OXFORD ECONOMICS

THE SOCIO-ECONOMIC BENEFITS OF BUSINESS AVIATION IN EUROPE

METHODOLOGY REPORT

JANUARY 2025

EBAA

GAMA General Aviation Manufacturers Association

ABOUT OXFORD ECONOMICS

Oxford Economics was founded in 1981 as a commercial venture with Oxford University's business college to provide economic forecasting and modelling to UK companies and financial institutions expanding abroad. Since then, we have become one of the world's foremost independent global advisory firms, providing reports, forecasts, and analytical tools on more than 200 countries, 100 industries, and 8,000 cities and regions. Our best-in-class global economic and industry models and analytical tools give us an unparalleled ability to forecast external market trends and assess their economic, social, and business impact.

Headquartered in Oxford, England, with regional centres in New York, London, Frankfurt, and Singapore, Oxford Economics has offices across the globe in Belfast, Boston, Cape Town, Chicago, Dubai, Dublin, Hong Kong, Los Angeles, Mexico City, Milan, Paris, Philadelphia, Stockholm, Sydney, Tokyo, and Toronto. We employ 700 staff, including more than 450 professional economists, industry experts, and business editors—one of the largest teams of macroeconomists and thought leadership specialists. Our global team is highly skilled in a full range of research techniques and thought leadership capabilities from econometric modelling, scenario framing, and economic impact analysis to market surveys, case studies, expert panels, and web analytics.

Oxford Economics is a key adviser to corporate, financial, and government decision-makers and thought leaders. Our worldwide client base now comprises over 2,500 international organisations, including leading multinational companies and financial institutions; key government bodies and trade associations; and top universities, consultancies, and think tanks.

January 2025

The modelling and results presented here are based on information provided by third parties, upon which Oxford Economics has relied in producing its report and forecasts in good faith. Any subsequent revision or update of those data will affect the assessments and projections shown.

To discuss the report further please contact:

Vasilis Douzenis: vdouzenis@oxfordeconomics.com

Oxford Economics

4 Millbank, London SW1P 3JA, UK

Tel: +44 203 910 8061

1. APPENDIX: METHODOLOGY AND DATA

MEASURING CONNECTIVITY

We measure business aviation connectivity and commercial aviation connectivity in Europe using two airport connectivity indices. Business aviation connectivity quantifies how easy it is for passengers to reach other economic centres by business jet from a particular airport, city, or country. Similarly, commercial aviation connectivity quantifies the ease with which passengers can reach other economic centres by a commercial flight. Since the same methodology is applied to determine both commercial and business aviation connectivity, it will be referred to as "connectivity" hereinafter.

Our approach for measuring connectivity is based on the approach followed by Arvis and Shepherd.[1] This approach is grounded in network analysis methods and is based on a gravity-like[2] model commonly used in international trade studies. Its advantage is that it accounts for the hub-and-spoke nature of global air transport in a way that aggregating flights or seats data would not. Our measure of connectivity is based on European data but covers the links of European cities with all global destinations. It aims to capture the relationship between all network nodes even when there is no direct flight connection between them.

The main limitation of the air connectivity index produced by Arvis and Shepherd is that it is based on weekly data from June, a month where tourism flows in the early summer period in the northern hemisphere might bias the connectivity scores. We have updated the analysis by using annual data for the five-year period from 2019 to 2023. Using annual data allows us to avoid biases due to seasonality as well as any one-off events that may increase or decrease connectivity for a limited time period (such as special sporting events). Further, using GDP per capita as one of the model variables allows us to account for changes in connectivity due to changes in the economic strength of the origin/destination.

We follow a two-step approach to creating our Air Connectivity Index:

Step 1: Estimating the connectivity value of each country as an origin and as a destination

Using econometric analysis, we determine the connectivity value of each country as an origin and as a destination. Each country's connectivity value is a function of its economic size, distance from other countries, and special characteristics (e.g., historic links between Commonwealth countries). This

[1] Arvis, Jean-Francois and Shepherd, Ben, "The Air Connectivity Index: Measuring Integration in the Global Air Transport Network", World Bank Policy Research Working Paper No. 5722, June 2011

[2] The name "gravity" comes from the fact that in its nonlinear form, the model resembles Newton's law of gravity. The gravity model of trade considers exports to be directly proportional to the exporting and importing countries' economic "mass" (GDP), and inversely proportional to the distance between them. The gravity model predicts that larger country pairs would tend to trade more, and countries that are further apart would tend to trade less, perhaps because transport costs between them are higher.

approach isolates any non-systematic factors that may have caused an increase in flights in some years (e.g., the Olympics).

I. Model Specification

The econometric model for business aviation air connectivity uses data between 5,075 origin and destination country pairs over a five-year period from 2019 to 2023 while the econometric model for commercial aviation air connectivity uses data between 4,757 origin and destination country pairs over the same period.[3] The model specification is the same for both models and is set out below:

$$Flight\_number_{i,j,t} = \beta_0 + \beta_1 * GDP\_capita_{i,t} + \beta_2 * GDP\_capita_{j,t} + \beta_3 * Distance_{i,j} + \varepsilon$$

In the equation above, $Flight\_number_{i,j,t}$ is the number of flights, either business or commercial, between origin country i and destination country j at time t sourced from EBAA data; GDP_capita_i and GDP_capita_j represent the GDP per capita of the origin and destination country respectively in year t sourced from Oxford Economics and $Distance_{i,j}$ is the distance between the two countries. The βs represent the econometric coefficients that indicate the weight of each of respective variables on the right-hand side of the equation in explaining the number of flights. The ε captures the non-systematic factors that may influence the number of flights in a particular year.

We used the Poisson pseudo-likelihood regression (PPML) (implemented using the ppmlhdfe command in STATA). Silva and Tenreyro (2006)[4] suggest this method as the ideal estimator for gravity equations. In the presence of non-negative data with possibly many zeros, PPML is the appropriate estimator to use if one wants to make minimal assumptions about the distribution of the data.

Fig. 1. Econometric regression outputs for business aviation model

Variables	Coefficient
GDP per capita (origin)	1.9156***
GDP per capita (destination)	2.0479***
Distance	-0.0021***
Constant	-31.8820***

significance level: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Oxford Economics

[3] Data provided by EBAA.

[4] J. M. C. Santos Silva & Silvana Tenreyro, "The Log of Gravity," The Review of Economics and Statistics, MIT Press, vol. 88(4), (2006), pages 641-658, accessed July 2024

Fig. 2. Econometric regression outputs for commercial aviation model

Variables	Coefficient
GDP per capita (origin)	2.8745***
GDP per capita (destination)	2.8602***
Distance	-0.0013***
Constant	-47.9927***

significance level: **** p<0.01, ** p<0.05, * p<0.1*

Source: Oxford Economics

II. Data Description

A dataset consisting of more than 3.5 million business aviation flights and more than 32 million commercial aviation flights from 2019 to 2023, departing or arriving at an airport in Europe, was obtained from EBAA. The dataset includes information like the departure and arrival date for a specific flight, the departure and arrival airport, their distance between them, the aircraft identifier, and the flight's mission. GDP per capita was collected for both the origin and destination countries over the 2019 to 2023 period from the Oxford Economics database.

Step 2: Combining the connectivity values into an Air Connectivity Index

We then combine the estimated connectivity values into an Air Connectivity index for business aviation and an Air Connectivity index for commercial aviation for each country as an origin and a destination in a way that accounts for:

a. the connectivity values of all other countries it is connected to; and

b. the overall increase in connectivity between other countries.

Our calculations to estimate the two indices are identical to those in Arvis and Shepherd. The scores are then normalised across years using the five-year moments as the basis for normalisation.

Results

With the exception of Belgium and Greece, the ten best-connected countries in Europe remain consistent across the two indices. Countries like France and Switzerland score higher in the business aviation connectivity rankings because French and Swiss airports are relatively more important for business aviation than they are for commercial aviation, as determined by the number of flight movements (departures or arrivals) to those airports. The same holds in the case of Belgium and Greece.

Fig. 3. Normalised Commercial Aviation Air Connectivity Index scores

Country	2019	2020	2021	2022	2023
United Kingdom	5.46	5.80	5.30	5.14	5.19
Germany	4.01	4.68	3.61	2.99	3.69
France	3.57	4.05	3.59	3.77	3.46
Spain	3.48	3.84	3.38	2.79	3.01
Netherlands	3.03	3.00	2.89	2.74	2.77
Italy	2.79	3.23	1.72	2.78	2.25
Turkey	2.13	2.29	2.59	2.02	2.18
Belgium	2.01	1.77	1.55	1.87	1.82
Switzerland	1.69	2.28	1.95	1.46	1.81
Portugal	1.36	1.24	1.23	0.81	1.01

Source: Oxford Economics

Fig. 4. Normalised Business Aviation Air Connectivity Index scores

Country	2019	2020	2021	2022	2023
United Kingdom	4.68	4.58	4.28	5.48	7.56
France	4.37	3.05	3.94	3.87	4.20
Spain	4.05	2.43	3.24	4.25	4.00
Switzerland	3.46	3.45	2.66	4.02	3.69
Italy	2.39	1.56	1.45	2.55	3.11
Germany	1.89	2.09	2.42	3.30	2.89
Turkey	0.75	1.04	0.82	1.43	1.59
Portugal	2.37	1.34	1.15	1.61	1.47
Greece	1.05	0.22	0.39	2.24	1.10
Netherlands	1.25	1.46	1.28	1.16	1.09

Source: Oxford Economics

MEASURING BUSINESS AVIATION'S AIR CONNECTIVITY IMPACT ON FDI

This section describes the econometric model used to estimate the relationship between business aviation connectivity and FDI. In particular, we used the gravity model framework described previously. Gravity models are most commonly used to assess factors influencing bilateral trade flows, but this framework lends itself naturally to modelling the drivers of FDI which, similarly, represents economic transactions between countries. Applications of this approach to modelling FDI flows have grown in recent years given the improvement in the quality and volume of bilateral FDI data. Falk (2016)[5] analyses a database of 2,420 FDI projects carried out by 50 parent countries in 104 host countries from 2005 to 2011 and determines the factors influencing FDI in the hospitality industry using a

[5] Martin Falk, "A gravity model of foreign direct investment in the hospitality industry", Tourism Management 55, (2016), pp. 225 – 237, accessed August 2024

gravity model. Similarly, Dorakh (2020)[6] employs a gravity model which covers 39 host and home countries from 1991 to 2017 to investigate whether EU membership is a key FDI determinant.

Gravity models employed for this purpose use the historic path of bilateral FDI flows to assess the influence of various factors in promoting or constraining FDI between pairs of countries. As such, these models provide a framework to assess the influence of business aviation connectivity on FDI flows.

Model Specification

The concept of gravity models resembles Newton's law of gravity whereby FDI is directly proportional to the mass of the two countries (represented by GDP) and inversely proportional to the distance between the two countries. This suggests that we can expect country pairs with larger GDP to engage more in FDI, but countries that are further apart to engage in less FDI.

The model specification is set out below:

$$\log FDI_{i,j,t} = constant + \log GDP_{i,t} + \log GDP_{j,t} + Distance_{i,j} + T_{ijt} + \varepsilon$$

where $FDI_{i,j}$ indicates the number FDI projects from host country i to destination country j at time t, GDP is each country's real gross domestic product at time t, while $Distance_{i,j}$ represents the distance between the host and destination countries and is fixed over time. T_{ijt} is a matrix of variables representing an extension to the basic gravity model and includes factors that are likely to influence FDI flows between country i and country j such as business aviation connectivity, commercial aviation connectivity, labour costs and exchange rate.

Our dataset includes pairs of countries between which no FDI was recorded for the time period we are considering. Excluding these observations from the analysis will introduce selection bias leading to inconsistent estimates. However, models with lots of zero values cannot be estimated efficiently using standard econometric techniques. Silva and Tenreyro (2006)[7] suggest a method based on the Pseudo-Poisson Maximum Likelihood (PPML) estimator. One feature of the PPML method is that it gives the same weight to each observation (even zeros) and the effect of higher conditional mean that stems from the exponential function of the distribution of FDI flows would be offset by a larger variance. This will ensure that the inclusion of zeros in the sample does not bias the estimation.

Data Description

A dataset consisting of 31,914 projects originating from various countries around the world and directed towards European countries was obtained from the Orbis Crossborder Investment database of Bureau van Dijk.[8] For each project, the database includes information including the source market, the destination market, status of project, and the value of investment. The dataset covers activity

[6] Alena Dorakh, "A gravity model analysis of FDI across EU member states", Journal of Economic Integration 35, no. 3, (2020), pp. 426 – 456, accessed August 2024

[7] J. M. C. Santos Silva & Silvana Tenreyro, "The Log of Gravity," The Review of Economics and Statistics, MIT Press, vol. 88(4), (2006), pages 641-658, accessed July 2024

[8] Orbis Crossborder Investment is a database that looks at cross-border FDI projects and delivers information on the companies behind these investments – both listed and private.

across multiple industries and countries for the period between 2019 and 2023. The number of FDI projects is aggregated for each country pair for every year. With 108 host countries and 46 destination countries, this resulted in around 5,000 unique country pairs. Other variables collected for both the source and destination countries over the 2019 to 2023 period include unit labour costs and exchange rates from the Oxford Economics database.

Results

The key variables in our model are shown in Fig. 55.

Fig. 5. Econometric results from model

Variables	Coefficient
GDP (source)	0.9534***
GDP (destination)	3.3519***
Exchange rate (per $) (destination)	0.0006**
Distance	-0.0006***
Unit Labour Cost (destination)	1.6059**
Commercial Aviation Connectivity Index	1.0986**
Business Aviation Connectivity Index	0.6338***
Business Aviation Connectivity Index * Commercial Aviation Connectivity Index	-0.2128**
Constant	-65.1938***

*significance level: *** p<0.01, ** p<0.05, * p<0.1*

Source: Oxford Economics

Our results are in line with key findings in the literature in both the sign and magnitude of coefficients and all variables are statistically significant at the 5% level. The mass variables consisting of the source and destination GDP are all positive and significant as expected. Distance is negative and significant, as expected, while destination unit labour costs are positive and significant, implying that FDI generates high skill employment. Lastly, the exchange rate is positive and significant, implying a depreciation in the domestic currency attracts FDI, as expected.

Furthermore, our results show that both commercial and business connectivity have a significant positive effect on FDI. The interaction term is significant and negative, which indicates that the impact of business aviation connectivity on FDI depends on the existing scale of the commercial connectivity index. Simply put, a higher volume of business flights would have a greater impact in areas with fewer commercial flights than in areas with many commercial flights.

From the coefficients of the business aviation connectivity index and the interaction term we find that, on average, ceteris paribus[9], a 1% reduction in the business aviation index is associated with an 0.0062% reduction in FDI attractiveness.

[9] All other things being equal.

MEASURING THE RELATIONSHIP BETWEEN FDI AND EMPLOYMENT

To measure the economic impact of FDI on employment we estimate the relationship between FDI and employment in foreign-controlled entities.

We first estimate annual FDI losses as the product of the reduction in FDI attractiveness multiplied by the stock of direct investment liabilities. Data on direct investment liabilities were sourced from Eurostat[10] for the EU27 from 2013 to 2022 and they capture direct investments by non-residents in resident enterprises. We used historical trends to grow forward direct investment liabilities to 2030.

We then determine the ratio between employment and FDI in 2021, which is the only year for which we have data on employment by foreign-controlled EU enterprises and on direct investment liabilities. Data on the number of persons employed by foreign-controlled EU enterprises is sourced from Eurostat[11] and is available for each EU27 country. We combine the employment data with the stock of direct investment liabilities in 2021 to determine the ratio between employment and FDI in 2021.

Finally, we multiply this ratio by the value of FDI lost in 2030 to determine the value of employment lost in 2030. We also account for the growth in productivity over time by adjusting for national productivity growth.

MEASURING ENVIRONMENTAL IMPACT

To measure the environmental impact from a reduction in the volume of business aviation flights we use the Small Emitters Tool (SET)[12], a tool developed by Eurocontrol to estimate fuel burn and associated CO2 emissions by small emitters in 2023.[13]

We input the ICAO Aircraft type designator and distance flown between a pair of cities, data provided by EBAA, into the SET. Our model leverages SET's excel architecture and links it with a set of inputs calculated using EBAA's detailed business aviation flight data.

We estimate CO_2 emissions in 2023 for flights that depart from an airport in the EU27 and arrive at an airport in EU27. We used data from EBAA on 414,000 flights departing 1,100 European airports for flights averaging 800 km.

Furthermore, we estimate CO_2 emissions in 2023 for flights that depart from an airport in the EEA and arrive at an airport in the EEA, Switzerland, or the UK. For this we use data on 515,000 flights departing 1,339 European airports for flights averaging 815 km, provided by EBAA.

[10] Available at https://ec.europa.eu/eurostat/databrowser/view/BOP_FDI6_POS/default/table?lang=en
[11] Available at https://ec.europa.eu/eurostat/databrowser/view/fats_activ__custom_9997677/default/table?lang=en
[12] Eurocontrol, "Small Emitters Tool", 2023, accessed May 2024
[13] Aircraft operators operating fewer than 243 flights per period for three consecutive four-month periods or emitting fewer than 25,000 tCO2 annually.

OXFORD ECONOMICS

Global headquarters
Oxford Economics Ltd
Abbey House
121 St Aldates
Oxford, OX1 1HB
UK
Tel: +44 (0)1865 268900

London
4 Millbank
London, SW1P 3JA
UK
Tel: +44 (0)203 910 8000

Frankfurt
Marienstr. 15
60329 Frankfurt am Main
Germany
Tel: +49 69 96 758 658

New York
5 Hanover Square, 8th Floor
New York, NY 10004
USA
Tel: +1 (646) 786 1879

Singapore
6 Battery Road
#38-05
Singapore 049909
Tel: +65 6850 0110

Europe, Middle East and Africa

Oxford
London
Belfast
Dublin
Frankfurt
Paris
Milan
Stockholm
Cape Town
Dubai

Americas

New York
Philadelphia
Boston
Chicago
Los Angeles
Toronto
Mexico City

Asia Pacific

Singapore
Hong Kong
Tokyo
Sydney

Email:
mailbox@oxfordeconomics.com

Website:
www.oxfordeconomics.com

Further contact details:
www.oxfordeconomics.com/about-us/worldwide-offices