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STUDY OF THE EFFICIENCY OF SPANISH AIRLINES: A NON-PARAMETRIC DATA ENVELOPMENT ANALYSIS

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ABSTRACT

Spain is an eminently tourist country, which allows the creation of countless jobs and contributes greatly to GDP growth. Millions of people visit this country every year, and more than 80% do so through air transport. This paper studies whether the 13 Spanish airlines with the highest revenues in 2018 were efficient in that year, thus filling a gap in the tourism literature. For this purpose, the non-parametric DEA technique has been used, using as inputs the total number of workers in the company and the total number of seats available (airline capacity). Total revenue and number of passengers have been used as outputs. The results obtained show that all the airlines studied within the IAG group (Iberia, Vueling, Air Nostrum, Iberia Express) are efficient, in addition to the Canary Islands airlines (Binter Canarias, Canarias Airlines and Canary Fly) and Air Europa. Likewise, the reference airlines for the inefficient ones have been determined, which will have to reduce the number of workers or make changes in capacity in order to achieve greater income and be efficient.

KEYWORDS

Airlines; Efficiency; DEA; Spain; Tourism.

ECONLIT KEYS

Z30; L93; Z38

1. INTRODUCTION

The tourism sector is an engine for strengthening the economy (Mayer and Vogt, 2016; Li et al., 2018; Comerio and Strozzi, 2019; Liu and Wu, 2019). Tourism can also stimulate investment in new infrastructure and encourage the creation of economies of scale (Brida et al., 2008), as well as reduce poverty levels (Ashley and Mitchell, 2006; Spenceley and Meyer, 2017) and income inequalities (Mahadevan and Suardi, 2019). In addition, international tourism has been one of the fastest growing sectors in recent years and the largest source of income for many countries in the world (Gwenhure and Odhiambo, 2017; Sokhanvar, 2019). High productivity in aviation will generate rapid growth, enhance globalization and increase international cooperation (Ahmad and Khan, 2011).

Spain is a very touristy country. According to figures provided by the Ministry of Industry, Trade and Tourism, 82.6 million international tourists visited our country in 2018, a record figure that confirms the upward trend. In addition, 100,000 new tourism-related jobs were created in Spain in 2018. The tourism sector is an engine for the strengthening of the economy. Likewise, the average expenditure per tourist experienced an increase of 2.2% last year, reaching 1,082 euros per person, according to data provided by the National Institute of Statistics (INE). The British are at the head of those who visit Spanish territory. 18.5 million Britons did so last year, representing 22.3% of total tourists.

Spain leads the Travel and Tourism Competitiveness Index prepared by the World Economic Forum, in order to measure the policies and factors that enable the sustainable development of the tourism sector and make it attractive. This report is elaborated in 136 countries, placing Spain at the top followed by France and Germany.

The airplane is the main means of transport used by international tourists to reach Spain, with 81.6% of visitors using this means. Therefore, it is of great importance to know the efficiency of Spanish airlines. In this work, the efficiency of the main Spanish airlines in 2018 is studied based on certain inputs and outputs using the non-parametric DEA technique.

The structure of the work is as follows. Section 2 explains the air sector in Spain and introduces the main Spanish airlines; section 3 reviews the existing literature on airport efficiency; section 4 refers to the methodology used; section 5 presents the results; and finally, section 6 offers conclusions.

2. SPANISH AIRLINES

The air sector contributes 107 billion euros, which represents 9.1% of Spain's GDP, according to data provided by the International Air Transport Association (IATA) 2018 Air Transport Competitiveness Index for Spain. This figure is higher in the peninsula if we take into account the 3.6% that the air sector contributes to the world's GDP, according to Air Transport Action Group (ATAG).

More than 2 million flights were made in 2018, 5% more than in the previous year. More than 263.75 million passengers flew in Spain in 2018, 5.8% more than in 2017. The air industry generates 1.7 million direct and indirect jobs in Spain. The air sector in Spain is a driving force behind tourism, representing 11.7% of GDP and generating more than 12% of employment in Spain, according to INE data for 2017 published in December 2018.

Spain is the third country with the highest demand for air connectivity in Europe, which favours tourism, commercial exchanges, economic growth and the generation of employment, according to the Air Transport Competitiveness Index in Spain for 2018. According to data offered by Aeropuertos Españoles y Navegación Aérea (AENA), Spain offers air connections with more than 140 countries and reaches a figure of more than 350 destinations.

Given the relevance and importance of the tourism sector in our country, and specifically the aviation sector, a study of the efficiency of the main Spanish airlines has been carried out. The main Spanish airlines are shown in table 1.

Airlines	Foundation	Operating revenue 2018*	Field of operation
Iberia	1927	4.865.000	National International
Vueling	2004	2.360.865	National International
Air Europa	1986	2.130.517	National International
Air Nostrum	1994	510.386	National
Iberia Express	2011	504.510	National International
Volotea	2011	396.547	National International

Wamos Air	2003	233.609	International
Binter Canarias	1989	199.451	National
Evelop Airlines	2013	177.499	International
Canarias Airlines	2011	106.609	National
AlbaStar	2010	79.248	International
Plus Ultra Airlines	2011	55.277	International
Canaryfly	2008	38.712	National

Table 1. Main Spanish airlines, total revenues in 2018 and scope of operation
Source: Own elaboration
*Data in thousands of euros.

Iberia is the main Spanish airline based at Madrid-Barajas airport, operating 126 destinations in 47 different countries, with an additional 224 destinations in 50 countries thanks to code-sharing agreements with other airlines. Vueling Airlines currently serves more than 140 destinations. From its main Hub, Barcelona-El Prat Airport, it operates around 300 flights every day.

Air Europa offers almost 200 daily flights between its more than 70 destinations, most of them international. Air Nostrum is a company that mainly operates regional flights, although it also makes occasional trips to some countries in Europe and North Africa. Iberia Express is a low-cost airline owned by Iberia that emerged in 2011 as a project to operate short- and medium-range routes in the Spanish and European markets.

Volotea operates both domestic and international flights, but only to European or North African destinations. Wamos Air is an airline that only flies to the Caribbean from Madrid, specifically to Cancun, Varadero, Punta Cana and Samana. Evelop, like Wamos Air, flies from Madrid to various points in the Caribbean, although it also sporadically covers some routes between Portugal and the Balearic Islands in summer.

Binter Canarias is a mainly regional airline, although it also operates some international destinations from the Canary Islands. Canarias Airlines operates inter-island flights in the Canary Islands under a franchise agreement with Binter Canarias.

AlbaStar operates flights to various European destinations. Plus Ultra Airlines operates exclusively international flights, specifically covering routes from Madrid to Lima, Caracas, Quito and Guayaquil. Lastly, Canaryfly operates only inter-island flights between the Canary Islands.

3. REVIEW OF LITERATURE ON AIRLINES EFFICIENCY

The growing interest in tourism around the world and the great global connectivity that exists today has led to an increasing study of the efficiency of airlines, due to the importance they have for the development of tourism. However, to date there is no evidence of any work studying the efficiency of Spanish airlines.

Table 2 shows a summary of various works studying airline efficiency. The terms "airlines" and "efficiency" were used to search for articles in Google Scholar in order to find out what work has been done so far on airline efficiency. Among these papers, we selected those that belonged to different geographical areas and had a high number of citations. In this table we can distinguish the different inputs and outputs used in each publication, as well as the period of study and the scope in which they are used. We find more restricted studies (at the country level) and other more global ones (at the continent or world level). We can also observe the technique applied by each author. Some perform econometric and others non-parametric parametric techniques, such as Data Envelopment Analysis (DEA) or Total Factor Productivity (TFP). Most studies use non-parametric methods and estimate technical efficiency.

Authors	Period	Nº airlines	Geographical área	Inputs	Outputs	Methodology
Schefczyk (1993)	1990	15	International	ATK, operating costs, non-flight assets	RPK, RTK	Two-stage DEA
Distexhe and Perelman (1994)	1977-1988	33	International	Sum of all aircrafts weighted by the days in operation in the year, number of flying personnel	ATK	DEA
Sengupta (1999)	1988-1994	14	International	ATK, total non-flight assets, operating cost net of depreciation and amortization	RPK, non passenger revenue	Dynamic DEA
Duygun et al. (2000)	1991-1995	17	Europe	ATK, costs operational and non-flight assets	RPK, NRPK (N= number of passengers)	Two stage DEA and Tobit
Martinez and Zofio (2000)	1994	36	International	Flight equipment, ground property and equipment, salaries and flight crew costs,fuel, maintenance and overhaul	RPK, RTK	DEA
Arai (2003)	1976-2000	17	America, Asia, Europe	Labour cost, capital cost	Passenger-kilo, ton-kilo	Stochastic frontier analysis (SFA)
Araujo et al. (2006)	2000-2005	45	America, Asia, Europe	Employees, fleet, Hours flown per aircraft and day, Passenger load factor	Transported passengers per employee, Revenue Seat-km per employee and aircraft	Total Factor Productivity (TFP)
Färe et al. (2007)	1979-1994	19	USA	Multilateral labor index, fuel, fleet index adjust for aircraft size and age, material input	RPK, RTK	Malmquist Index

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Barbot et al. (2008)	2005	49	International	Employees,fuel,number of aircraft	RPK, RTK	DEA and TFP
Assaf (2009)	2002-2007	15	USA	Labor cost, fuel cost, other operating expense, number of airplanes	Total revenue	Bayesian random stochastic frontier
Barros and Peypoch (2009)	2000-2005	29	Europe	Employees, operational costs, number of aircraft	RPK, EBIT	DEA Bootstrapped truncated regression
Chow (2010)	2003-2007	16	China	Labor, fuel, seat capacity	RTK	Malmquist Index
Ahmad and Khan (2011)	1995-2009	3	Asia	Employees	ATK, ASK	Partial factor productivity, average costs
Lee and Worthington (2011)	2006	42	International	Employees, fleet, fuel, kilometres flown Dummies ownership type, low-cost, the passenger load factor and weight load factor	ASK,ATK	DEA (VRS) bootstrap approach
Zhu (2011)	2007-2008	21	International	CASM, Salaries, wages, and benefits per available seat mile, Fuel expense per available seat mile, Fuel cost, Gallons of fuel used	Load factor, fleet size, RPM and passenger revenue (money spent by passengers on items such as food and bag checks)	Two-stage DEA

Assaf and Josiassen (2011)	2002-2007	15	UK	Total operating costs (excluding labor costs), labor costs, fuel costs, aircraft value	ATK, total operating revenue	DEA double bootstam second stage regression
Lu et al. (2012)	2004-2008	30	USA	Employees, fuel, fleet, maintenance expense, seat capacity	First stage: ASM, ATM. Second stage: RPM and non-passenger revenue	Two stage DEA and truncated regression
Quintanilha da Silveira et al. (2012)	2005	14	Brasil	Fleet, employees	Passenger-km, tonne-km	DEA, MCDEA
Duygun et al. (2013)	1999-2011	86	Europe	Labour, capital and materials including fuel expenses. Stage length, load factor, average airplane seating capacity, jet the percentage of the airline's fleet comprising jets, and the percentage of the airline's fleet that is wide-bodied	RPK	Stochastic frontier analysis (SFA)
Pereira et al. (2013)	2008	17	Brasil	Fleet, maximum take-off weight, employees	ASK, ATK	DEA, MCDEA
Rai (2013)	1985-1995	10	USA	Fleet, employees, fuel	ASK,ATK	DEA (CCR)
Barros et al. (2013)	1998-2010	11	USA	Employees, fuel, total cost	Total revenue, RPM, passenger load factor	B-Convex

Wu et al. (2013)	2010	15	International	Employees, fleet, operating costs	RTK, total revenue	Two stage DEA
Arjomandi & Seufert (2014)	2007-2010	48	International	Labor, capital (flying hours, daily revenue hours)	ATK, CO_2 emission	Bootstrapped DEA
Lee and Worthington (2014)	2006	42	International	Employees, kilometers flown	ATK	DEA Bootstrapped truncated regression
Lozano and Gutiérrez (2014)	2007	16	Europe	Fuel costs, wages and salaries, non-current assets and other operating costs	ATK	Slack-based network DEA
Cao et al. (2015)	2005-2009	29	China	Employees, fuel, number of aircraft	RTK, total number of flights	Malmquist Index
Mallikarjum (2015)	2012	27	USA	First stage: operating expenses Second stage: ASM Third stage: RPM	First stage: ASM Second stage: RPM Third stage: operating revenue	Three stage DEA
Merkert and Pearson (2015)	2011-2012	116	International	Employees, ASK	Custom Rank (service quality), Margin (operational profit/loss), RPK	DEA
Duygun et al. (2016)	2000-2010	87	Europe (23 countries)	Employees, fleet, materials	RTK	Two-stage DEA
Ferro and Monterubbianesi (2016)	1995-2015	19	15 airlines from USA and 4 latin airlines	Employees, fleet, fuel Dummy latin, lcc, one world, star alliance, skyteam	ASM	Coob Douglas estimation log

Sjögren (2016)	1990-2003	41	International	Labor, Fuel consumed, Aircraft capacity (1st model & 3rd model) Hours flown, aircraft departures, Kilometers flown (2nd model)	Hours flown, Aircraft departures, Kilometers flown (1st model), RPK, TK (2nd model & 3rd model)	DEA, Malmquist Index
Omrani and Soltanzadeh (2016)	2010-2012	8	Iran	First stage: employees (headcount), Second stage: ASK, number of scheduled flights	First stage: ASK, Number of scheduled flights, Second stage: RPK, Passenger Tonne kilometer	Two stage DEA
Cui and Le (2017)	2008-2015	29	International	Employees, fuel, previous year fleet size	Total revenue, greenhouse gases	Dynamic Epsilon-Based Measure
Yu et al. (2017)	2009-2012	30	International	First stage; Labor expenses, size of leased fleet, fuel expenses, other operational expenses Second stage: ASK, ATK	First stage: ASK, ATK Second stage: RPK, RTK	Two stage DEA
Seufert et al. (2017)	2007-2013	33	International	Capital (Total number of flight hours divided by average daily revenue hours), Staff (Number of pilots and flight attendants)	ATK, CO_2 emissions	DEA, Luenberger-Hicks-Moorsteen indicator
Kottas et al. (2018)	2012-2016	30	International	Employees, total operating costs, number of operated aircraft	Total operating revenue, RPK, RTK	DEA (CCR)

Kuljanin et al. (2019)	2008-2012	17	Europe	Employees, fleet, cost per ASK, employee cost per ASK, ASK, delay	Aircraft/employee, passenger per employee, RPK , load factor, number of passengers, operating revenue, destinations	DEA and Malmquist index

Table 2. Main papers on airline efficiency and employed inputs and outputs.
Source: Own elaboration
RTK (Revenue Tonne Km)
RPK/M (Revenue Passenger Km/mile)
ATK (Available Tonne Km)
ASK/M (Available Seat Km/mile)
CASM (Cost per available seat mile)

In many papers, Available Tonne Km (ATK) has been used as input and Revenue Passenger Km (RPK) and Revenue Tonne Km (RTK) as outputs, due to the high representativeness of total revenues in airlines to be efficient. Some works studied the efficiency of airlines at international level. For example, Kottas et al. (2018) determined that airline membership in a group of alliances does not imply greater efficiency, and that Asian and European airlines are more efficient than US airlines. Yu et al. (2017) reveals that the yearly weights distribution has significant impact on the operational efficiency of airlines. Cui and Lee (2017) determined that the European Union Emission Trading System has little influence on the pollution abatement costs for most of the airlines. Sjögren (2016) shows that North American airlines are more efficient in producing services offered to customers. Arjomandi & Seufert (2014) reveals that European full-service carriers seem relatively more environmentally efficient.

There are also papers that focus on airlines in a particular country. For example, Pereira et al. (2019) studied the efficiency of 17 Brazilian airlines in 2008, and found that only 3 of them were efficient (Gol Airlines/VRG Airlines, TAM Airlines, and TAF Airlines). Barros et al. (2013) did the same for US airlines for the period 1998-2010. They concluded that US airlines display a reasonable level of efficiency, with Delta Airlines, United Airlines, US Airways and Frontier maintaining a remarkable level of efficiency in all years.

The results obtained in the papers vary considerably depending on the inputs and outputs used in the literature. Due to the difficulty in obtaining data and the fact that the information published in Spain in this area is very generic, no previous study on the technical efficiency of Spanish airlines has been found.

4. METHODOLOGY: IMPLICATIONS OF THE DEA ANALYSIS

Data Envelopment Analysis (DEA) is a methodology that aims to measure the efficiency of a set of productive units called DMUs (Decision Making Units), which consume multiple inputs to produce outputs. The DEA compares the relative efficiency of a set of units that produce similar outputs from a series of common inputs. This technique is widely used in the literature to measure efficiency and is the methodology employed in this work.

The DEA concept is a non-parametric and deterministic procedure that allows, through a linear programming technique, the evaluation of the relative efficiency of a set and homogeneous productive units. The DEA methodology facilitates multidimensional treatment, both on the input side and on the output side, without implying the need to systematize and process multiple cross-cutting indicators.

Data Envelopment Analysis was proposed by Charnes, Cooper and Rhodes (1978) following mainly the concepts of Farrell's work (1957) and has been a widely used technique since then since it presents a great number of advantages.

Among the advantages of the DEA method, the following stand out

- It allows the use of different units to represent inputs and outputs, without requiring a predefined relationship between them.
- It is suitable for situations where factor and product prices are unknown or difficult to calculate
- Specific objectives or efficient projections are obtained over the border, for each inefficient DMU.
- It is a non-parametric technique and, therefore, does not assume any functional form of the relationship between inputs and outputs, nor does it assume a distribution of inefficiency (Banker et al., 1993).
- It provides a large amount of information tailored to each DMU.

However, like any model, it also has a number of limitations or drawbacks:

- The estimated boundary is made on a subset of the sample, being very sensitive to the existence of outliers.
- Requirement for the homogeneity of the units subjected to analysis to avoid the inefficiencies of the centres being detected due to any non-uniform factor and which imply homogeneity in the scale of production, homogeneity in the use of inputs and outputs and in the circumstances that constitute the scope of action of the units.
- It poses problems when the number of DMUs is low.
- It does not provide information on how a unit behaves with respect to the theoretical maximum.

- Flexibility in the choice of weights could be a problem since, when evaluating the efficiency of some unit, some output or input may receive a zero weighting and, therefore, not be considered in the process.

Despite a series of limitations, it is considered that the DEA methodology is totally adequate to be applied as a measure of efficiency, standing out among other non-parametric methods thanks to its standardization and the possibility of considering multiple inputs and outputs.

To calculate efficiency, there are two different orientations, an input orientation that consists of minimizing the input while keeping the output constant, and an output orientation whose objective is to maximize production (outputs) while keeping the amount of resources consumed (inputs) constant.

The reliability of the results of the DEA analysis will depend on the relationship between the number of variables considered and the number of units to be analysed, and there are various proposals in this regard (Banker et al., 1989; Cooper et al., 2000). The rule of practice recommended by Cooper et al. (2000) has been followed, who recommend that the number of entities analysed should be at least three times the relevant variables introduced in the model. In this paper, the total number of input and output variables considered, multiplied by three, should not exceed the number of airlines.

Taking into account the literature studied previously, the total number of company employees, widely used in the vast majority of works (Duygun et al, 2015; Ahman & Khan, 2011) and obtained through the SABI (Iberian Balance Sheet Analysis System) database, has been selected as the input. The total number of seats available on each airline has also been used (Chow, 2010; Lu et al., 2012). These data have been obtained through reports provided by each company and information extracted from each airline's own website, taking into account the available fleet. The outputs used are the airline's total revenue (obtained from the SABI database) and total passengers (Araujo et al., 2006; Kuljanin et al., 2019) carried by the airline in 2018 (obtained from AENA). Table 3 shows the data of the outputs and inputs used for the year 2018.

Airline	Total Revenues (in thousand euros)	Passengers	Employees	Seats
Iberia	4.865.000	19.278.848	15.239	20.211
Vueling	2.360.865	39.384.323	3.552	22.488
Air Europa	2.130.517	17.357.446	3608	10.838
Air Nostrum	510.386	8.414.227	1.443	3.236
Iberia Express	504.510	9.531.028	705	4.128
Volotea	396.547	1.525.278	888	5.089
Wamos Air	233.609	187.024	679	4.512
Binter Canarias	199.451	4.131.015	237	1.660
Evelop Airlines	177.499	548.446	340	2.044
Canarias Airlines	106.609	2.914.716	153	720
Albastar	79.248	244.280	197	1.096
Plus Ultra Airlines	55.277	99.599	246	1.212
Canary Fly	38.712	1.120.746	206	432

Table 3. Outputs and inputs used for efficiency analysis.
Source: own elaboration.

We used the output-oriented variable returns-to-scale (VRS) model to derive efficiency scores. R software has been used to perform the efficiency analysis. This orientation is used because constant returns-to-scale (CRS) is appropriate only when operating at its optimal scale, which is unlikely in such a volatile sector (Lee and Worthington, 2011).

5. RESULTS

All Spanish airlines dedicated to passenger transport have been studied, with a total of 13. As there are 13 DMUs, two inputs and two outputs have been selected to measure efficiency. The main business of the airlines studied is passenger transport, although some of them also carry out freight transport. In this paper we focus exclusively on passenger transport.

DMU	Efficiency
Iberia	1
Vueling Airlines	1
Air Europa	1
Air Nostrum	1
Iberia Express	1
Volotea	0,6406
Wamos Air	0,4790
Evelop Airlines	0,6783
Binter Canarias	1
Canarias Airlines	1
AlbaStar	0,5357
Plus Ultra Airlines	0,3160
Canary Fly	1

Table 4. Efficiency of Spanish airlines using the DEA technique.
Source: Own elaboration.

Table 4 shows the results obtained after performing the DEA analysis with output orientation. These results show that, for the inputs and outputs used, 8 airlines are efficient by obtaining a value equal to 1. The closer to 1, the greater the efficiency. In this way, Iberia and its two subsidiaries, Air Nostrum and Iberia Express, proved to be fully efficient in 2018. Vueling Airlines, which is dependent on the group formed by Iberia and its subsidiaries is also efficient (IAG Group). The Canary Islands airlines (Binter Canarias, Canarias Airlines and Canary Fly) are fully efficient in operating in their territory and manage their resources appropriately. Another major Spanish airline, Air Europa, is also efficient. However, Volotea, Wamos Air, Evelop Airlines and AlbaStar are far from efficient. These airlines will have to significantly reduce the number of employees or their seating capacity in order to become more efficient and achieve higher revenues.

Efficient airlines serve as a model or benchmark for inefficient ones. Some stand out as being more efficient than others, as they are benchmarks for a greater number of airlines seeking to achieve efficiency (Figure 1). Air Europa is the reference airline for 4 inefficient airlines (Volotea, Evelop Airlines, AlbaStar and Plus Ultra Airlines). Binter Canarias is the reference for 4 of them (Wamos Air, Evelop Airlines, AlbaStar and Plus Ultra Airlines). Iberia Express is a reference for Volotea and Evelop Airlines.

Canarias Airlines is the reference airline for AlbaStar and Plus Ultra Airlines, and Vueling is the reference for Volotea and Wamos Air.

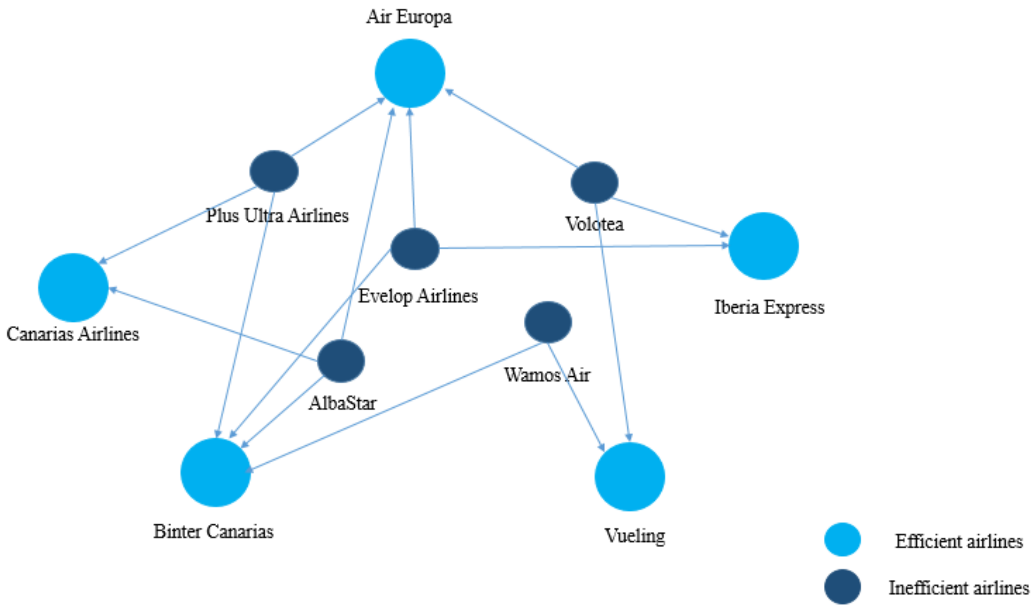

Figure 1. Groupings of efficient and inefficient airlines.
Source: own elaboration

6. DISCUSSION AND CONCLUSIONS

The tourism sector is an engine for the strengthening of the Spanish economy with the creation of new jobs and a great contribution to the growth of the Spanish GDP. In addition, air travel is the main means of transport used by international tourists to reach Spain, being used by 81.6% of visitors, so it is vital to know whether Spanish airlines are acting efficiently. The literature presents many works which measure the efficiency of airlines at an international, continental or local level, using a wide variety of inputs and outputs. However, there are no papers studying the efficiency of Spanish airlines. Thus, this paper fills this gap in the literature.

Therefore, Data Envelopment Analysis (DEA), a methodology that aims to measure the efficiency of a set of productive units called DMUs, has been used to measure the efficiency of the main Spanish airlines.

To this end, the total number of workers in the company and the total number of seats available in each airline have been used as inputs. Total revenues and the number of passengers have been used as outputs. It has been obtained that, for the inputs and outputs used, 8 airlines are efficient (Iberia, Vueling, Air Nostrum, Iberia Express, Binter Canarias, Canarias Airlines, Canary Fly and Air Europa). This demonstrates the great efficiency of the IAG group and the effectiveness of the Canary Islands airlines operating in its territory. Air Europa, another major Spanish airline, is also efficient. The rest of the airlines should reduce the total number of employees and make adjustments to their capacity in order to be efficient. Air Europa and Binter Canarias stand out for being the airline of reference for four inefficient airlines. It is followed by Vueling, Iberia Express and Canarias Airlines with two airlines that consider them to be a reference.

As there is no previous work evaluating the efficiency of Spanish airlines, it is only possible to compare the results obtained with other airlines in other countries. In Spain, the efficient airlines include those that are part of the IAG group, where the country's main airlines, such as Iberia, are concentrated. In this regard, the results are in line with those obtained by Pereira et al. (2019) for Brazilian airlines and Barros et al. (2013) for US airlines. In both works, the main airlines in the country are the most efficient (Gol Airlines or Tam Airlines in the case of Brazil, or United Airlines or Delta Airlines in the case of US airlines). Low-cost airlines have also been a boon in recent years due to their high competitiveness and attraction of market share. (Lee and Worthington, 2011) and with the current Covid-19 crisis, are likely to come closer to efficiency due to their low prices.

Non-efficient airlines should evaluate their current position and adopt an appropriate management procedure that will allow them to achieve the most efficient practices. They should improve their management and adopt policies aimed at increasing their revenues and passengers. Among the possible strategies are a reduction in prices or the implementation of various promotions to increase the number of passengers, so that the total number of available seats is always completed. In case the expected demand for passengers is very low and the total number of seats is well above the actual capacity, one of the options could be the sale of one of the company's aircraft.

In terms of future work, it will be interesting to consider another series of inputs and outputs, such as the levels of CO_2 emitted, to see whether the airlines are efficient and environmentally sustainable, a very current and necessary issue today.

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