REM WORKING PAPER SERIES

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

Maria Inês Castro, Maria Paula Fontoura

REM Working Paper 0200-2021

October 2021

REM – Research in Economics and Mathematics
Rua Miguel Lúpi 20,
1249-078 Lisboa,
Portugal

ISSN 2184-108X

REM – Research in Economics and Mathematics

Rua Miguel Lupi, 20
1249-078 LISBOA
Portugal

Telephone: +351 - 213 925 912
E-mail: rem@iseg.ulisboa.pt

https://rem.rc.iseg.ulisboa.pt/

https://twitter.com/ResearchRem

https://www.linkedin.com/company/researchrem/

https://www.facebook.com/researchrem/

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

Maria Inês Castro
ISEG-Lisbon School of Economics and Management,
Universidade de Lisboa

Maria Paula Fontoura*
ISEG-Lisbon School of Economics and Management
UECE-Research Unit on Complexity and Economics and REM- Research in Economics and Mathematics, Universidade de Lisboa

* Corresponding author (fontoura@iseg.ulisboa.pt)

♠ 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.

IMPROVING THE AIR CONNECTIVITY OF HUB AIRPORTS: AN INSTRUMENT TO BOOST THE ECONOMIC PERFORMANCE OF EU COUNTRIES?

Abstract: This study discusses the importance of hub airports' air connectivity in improving the economic performance of the European Union countries during the period of 2008-2019. For this purpose, we use two different measurements of air connectivity - airport and hub connectivity, which are calculated using the Nestcan Model, and then, as a first step, we analyse the degree of linear association of each one of them 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 will boost a country´s economic performance, namely: inflows and outflows of foreign direct investment (FDI), imports, exports, and international tourism expenditures. We conclude that the type of air connectivity adopted matters. The results show that hub connectivity has a higher correlation with key variables for economic growth and is increasingly correlated with GDP during the period analysed, while a downward tendency over the more recent years was observed with regards airport connectivity. Next, we test the strength and direction of the quantitative relationship between hub connectivity and GDP/each EV for a sample of EU countries with 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 the scatter diagrams and regression lines. The results provide policy guidance regarding the role of hub connectivity in increasing the economic performance of a country, especially for those countries that are highly dependent on FDI, trade, and tourism for economic growth, as we illustrate for the case of Portugal.

Keywords: air connectivity; airport connectivity; hub connectivity; foreign direct investment; international trade; tourism; Netscan Model; European Union; Portugal.
JEL code: E69; F20; L93

1. Introduction

Air transport provides a worldwide transportation network which generates several 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 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), mainly 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 investigated the relation between air connectivity and economic performance, more precisely in terms of economic growth (Button & Taylor, 2000; Kasarda & Green, 2005; Green, 2007; Y-H, Chang & Y-W, 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.

Firstly, we consider two perspectives regarding air connectivity: airport and hub connectivity. Airlines compete both on direct routes (from A to B), and indirectly with a transfer 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 connections and connecting times available to the consumer at a certain airport. Another perspective on 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 consider it to be of most interest, to the extent that it enables one to highlight the economic benefits of hub airports.

Relative to point-to-point airports, which are smaller, with most passengers using them being on 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). In a hub airport, interconnections between flights become easier and less conducive to delays and a large variety of flights can easily respond to a greater demand. For passengers, there are a large number of benefits from using a hub airport,

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

such as easier access to and from the airport due to more surrounding infrastructure (e.g., means of transportation), wider choice of destinations, more frequent flights, and cheaper fares due to competition between airlines (Heathrow, 2014). For airlines, it is possible to maximise the number of passengers transported, by filling flights with transfer passengers, a resource that can make routes viable. With regards trade, 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), hub airports provide quick access to long-haul markets for products which are time-sensitive to 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 to increase a country's foreign trade. It should also be noted that airlines using hub airports frequently promote a 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 between the best-connected hubs in the world, which is explained by their geographic location, high population density, and strong economic position, especially owing to the strengths of the European aviation market[2]. According to Airports Council International (ACI) Europe (2020), in 2019, Europe continued to dominate worldwide in terms of hub airports. This is an additional reason to research the economic impact of hub connectivity in the EU area.

A second methodological difference of this study that needs to be mentioned is the fact that our focus is not 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 air connectivity, namely: 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 & Moura (2013) for inward FDI, Herzer (2008) for outward FDI, Reis (2019) for trade, and Sequeira & Nunes (2008) for tourism.

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

---

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

[3] See Oxford Economics and York Aviation (2013) for a survey.

The link between air travel and air connectivity to promote inward FDI is well documented. For instance, Bel & Fageda (2008) have shown that a 10% increase in the supply of intercontinental flights involves around 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 & 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. The importance air connectivity remains 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 to promote 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 connectivity can play a key role in reducing costs associated with time travel between geographically distant markets and, ultimately, to improve exploitation of comparative advantage, resulting in a more efficient allocation of resources. Just to mention the results of some studies, the Conference of British Industry (CBI), in a research published in 2013 and quoted by Oxford Economics and York Aviation (2013), established a strong link between the level of air connectivity and trade for the six largest EU economies. Namely, an additional daily 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 "Connecting for Growth" 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 where there are at least daily flights, and that UK trade could be increased by around £1.2 billion per annum if there were sufficient capacity at Heathrow to accommodate viable routes to emerging markets.

Finally, developing and broadening air connectivity has the obvious 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). A research of York Aviation for ACI Europe, quoted in Oxford Economics and York Aviation (2013, p. 22), shows that even for major European cities where other transport modes are more competitive, air connectivity can account for a third or more of foreign visitors. Inbound tourism may have a vital role to increase the level of consumption in countries highly reliant on tourism.

[4] The Frontier Economics report can be downloaded at: http://hub.heathrowairport.com/.

We also investigate 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 this long run effect, previous considerations and a range of previous studies, such as Oxford Economics (2008, 2014), allow to expect a significant impact.

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 we extract conclusions for individual countries by using the scatter diagrams and the 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 did (ATAG, 2020). When compared with 2019 figures, total world passenger traffic declined in 2020 by 60%, which represents 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 ending before the COVID-19 crisis, this analysis will hopefully assist those who have to plan strategies to improve economic growth in the aftermath of COVID-19.

The research is presented as follows. Section 2 presents the empirical analysis, whilst Section 3 concludes.

2. Empirical study

As the first step of the 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 (excluding therefore the United Kingdom) between 2008 and 2019[5].

As the second step of the analysis, in order to obtain a more clear insight of the role of hub connectivity in improving a country´s 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 sample of EU countries chosen with the above-explained criteria. The countries included were the following, presented in decreasing order of hub connectivity (the hub connectivity and the main hub airport is shown in brackets): Germany (121,141; Frankfurt Airport, that is the Lufthansa Hub), Netherlands (58,354; Schiphol Airport, that is the KLM Hub), France (49,972; Charles de Gaulle Airport, that is the Air France Hub), Spain (27,994; Madrid-Barajas Airport, that is the Iberia Hub), Italy (17,755; Fiumicino Airport, that is the Alitalia Hub), Austria (15,698; Viena Airport, that is the Austrian Airlines Hub), Finland (12,397; Helsinki Airport, that is the Finavia Hub), Portugal (6,807; Lisbon Airport, that is the TAP Air Portugal Hub). The advantage of a smaller sample of countries is that it 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, built by SEO Aviation Economics in collaboration with ACI, which provides measurements for both airport and hub connectivity.

The SEO Netscan connectivity model "identifies all direct and indirect (one stop) connections available on an airport-pair" (ACI Europa, 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), and 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. For the quantitative component of the study, the input used is airline schedule data, which provides the number of weekly frequencies (both direct and indirect). The

[5] Data for tourism expenditures is available only until 2018.
[6] See Burghoust & Redondi (2013) for a presentation of the main measurements and the discussion of each one's merits.

quality part of this model ranges between zero (when predetermined flight time limits are exceeded) and 1 (the shortest travel time)[7](ACI Europa, 2014)[8]

The Netscan model is considered very reliable and is popular among researchers for two main reasons. 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 one's quality on a continuous scale.

For the remaining variables (EVs and GDP), we use the World Bank Open Data.

Tables 1 and 2 below show the linear correlation coefficients of airport and hub connectivity, respectively, with each EV and with GDP.

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.

[7] See ACI Europa (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 the global air connectivity assessment in 2000 by the Air Transport Association (IATA) and also the yearly evaluation of air connectivity using this index, by ACI.

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 conclude that the correlation coefficients are all positive in the case of both measurements, and are very high in the case of the trade, tourism expenditures, and GDP variables.

The correlations with FDI inflows present, in an overview, the lowest values, with both FDI flows displaying a high variation over the period analysed, which is not surprising, considering that the distinction between FDI and portfolio investment is in practice ambiguous (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 they 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.

Finally, we draw attention to the fact that in the case of airport connectivity, there has been a downward tendency since 2015 with GDP, whereas in the case of hub connectivity, the trend 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 main European hub airports have increased their capacity,

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

such as in the case of Schipol and Frankfurt airports. Furthermore, in recent years, Lufthansa has increased some of its hub operation in Munich airport, which, in turn, is expanding 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 to carried 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:

$$Y_j=b_0+b_1X_j+e_j,$$

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 of 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, with a pattern which is in line with that shown by the coefficients of correlation, 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 is random. Nevertheless it is a good fit, considering that the sample is cross-sectional and that many other variables 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.

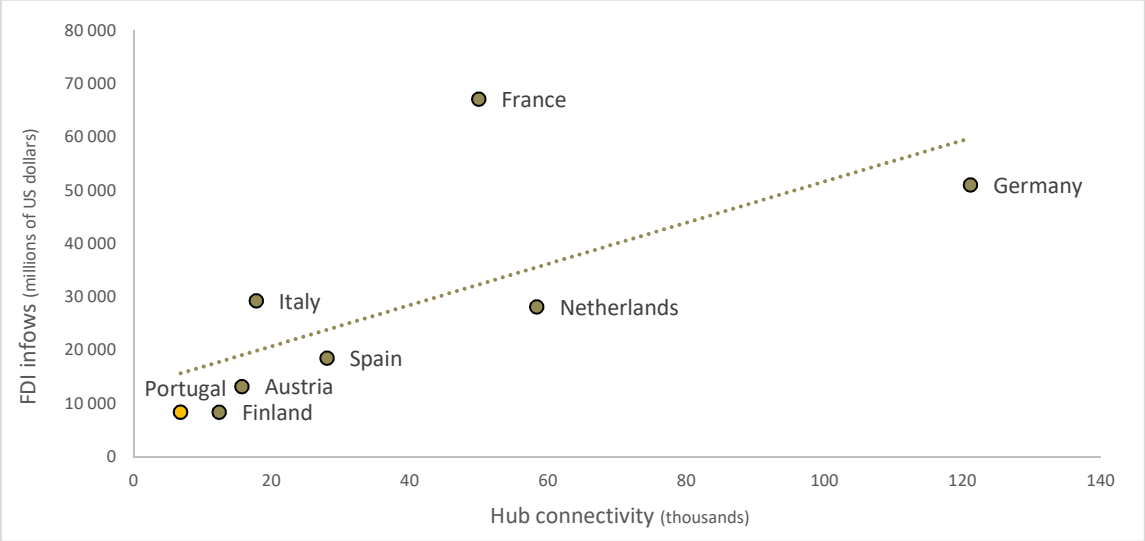

Figure 1: FDI inflows as a function of hub connectivity*, 2019
* Scatter diagram and regression line
Source: World Bank Open Data and SEO Aviation Economics and ACI. Authors' calculations.

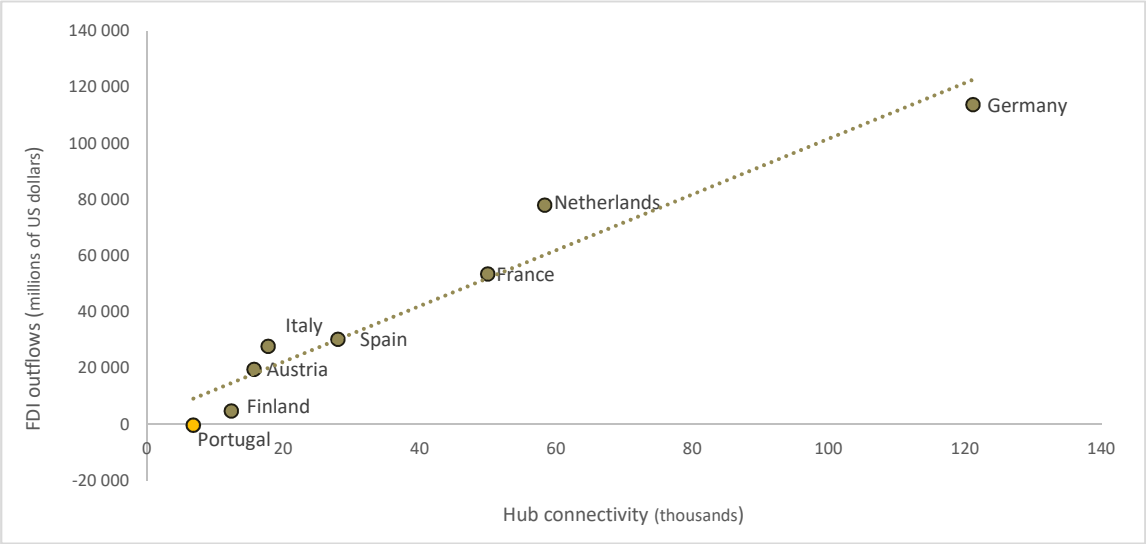

Figure 2: FDI outflows as a function of hub connectivity*, 2019
* Scatter diagram and regression line
Source: World Bank Open Data and SEO Aviation Economics and ACI. Authors' calculations.

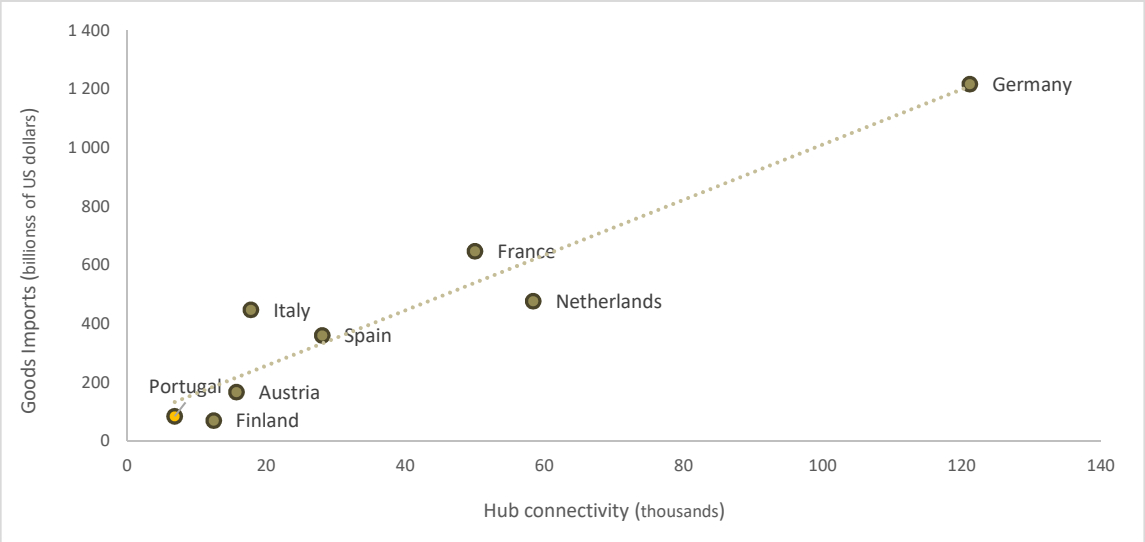

Figure 3: Goods imports as a function of hub connectivity*, 2019

*Scatter diagram and regression line

Source: World Bank Open Data and SEO Aviation Economics and ACI. Authors calculations

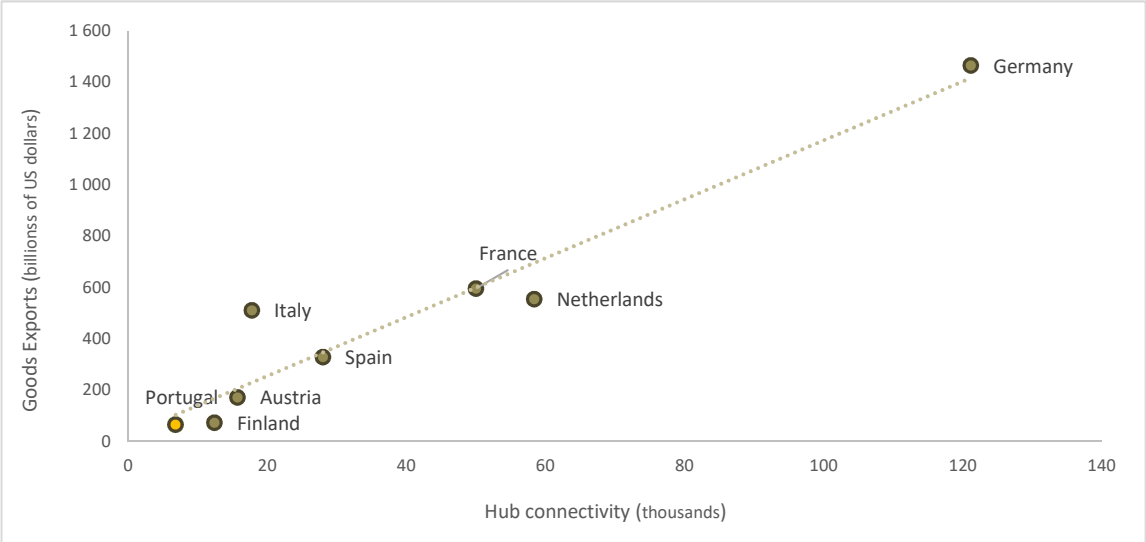

Figure 4: Goods exports as a function of hub connectivity*, 2019

* Scatter diagram and regression line

Source: World Bank Open Data and SEO Aviation Economics and ACI. Authors' calculations.

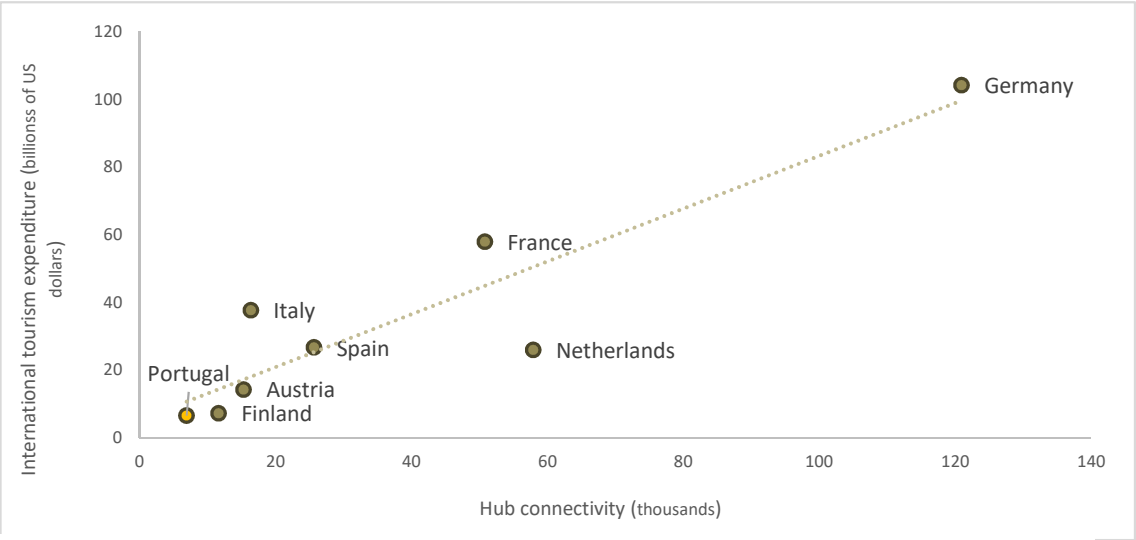

Figure 5: International tourism expenditures as a function of hub connectivity*, 2018
* Scatter diagram and regression line
Source: World Bank Open Data and SEO Aviation Economics and ACI. Authors' calculations.

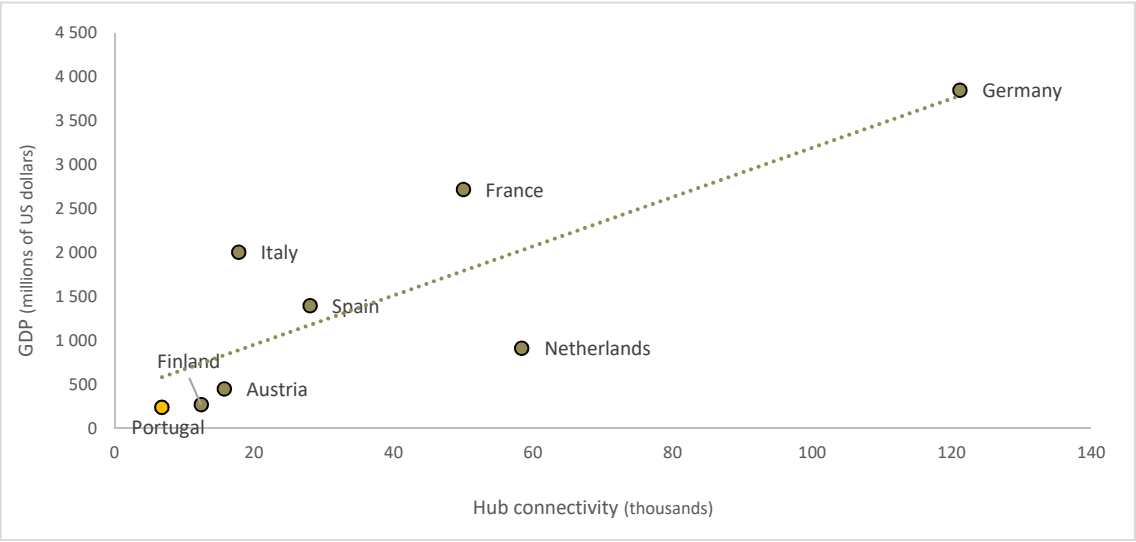

Figure 6: GDP as a function of hub connectivity*, 2019
* Scatter diagram and regression line
Source: World Bank Open Data and SEO Aviation Economics and ACI. Authors' calculations.

In the scatter diagrams above, Germany stands out as an influential observation, as it shows 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 variables, except for FDI inflows (as to be expected). These results are therefore supportive of the conclusion that the high degree of Germany's hub connectivity (mainly due to Frankfurt Airport, which since 2014 has been the world's number one hub airport, according to ACI Europe, 2020) facilitates the outstanding economic performance of Germany in terms of key economic growth variables.

Netherlands is the second ranked country, mostly due to the Schiphol hub airport, but, different from Germany, 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 Schelde 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 the regression analysis. This country is highly dependent on FDI, trade, and tourism for economic growth (see, for instance, Kolodziejerki, 2019). In 2017, Portugal was the ninth largest EU tourist destination, 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, and an impact of international visitor spend of 22.5 billions USD (World Travel and Tourism Council, 2021), and it was the 12th most competitive of 140 economies, according to the Travel & Tourism Competitiveness Index of the World Economic Forum (2019). Covid-19 impact on Portuguese GDP (-8.4% in 2020) was in part explained by the weight of the tourism sector, making economic growth even more pressing. Returning to previous results, in the case of Portugal, the relations between hub connectivity and the independent variables fit the linear regression very well, which means that (albeit conditional on the estimations used) increasing hub connectivity leads to an almost directly proportional impact on those economic variables that are essential to unlock the country´s economic growth.

Morphet & Bottini (2013) provide some guidelines on how to increase a country's 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

[10] See Netherlands Facts | Britannica

(e.g., low-cost, such as Ryanair, in order to captivate a large group of consumers with lower incomes, and/or a network, centred on a main centre or hub, such as TAP Air Portugal, supplying a wide range of routes combined with very regular and flexible services that meet the needs of both business and 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, for 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 take advantage of its geographic position, for instance, with regards the two continents which currently represent a relative reduced number of passengers travelling to Portugal, namely America and Africa[11]. According to the results of this study, Portugal could achieve increased FDI flows, trade, and tourism expenditures by focusing on the two above-mentioned continents, which are currently at relative low levels compared with the other EU countries[12]. Additionally, for long-haul routes, the country could become an advantageous intermediate location for passengers originating from the east coast of North America through to Asian destinations.

3. Conclusions

This study highlights the importance of hub connectivity for the economic performance of the EU countries, namely to increase trade, outward FDI, and tourism expenditures. A positive relation was also found with current GDP, as expected, and, according to the literature, a country´s economic growth will 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 a country's economic performance.

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

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

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

Naturally, the analysis conducted in this study is far from exhaustive with regards the relation between air connectivity and a country's economic performance. One limitation is that additional economic impacts can arise from increased air connectivity, both for the air transport industry, e.g., service providers, civil aerospace sector, airport services, and its supply chain, and for other industries, e.g., by facilitating labour supply and by promoting market efficiency and consumer welfare (ATAG, 2005). In future research, a richer set of economic variables therefore needs to be investigated, as well as whether reciprocal (two way) causations exist. Besides, 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 outflows (Bhattari, 2016). In any case, the results shown in this study are consistent with the expectation that air connectivity and, more specifically, hub connectivity, would produce positive effects on the variables analysed.

References

ACI (2018). Airport Industry Connectivity Report 2018, in *27th ACI EUROPE General Assembly, Congress & Exhibition*. doi.org/10.1016/0090-8258%2890%2990012-A

ACI Europe (2014). *Airport Industry Connectivity Report*. 2015-06_ACI_EUROPE_Airport_Connectivity_Report_2004_-_2014.pdf (netdna-ssl.com)

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

ATAG (2005). *The economic and social benefits of air transport.* untitled (icao.int)

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

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*, Vol. 47, Issue 1, 35-53. http://www.jstor.org/stable/24396351

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

Button, K & Taylor, S. (2000). International air transportation and economic development, *Journal of Transport Management*, vol. 6, issue 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*, vol 15, issue 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 Sataes: A new look*, Transport Air*, vol 29, sep. 257-260. doi.org/10.1016/j.tranpol.2013.03.005.

Crespo, N. & Fontoura, M. P. (2007). Determinant factors of FDI spillovers - what do we really k now?, *World Development*, vol 35, 410-25. doi.org/10.1016/j.worlddev.2006.04.001

Dimitriou, 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. Accessed June 14, 2020 on

doi.org/10.1111/j.1540-6229.2007.00183.x

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

Herzer, D. (2008). The long-run relationship between outward FDI and domestic output: Evidence from panel data, *Economics Letters*, Vol. 100, Issue 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, *Jornal of Air Transport Management*, vol 11, issue 6, 459-462. doi.org/10.1016/j.jairtraman.2005.06.002

Kołodziejski, M. (2019). Economcic social and territorial situation of Portugal, 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

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*. Air connectivity: Why it matters and how to support growth - PDF Free Download (docplayer.net)

Oxford Economics (2008). *Aviation: The real world wide web*. http://www.oxfordeconomics.com/myoxford/projects/128832%5Cnhttp://www.oxfordeconomics.com/FREE/PDFS/OEAVIATION09.PDF

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

Oxford Economics & York Aviation (2013). *The Economic Value International of Connectivity* (Issue November). The Economic Value of International Connectivity April 2013 (tfl.gov.uk)

Profudllidis, V. & Botzoris, G. (2015). Air passenger transport and economic activity, *Journal of Air Transport Management*, vol. 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. Accessed June 20, 2020 at Microsoft Word - Versão final_EduardaReis_OA01set2019.docx (up.pt)

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*. Accessed July 25, 2021 at The travel industry turned upside down: Insights, analysis, and actions for travel executives (mckinsey.com)

UNCTAD (2006). *World Investment Report*, UNCTAD, Genebra. UNCTAD/WIR/2006

World Economic Forum (2019). The Travel and Tourism Competitiveness Reports. Accessed September 15, 2021 at The Travel & Tourism Competitiveness Report 2019 | World Economic Forum (weforum.org)

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

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