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Economic impacts of Business Aviation in Europe

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Abstract

Despite of being an important segment of non-scheduled air transport, the Business Aviation sector has hardly been dealt with in the academic literature. We give insight into the European Business Aviation sector with a special focus on its economic impacts. Based on an extensive data collection, we conduct an input-output analysis and find that about 374,000 European jobs depend directly or indirectly from Business Aviation activities, which further represent 0.2% of the European (EU28) GDP. In addition, a data analysis approach comparing actual European Business Aviation flights against the fastest commercial travel alternatives indicates that users of Business Aviation experience average travel time savings of 127 minutes and a 150% average increase in productive work time per trip, as well as annual savings of about €15 million in overnight hotel. These effects partly stem from improved connectivity, as Business Aviation serves about 25k city or area pairs which are not connected by nonstop scheduled services, including many region-pairs of different economic strengths.

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Keywords: Business Aviation; Air transport; Connectivity; Economic Impact; Input-Output analysis; travel time saving; MRO; FBO

1. Introduction

1.1 Classification of Business Aviation

There is no common definition for Business Aviation. According to the US National Business Aviation Association (NBAA), BA is non-scheduled and non-military flying for business purposes.[1] For the European Commission (2008), "General” and “Business Aviation" cover a wide spectrum of civil aviation activities, “ranging

[1] See https://www.nbaa.org/business-aviation/.

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from recreational flying with non-powered aircraft to the operation of high-performance business aircraft and specialised aerial works", which may be subsumed under two groups:

- "all civil aircraft operations other than commercial air transport", i.e. civil aircraft operations that are not performed with an intention to realize a profit; and
- "on-demand, remunerated, civil air transport operations", i.e. commercial operations that are performed on an on-demand basis on behalf of and exclusively for the respective client and not for the general public.

This definition, however, does not differentiate between "General Aviation" and "Business Aviation". For this paper, we regard as BA not only remunerated on-demand operations and closely related services, but also own-account air services of firms, entrepreneurs, organizations or others (Figure 1).[2] The latter refers to flights performed by in-house operators or the entrepreneur himself.

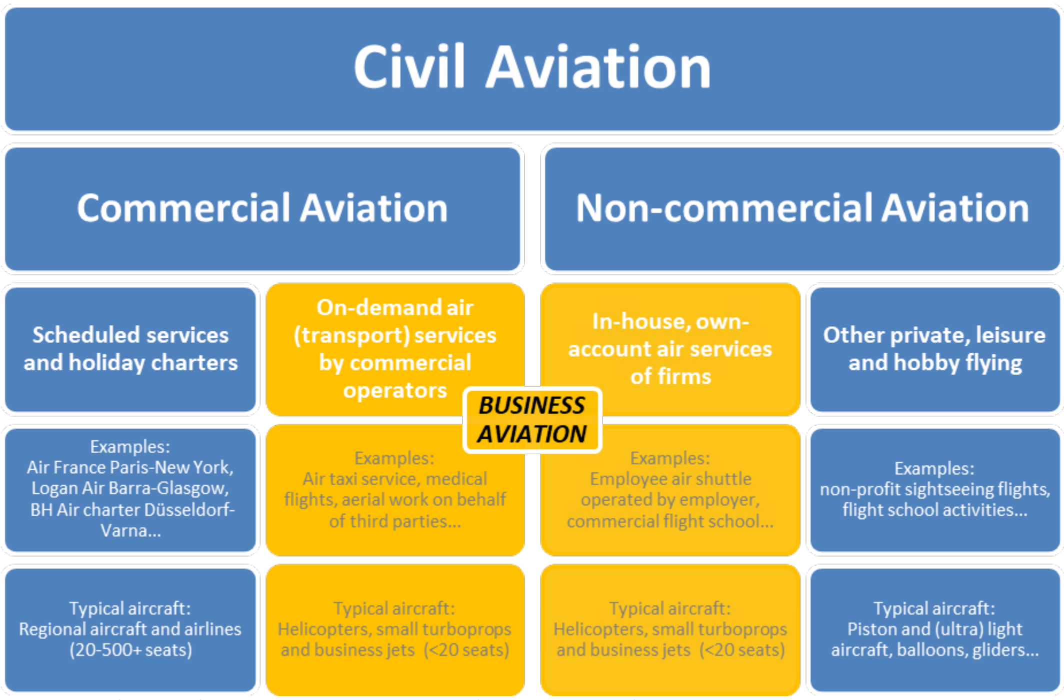

Fig. 1. Classification of Business Aviation (Source: all figures and tables from authors unless otherwise stated)

Extending the above classification to a system-oriented view (e.g. Schmitt and Gollnick, 2016), not only the actual aircraft operators but also some other stakeholders will have to be considered as integral parts of the BA sector. These include aircraft owners (e.g. firms outsourcing their aircraft operations to professional operators); maintenance, repair and overhaul ("MRO") firms focusing on business aircraft; fixed-base operators ("FBO") and other ground handlers specialized in business flights; airports and airfields with a (strategic) focus on business aviation; air charter brokers, consultants and market intelligence providers; or manufacturers of business aircraft and parts.

In section 2, we assess the economic footprint of the business aircraft operators, MRO's, FBO's and aircraft manufacturers, which together make a large share of the sector. Due to a lack of data, estimates for e.g. charter brokers or airport and airfield employees other than those working with FBO's could not be undertaken.

[2] Typical examples include: an oil company operating own helicopters to bring employees to oil platforms; test and research flights; or the self-flying lawyer or entrepreneur visiting a client.

1.2 Previous studies and research on Business Aviation

Business Aviation has hardly been dealt with in the transportation research literature. For example, the “ScienceDirect” database, which claims to cover more than 15 Million papers from about 3,800 journals (Elsevier B.V., 2018), generates only seven results for the keywords “Business Aviation” and “Business Charter”, but e.g. 310 hits for the keywords “Low Cost Carrier”.

The few existing papers on BA tackle different questions like the global fleet distribution and current industry trends (Budd and Graham, 2008), the impact of slot shortages and capacity constraints at larger airports on regional airport choice by BA operators (Berster et al, 2011), operational and capacity issues of business aviation operational control centers (Pazourek and Václavík, 2017), or they tackled the business aviation sector only marginally, e.g. in the context of a Delphi-study on the future of the aviation industry (Linz, 2012) or of a study on the development of Warsaw Airport (Tloczynski, 2016). The role of the (potential) BA users was assessed by Kaps et al (2001) and by Yen and Chen (2017). In a survey-based approach for the US only, Kaps et al (2001) identified relatively little degrees of awareness by potential users and travel agents, and ineffective marketing efforts at the operator level. Yen and Chen (2017) modelled the preference for business charter flights in the Mainland China-Taiwan market and identified factors with a positive impact on business charter usage.

In addition to these few academic papers, there have been a number of industry studies on different aspects of the sector, like fleet forecasts, market overviews, or economic impact and business benefit studies. Regular BA forecasts include Bombardier’s latest “Business Aircraft Market Forecast” (Bombardier, 2016), Honeywell’s Global Business Aviation Outlook (Honeywell, 2017) or Jetcraft’s “10 year business aviation market forecast” (Jetcraft, 2017). For the timeframe 2016-2025, Bombardier expects about 8,300 new aircraft deliveries at the worldwide level, as well as a trend to larger BA jets, with Honeywell and Jetcraft coming to similar numbers.

An example for a market overview and economic footprint/benefit study on the BA sector is the NBAA Business Aviation Factbook series (National Business Aviation Association, 2014) which informs (from the sector’s perspective) on key economic and business benefits stemming from the sector in the US, as well as on developments in the field safety, security and environment. For Europe, a small number of studies were prepared on behalf of the European Business Aviation Association (EBAA): Using an input-output (“I-O”) approach, PricewaterhouseCoopers (2008) assessed the sector’s macro-economic impacts in Europe for the year 2007, based on data from various sources and on interviews with firms representing 45% of the market. The study further discussed, but did not quantify, the main socio-economic and business benefits stemming from BA, like travel time and cost savings, enhanced flexibility and deal facilitation. Some years later, Oxford Economics (2012) used Eurocontrol data from 2011 to provide some insight into the sector’s geography and identified France, Germany and UK as the largest European BA markets. Other findings include the fact that about 70% of BA movements occurred at regional airports, which may hint at the sector’s importance for decentralized regions, and that 96% of all 88,800 European city-pairs connected by business aviation lacked a (minimum) daily scheduled service. Eurocontrol itself looked at the sector and analyzed the structure, numbers and growth of Business Aviation IFR (instrument flight rules) flights (Eurocontrol , 2010). As in the later Oxford Economics Study, the authors identified France, Germany and UK as the main places for BA movements and they found that BA largely concentrates on routes without any direct link on a daily or more frequent basis.

1.3 Aim and structure of this paper

This paper aims at providing current and more detailed insight into the structure of the Business Aviation sector throughout Europe, as well as into its main economic impacts and user benefits. It contains research that was used as basis for a study by Booz Allen Hamilton and German Aerospace Center (DLR) on the economic impacts and business benefits of Business Aviation in Europe (Booz Allen Hamilton, 2016). The economic impact section of this study can be regarded as an update of the 2008 work done by PriceWaterhouseCoopers, using a new collection of firms and direct employment (estimates) and the (then) latest input-output tables as basis. As novelty, using a data science analysis approach which compared European BA flights against their fastest commercial travel alternatives, this contribution provides estimations for the actual travel time savings achieved by BA users and for the increase in productive work time per trip. An update of the macroeconomic section of the 2016 study, as well as an extension of the business benefits section, with a stronger focus on the sector's connectivity impacts, were later conducted by the authors, resulting in the EBAA publication "European Business Aviation – Economic Value and Business Benefits" (EBAA, 2018) which also serves as a basis for this paper.

Section 2 presents the methodology and main results of the input-output work on the sector's employment and gross value added (GVA) effects, while Sections 3 and 4 look into the user (time savings) and regional (connectivity) benefits. Section 5 eventually wraps up the main findings and some of the work's main limitations and resulting scope for future research.

2. Employment and GVA effects

2.1 Structure and macroeconomic impact of the Business Aviation sector in Europe

This part of the contribution aims at quantifying the direct, indirect, induced and total employment and gross value added (GVA) effects of the Business Aviation sector on the European economy (EU28 incl. Monaco, San Marino, Gibraltar, the Channel Islands and the Isle of Man, plus the EFTA states Norway, Switzerland and Liechtenstein). Employment is defined as the total number of jobs, including self-employed, supported by the economic activity in the value chains of the Business Aviation sector and by the spending of the employees of the Business Aviation sector in those value chains. GVA is the monetary worth of the production and services generated by the firms in the Business Aviation sector and by their supplier, measured as the sector's output at basic prices minus intermediate consumption (input) at purchaser prices.

We consider two main groups of activities as part of the BA sector: "Operations", which refers to the actual operation of aircraft, to ground handling and fixed-base operations, and to the maintenance, repair and overhaul of business aircraft, and the "Manufacturing" of business aircraft and related parts and components.

The economic impact analysis undertaken is based on Vassily Leontief's input-output methodology (e.g. Leontief, 1986) and differs between different types of effects: Direct effects occur in the sector concerned, e.g. employees in or gross value added stemming from the above defined operation and manufacture of business aircraft. Indirect effects originate from inputs delivered from external industries to the business aviation sector. Examples include aircraft manufacturers being supplied with metal, plastic or components, or aircraft operators purchasing fuel or paying commissions to brokers. Induced effects are defined as the additional economic activity generated by the consumption of income from direct and indirect employees of the Business Aviation sector. They can, therefore, be considered as the multipliers of income of persons directly and indirectly employed in the aviation sector.

Methodology-wise, we proceed as illustrated in Figure 2. First, and based on various data sources, we estimate direct employment numbers at the country level for aircraft operation, FBO, MRO and Manufacture. Second, we apply ratios from the National Accounts to the employment figures to estimate the sector's direct GVA. Third, we apply an Input-Output (IO) model to estimate the indirect and induced effects for these two indicators, and we calculate the total impacts at the country and European levels.

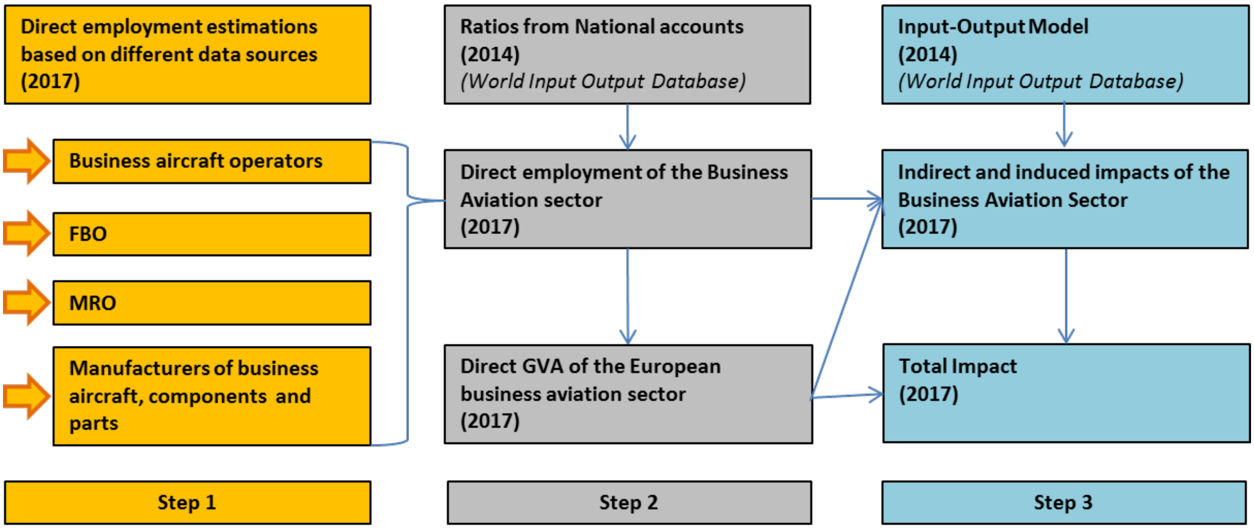

Fig. 2. Methodology

2.2 Direct employment estimations

It is not straightforward to collect employment data for the BA sector as Eurostat's national accounts and sectoral statistics differ between 64 sectors only, and hence do not provide isolated figures for the relatively small "subsectors" business aircraft operation, MRO, FBO and business aircraft manufacture.[3] "Bottom-up", however, data availability is also limited as the above-defined sector consists of virtually thousands of relatively small stakeholders along the value chain which usually are not required to disclose financial and employment data. We therefore make use of a mix of different approaches and sources to estimate the direct effects in the BA subsectors:

Aircraft Operators

We apply a "fleet-based approach" to assess the direct employment with European-based business aircraft operators. Intelligence providers like Ascend provide up-to-date fleet and operator databases, which also allow for a segmentation of firms operating in the Business Aviation segments as defined in Figure 1. However, employment data is currently only provided for a small number of firms, usually the "big" airlines and not the business aircraft operators.

Therefore, we apply average workforce-per-aircraft ratios of 7.67 employees per fixed-wing aircraft and 5.05 employees per helicopter to the current (26 July, 2017) business aircraft fleet provided by Ascend, to get an idea of the 2017 workforce of the sector. These indicators were derived from the 2010 edition of the (meanwhile discontinued) fleet yearbook "JP Airlines Fleets" – which, at that time, still reported employment figures at the firm level. As business models, crew requirements and other operational conditions in the Business Aviation sector have remained rather stable, these ratios are unlikely to have considerably changed over time.

Table 1 shows the results of this exercise: 2660 helicopters and 3103 fixed-wing aircraft based in Europe translate into some 37,232 employees in the operation of business aircraft, with Germany (18%), UK (17%) and France (10%) accounting for the highest shares.

[3] See, e.g., the description of Eurostat's input-output tables on https://ec.europa.eu/eurostat/web/esa-supply-use-input-tables/overview. The same applies to data provided at the national levels.

Table 1. Employment with helicopter and fixed-wing operators in Europe (2017)

Country	**Region**	**Helicopter**			**Fixed-wing**			**Total**	
		Fleet	**Employees**	**Share**	**Fleet**	**Employees**	**Share**	**Employees**	**Share**
Austria	EU28	86	434	3%	236	1,810	8%	2,244	6%
Belgium	EU28	107	540	4%	89	683	3%	1,223	3%
Bulgaria	EU28	15	76	1%	20	153	1%	229	1%
Croatia	EU28	3	15	0%	10	77	0%	92	0%
Cyprus	EU28	7	35	0%	8	61	0%	96	0%
Czech Republic	EU28	63	318	2%	91	698	3%	1,016	3%
Denmark	EU28	42	212	2%	76	583	2%	795	2%
Estonia	EU28	6	30	0%	10	77	0%	107	0%
Finland	EU28	19	96	1%	16	123	1%	219	1%
France*	EU28	372	1,879	14%	243	1,864	8%	3,743	10%
Germany	EU28	330	1,667	12%	649	4,978	21%	6,645	18%
Greece	EU28	40	202	2%	27	207	1%	409	1%
Hungary	EU28	23	116	1%	16	123	1%	239	1%
Iceland	EFTA	7	35	0%	3	23	0%	58	0%
Ireland	EU28	26	131	1%	34	261	1%	392	1%
Italy**	EU28	238	1,202	9%	135	1,035	4%	2,237	6%
Latvia	EU28	8	40	0%	5	38	0%	78	0%
Liechtenstein	EFTA	1	5	0%	3	23	0%	28	0%
Lithuania	EU28	5	25	0%	9	69	0%	94	0%
Luxembourg	EU28	14	71	1%	109	836	4%	907	2%
Malta	EU28	3	15	0%	163	1,250	5%	1,265	3%
Netherlands	EU28	25	126	1%	48	368	2%	494	1%
Norway	EFTA	119	601	4%	33	253	1%	854	2%
Poland	EU28	138	697	5%	55	422	2%	1,119	3%
Portugal	EU28	13	66	0%	123	943	4%	1,009	3%
Romania	EU28	19	96	1%	10	77	0%	173	0%
Slovakia	EU28	30	152	1%	13	100	0%	252	1%
Slovenia	EU28	4	20	0%	16	123	1%	143	0%
Spain	EU28	118	596	4%	94	721	3%	1,317	4%
Sweden	EU28	81	409	3%	55	422	2%	831	2%
Switzerland	EFTA	185	934	7%	225	1,726	7%	2,660	7%
United Kingdom***	EU28	513	2,591	19%	479	3,674	15%	6,265	17%
Total EU28	EU28	2,348	11,857	88%	2,839	21,775	91%	33,633	90%
Total EFTA	EFTA	312	1,576	12%	264	2,025	9%	3,600	10%
Total EU28+EFTA	ALL	2,660	13,433	100%	3,103	23,800	100%	37,233	100%

***) including Monaco **) including San Marino ***) including Isle of Man, Guernsey and Gibraltar**

MRO and FBO

Employment numbers for MRO and FBO firms are also difficult to retrieve as most providers are either small or medium-sized firms with only very limited reporting requirements or part of larger entities which report at very aggregated levels only. Also, many aircraft operators provide such services in-house. Finally, some MRO firms also deal with either large commercial aircraft or non-business forms of general aviation. Against this background, we have chosen the following methodology for the assessment of the number of employees with European MRO and FBO firms specialized in Business Aviation (Figure 3):

(a) Identification of MRO and FBO service providers by country using the 'Handbook of Business Aviation' online database4 and 2017/2018 print edition. MRO firms focusing on light aircraft or on large passenger jets have not, or only partly, been taken into account.

(b) Estimation of each firm's employment figure using one of the following sources (in descending priority):
- "Official" employment figures, e.g. available from company websites or provided by the firm upon request by e-mail.
- Employment figure from financial firm databases such as Firmenabc.at, Kompass.com, Findthecompany.com, Moneyhouse.de, Societe.com, or from LinkedIn. If employment figures are provided in form of a range (e.g. "10-20 employees"), we consider the mean value.
- 3rd priority: sector median.
- In cases in which the FBO operation is part of an MRO firm or aircraft operator, the firm's total workforce has been distributed over these activities in a reasonable way.

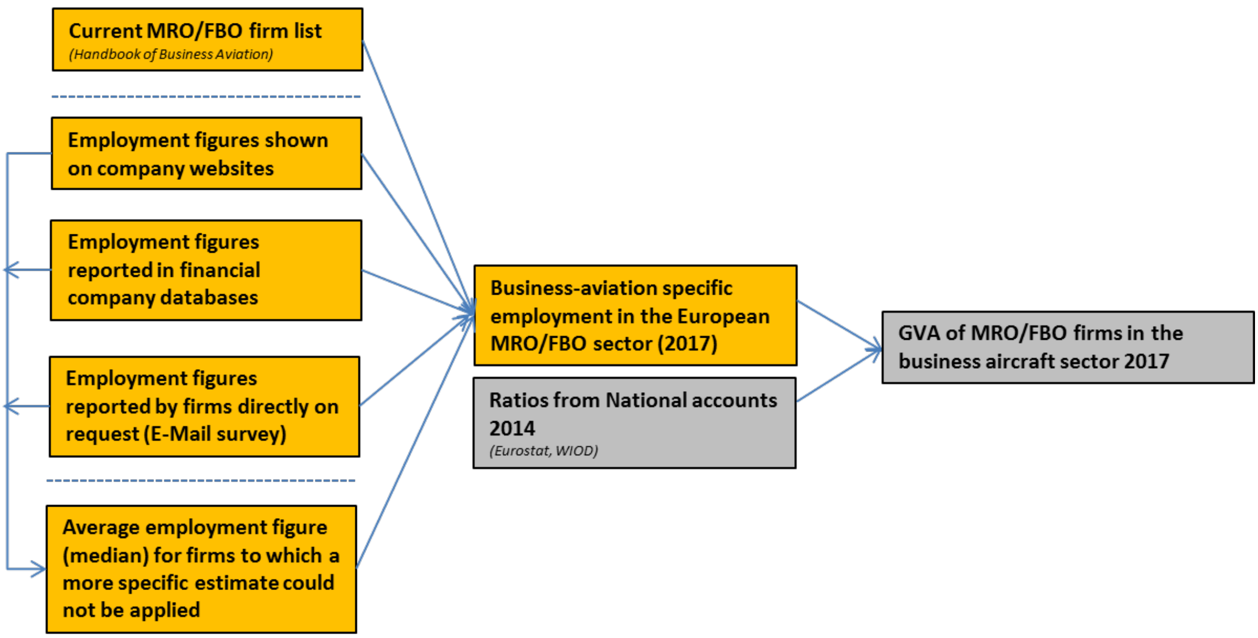

Fig. 3. Approach to estimate direct employment and GVA with European MRO and FBO firms

The results are illustrated in Table 2 further down. Interestingly, Swiss ends up at number two in the MRO market – our data collection revealed that Swiss firms have a very strong presence here. A total of 2,683 employees is estimated for the executive ground handling and FBO segments in Europe. The countries with the highest shares are France (388), Spain (370), the UK (368), Germany (300), Italy (285), and Switzerland (146).

[4] http://www.handbook.aero/hb_maintenance.html.

Aircraft Manufacturers

Apart from significant BA operations in many European countries, Europe is also an important place of business for the manufacture of business aircraft and related parts and components. We report up-to-date estimates of the European workforce in this area for the year 2017. Hereby, we have only considered employees of manufacturers of aircraft and engines, as well as of the leading manufacturers of other components (such as Honeywell, Thales or Safran) as direct effects, while the manufacture of other components and parts has been allocated to the sphere of indirect effects. Similar to our methodology with FBO and MRO, workforce estimates for the aircraft manufacturers are based on various sources, mainly company (annual) reports, feedback/information from direct contacts, and internal assumptions.

We estimate some 41,238 direct employees for the European manufacture of business aircraft and components (Table 3). Unlike the operations segments, these are much more concentrated on few leading countries, led by France (45%), Germany (18%), and the UK (14%), where firms like Airbus Group, Bombardier, Daher, Dassault, MTU, Rolls-Royce, Safran and Thales are located. Other countries that nevertheless play a (minor) role include Italy (Leonardo Helicopters and Piaggio), Switzerland (Pilatus) and the Czech Republic (Honeywell).

Direct employment summary

Table 3 and Figure 4 summarize the results stemming from the direct employment estimations for the Business Aviation sector in Europe. In total, we estimate a total workforce of 51,560 people for the operation business aircraft and related services, which is joined by some 41,238 employees in the manufacture of business aircraft and related parts. Figure 4 underlines that the aircraft and components manufacturing industry is largely concentrated in France and a few other key countries, while activities and hence resulting employment impacts in the operational field are more spread across Europe.

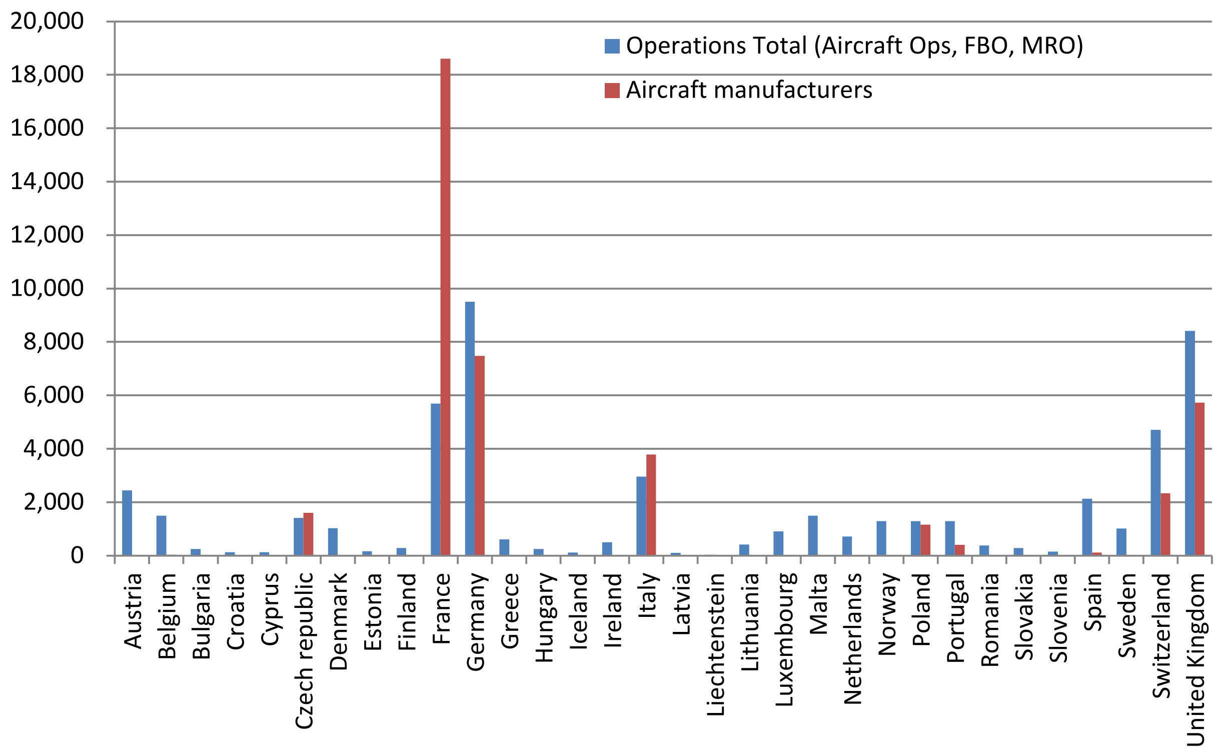

Fig. 4. Business aviation-related direct employment in operations and manufacture by European country (2017)

Table 2. Overview of Business aviation-related direct employment estimates for Europe (2017)

Country	Region	Aircraft Ops	FBO	MRO	Operations Total	Aircraft Manufacture	sum	Share
Austria	EU28	2,244	87	113	2,444	0	2,444	3%
Belgium	EU28	1,223	60	209	1,492	30	1,522	2%
Bulgaria	EU28	229	24	0	253	0	253	0%
Croatia	EU28	92	19	13	124	0	124	0%
Cyprus	EU28	97	28	3	128	0	128	0%
Czech Republic	EU28	1,016	51	340	1,407	1,600	3,007	3%
Denmark	EU28	795	20	208	1,023	0	1,023	1%
Estonia	EU28	107	20	31	158	0	158	0%
Finland	EU28	219	9	51	279	0	279	0%
France	EU28	3,742	388	1,566	5,696	18,604	24,300	26%
Germany	EU28	6,644	300	2,565	9,509	7,479	16,988	18%
Greece	EU28	409	96	105	610	0	610	1%
Hungary	EU28	239	9	0	248	0	248	0%
Iceland	EFTA	58	42	16	116	0	116	0%
Ireland	EU28	392	77	34	503	0	503	1%
Italy	EU28	2,237	285	433	2,955	3,782	6,737	7%
Latvia	EU28	79	20	0	99	0	99	0%
Liechtenstein	EFTA	28	0	0	28	0	28	0%
Lithuania	EU28	94	12	308	415	0	415	0%
Luxembourg	EU28	907	5	0	911	0	911	1%
Malta	EFTA	1,265	15	213	1,493	0	1,493	2%
Netherlands	EU28	494	21	203	718	0	718	1%
Norway	EFTA	854	29	407	1,290	0	1,290	1%
Poland	EU28	1,119	32	142	1,293	1,164	2,457	3%
Portugal	EU28	1,009	73	208	1,290	401	1,691	2%
Romania	EU28	173	32	177	382	0	382	0%
Slovakia	EU28	251	16	11	278	0	278	0%
Slovenia	EU28	143	3	8	154	0	154	0%
Spain	EFTA	1,317	370	444	2,131	114	2,245	2%
Sweden	EU28	831	23	160	1,014	0	1,014	1%
Switzerland	EFTA	2,660	146	1,904	4,710	2,338	7,048	8%
United Kingdom	EU28	6,265	368	1,775	8,408	5,726	14,133	15%
Total EU28	EU28	33,633	2,465	9,317	45,415	38,900	84,315	91%
Total EFTA	EFTA	3,600	217	2,327	6,145	2,338	8,483	9%
Total EU28+EFTA	ALL	37,233	2,683	11,644	51,560	41,238	92,798	100%

2.3 Estimation of direct GVA effects

The above estimated employment figures were used as a basis for the estimation of the sector's gross value added (GVA). For this, and due to a lack of more recent data, we applied ratios from the National Accounts provided by Eurostat and WIOD (World Input-Output (IO) Database)[5] for the year 2014 and converted USD values into EUR using official end-of-the-year exchange rate. By this, we assume that the economic structure between the business air transport sector and its suppliers to have remained constant between 2014 and 2017. Furthermore, as IO tables are not available for Iceland and Liechtenstein, we used those of similar or neighboring countries (e.g., Switzerland for Liechtenstein).

Also, as Business Aviation is not directly featured as a sector in the I-O-tables, we had to refer to the subordinate sectors "Air Transport" (for business aircraft operators), "Warehousing and support activities for transportation" (for FBO), "Repair and installation of machinery and equipment" (for MRO) and "Manufacture of other Transport Equipment" (for manufacturers) as proxies.

Figure 5 provides an overview of the European distribution of gross value added in business aviation. Not surprisingly, France ranks first with a GVA of more than EUR 4 bn, but Switzerland follows with a GVA of about EUR 2.5 bn, which may reflect a relatively high labor productivity of the Swiss business aviation sector.

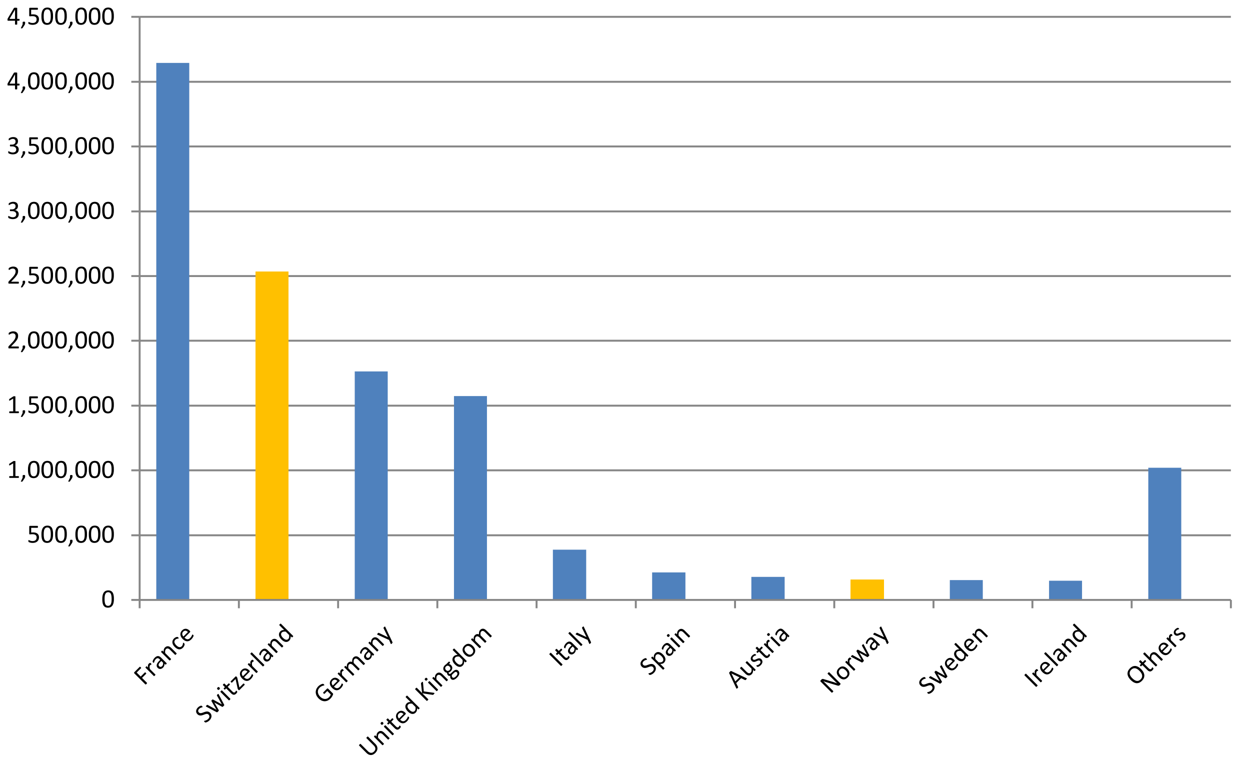

Fig. 5. Business aviation-related direct gross value added by European country (2017) (in 1,000 EUR)

[5] The World Input-Output Database (WIOD) was funded by the EU FP7 program. The latest (2016) release "provides time-series of world input-output tables for 43 countries worldwide (incl. EU28) and a model for the rest-of-the-world, covering the period from 2000 to 2014." For more information please refer to Timmer et al (2016).

2.4 Indirect, induced and total effects

A second input-output model run was undertaken to estimate the indirect and induced effects of the business aviation sector. Indirect effects are those employment and GVA impacts which stem from inputs delivered from other sectors to the business aviation industry (so-called "intermediate consumption"). Examples include the supply of metal or composites to the business aircraft manufacturers, or the purchase of fuel or catering by business aircraft operators. This way, Business Aviation activities do not only contribute to the European economy directly, but also indirectly. Hereby, the complete chain of inputs is considered to account for the fact that those industries which supply inputs to the aviation sector will also require inputs from sectors even further upstream.

We have estimated the indirect effects stemming from the Business Aviation sector using the macro-economic modelling approach called Input-Output model (IO model) where economies and their interrelations are summarized in matrix form, allowing for a prediction of the effects changes in activity in one sector have on the other sectors. This approach goes back to the work of Wassily Leontief who developed the so-called Leontief inverse that translates the IO model into multipliers for each unit of direct output (Leontief, 1986). In applying these multipliers, for each country and sector, the whole chain of inputs can be estimated differentiated by country and industry of origin. The basis for our IO estimations are Input-Output tables taken from WIOD (World Input Output database) (Timmer at al, 2016), For Norway and Switzerland, which are not covered by WIOD, we referred to the economic structures of Iceland and Liechtenstein, respectively, as proxies.

To provide a broad picture of the impact of the Business Aviation sector, we report activities of MRO service providers, FBOs and other dedicated handling firms, as well as of business aircraft manufacturers as direct effects, although, strictly speaking, such activities would represent indirect effects of business air transport operations. As a consequence, we had to adjust the indirect effects and resulting totals to avoid double-counting. Again, as Business Aviation is not directly included as a separate sector in the WIOD tables, we refer to the economic structure of the "WIOD-"sectors "Air Transport" (as proxy for business aircraft operators), "Warehousing and support activities for transportation" (for FBO), "Repair and installation of machinery and equipment" (for MRO) and "Manufacture of other Transport Equipment" (for aircraft and parts manufacturers).

Induced effects are defined as the economic activity (e.g. in form of employment or GVA) generated by the consumption of income stemming from the direct and indirect activities. Again using a Leontief model, we estimated the direct and indirect salaries over the Business Aviation value chain as a basis for the assessment of the induced effects of Europe's Business Aviation sector. In this approach, the consumption of direct and indirect Business Aviation employees is split into 56 groups of consumer goods, which are characterized by different multipliers each. The underlying model operates with a number of assumptions: First, consumption depends on total disposable income and not just on actual salaries. It was hence assumed that the share of salaries for persons employed in the Business Aviation value chain is the same as in other sectors. Furthermore, the average propensity to consume of employees in the Business Aviation sector is assumed to be the same as in other sectors.

Tables 3 and 4, respectively, provide an overview of the direct, indirect, induced and total employment and GVA impacts at the aggregated European level.

Table 3. Overview of European Business Aviation-related direct, indirect, induced and total employment effects (2017)

Level	**Unit**	**Aircraft operators**	**FBO/ Handling**	**MRO**	**Operations (total*)**	**Aircraft manufacturers**	**Total***
Direct	Number of jobs	37,233	2,683	11,644	51,560	41,238	**92,798**
Indirect	Number of jobs	100,737	2,749	10,788	114,274	113,337	**227,610**
Induced	Number of jobs	23,048	712	2,714	26,475	27,161	**53,635**
Total	Number of jobs	161,018	6,144	25,147	192,309	181,735	**374,044**

Table 4: Overview of Business Europe-wide aviation-related direct, indirect, induced and total GVA estimates (2017)

Level	Unit	Aircraft operators	FBO/ Handling	MRO	Operations (total*)	Aircraft manufacturers	Total*
Direct	1,000 EUR	3,799,352	253,065	959,917	5,012,333	7,255,663	12,267,997
Indirect	1,000 EUR	6,679,553	185,525	1,375,882	8,240,960	7,429,977	15,670,937
Induced	1,000 EUR	1,536,346	48,054	174,954	1,759,354	2,176,481	3,935,835
Total	1,000 EUR	12,015,251	486,644	2,510,753	15,012,648	16,862,121	31,874,769

In total, some 374,000 European jobs are directly or indirectly dependent on the European Business Aviation sector, a number which exceeds the total number of jobs e.g. in Cyprus.6 The total GVA generated by the sector and induced activities amounts to almost EUR 32 bn, which exceeds the GVA of Latvia and implies a contribution of the sector to the European GDP of about 0.17% (EU only, not counting EFTA GVA and GDP).7 At the employment level, the "Operations" segments are slightly larger than the manufacture of business aircraft and components, while the latter leads in terms of GVA.

Finally, Table 5 summarizes the total employment and GVA effects stemming from the Business Aviation sector at the European country level.

Table 5: Total employment and GVA effects by country (2017)

Country	Region	Operations only		Operations and Manufacture	
		Employment	GVA (1,000 EUR)	Employment	GVA (1,000 EUR)
Austria	EU28	12,411	968,593	12,411	971,828
Belgium	EU28	6,574	532,112	6,642	542,806
Bulgaria	EU28	3,471	58,948	3,471	58,948
Croatia	EU28	520	16,573	520	16,614
Cyprus	EU28	495	18,093	495	18,142
Czech republic	EU28	8,291	305,155	11,100	387,214
Denmark	EU28	4,019	401,833	4,019	409,790
Estonia	EU28	317	7,363	317	7,718
Finland	EU28	1,324	123,355	1,324	124,002
France	EU28	12,655	1,281,148	117,828	10,070,103
Germany	EU28	35,731	2,721,399	60,750	4,497,896
Greece	EU28	3,012	224,154	3,012	224,588
Hungary	EU28	2,935	164,210	2,935	164,210
Iceland	EFTA	353	40,286	353	40,681
Ireland	EU28	1,998	278,120	1,998	278,593

[6] According to Eurostat's Employment by sex, age and economic activity database (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfsa_egan2&lang=en), the number of employees in Cyprus amounted to about 369,800 in 2017.
[7] Please refer to the Eurostat GDP and main components database available here: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_gdp&lang=en.

Italy	EU28	17,752	1,094,288	31,162	1,950,767
Latvia	EU28	588	20,557	588	20,557
Liechtenstein	EFTA	137	12,537	137	12,537
Lithuania	EU28	971	41,780	971	43,488
Luxembourg	EU28	1,780	83,763	1,780	83,763
Malta	EFTA	3,228	153,229	3,228	156,664
Netherlands	EU28	2,025	182,640	2,025	186,253
Norway	EFTA	3,722	436,431	3,722	446,487
Poland	EU28	4,442	145,860	6,700	208,004
Portugal	EU28	6,161	329,401	6,991	360,298
Romania	EU28	1,150	34,015	1,150	34,429
Slovakia	EU28	1,145	56,519	1,145	56,623
Slovenia	EU28	894	42,271	894	42,326
Spain	EFTA	7,014	512,586	7,395	542,838
Sweden	EU28	3,778	392,738	3,778	395,316
Switzerland	EFTA	18,557	2,084,027	34,086	6,006,701
United Kingdom	EU28	24,858	2,248,664	41,115	3,514,586
Total	**EU28+EFTA**	**192,309**	**15,012,648**	**374,044**	**31,874,769**

3. Travel time-related benefits for BA users

Qualitatively, the impacts of business aviation on business efficiency of its users were discussed in a number of studies (e.g., Andersen, 2001, PricewaterhouseCoopers, 2008, or Oxford Economics, 2012). Major factors here are travel time savings and more seamless connections, which stem from the fact that business aviation can provide “à la carte” nonstop connections on city pairs that are not (or only infrequently) served (directly) by scheduled air transport, and higher flexibility. In the following, we present and apply a methodology to quantify these effects for the European Business Aviation sector.

3.1 Data and Methodology

In a data science approach, each trip from a sample of over 800,000 Business Aviation flights reported by WingX for the year 2014 was compared against the best scheduled alternative. The latter were collected from the Application Program Interface (API) of Rome2Rio.com, a multimodal transportation meta search engine providing travel times for scheduled air and ground travel alternative options, including ground transport access and egress modes to and from e.g. airports or train stations. Over the whole sample, cumulative and average time savings were computed and converted into monetary values.

The WingX dataset contains departure date and time, origin and destination, and operating aircraft and flight duration for all 806,817 tracked business aviation flights from, to or within Europe in 2014. According to information from WingX, this selection of flights focuses on instrument flight rules (IFR) fixed-wing activities.[8] According to our classification illustrated in Figure 1, the Business Aviation sector further covers a wide range of flights not included in the WingX sample, like flights under visual flight rules (VFR), including the “self-flying

[8] See https://www.wingx-advance.com/faqs.

entrepreneur", or aerial work and helicopter services. Hence, our approach is likely to underestimate the sector's real effects.

We have designed and applied an algorithm to compare each of the 806,817 private business flights for which data is available against the best (i.e fastest) scheduled alternatives reported by Rome2Rio.com. Each airport in the Business Aviation flight sample is resolved to the nearest major city such that every Business Aviation itinerary is mapped to a journey between two cities. As Rome2Rio.com considers actual flight and ground transport schedules, real departure times and dates of business flights could be compared with the fastest scheduled services operating the same day. The latter may be any means of travel: For farther journeys, they usually contain surface segments (train, taxi, bus, ferry…) from the origin city to the departure airport, any number of flights to a final destination airport, and a surface sector to the final destination city. Additionally, on some shorter journeys, the best scheduled option may be entirely a train or car ride.

We model the total trip time of a Business Aviation itinerary as the sum of (a) the ground access time from the origin city to the Business Aviation airport or airfield, (b) any handling and waiting time at the airport, (c) the flight time itself, and (d) the travel time to the final destination in the destination city. These times were modeled as follows:

- (a) and (d): Surface travel time from the nearest major city to the departure airport/airfield in the actual flight dataset, and from the destination airport/airfield to its nearest major city (Source: Rome2Rio.com);
- (b) Addition of 10 minutes of minimum check-in and waiting time before departure, acknowledging the relatively short ground processes achieved in the Business Aviation sector;
- (c) actual flight time provided by WingX.

For the fastest commercial alternative, we refer to the complete travel times provided by Rome2Rio.com. While, in most cases, flying (incl. airport access and egress) is the fastest scheduled option, Rome2Rio would, in some cases, also return non-flying options like train itineraries. A 35min[9] check-in time was added to accommodate for processing and waiting times at the airports.

The analysis was further based on some additional assumptions and restrictions. First, in the real world, BA passengers would not always choose the fastest scheduled alternative, as it may leave at an inconvenient departure time, or because it may be fully booked or not be on the preferred airline or alliance. Second, as Rome2Rio.com does not provide the days and times of operation for ground transport, we have to assume that all trains, busses or ferries operate on a daily basis and exactly at the required times set by the scheduled flights. Furthermore, this implies that a train or bus would always wait to depart to take a traveler to or from an airport. All this further underlines that the below reported time savings can be regarded as a "conservative" minimum.

3.2 Results

The described approach yields in average BA trip durations of about 145 minutes, which includes 105min in the aircraft, the generic check-in delay assumption of 10min and modeled airport or airfield access and egress times of, on average, about only 15 minutes each (Figure 6). If business aviation was replaced by the fastest scheduled (air) transport alternative, average trip time would rise to 272 minutes, including some 163 min pure flight time. This equals an average travel time saving stemming from business aviation of about 127min.

[9] A check-in deadline of only 35min is, for instance, offered for business class passengers by Austrian Airlines. In the context of our "conservative" approach, we are aware that the check-in deadlines and resulting latest airport arrival times at many airports will exceed this value.

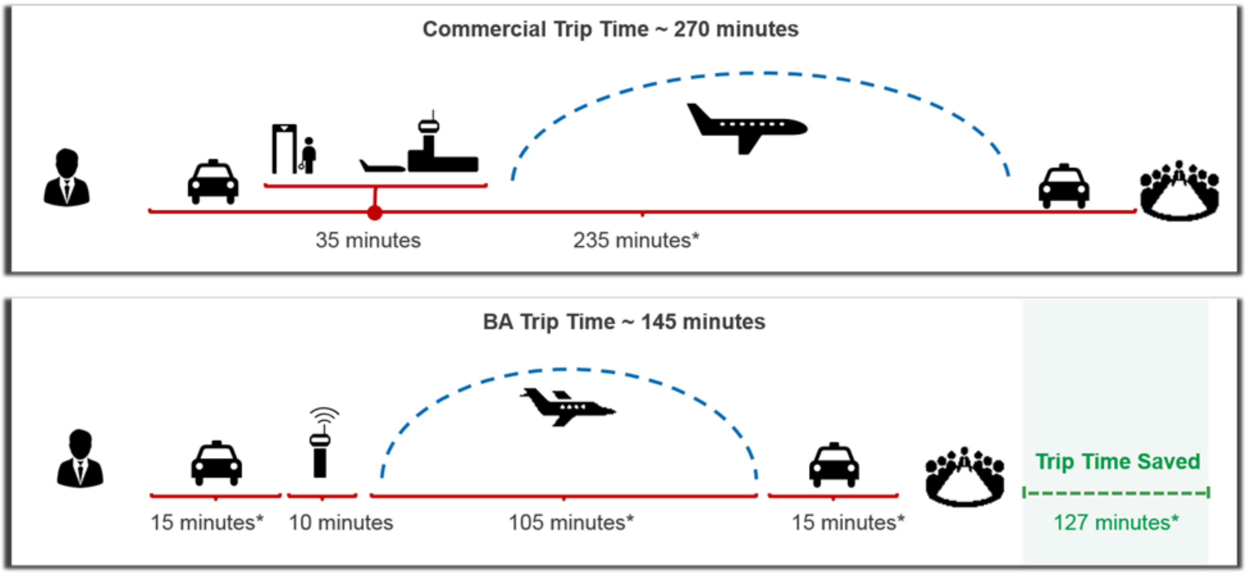

Fig. 6. Travel time advantage of the average Business Aviation trip in Europe

Business Aviation is also capable of offering quicker and more seamless multi-city itineraries, defined as three or more segments of the same aircraft on different routes on the same day, where users visit more than one place in a row. Using scheduled air transport, such trips would often last several days, causing overnight stay costs, as a lack of direct flight connections at the right time made it impossible to reach all destinations on one day. Based on a small sample of 792 multi-city trips conducted by 151 unique business aircraft (identified by their tail numbers), we conduct a similar travel time savings assessment as above.10 Using Eurocontrol arrival and departure data, we identified how long every flight spent on the ground between segments. Again, the Rome2Rio.com API was used to identify the fastest scheduled alternative for each segment of the multi-itinerary trips. Time spent on the ground was added to obtain the total commercial trip time, with the difference between the set of the fastest scheduled alternatives and the business aircraft itinerary giving the time savings for that itinerary. The analysis reveals an average time savings of 393 minutes i.e., 6 hours and 33 minutes. We also looked at the savings in hotel costs stemming from multi-city trips by business aviation. Assuming that the 151 aircraft were drawn randomly out of the total population of about 3,100 active business aircraft in Europe (not including helicopters), we estimate about 16,000 multi-city itineraries for the year 2014. Each business aircraft carrying an average 4.7 passengers, the total number of avoided hotel stays would amount to about 75,000, which translates into total savings of € 15 Mio. p.a. if an average nightly rate of € 200 is assumed.

Finally, we assessed the impact of business aviation on productive work time: According to Harris (2009)11, business travelers are 20% more productive on board of private business aircraft than when in the office, and 40% less productive on scheduled flights. Business Aviation users hence generate 105 minutes × 1.2 = 126 minutes of productive work time per flight and, in addition to this, also save an average of 127 minutes over other scheduled air transport, which may be translated into additional office work time before or after their trip. This adds up to 253 minutes of productive work time per trip for BA users and compares to only 98 minutes (60% of 163 minutes) for scheduled aviation. Hence, for every trip, European Business Aviation will generate, on average, a 251 – 98 = 153-minute (or >150%) productivity advantage over the fastest scheduled transport options. For all 800,000 trips in the

[10] It was assumed that there are always available commercial flights to perform the trips mentioned and therefore, delays between trips that could have been due to lack of availability of the next flight until many hours later are not accounted for. As with the single-trip analysis, the analysis therefore provides a minimum time savings estimate for multi-itinerary trips.
[11] While the Harris (2009) estimates are based on US surveys, we assume them not to be very different in Europe.

WingX data set minus the empty-leg flights and the average 4.7 passengers per flight, this amounts to a productivity effect of 5.7 million additional working hours or 3,100 full time jobs (based on 1,840 working hours p.a.) (Figure 7).

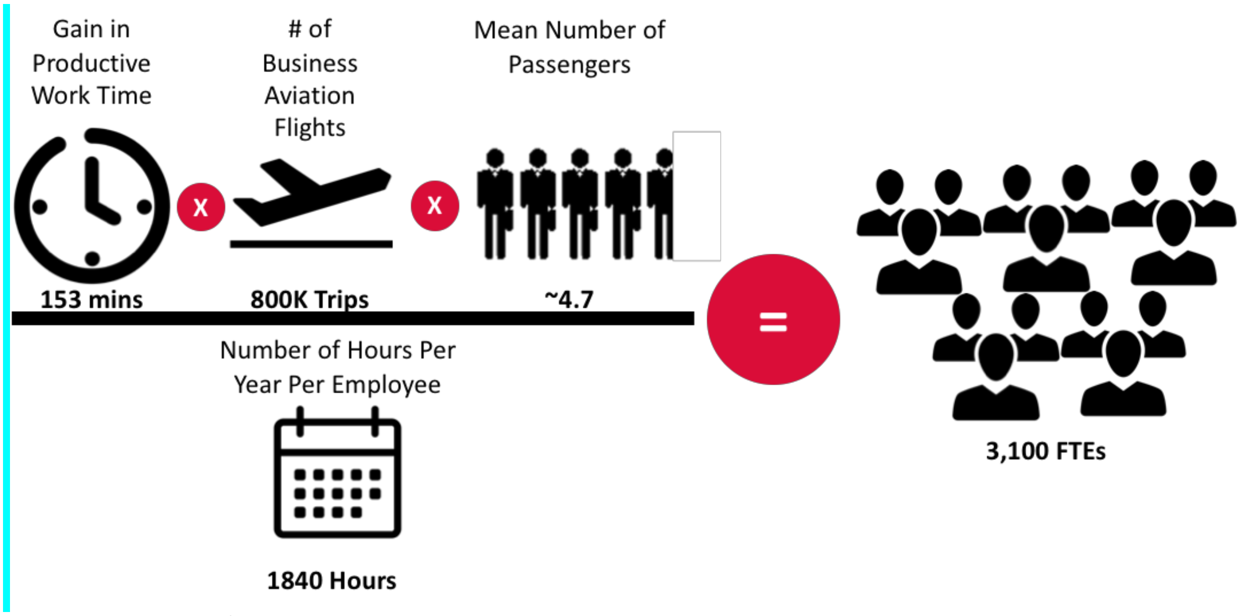

Fig. 7. Productivity gains for Business Aviation users

4. Connectivity impacts

It is obvious that Business Aviation is capable of providing travel time advantages as it provides additional connectivity. In this section, we look at this issue from two different angles:

First, we use the datasets described in the previous section to assess the sector's connectivity contribution from the aggregated European perspective. For this, we identify the shares of the Business Aviation flights operating on city-pairs that are or that are not served (directly) by scheduled air transport.

Second, we assess the travel time savings from regional perspective and consider different economic levels throughout Europe.

The WingX sample of over the 800,000 BA flights in 2014 includes some 81,000 different European city pairs, of which 25,280 city pairs (=31%) are not connected by nonstop scheduled service. Especially for demand on these city-pairs, the value of Business Aviation is evident as it keeps them efficiently (à la carte) connected to the European and global economies.

Another important societal function of Business Aviation, especially for remote regions, is the sector's capability in the fields of air ambulances and medical evacuations. According to EBAA data, 12,000 departures (or 2 % of all Business Aviation departures in 2017) were flown to serve medical evacuations. This enables important services to the society by ensuring that critically ill or injured patients or organs can be transported quickly and safely between medical centres, even to and from the most remote locations. Flexibility and speed are key here, which makes the option that aircraft are available 24/7 and can be dispatched within 1 to 1.5 hour notice invaluable. Business Aviation operators can mobilise specialist medical teams as required, which can include experts in the fields of cardiology, pediatrics, neo-natal and intensive care. Aircraft are typically equipped with the most advanced medical technology and can be adapted to suit the needs of a patient. This includes carrying infant incubators or intensive care equipment.

Interestingly, additional analyses have revealed that business aviation does not only provide additional connectivity for remote regions, but also for large and economically strong metropolitan areas that are already well-connected by scheduled air transport. For the year 2014, Figure 8 shows the factors by which BA has increased the number of destinations served from Paris, Côte d'Azur, London, Berlin, Munich, Stuttgart, Geneva and Zurich regions. These range from 178% (London) to over 700% (Côte d'Azur).

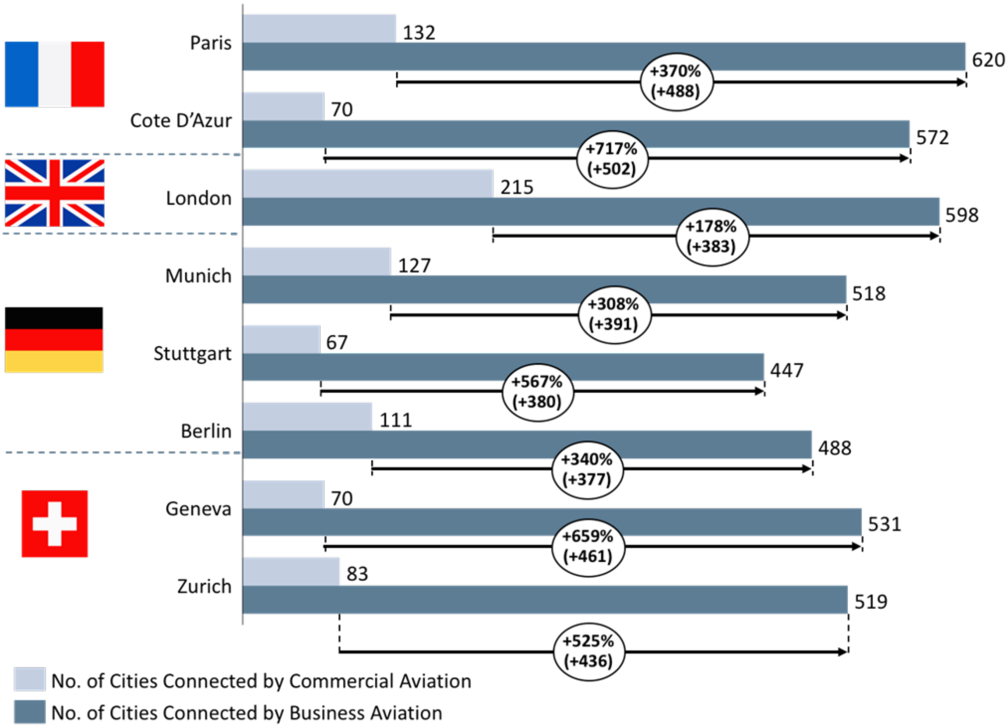

Fig. 8. Regional assessment of BA's impact on connectivity and travel time

Figure 9 shows the average time savings by European country. Time savings are much larger in Eastern Europe and in the continent's periphery in general, illustrating the more limited connectivity of these regions to the global aviation network. Conversely, time savings are much lower in Central and Western Europe, especially Germany and France, as these are much larger global aviation hubs and are well connected.

Fig. 9. Average Business Aviation time savings for Europe. Larger time savings are seen in Eastern Europe and on the continent's periphery in general

5. Summary

This contribution looked at the economic impact of the European Business Aviation sector from different perspectives. It summarizes the main results of two studies conducted by the authors on behalf of the European Business Aviation Association (EBAA) in 2016 and 2018, respectively, and complements earlier findings from e.g. Oxford Economics or PriceWaterhouseCoopers.

After a review of the scarce literature on Business Aviation and a classification of different BA market segments, we first applied the Input-Output methodology to assess the sector's share in the national accounts. Our findings suggest that some 374,000 European jobs are either directly or indirectly dependent on the European Business Aviation industry – a number which exceeds the total number of jobs in Cyprus. The sector and its value chain account for EUR 32 bn in gross value added (GVA), which equals the total GVA of Latvia and represents about 0.19% of the EU GDP. Holding large market shares not only in the operation, maintenance and handling, but also in the manufacture of business aircraft, France, Switzerland, Germany and the UK are the main players in the sector, producing 76% of the total GVA of the industry.

Comparing a 2014 sample of more than 800,000 Business Aviation flights with their best possible (i.e. fastest) scheduled alternatives obtained from the meta-search engine Rome2Rio.com, we further looked at the sector's impact on travel times, productivity and regional connectivity. This assessment revealed that the users of business aviation save an average 127 min per trip compared to scheduled transport options. Furthermore, they could potentially increase their productivity by 153min (or more than 150%) as the travel time savings are complemented by better working conditions in-flight. Additional advantages like higher flexibility regarding departure times are not yet modeled here.

Finally, we used the datasets to get an idea of the connectivity impact of the sector: Here, we found that almost 1/3 of all Business Aviation flights in 2014 happened on city-pairs not directly served by schedules (air) transport. While a big connectivity impact on remote and eastern European regions is maybe not that surprising, we further found that even for some of the economically strongest and – by scheduled air transport – best connected regions in Europe, like e.g. London, Paris or Munich, Business Aviation significantly increases the number of different directly served destinations (by, on average, 450%).

The work described in this paper has some limitations which might partly be tackled in future research. First, the input-output results are limited by the fact that national account data for superordinate sectors have to be applied to the BA sector, which will bias our results. In addition, the "classical" limitations of the input-output methodology of course apply, like the risk of misuse for investment decisions (Malina and Wollersheim, 2009). Hence, the results might be of more value in a political context (where jobs count as political currency) than in the academic world.

The travel time benefits estimated in this paper are likely to be underestimated as we could not (yet) model additional advantages like higher flexibility of Business Aviation when it comes to the clients preferred departure times. In other words: In this approach, we have assumed that the fastest commercial alternative would leave the point of origin at exactly the same time as the BA option. In reality, so-called scheduled delay is likely to occur.

Finally, as a general comment, the user benefits could potentially be modeled in much more detail if there was better knowledge on the actual purposes of BA flights. The preparation of an, e.g., survey-based study could bring more light here.

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