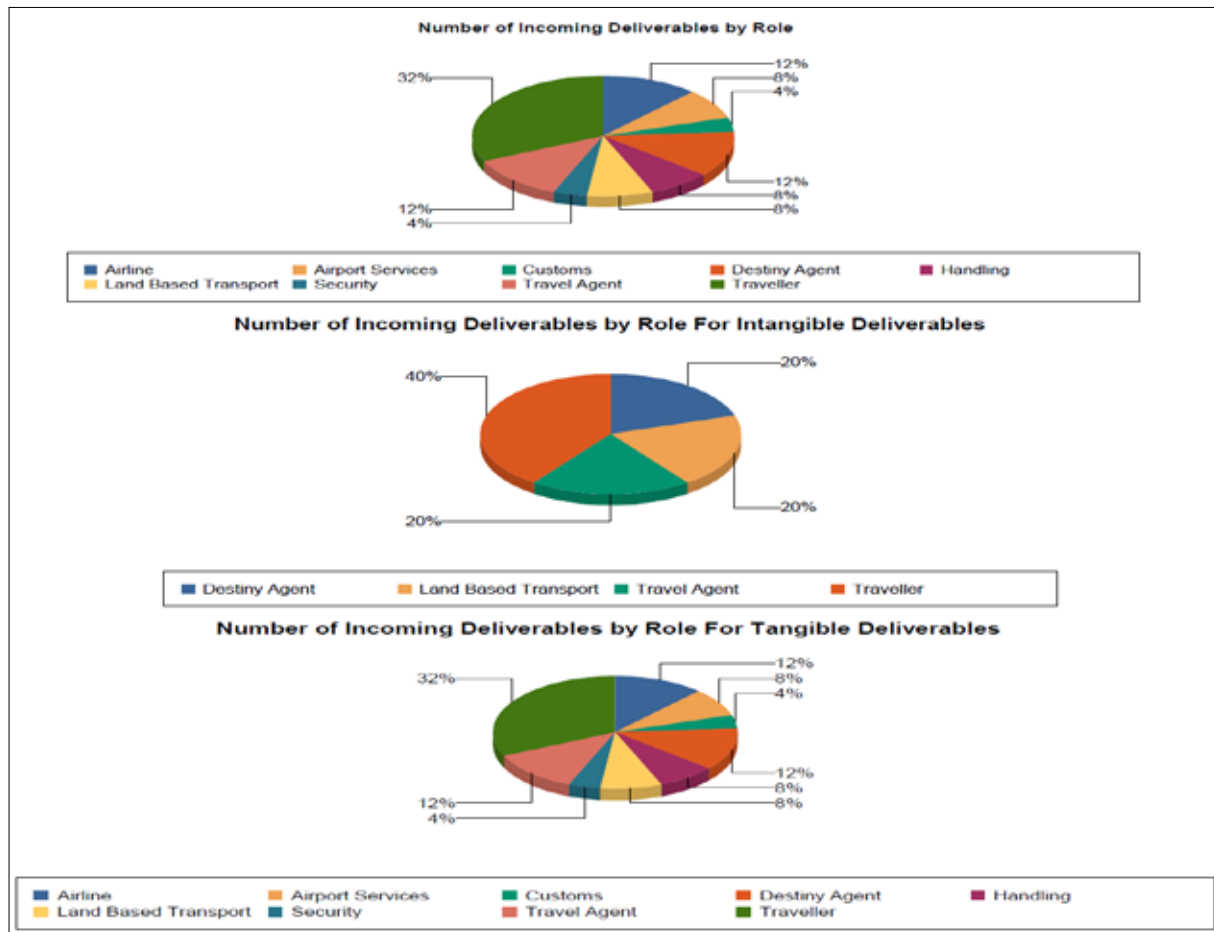


Source: Own elaboration

Structure and value

Centrality indicators help to show **value from a structural standpoint** and explain how roles gain (or contribute to) value. **Roles with more ties hold important structural positions**; they may have access to more of the resources of the network as a whole. Nevertheless, a **role with a strong structural position does not necessarily provide the most value to the network**. It is possible to examine incoming and outgoing ties separately, using other centrality indicators such as the **centrality in degree** (related to the **value that a role gains from the network**) and the **centrality out degree** (related to the **value that a role provides to the network**). The **traveller's role is, by far, the one that gains more (tangible and intangible) value from the air traveller network** (see Figure 5).

Figure 5. Centrality In Degree of Air Traveler Network



Source: Own elaboration

In addition, the **traveller's role** is, by far, the one that provides more value to the **network** (see Figure 6).

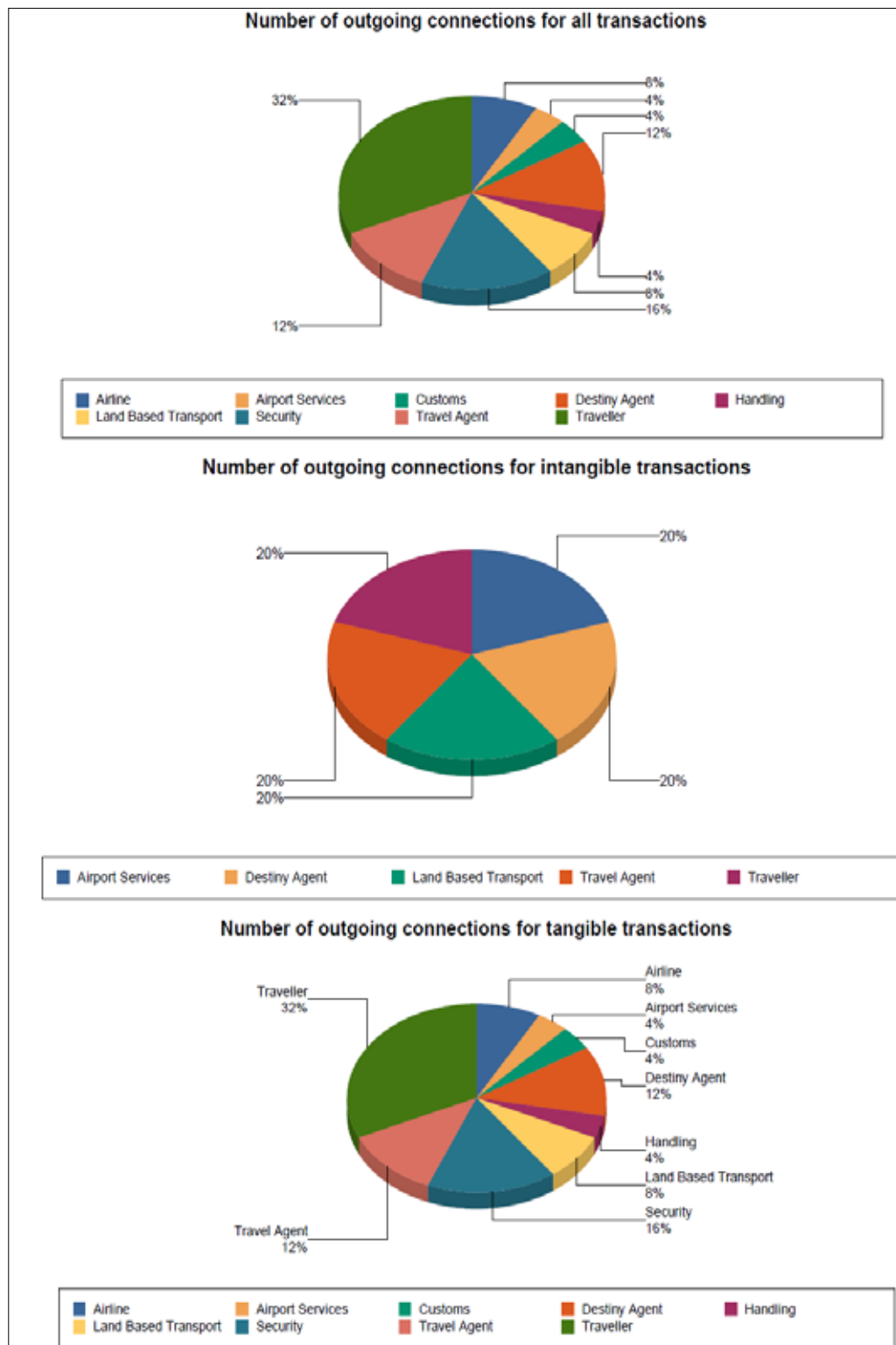
It is possible to say that the **traveller's role** has a **strong structural position** within the air traveller network, receiving and sending more value (see Figures 5 and 6).

Risk

One kind of risk to the network appears in role dependency. The risk is that the role could represent a bottleneck. If the role is not adequately resourced, then the flow paths could be negatively affected by time delays. If a role cannot keep the value flow paths moving, it affects the speed of value creation and conversion in the network. A good cross-check for whether a role is a bottleneck is to look at the speed indicators to see whether a potential bottleneck role is slowing down the value flow paths.

The second risk factor is that if there is too much structural dependency on a role, it can affect the entire network if a problem occurs.

Figure 6. Centrality Out Degree of Air Traveler Network



Source: Own elaboration

Structural dependency is based on centrality, one of the most common structural indicators in network analysis. Centrality concerns which roles or participants have the most ties or connections. In value network analysis, extremely high centrality for any one role or participant may actually be a risk factor for the network.

Structural dependency is correlated with variance between the connections of all the roles. We can assume that the higher the variance, the more we are likely to find some roles with many connections and others that have almost none. This means that the power in the network is not well distributed (the wider the variance, the higher the risk to the network). The network might be unduly influenced or controlled by one or two roles. In such cases, the network might break down or disintegrate if those roles disappear or are unable to perform for some reason.

Structural Dependency	All	Intangible	Tangible
a) Highest Number of connections per Role for Transactions	33	4	29
b) Lowest Number of connections per Role for Transactions	2	2	2
c) Variance Transactions	82.84	1.17	64.62
d) Average number of connections per Role for Transactions	11.78	1.56	10.22

In spite of the strong structural position of the traveller's role, the predominance of the highest number of connections per role for transactions and the relatively low level of variance transactions allows us to state that the **power in the air traveller network is distributed across almost all the roles**. This means that if the traveller is the main focus of several roles, it is also true that the experience of the traveller is dependent on those roles.

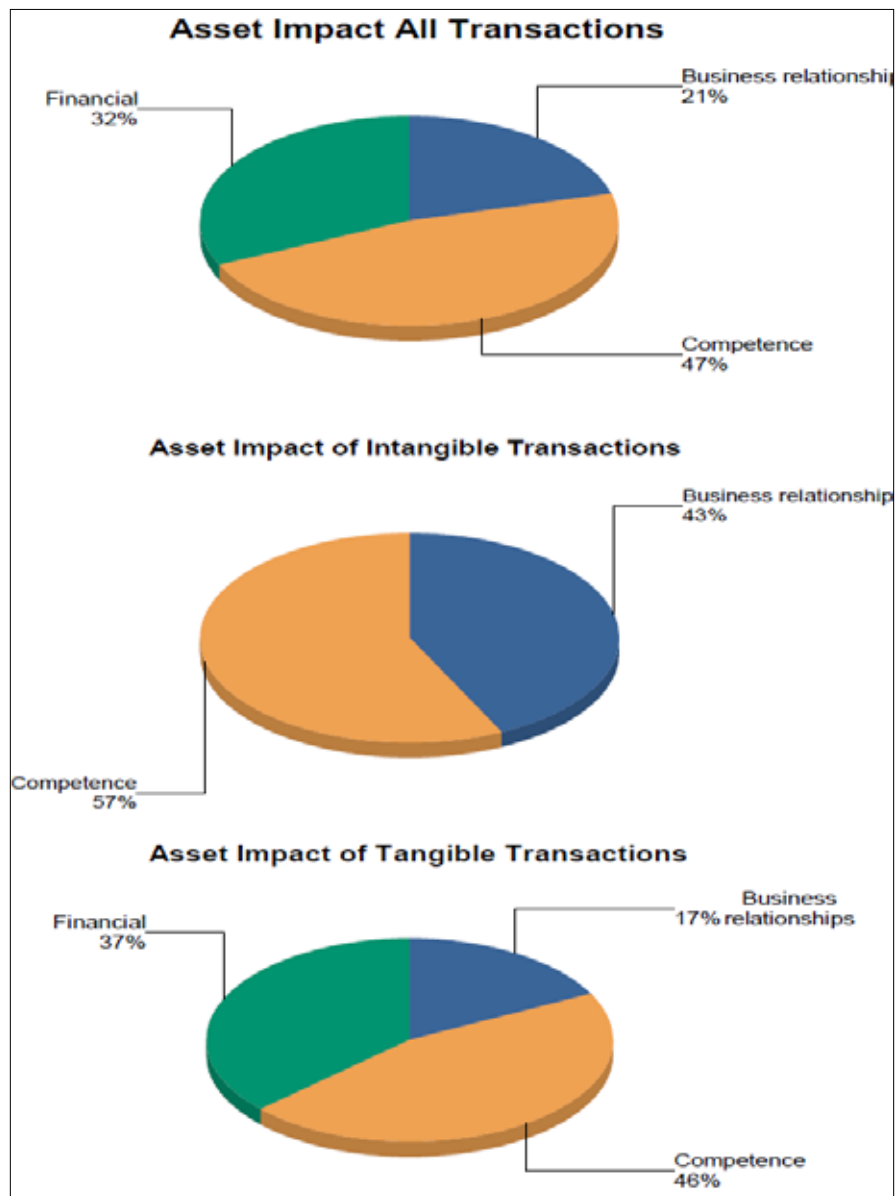
Asset impact

Asset impact measures the impact of a transaction on the network as a whole. Therefore, it is necessary to **identify the assets that are influenced by the transaction activity in the network** and the **assets that are most affected by the network behaviour as a whole and by the actions of specific roles**.

In the air traveller network, we identified **three main assets**: financial, competence and business relationships. The following charts show which assets are affected by the transaction activity in the network. These figures are compiled from **the way in which individual transactions exert an impact on assets**. These indicators can be used to consider which assets are most affected by the network behaviour as a whole and by the actions of specific roles.

Within the air traveller network, **“competence” and “financial” assets are the most influenced by the transaction activity of the network as a whole**, the “Competence” asset receiving a greater impact either from tangible or from intangible transactions (see Figure 7).

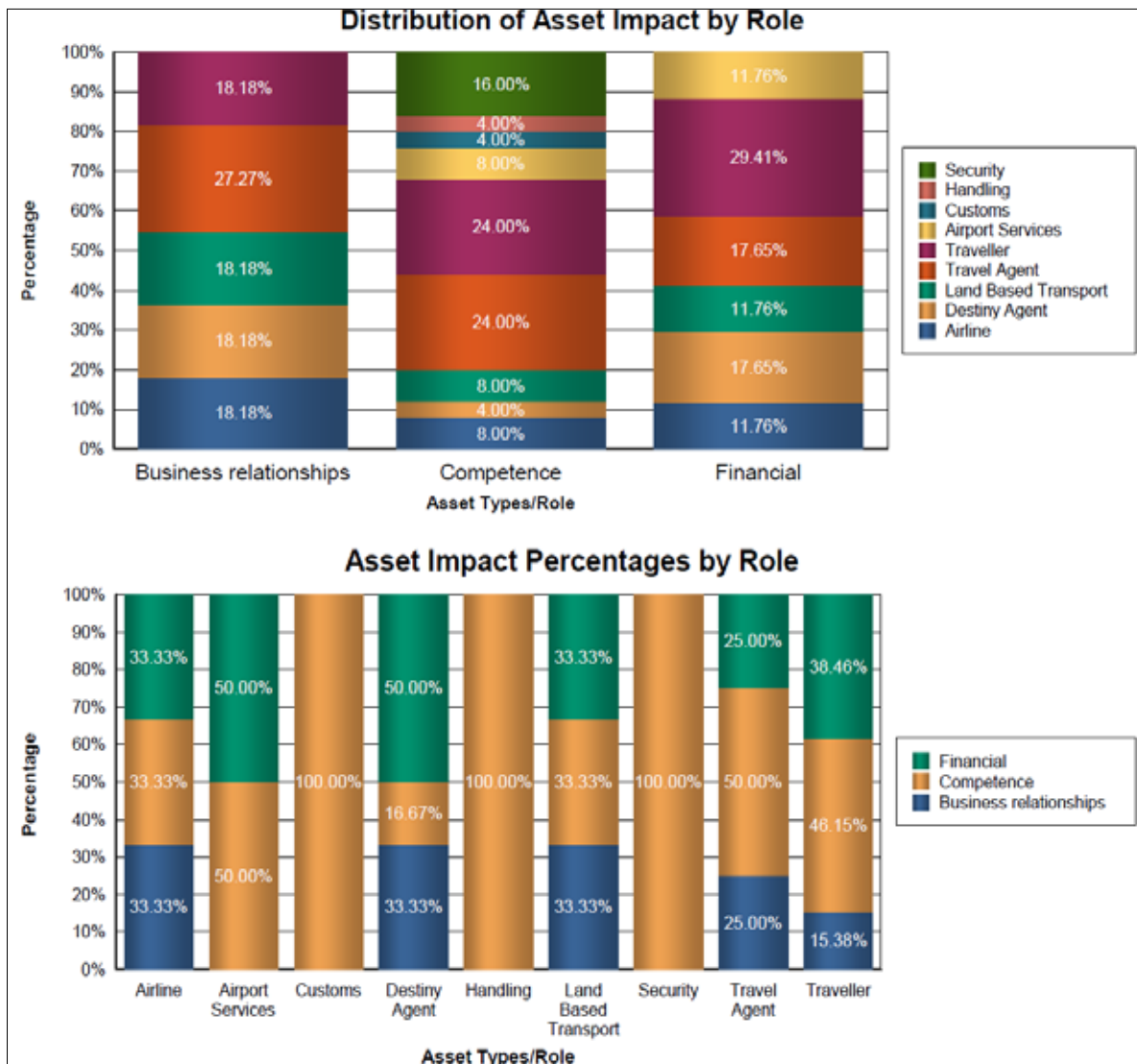
Figure 7. Asset Impacts of Air Traveler Network



Source: Own elaboration

The following charts (Figure 8) show the role distributions for the asset impact. We can conclude that the **role of travel agent has great impact on the business relationship asset as well as on the competence asset**. Furthermore, the traveller role has a significant impact on the competence and financial assets.

Figure 8. Role distributions for Asset Impact



Source: Own elaboration

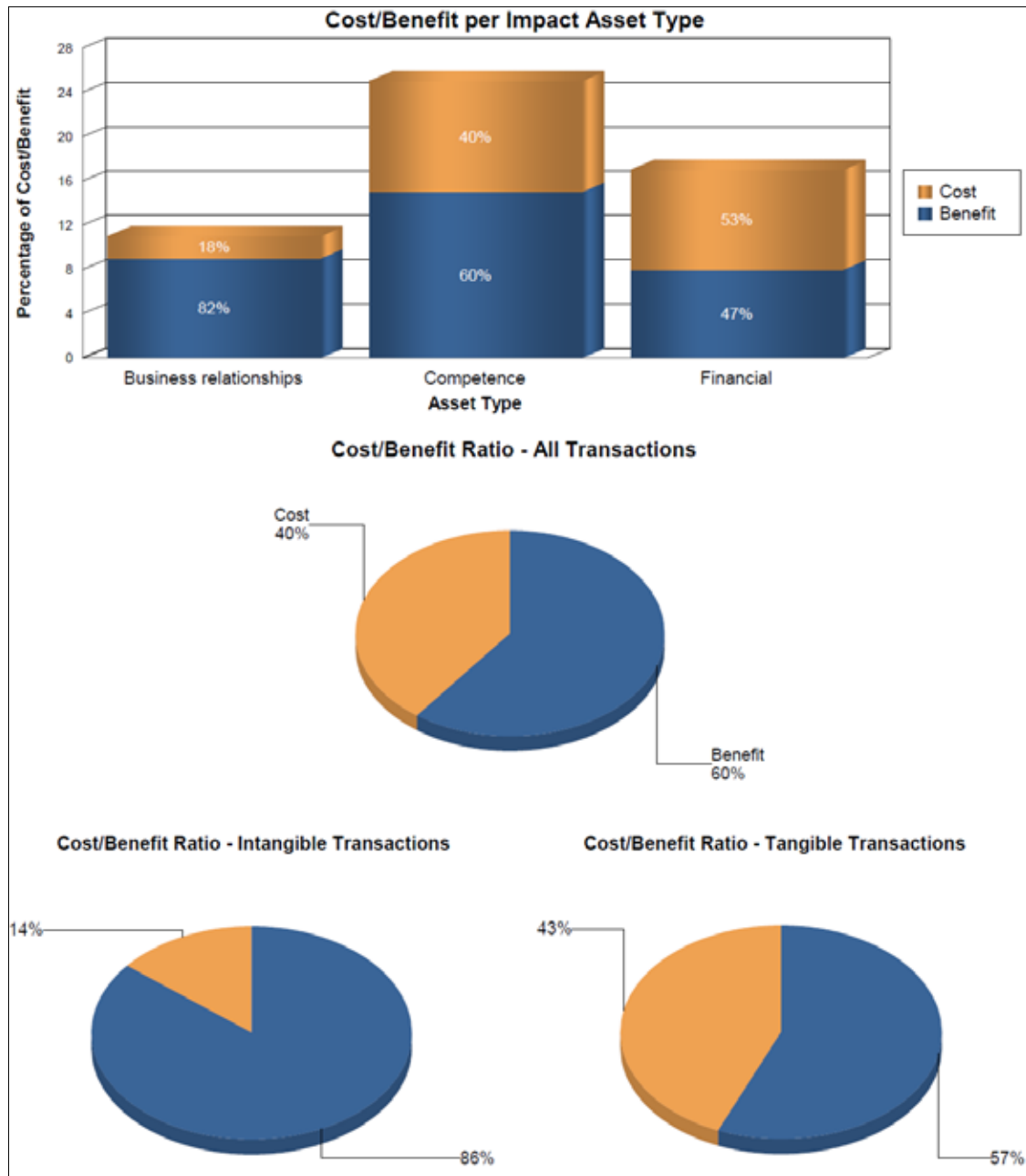
Analysing the asset impact percentages by role (Figure 8), we can conclude that the **asset competence is transversal to all the roles, notably being important to the roles of customs, handling, security, airport services, travel agent and traveller**. It is interesting to observe that the **financial asset, present in almost all the roles, has great importance for the roles of airport services and destination agent, for which the competence asset has a lower relative weight**.

Asset impact–cost/benefit

Once the influenced asset has been identified, the next questions are “Does the transaction have a positive or negative impact on the asset? When the deliverable is received, how is it going to affect the overall asset picture?”

The next figure (Figure 9) shows the cost/benefit ratio from all the transactions then from intangible transactions only and finally from tangible transactions. **All the transactions have more positive (benefits) than negative (costs) impacts on the different assets within the air traveller network, either for tangible transactions or for intangible ones.**

Figure 9. Cost/Benefit Ratio from Transactions (tangible, intangible and all) of Air Traveler Network

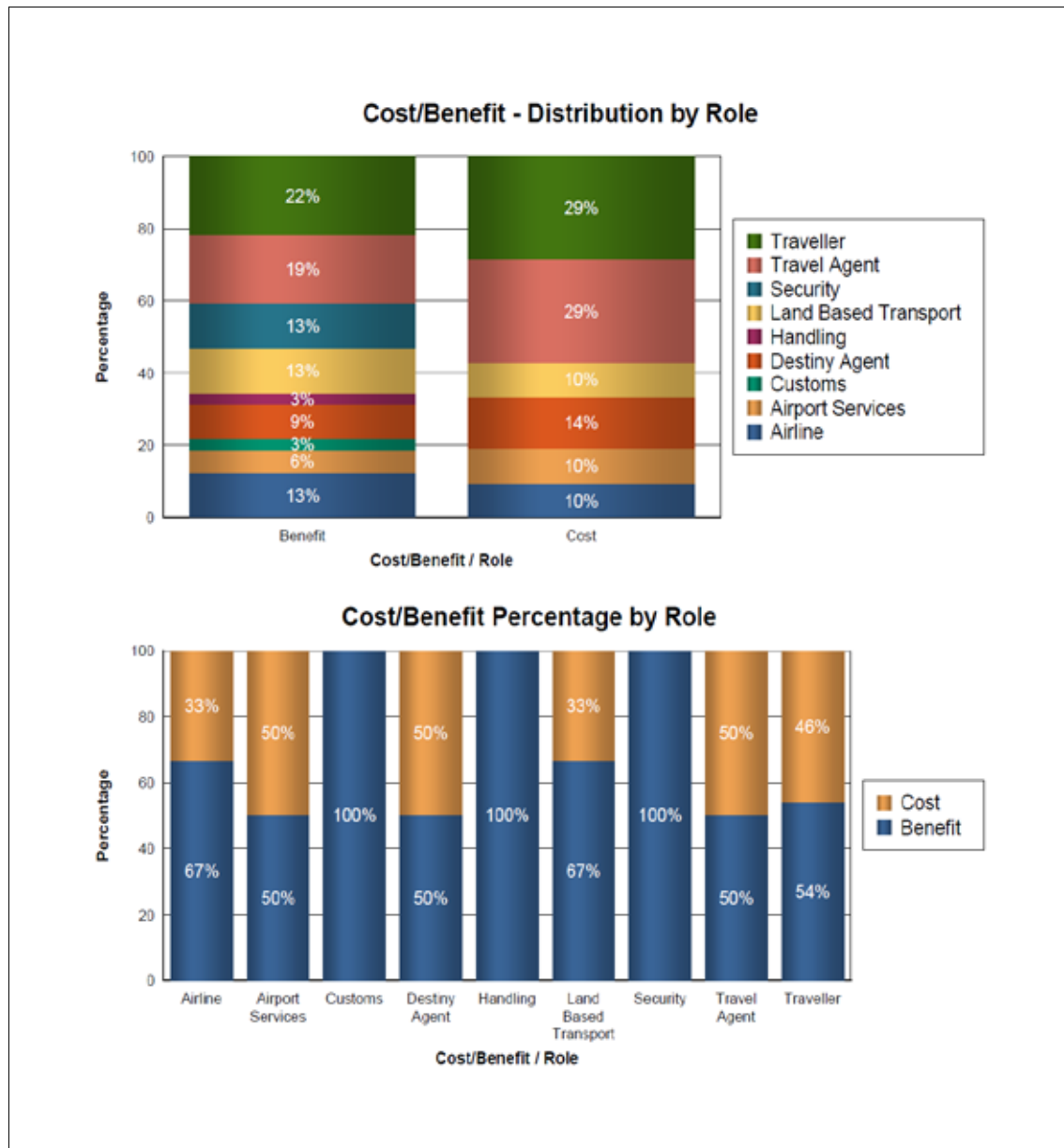


Source: Own elaboration

The following figure (Figure 10) examines the cost/benefit distribution and percentage by role.

The roles of traveller and travel agent are the roles that contribute more to the positive (benefits) and to the negative (cost) impacts on the assets. For the roles of customs, handling and security, the transactions have a 100% positive impact (benefit) on the assets. For the other roles, the transactions have both a positive and a negative impact on the assets (see Figure 10).

Figure 10. Cost/Benefit Distribution and Percentage by Role of Air Traveler Network



Source: Own elaboration

Transaction speed

The transaction speed indicator is helpful in spotting network bottlenecks. Transaction speed can refer to the actual transit time of the deliverable. Used in this way, it is useful for comparing the speed with the transport channel profile.

The transaction speed can also refer to how slowly or quickly the deliverable is executed and released by the role. Used in this way, it represents the “waiting time” for a role to complete and send the deliverable. This approach is useful for identifying any roles that could be better supported with resources or improved processes for faster execution.

The average speed is calculated by giving the following rating: fast = 1, medium = 2 and slow = 3.

Average Speed of All Transactions:

Total Number of Transactions: 53

Average Speed: 1.17

Average Speed of Intangible Transactions:

Total Number of Transactions: 7

Average Speed: 1.71

Average Speed of Tangible Transactions:

Total Number of Transactions: 46

Average Speed: 1.09

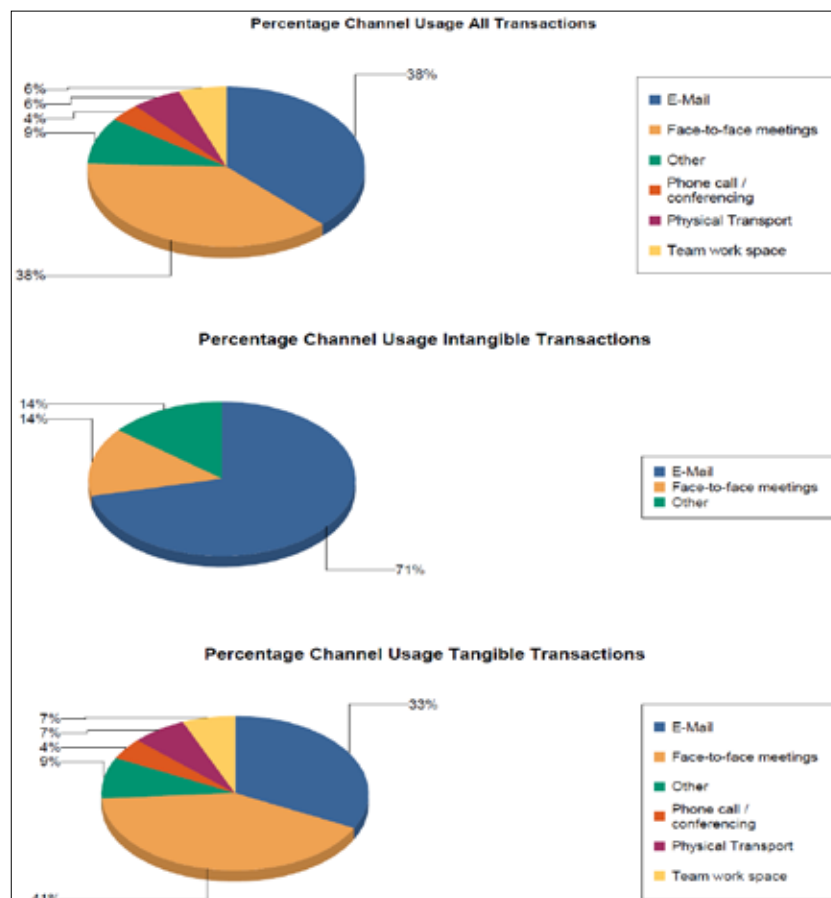
The obtained results allow us to state that, within the air traveller network, all the transactions (tangible and intangible) are executed quickly and released by the roles.

Channel

The channel profile provides a way to consider the effectiveness of different delivery mechanisms for specific deliverables. For example, some companies rely heavily on face-to-face meetings, but video conferencing might be a more effective way to work. Other companies rely on technology and systems for delivering information or automating provisioning.

The next figure (Figure 11) shows the distribution of different channels used within the air traveller network for all the transactions, intangible transactions only and, finally, tangible transactions.

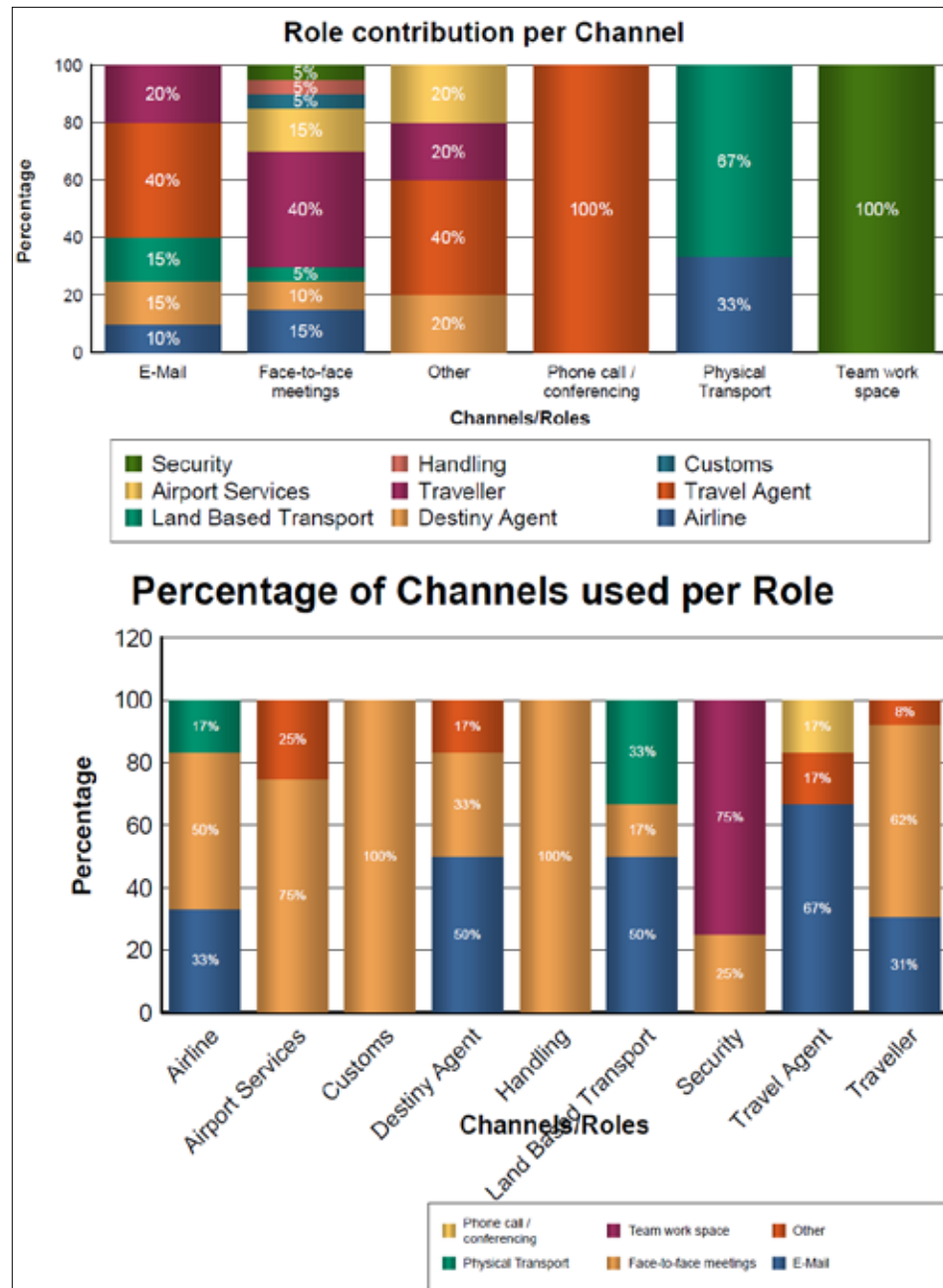
Figure 11. Chanel profile of Air Traveler Network's Transactions



Source: Own elaboration

Email is the most-used channel in all the transactions of the air traveller network, but for the tangible transactions, face-to-face meetings are the dominant channel. However, the preferred type of channel varies depending on the role, as shown by the next figure (Figure 12).

Figure 12. Channels used per Air Traveler Network's Roles



Source: Own elaboration

Agility

One indicator of network agility is the speed with which information can move around the network. The “degrees of separation”, technically referred to as “distance” in a network, are a measure of how quickly information can spread out across the network to reach all its members. It is an important indicator of a network’s agility in being able to make sense of and adapt to internal and external changes. It is also an indicator of the ease with which

any individual can reach the person who might be able to solve a specific problem. A high average distance between roles can be an indication that there are not enough hubs or connectors in the network.

Average Degrees of Separation for all Transactions	:	1.61
Average Degrees of Separation for all Intangible Transactions	:	0.14
Average Degrees of Separation for all Tangible Transactions	:	1.61

Within the air traveller network, the tangible transactions present greater agility than the intangible ones.

Stability

Stability is revealed by measures of network density. Density is calculated as the number of actual connections between roles divided by the number of potential connections between roles. The most significant density indicator is weak tie stability, which helps us to understand the extent to which the loss of connections in the network will affect the performance of the network as a whole.

Weak tie stability is the ratio between intangible and tangible transaction density: the higher the ratio, the more dominant the density of intangible connections; the lower the ratio, the more dominant the density of tangible connections. A resilience score of 1 shows a perfect balance between the densities of tangible and intangible connections.

Weak Tie Stability:	0.15
(intangible/tangible)	

Within the Air Traveler Network the density of tangible connections are dominant.

Density All transactions:
In your network 147.22 % of all possible ties are present.
Density Intangible transactions:
In your network 19.44 % of all possible intangible ties are present.
Density Tangible transactions:
In your network 127.78 % of all possible tangible ties are present.

4. SYNTHESIS AND CONCLUSIONS

People travel for many reasons, and as Denys and Mendes (2014, p. 4) argued, “(...) to comprehend what factors drive tourists and determine their choices requires a thorough analysis of various complicated variables of internal and external environments that embrace the tourist behavior”.

Applying the VNA methodology to tourists as air travellers, we identified the key roles related to the air traveller experience: traveller, travel agent, destination agent, airline, land-based transport, customs, security, handling and airport services.

The information (intangibles) about destination, transport, lodgings and so on is crucial to the traveller's decision about his/her trip. Nevertheless, all the roles engaged in contributing to his/her (good) experience while travelling have to work efficiently. This fact may explain why the scenario of the air traveller experience presents a higher level

of tangible than intangible transactions, meaning that it is a process-focused operational network characterised by a formal structure.

The traveller and travel agent roles are the ones that create more value within the traveller experience network, followed by the roles of land-based transport and airlines. They are indeed the key roles for the realisation of travel.

Either on the demand side or on the supply side, tourism demands large amounts of information (intangibles) (Benabdallah and Ben Soltane, 1996). Airport services and land-based transport are the roles that generate more intangible deliverables; also important in this context are the roles of travel agent, destination agent and traveller. Notably, the traveller is the role that generates more tangible value, followed by the travel agent. Indeed, the traveller is the one for whom all the other roles converge.

The traveller's role is, by far, the one that gains more (tangible and intangible) value from the air traveller network. In addition, the traveller's role provides more value to the network. Accordingly, we can say that the traveller's role has a strong structural position within the air traveller network, receiving and sending more value.

In spite of the strong structural position of the traveller's role, the predominance of the highest number of connections per role for transactions and the relatively low level of variance transactions allows us to state that the power in the air traveller network is distributed across almost all the roles. This means that if the traveller is the main focus of several roles, it is also true that the experience of the traveller is dependent on those roles.

Three main assets were identified in the air travel network: financial, competence and business relationships. The "competence" and "financial" assets are the most influenced by the transaction activity of the network as a whole, the "Competence" asset being more affected by either tangible or intangible transactions. The role of travel agent has a great impact on the business relationship asset as well as on the competence asset. Furthermore, the traveller role has a significant impact on the competence and financial assets. The asset "competence" is transversal to all the roles and notably important to the roles of customs, handling, security, airport services, travel agent and traveller. It is interesting to observe that the "financial" asset, present in almost all the roles, has great importance for the roles of airport services and destination agent, for which the competence asset has lower relative weight.

All the transactions have more positive (benefits) than negative (costs) impacts on the different assets within the air traveller network, either for tangible transactions or for intangible ones. The roles of traveller and travel agent are the ones that contribute more to the positive (benefits) as well as the negative (cost) impacts on the assets. Within the air traveller network, all the transactions (tangible and intangible) are executed quickly and released by the roles. Email is the most-used channel in all the transactions of the air traveller network, but for the tangible transactions, face-to-face meetings are the dominant channel. However, the preferred type of channels varies depending on the role. Within the air traveller network, the tangible transactions present greater agility than the intangible ones. In this regard, we recall Belo *et al.*'s (2014, p. 218) statement that "the key features of business and innovation, which in past decades were tangible, are now replaced by intangible assets such as connections, knowledge, and integration". Although, in our opinion, not all tangible assets are replaceable by intangible ones, it is necessary to take into account the growing importance of the latter in the business and innovation strategies.

As mentioned by Fattah *et al.* (2009), airports need to adopt a customer-centric approach focused on enhancing the passenger experience and, in this context, "the airport's role must evolve from passive landlord to active participant, enriching the passenger journey as a key ecosystem partner". For this goal, consistency, control and manageability, customised experiences and the right level of service intensity are needed as passengers increasingly

expect their travel experience to be seamless, stress-free and comfortable (Fitzpatrick and Bluell, 2015). The ability of VNA to describe better the effective network of the airport system justifies the choice of this methodology. We conclude that the application of VNA provided a network ecosystem perspective on how processes and people create value within the air traveller network.

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ISSN: 2183-1912

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