Journal of **Tourism** & Development | n.º **39** | 2022 | [**301** - 313]
DOI: 10.34624/rtd.v39i0.30483
e-ISSN 2182-1453

Improving the **air connectivity** of **hub airports**: an instrument to boost the **economic performance** of EU countries?

Aumentar o grau de **conectividade aérea** dos **aeroportos hub**: um instrumento para melhorar a **performance económica** dos países da UE?

MARIA INÊS CASTRO * [maria16ines@gmail.com]

MARIA PAULA FONTOURA ** [fontoura@iseg.ulisboa.pt]

Abstract | This study discusses the importance of hub airports' air connectivity in improving the economic performance of the EU countries during the period of 2008-2019. Two different measurements of air connectivity are used, namely airport and hub connectivity, which are calculated using the Nestcan Model. As a first step, we analyse the degree of linear association of each measurement with gross domestic product (GDP) and with a set of economic variables (hereafter designated as EVs) which, according to the literature, are expected to be positively determined by air connectivity and tend to boost countries' economic performance. These EVs are: inflows and outflows of foreign direct investment, imports, exports, and international tourism expenditures. We conclude that the type of air connectivity that is adopted matters, as hub connectivity has a greater correlation with key variables for economic growth and is increasingly correlated with GDP during the period under analysis, while a downward trend over the more recent years was observed for airport connectivity. As a second step, we test the strength and direction of the quantitative relationship between hub connectivity and GDP/each EV for a sample of EU countries which have a hub connectivity level of at least 5% of the TOP hub-connected EU country (Germany). Finally, we extract conclusions for individual countries, with the help of scatter diagrams and regression lines.

Keywords | Air connectivity, airport connectivity, hub connectivity, foreign direct investment, international trade

* **Master's in International Economics** ISEG - Lisbon School of Economics and Management, Universidade de Lisboa
** **Full Professor** at ISEG - Lisbon School of Economics and Management. **Member** of UECE - Complexity and Economics Research Unit and REM - Research in Economics and Mathematics, Universidade de Lisboa

Resumo | Este estudo aborda a importância da conectividade aérea dos aeroportos hub para o desempenho económico dos países da União Europeia durante o período 2008-2019. Para o efeito, como primeiro passo, utilizamos duas medições diferentes da conectividade aérea - a conectividade aeroportuária e a hub, relativa aos aeroportos hub, calculadas com o Modelo Nestcan, e, de seguida, analisamos o grau de associação linear de cada uma delas com o Produto Interno Bruto (PIB) e com um conjunto de variáveis económicas (doravante designadas como VE) que, de acordo com a literatura, se espera que sejam positivamente determinadas pela conectividade aérea e impulsionem o desempenho económico de um país, nomeadamente: entradas e saídas de investimento direto estrangeiro, importações, exportações e despesas internacionais de turismo. Concluímos que o tipo de conectividade aérea adotada é relevante. Os resultados mostram que a conectividade hub tem uma maior correlação com variáveis-chave para o crescimento económico e está cada vez mais correlacionada com o PIB durante o período analisado, enquanto uma tendência decrescente ao longo dos últimos anos foi observada no que diz respeito à conectividade aeroportuária. Em seguida, testamos a magnitude e a direção da relação quantitativa entre a conectividade hub e o PIB/cada VE para os países da UE com um nível de conectividade hub de pelo menos 5% da do país com valor mais elevado (Alemanha). Por último, extraímos conclusões para cada país, com a ajuda de diagramas de dispersão e linhas de regressão.

Palavras-chave | Conectividade aérea, conectividade aeroportuária, conectividade hub, investimento direto estrangeiro, comércio internacional

1. Introduction

Air transport provides a worldwide transportation network which generates various vital economic benefits. The European Union (EU) has been the largest international market in air transport services in the world since 1997 (Button, 2008). In 2018, the EU aviation industry supported 9.8 million jobs and €672 billion in terms of EU economic activity and was responsible for 4.2% of EU employment and 4.2% of EU GDP, with EU air traffic transporting 903 million passengers (19.6% of the world passenger traffic), most of whom are tourists (Air Transport Group [ATAG], 2020)[1].

The objective of this study is to analyse the contribution of air connectivity of hub airports for the economic performance of EU countries (without the United Kingdom) during the period 2008-2019. Several previous studies have also studied the relation between air connectivity and economic performance, more precisely in terms of economic growth (Button & Taylor, 2000; Kasarda & Green, 2005; Green, 2007; Chang & Chang, 2009; Button & Yuan, 2013; Chi & Baek, 2013; Profillidis & Botzoris, 2015; Dimitrios & Sartzetaki, 2018), however the methodology adopted in this research differs in two main respects.

While studies relating air transport and economic activity usually measure the former as the number of either transport passengers/ revenue passenger-kilometers (Profillidis & Botzoris, 2015) or air cargo (Kasarda & Green, 2005), we consider two perspectives regarding air connectivity, namely: airport and hub connectivity. Airlines compete both on direct routes (from A to B), and indirectly in the form of transfers at a hub airport (from A to B, via hub airport X). This is the accessibility perspective of air connectivity, which is also called 'airport connectivity'. Its measurement considers the number of direct and indirect connec-

[1]The EU includes the United Kingdom in this particular study.

tions and connecting times available to the consumer at a certain airport. Another perspective regarding air connectivity is related with the number and quality of transfer opportunities available via a specific hub airport. The measurement of transfers at hub airports provides information about the centrality offered by hub airports in terms of the number and quality of airline routes – which is usually called 'hub connectivity'. This distinction has been adopted by various authors (Veldhuis, 1997; Burghouwt, 2007; Malighetti, Paleari, & Redondi, 2008) and we also consider it to be of most interest for our study, based on the fact that it is convenient for highlighting the economic benefits of hub airports.

With regards point-to-point airports – which are smaller and where most passengers who frequent them are short haul flights – hub airports work to create economies of scale by pooling demand from "leisure passengers, international transfer passengers, business passengers, and freight to make routes and regular flights viable" (Heathrow, 2014, n.p.). In a hub airport, interconnections between flights become easier and are less prone to delays and the typically large variety of flights can easily respond to a greater demand. On the one hand, for passengers, there are a large number of benefits from using a hub airport, such as easier access to and from the airport due to a greater quantity of surrounding infrastructure (e.g., means of transportation), a wider choice of destinations, more frequent flights, and cheaper fares due to competition between airlines (Heathrow, 2014, n.p.). On the other hand, for airlines, hub airports maximise the number of passengers transported by filling flights with transfer passengers, which is a resource that contributes to making routes viable. With regards cargo, while point-to-point airports are not designed to transport freight due to the preponderance of "smaller aircraft, short-haul routes, and tighter turn-around times" (Heathrow, 2014, n.p.), hub airports provide quick access to long-haul markets for products which are time-sensitive in terms of freight. As an example, an airline that has a Cargo-owned subsidiary that operates in a hub airport, such as Lufthansa Cargo or Air France KLM Cargo, helps increasing a country's foreign trade. It should also be noted that airlines using hub airports frequently promote an overnight break, or even a stay in the 'hub country', which can even be a Stopover, i.e., with a duration of at least 24 hours (e. g., a Stopover of at least 24 hours in Frankfurt airport during a flight from Bangkok via Frankfurt to Havana); in any case, these time periods contribute to increasing passenger expenditures.

European hub airports are acknowledged to be among the best-connected hubs in the world, which is explained by their geographic location, high population density, and strong economic position, especially due to the strengths of the European aviation market[2]. According to the Airports Council International [ACI] Europe (2020), Europe continued to dominate hub airports worldwide in 2019. This is an additional reason to research the economic impact of hub connectivity in the EU area.

The second noticeable difference from the methodology used in similar studies is the fact that our focus is not on the direct relation between air connectivity and economic growth, but rather we consider a set of economic variables (hereafter designated by EVs) which, according to the related literature, are expected to be positively determined by the level of air connectivity. These EVs are: inflows and outflows of foreign direct investment (FDI), international trade, and international tourism expenditures. In turn, these variables are expected to boost economic growth, as shown, for instance, by Forte and Moura (2013) for inward FDI, Herzer (2008) for outward FDI, Reis (2019) for trade, and Sequeira and Nunes (2008) for tou-

[2]See Frankfurt Airport's site. Available at Frankfurt Airport | Frankfurt International Airport (FRA) (frankfurt-airport.org). Accessed December 3, 2019.

rism.

We start by analysing the degree of linear association between airport and hub connectivity with each one of the EVs and also with GDP. Results confirm that the degree of hub connectivity of a country matters, as correlations are generally higher in the case of this measurement. Next, we build a simple linear regression for the relationship between hub connectivity and GDP/each EV for a sample of EU countries that have a hub connectivity level of at least 5% of the TOP hub-connected EU country (Germany), and then we extract conclusions for individual countries by using scatter diagrams and regression lines.

The proliferation of the COVID-19 virus since 2020 resulted in unprecedented major negative impacts on the aviation industry. Past shocks, such as 9/11, SARS, or the Eyjafjallajökull eruption airspace closure, did not affect air transport nearly as much as COVID-19 has (ATAG, 2020). When compared with 2019 figures, total world passenger traffic declined by 60% in 2020, which is the equivalent of losses of 125 billion USD and 371 billion USD for airports and airlines, respectively (Skift Research, 2020). The global airline industry is estimated to have lost 315 billion USD in passenger revenue in 2020, with 18 airlines filing for bankruptcy (idem). The world's air connectivity was critically threatened, with major implications for economies worldwide, especially those that are highly dependent on tourism. The real impacts of the COVID-19 pandemic for the world's economy remain uncertain, although it is estimated that the aviation industry will take several years to fully recover from the major losses. By illustrating the relation between air connectivity and crucial variables for economic growth during a period that was prior to the COVID-19 crisis, an objective of this analysis is to contribute to assisting those who have the responsibility to plan strategies to improve economic growth during the aftermath of COVID-19.

The research is presented as follows. Section 2 presents arguments for expecting a positive relation between air connectivity and economic performance at a country level, Section 3 describes the methodology and the data used in the empirical study, Section 4 shows the results obtained, and Section 5 concludes.

2. The relationship between air connectivity and economic performance

The basis of the expected positive economic impact of air connectivity on the EVs is supported by several previous studies[3].

The link between air travel and air connectivity to promote inward FDI is well documented. For instance, Bel and Fageda (2008) have shown that a 10% increase in the supply of intercontinental flights leads to a 4% increase in the number of headquarters of large firms located in the corresponding urban area. Along the same line, Oxford Economics & York Aviation (2013) quotes several studies, such as the annual survey of "European Cities Monitor" of 2011, produced by Cushman and Wakefield, which shows evidence of how connectivity can be a key element for a company's location decision, and that European cities with major hub airports are considered to be preferential locations for firms. In 2011, London, Paris, Frankfurt, and Amsterdam were at the top of this list. Air connectivity is also important for outward FDI, as "it is simply the direction of flow that is reversed" (Oxford Economics and York Aviation, 2013, p. 18).

The value of air connectivity in promoting trade has long been suggested. Air cargo can be the most efficient way to transport goods worldwide, especially as we are now living in a world where time is money, and distance matters more than ever. Accordingly, improving air connec-

[3]For a survey, see Oxford Economics & York Aviation (2013).

tivity can play a key role in reducing costs associated with time travel between geographically distant markets and, ultimately, in improving the exploitation of comparative advantage, resulting in a more efficient allocation of resources. This relation has been proved in several studies whose results include those of the Conference of British Industry (CBI), which established a strong link between the level of air connectivity and trade for the six largest EU economies in a study published in 2013 and quoted by Oxford Economics and York Aviation (2013). In concrete terms, an additional daily air service to each of the world's largest high growth economies would result in a positive impact of around £1 billion in additional trade. The report entitled "Connecting for Growth" that was published on 22nd September 2011, prepared for Heathrow by Frontier Economics on the role of Britain's hub airport in economic recovery[4], concluded that UK businesses traded 20 times as much with countries with which there are at least daily flights, and that UK trade could be increased by around £1.2 billion per annum if there was sufficient capacity at Heathrow to accommodate viable routes to emerging markets.

Finally, developing and broadening air connectivity obviously has the potential to increase the number of visitors that enter a country, either for business or for leisure purposes, as well as the related expenditures (e.g., travel tickets, accommodation, food, and beverages). Research carried out by York Aviation for ACI Europe, quoted in Oxford Economics & York Aviation (2013, p. 22), shows that air connectivity can account for a third or more of foreign visitors, even in the case of major European cities where other transport modes are more competitive. Inbound tourism may have a vital role in increasing the level of consumption in countries that are highly reliant on tourism. Using the northern region of Portugal as a case study, Costa, Almeida and Conceição (2017, p. 212) concluded that "airports act as operational spheres of influence which, along with tour agents in the area they serve, form the point of regional structure for international tourism".

We also examine the relation between the air connectivity variables and GDP, where the expected impact of increased air connectivity on economic growth and the long run level of GDP is especially relevant. Although we do not test for this long run effect, previous considerations, and a wide range of previous studies (such as that of Oxford Economics, 2008, 2014), lead to expect a significant impact.

3. Methodology and data

As a first step of our empirical analysis, we calculate the correlation coefficient of airport connectivity and hub connectivity with FDI inflows and outflows, goods exports and imports, international tourism expenditures, and the GDP of the current EU area for 2008 to 2019 (therefore excluding the United Kingdom)[5].

In a second step of the analysis, which is designed to obtain a more clear insight of the role of hub connectivity in improving countries´ economic performance, as well as the strength and direction of the previous relationships, we estimate the impact of hub connectivity on GDP and on each EV with a simple linear regression for a relatively small sample of EU countries chosen using the above-explained criteria. The following countries were included, presented in decreasing order of hub connectivity (where the hub connectivity and the main hub airport is shown in brackets): Germany (121,141; Frankfurt Airport, which is the Lufthansa Hub), Netherlands (58,354; Schiphol Airport, which is the KLM Hub), France (49,972; Charles de Gaulle Airport, which is the Air France Hub), Spain (27,994; Madrid-Barajas Air-

[4]The Frontier Economics report can be downloaded at: http://hub.heathrowairport.com/.
[5]Data for tourism expenditures is only available up until 2018.

port, which is the Iberia Hub), Italy (17,755; Fiumicino Airports, which is the Alitalia Hub), Austria (15,698; Vienna Airport, which is the Austrian Airlines Hub), Finland (12,397; Helsinki Airport, which is the Finavia Hub), and Portugal (6,807; Lisbon Airport, which is the TAP Air Portugal Hub). The advantage of using a relatively small sample of countries is that such a sample facilitates the analysis of individual countries.

A variety of measures exists for air connectivity, which include: total passengers, airfares, the number of destinations, travel time, all of which are either used "as standalone proxies or combined to produce a measure capturing different features of air-transport" (Morphet & Bottini, 2015, p. 11)[6]. In this study, we use the Nestcan Connectivity Index, which was conceived by SEO Aviation Economics in collaboration with ACI, which provides measurements for both airport connectivity and hub connectivity.

The SEO Netscan connectivity model "identifies all direct and indirect (one stop) connections available on an airport-pair" (ACI Europe, 2014, p. 66). It includes "seat capacity, both direct and indirect connections, transfer time and potential delay time when connecting" (Morphet & Bottini, 2015, p. 13). Furthermore, it is both quantitative and qualitative, as it measures not only the number of direct (non-stop) connections and indirect connections through other airports, but also the quality of individual connections. Airline schedule data is used as the input for the quantitative component of the study, which provides the number of weekly frequencies (both direct and indirect). The quality part of this model ranges between zero (when predetermined flight time limits are exceeded) and 1 (the shortest travel time)[7] (ACI Europe, 2014).

The Netscan model is considered very reliable and is popular among researchers for two main reasons[8]. First, it includes the most important connection elements (frequency, travel time, and connecting time) in a single indicator (ACI Europe, 2014). Second, it is rated as one of the most sophisticated network quality models, as it includes weights for each connection as a means of evaluating each connection's quality on a continuous scale. We use the World Bank Open Data for the remaining variables (EVs and GDP).

4. Empirical results

Tables 1 and 2 below show the linear correlation coefficients of both airport connectivity and hub connectivity, respectively, for each EV, and with GDP. We conclude that the correlation coefficients are all positive in the case of both airport connectivity and hub connectivity, and are very high in the case of the trade, tourism expenditures, and GDP variables.

In gerneral, the correlations with FDI inflows present the lowest values, with both FDI inflows and outflows displaying a high variation over the period under analysis, which is not surprising, considering that the distinction between FDI and portfolio investment is ambiguous in practice (UNCTAD, 2006). The higher correlations with FDI outflows are as expected, as countries with highest levels of hub connectivity are, in general, those that have the highest levels of development, and therefore such countries tend to be net exporters of FDI, according to the Investment Development Path Theory[9]. Interestingly enough, FDI outflows, imports, exports, and tourism expenditures all display higher values with hub connectivity.

[6] See Burghouwt & Redondi (2013) and OECD (2018) for a presentation of the main measurements and the discussion of each measure's merits.

[7] See ACI Europe (2014), p. 67, for a detailed explanation of the method used to determine the quality of individual connections.

[8] For other applications of the Nestcan model, see, for instance, Nguyen & Lee (2019) for the Tan Son Nhat International Airport. This model has been used since 2000 by the Air Transport Association (IATA) to assess global air connectivity.

[9] First proposed by Dunning (1981). For a more recent version, see Durán and Úbeda (2001).

Table 1 | Airport connectivity - European Union* (correlation coefficients), 2008-2019

	FDI inflows	FDI outflows	Goods exports	Goods imports	International tourism expenditures	GDP
2008	0.202	0.428	0.890	0.941	0.905	0.972
2009	0.270	0.540	0.889	0.932	0.900	0.970
2010	0.403	0.590	0.890	0.932	0.906	0.970
2011	0.264	0.331	0.888	0.925	0.901	0.966
2012	0.223	0.321	0.903	0.931	0.913	0.974
2013	0.266	0.247	0.913	0.936	0.917	0.977
2014	0.142	0.564	0.902	0.929	0.912	0.970
2015	0.188	0.326	0.902	0.930	0.930	0.969
2016	0.266	0.413	0.893	0.918	0.924	0.964
2017	0.572	0.674	0.882	0.910	0.918	0.958
2018	0.389	0.508	0.874	0.903	0.919	0.952
2019	0.543	0.570	0.868	0.895	n/a	0.948

Source: World Bank Open Data, and SEO Aviation Economics and ACI. *27 EU countries. Authors' calculations

Table 2 | Hub connectivity - European Union* (correlation coefficients), 2008-2019

	FDI inflows	FDI outflows	Goods exports	Goods imports	International tourism expenditures	GDP
2008	0.295	0.511	0.949	0.939	0.951	0.899
2009	0.411	0.722	0.950	0.949	0.953	0.906
2010	0.536	0.769	0.957	0.947	0.955	0.904
2011	0.458	0.511	0.952	0.949	0.960	0.912
2012	0.471	0.588	0.960	0.952	0.958	0.900
2013	0.482	0.487	0.959	0.951	0.951	0.895
2014	0.290	0.705	0.956	0.952	0.945	0.894
2015	0.382	0.541	0.951	0.953	0.946	0.898
2016	0.492	0.644	0.951	0.950	0.946	0.894
2017	0.770	0.908	0.948	0.944	0.936	0.883
2018	0.092	0.283	0.953	0.947	0.937	0.890
2019	0.550	0.693	0.953	0.949	n/a	0.894

Source: World Bank Open Data and SEO Aviation Economics and ACI. *27 EU countries, excluding Luxembourg for lack of data in certain years. Authors' calculations

We also draw attention to the fact that there has been a downward trend for airport connectivity with GDP since 2015, whereas the trend for hub connectivity has been upward since 2017. As shown in ACI Europe (2014), airport constraints, terminal infrastructure developments, and the fate of home-based carriers, all exercise a high influence on this correlation. Recently, some of the main European hub airports have increased their capacity, such as in the case of Schiphol and Frankfurt airports. Lufthansa has also increased some of its hub operation at Munich airport, which, in turn, has led to an expansion of its infrastructure.

The above results point to the importance of air connectivity for a country's economic performance, with special emphasis on the air connectivity of hub airports. Considering that previous correlations only measure the degree of linear association of the variables, we opted to carry out a second step of this research, where we estimate the following single-equation linear regression model for the above-mentioned sub-sample of countries:

$$Y_j = b_0 + b_1 X_j + e_j,$$

where Y_j is jth observation of GDP/ EV; X_j is the jth observation of hub connectivity, and e_j is the jth observation of the stochastic error term. This estimation was made for the last year of the period under analysis for which data was available at the time of this research. Table 3 presents the regression results, including the coefficient of determination R^2.

Table 3 | Regressions for hub connectivity on FDI flows, international trade, international tourism expenditures, and GDP, 2019*

	FDI inflows	FDI outflows	Goods imports	Goods exports	Int. tourism expenditures**	GDP
b_0	4.131	0.176	-2.841	1.001	0.750	3.356
b_1	0.001	0.001	0.096	0.080	1.067	0.023
t Stat	2.349	9.615	7.507	8.382	5.466	3.502
R2	0.479	0.939	0.904	0.921	0.832	0.672

Source: World Bank Open Data and SEO Aviation Economics and ACI. *EU countries with a hub connectivity level of at least 5% of the TOP hub-connected EU country. **Data for 2018. Authors' calculations

In Table 3, all the independent variables are statistically significant and with the expected sign. The R^2 statistics show that the estimated model fits the data very well for most regressions, demonstrating a pattern which is in line with that shown by the correlation coefficients, e.g.: low (0.46) for FDI inflows, but higher for FDI outflows (0.94); high for exports and imports (0.92 and 0.90, respectively), but less for tourism expenditures (0.83). The R^2 for GDP regression is 0.67, which shows, not surprisingly, that a significant portion of the variation is unexplained by the model or that it is random. Nevertheless, it is a good fit, considering that the sample is cross-sectional and also that many other variables can explain GDP. The scatter diagrams and regression lines of the regressions for each one of the independent variables are presented in Figures 1 to 6 below.

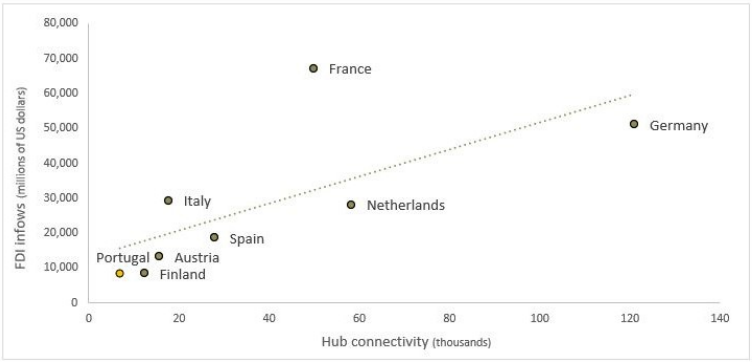

Figure 1 | FDI inflows as a function of hub connectivity*, 2019
Source: World Bank Open Data and SEO Aviation Economics and ACI. * Scatter diagram and regression line. Authors' calculations

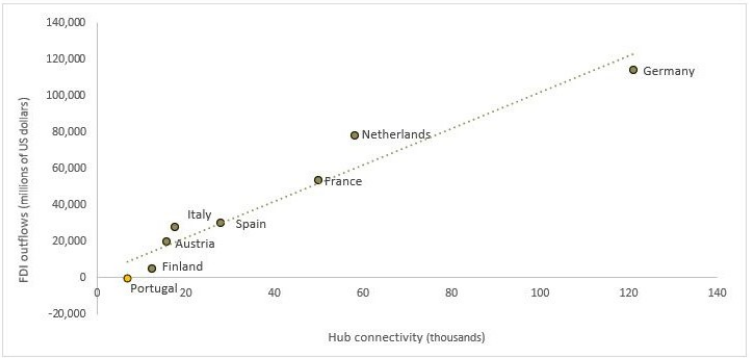

Figure 2 | FDI outflows as a function of hub connectivity*, 2019
Source: World Bank Open Data and SEO Aviation Economics and ACI. * Scatter diagram and regression line. Authors' calculations.

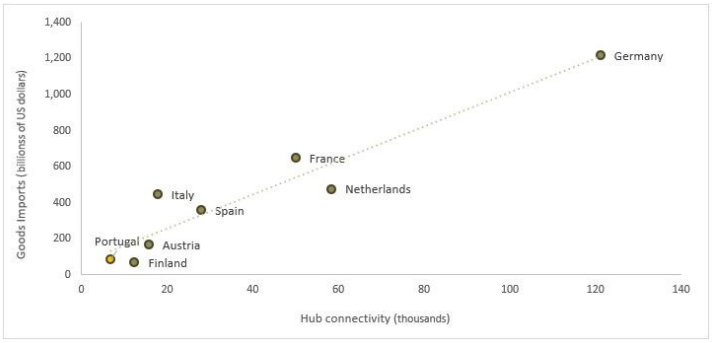

Figure 3 | Goods imports as a function of hub connectivity*, 2019
Source: World Bank Open Data and SEO Aviation Economics and ACI. *Scatter diagram and regression line. Authors' calculations.

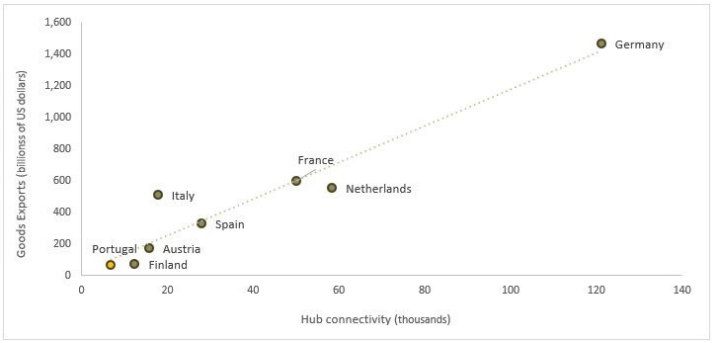

Figure 4 | Goods exports as a function of hub connectivity*, 2019
Source: World Bank Open Data and SEO Aviation Economics and ACI. * Scatter diagram and regression line. Authors' calculations.

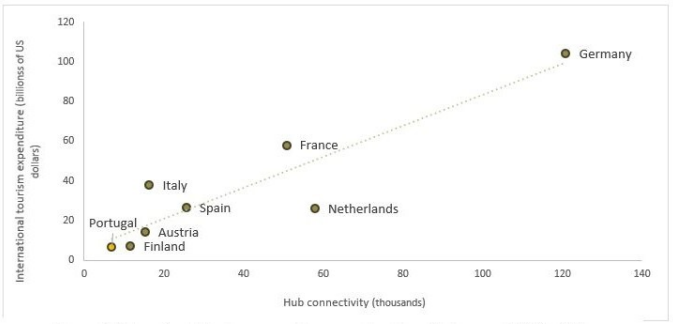

Figure 5 | International tourism expenditures as a function of hub connectivity*, 2018
Source: World Bank Open Data and SEO Aviation Economics and ACI. * Scatter diagram and regression line. Authors' calculations.

In the scatter diagrams above, Germany stands out as an influential observation, as it registers the highest value of hub connectivity, being way out in front of the remaining countries. Interestingly enough, the relation between the independent variables and hub connectivity in this country follows an almost perfect fit for all the variables, except for FDI inflows (as is to be expected). These results are therefore supportive of the conclusion that the high degree of Germany's hub connectivity facilitates the outstanding economic performance of Germany in terms of key economic growth variables (mainly owing to Frankfurt Airport, which since 2014 has been the world's number one hub airport, according to ACI Europe, 2020).

Netherlands is the second ranked country, mos-

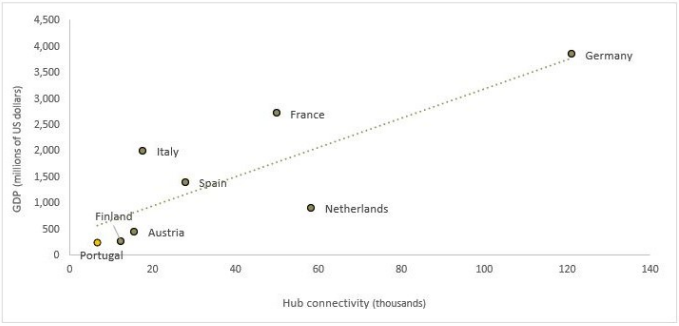

Figure 6 | GDP as a function of hub connectivity*, 2019
Source: World Bank Open Data and SEO Aviation Economics and ACI. * Scatter diagram and regression line. Authors' calculations.

tly on account of the Schiphol hub airport, albeit it is different from Germany, as this country appears as an outlier in terms of the relation of hub connectivity with tourism expenditures and GDP. It should be noted however that maritime traffic accounts for more than half of the total amount of goods loaded and unloaded in the Netherlands, and that the southern part of the North Sea is like an "immense traffic square fed by the Thames, Rhine, Maas, and Schelte rivers" (Encyclopaedia Britannica, the Economy of the Netherlands[10]).

An interesting case study is Portugal, which is the last ranked country of the sample of countries selected for our regression analysis. On the one hand, this country has been experiencing low rates of economic growth since adhesion to the EU. From the euro's start in 1999 to 2019, the average GDP growth rate of Portugal was only 1.1% and this country was the third least growing eurozone country, only Greece and Italy at worst rates[11]. On the other hand, Portugal is highly dependent on FDI, trade, and tourism for economic growth (see, for instance, Kolodziejerki, 2019). Portugal stands out as being an important tourist destination. It was the ninth largest EU tourist destination in 2017, as measured in nights spent in tourist accommodation (72 million nights in total, including 48.9 million spent by non-residents) (*ibidem*). In 2019, the travel and tourism sector contributed to 17.1% of the country' GDP, 20.7% of total employment, 23.6% of total exports, with the impact of international visitor spend being 22.5 billion USD (World Travel and Tourism Council, 2021). According to the Travel & Tourism Competitiveness Index of the World Economic Forum (2019), Portugal was the 12th most competitive of the 140 ranked economies. The impact of Covid-19 on Portuguese GDP (-8.4% in 2020) can be explained in part by the weight of the tourism sector, which makes the need for economic growth even more pressing. Returning to the previous results, the relations between hub connectivity and the independent variables fit the linear regression very well in the case of Portugal, namely with trade and tourist expenditures, which means that increasing hub connectivity leads to an almost directly proportional impact on economic variables that are essential to unlock the country´s economic growth (albeit this is conditional on the estimations used).

Morphet and Bottini (2013) provide some guidelines on how countries can increase their air connectivity, namely: to exploit the country's location by enhancing network connections; to strengthen airport infrastructure combined with a well-developed network that decreases travel costs not only for passengers, but also for air cargo; to improve the business models of the major airlines categories (e.g., low-cost, such as Ryanair, in order

[10] Available at Netherlands Facts | Britannica. Accessed June 10, 2021.
[11] In 2006, Portugal's GDP per capita expressed in Purchasing Power Standards (PPS) was 83% of the EU average, and was lower than not only that of Greece, but also that of the new Member States, Cyprus, and Slovenia. In 2020, this statistic represented only 76.4% of the EU average, 2.2 percentage points lower than in 2019.

to captivate a large group of consumers with lower income[12], and/or a network, centred on a main centre or hub, such as TAP Air Portugal, which supplies a wide range of routes combined with very regular and flexible services that meet the needs of both the business and the leisure traveller); and, finally, to develop a regulatory and economic framework that fosters air transport growth.

An important characteristic of Portugal is its unique advantage in comparison with the other European countries, as it is located on the western coast of the Iberian Peninsula that divides the inland Mediterranean Sea from the Atlantic Ocean. Increasing Lisbon's hub connectivity could enable Portugal to better take advantage of its geographic position, for instance, with regards the two continents which currently represent a relatively reduced number of passengers travelling to Portugal, namely America and Africa[13]. Crucial variables for economic growth, which are currently at low levels with the two above-mentioned continents when compared with the other EU countries[14], would ultimately increase. Additionally, for long-haul routes, Portugal could position itself as an advantageous intermediate location for passengers originating from the east coast of North America who are travelling to Asian destinations.

5. Conclusions

This study highlights the importance of hub connectivity for the economic performance of the EU countries, namely in terms of an increase in trade, outward FDI, and tourism expenditures. As expected, a positive relation was also found with current GDP. Additionally, in accordance with the literature, countries' economic growth can be boosted as a result of the observed economic impacts. Statistically-significant correlations can be a spurious coincidence, however regression analysis strengthens the relevance of efficient and hub-connected airline services in improving EU countries' economic performance.

The results of this study provide policy guidance, especially for those countries that are highly dependent on FDI, trade, and tourism for economic growth, as illustrated by the case of Portugal. With the resumption of air traffic after the economic collapse caused by the ongoing COVID-19 health pandemic, enhancing hub connectivity appears to be a viable instrument to increase key economic variables for economic growth.

Naturally, the analysis carried out in this study is far from exhaustive in terms of determining the relation between air connectivity and countries' economic performance. One limitation is that additional economic impacts can be caused by increased air connectivity, both for the air transport industry, e.g., service providers, civil aerospace sector, airport services, and its supply chain, and also for other industries, e.g., by facilitating labour supply and by promoting market efficiency and consumer welfare (ATAG, 2005). A more embracing set of economic variables therefore needs to be investigated in future research, as well as whether reciprocal (two way) causations exist. Furthermore, the contribution of the EVs for economic growth is not always straightforward, as shown, for instance, in the case of FDI inflows (Crespo & Fontoura, 2007) and FDI outflows (Bhattari, 2016). Nevertheless, the results shown in this study are consistent with the expectation that air connectivity produces positive effects on the variables analysed in this study, particularly hub connectivity.

[12] See Almeida & Costa (2012) for an overview of the operation of low cost airlines and the characteristics of its business model and, more specifically, the case of Ryanair.

[13] Passengers who flew to and from America and Africa in 2019 represented only 8% and 4% of the Portuguese passenger air traffic, respectively.

[14] In the case of Portugal, in 2019 the EU represented 71% of total FDI inflows and 89% of the country's total FDI outflows (source: OCDE.Stat), 70% of total exports, and 25% of total imports (source: the World Integrated Trade Solution), and 79% of total international tourism expenditure (source: Instituto Nacional de Estatística).

Acknowledgments

The Authors acknowledge the financial support from FCT – Fundação para a Ciência e Tecnologia (Portugal), and also national funding through research grant UIDB/05069/2020.

References

ACI Europe (2014). *Airport Industry Connectivity Report*. Available at 2015-06_ACI_EUROPE_Airport_Connectivity_Report_2004_-_2014.pdf (netdna-ssl.com). Accessed March 3, 2021.

ACI Europe (2020). *Airport Industry Connectivity Report*. Available at Airports Council International Europe | ACI EUROPE - Air connectivity (aci-europe.org). Accessed March 3, 2021.

Almeida, C. & Costa, C. (2012). A operação das companhias aéreas de baixo custo na Europa. O caso da Ryanair. *Revista Turismo e Desenvolvimento*, *17/18*(1), 387-402. https://doi.org/10.34624/rtd.v1i17/18.12863

ATAG (2005). *The economic and social benefits of air transport*. Available at untitled (icao.int). Accessed March 9, 2021.

ATAG (2020). *Aviation benefits beyond borders*. Available at Aviation: Benefits Beyond Borders (aviationbenefits.org). Accessed April 7, 2021.

Bel, G. & Fageda, X. (2008). Getting there fast: Globalization, intercontinental flights and location of headquarters. *Journal of Economic Geography*, *8*(4), 471-495. doi:10.1093/jeg/lbn017

Bhattari, K. (2016). FDI and Growth. *Advances in Management and Applied Economics*, RePEc:spt:admaec:v:6:y:2016:i:2:f:6_2_1.

Burghouwt, G. (2007). *Airline network development in Europe and its implications for airport planning*, Aldershot, Ashgate. 35–53. http://www.jstor.org/stable/24396351

Burghouwt, G. & Redondi, R. (2013). Connectivity in air transport networks an assessment of models and applications. *Journal of Transport Economics and Policy*, *47*(1), 35-53. http://www.jstor.org/stable/24396351

Button, K. (2008). The impacts of globalisation on international air transport activity. *Global Forum on Transport and Environment in a Globalising World* (Issue November), OECD/International Transport Forum [ITF]. doi.org/10.1016/j.virol.2009.10.018

Button, K. & Taylor, S. (2000). International air transportation and economic development. *Journal of Transport Management*, *6*(4), 209-222. doi.org/10.1016/S0969-6997(00)00015-6

Button, K. & Yuan, J. (2013). Airfreight transport and economic development: An examination of causality. *Urban Studies*, *50*(2), 329-340. doi.org/10.1177/0042098012446999

Chang, Y-H. & Chang, Y-W. (2009). Air cargo expansion and economic growth: Finding the empirical link. *Journal of Air Transport Management*, *15*(5), 264-265. doi.org/10.1016/j.jairtraman.2008.09.016

Chi, J. & Baek, J. (2013). Dynamic Relationship between air transport demand and economic growth in the United States: A new look. *Transport Air*, *29*, sep. 257-260. doi.org/10.1016/j.tranpol.2013.03.005

Costa, V., Almeida, C., & Conceição, O. (2017). Air Transport and tourism destinations: The case of Oporto Airport and Portugal's Northern Region. *Revista Turismo & Desenvolvimento*, *27/28*(2), 209-213. https://doi.org/10.34624/rtd.v2i27/28.20747

Crespo, N. & Fontoura, P. (2007). Determinant factors of FDI spillovers - what do we really know?. *World Development*, *45*, 410-25. doi.org/10.1016/j. worlddev.2006.04.001ally

Dimitrios, D. & Sartzetaki, M. (2018). Assessing air transport socio-economic footprint. *International Journal of Transportation Science and Technology*, *7*, 283-290. doi.org/10.1016/j.ijtst.2018.07.001

Dunning, J. (1981). Explaining the International Direct Investment Position of Countries: Towards a Dynamic or Developmental Approach. *Weltwirtschaftliches Archiv*, *117*(1), 30-64. doi.org/10.1007/BF02696577

Durán, J. & Úbeda, F. (2001). The Investment Development Path: A New Empirical Approach and Some Theoretical Issues. *Transnational Corporations*, *10*(2), 1-34.

Forte, R. & Moura, R. (2013). The effects of foreign direct investment on the host country´s economic growth: Theory and empirical evidence. *The Singapore Economic Review*, *58*, 1-28. doi.org/10.1142/S0217590813500173

Green, R. (2007). Airports and Economic Development. Available at doi.org/10.1111/j.1540-6229.2007.00183. Accessed June 14, 2020.

Heathrow (2014). *What makes a hub airport.* Available at What makes a hub airport | Heathrow. Accessed July 20, 2020.

Herzer, D. (2008). The long-run relationship between outward FDI and domestic output: Evidence from panel data. *Economics Letters*, *100*(1), 146-149. doi.org/10.1016/j.econlet.2007.12.004

Kasarda, J. & Green, J. (2005). Air cargo as an economic development engine: A note on opportunities and constraints. *Journal of Air Transport Management*, *11*(6), 459-462. doi.org/10.1016/j.jairtraman.2005.06.002

Kołodziejski, M. (2019). *Economic social and territorial situation of Portugal*. Available at Report for the European Parliament's Committee on Regional Development delegation visit to Portugal of 27 February to 1 March 2019. Economic, social and territorial situation of Portugal – Research4Committees. Accessed June 20, 2021.

Malighetti, P., Paleari, S., & Redondi, R. (2008). Connectivity of the European airport network: «self-help hubbing» and business implications. *Journal of Air Transport Mangement*, *14*, 53-65.

Morphet, H. & Bottini, C. (2013). *Air Connectivity: Why it matters and how to support growth*. Available at Air connectivity: Why it matters and how to support growth - PDF Free Download (docplayer.net). Accessed June 15, 2021.

Nguyen, T. & Lee, N. (2019). Using the Netscan model to evaluate air connectivity: The case of Tan Son Nhat International Airport. *International Integration*, June, 104-111.

OECD (2018). *Defining, Measuring and Improving Air Connectivity*, OECD and ITF. Available at defining-measuring-improving-air-connectivity.pdf (itf-oecd.org). Accessed January 11, 2022.

Oxford Economics (2008). *Aviation: The real world wide web*. Available at `http://www.oxfordeconomics.com/myoxford/projects/128832%5Cnhttp://www.oxfordeconomics.com/FREE/PDFS/OEAVIATION09.PDF`. Accessed December 10, 2020.

Oxford Economics (2014). *Economic Benefits from Air Transport in the UK*. Available at Microsoft Word - OE_AOA DRAFT report 09_11_2014 - with Tim's edits (airlinesuk.org). Accessed December 10, 2020.

Oxford Economics & York Aviation (2013). *The Economic Value International of Connectivity* (Issue November). Available at The Economic Value of International Connectivity April 2013 (tfl.gov.uk). Accessed December 10, 2020.

Profillidis, V. & Botzoris, G. (2015). Air passenger transport and economic activity. *Journal of Air Transport Management*, *49*, oct.23-27. doi.org/10.1016/j.jairtraman.2015.07.002

Reis, E. (2019). *O impacto do comércio internacional no crescimento económico nos países da União Europeia*. [Dissertação de mestrado, Faculdade de Economia do Porto]. Available at https://repositorio-aberto.up.pt/bitstream/10216/123548/2/363389.pdf Accessed June 20, 2021.

Sequeira, T. & Nunes, P. (2008). Does tourism influence economic growth? A dynamic panel data approach. *Applied Economics*, *40*(18), 2431-2441. DOI: 10.1080/00036840600949520

Skift Research (2020). *The Travel Industry Turned Upside Down*. Available at The travel industry turned upside down: Insights, analysis, and actions for travel executives (mckinsey.com) Accessed July 25, 2021.

UNCTAD (2006). *World Investment Report*, UNCTAD, Genebra. Available at UNCTAD/WIR/2006. Accessed December 18, 2020.

World Economic Forum (2019). The Travel and Tourism Competitiveness Reports. Available at The Travel & Tourism Competitiveness Report 2019 | World Economic Forum (weforum.org). Accessed August 10, 2021.

World Travel and Tourism Council (2021). Economic Impact Report. Available at Travel & Tourism Economic Impact | World Travel & Tourism Council (WTTC). Accessed August 10, 2021

Veldhuis, J. (1997). The competitive position of airline networks. *Journal of Air Transport Management*, *3*(4), 181-188. doi.org/10.1016/S0969-6997(97)86169-8