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Analysis of the recent evolution of commercial air traffic CO_2 emissions and fleet utilization in the six largest national markets of the European Union

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A B S T R A C T

This paper presents the results of a study performed to analyze the evolution of commercial air traffic and CO_2 emissions in the European Union, from 2010 to 2013. Data sources are the European Commission's Eurostat Air Transport Statistics (Eurostat) and EUROCONTROL flight plans database. The changes in the fuel efficiency are analyzed and the potential reasons for those changes investigated. The evolution in the airline fleet composition during the last decade is presented as one of the reasons for the improvement in fuel efficiency, measured in burnt fuel per total Revenue Tonne Kilometre (RTK), as well as the different parameters depending on the airline business model (network carriers, low cost companies, etc.) and the aircraft type.

Results show a slight reduction in the traffic, both for passengers and cargo (about −0.8%), and a more important reduction in CO_2 emissions (−4.3%), thanks to an improvement in the fuel efficiency parameter (−3.5%) for the three years period. There has been a relevant change in the fleet composition in the last ten years, with the replacement of older models for more efficient ones, and a shift to larger aircraft, particularly in the regional segment. Traffic has decreased in shorter distances (internal EU traffic), but increased in more efficient long range flights (extra-EU traffic), resulting also in an improvement of the efficiency parameter as average aircraft size and stage length increases.

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1. Introduction

The high growth of air transport has been accompanied by an increase in the fuel consumption and therefore CO_2 emissions growth in the last decade, despite of the improvements in the industry efficiency (Lee, 2010). Although the contribution of aviation to climate change is small in relative terms, about 3% of global fossil fuel consumption and 12% of transport-related CO_2 emissions, it is growing faster than other sources of emissions (Simone et al., 2013; Anger, 2010; Mayora, 2010; Macintosh and Wallace, 2009). The vast majority of these emissions come from international flights. By 2020, global international aviation emissions are projected to be around 70% higher than in 2005, which is the reference year for the baseline of the European Union (EU) Emissions Trading System (actual figure was the average of the yearly emissions during the 2004–2006, (Benito et al., 2010)), even if total system fuel efficiency improves by 2% per year. ICAO (2013a) forecasts that by 2050 emissions could grow up by a further 300–700%. The rapid growth in aviation emissions contrasts with the success of many other sectors of the economy in reducing emissions and it is unlikely that the ICAO goal of reaching a Carbon Neutral Growth (no CO_2 emissions increase from the sector) by 2020 could be achieved using exclusively technological measures (Chèze et al., 2013).

These concerns about the future growth of CO_2 emissions by air transport industry led to calls for additional market measures to restrict demand and encourage innovation in international aviation. A discussion of the pros and cons of the different measures can be found in Benito (2007). In this sense, the European Commission (2008) adopted Directive 2008/101/EC, to include aviation in the EU-ETS from the beginning of 2012 and have in study additional actions for the future (European Commission, 2011).

The first international action to put limits to greenhouse gas emissions was adopted in December 1997 when the Conference of the Parties (COP) approved the Kyoto Protocol, imposing

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mandatory target reduction to the emissions from developed countries. There was no agreement on the allocation of international civil flights emissions and ICAO received the responsibility of controlling them at world level. The analysis carried out by ICAO showed that technical measures were insufficient for the task, without a drastic cutting of air transport growth, and Market Based Measures (MBM) were needed. After a failed intent of launching a worldwide ETS in 2007, ICAO has initiated a dual process: on one side, a new requirement for certifying CO_2 emissions from new civil aircraft type should be approved in the 2016 General Assembly together with an additional requirement for models already in production. In the same meeting, Resolution A38-18 contains the approval of a Market based Measure (MBM) system, designed to offset emissions exceeding the 2020 level, is expected, starting by 2021 (ICAO, 2013b). At the same time States carrying at least 1% of international air transport RTKs are required to present to ICAO Action Plans for reducing civil aviation CO_2 not later than June 2015 (ICAO, 2011).

Fuel has been and still is a major component of airlines cost structure, rising up to 36% of the airlines total expenses in 2008. Even after the recent drastic fall down in oil price, the fuel is forecasted to be 21% of total expenses in 2016, as it is shown in Table 1 (IATA, 2015). Due to the rising price of oil and, in the 2006–2014 period, environmental concerns and legislations, fuel efficiency maximization has been always one of the main targets of the industry. The continuous introduction of new and more efficient airplane types such as the B787 and the A350 are the result of these improvements (Peeters, 2013). Including air transport industry in EU-ETS along with the increasing demand of air travel have motivated research and investment into sustainable fuel alternatives, more efficient airplanes and green technologies, and improvements in air traffic management (Gegg, 2014; Krammer et al., 2013; Gudmundsson and Anger, 2012). An interesting aspect is the impact of aircraft size and airlines strategies in the CO_2 emissions (Miyoshi and Mason, 2009). Some authors (Morrell, 2009; Givoni and Rietveld, 2010) have found that the utilization of larger aircraft might result in the reduction of the emissions.

This paper presents the results of a study performed to analyze the evolution of air traffic, CO_2 emissions and fuel efficiency in the European Union, from 2010 to 2013, continuing the work published in Alonso et al. (2014) that extrapolates possible scenarios of traffic and emissions in the EU, taken the 2010 year as starting point. Year 2010 was already characterized in that work, and represents an important reference in the modern evolution of air traffic in Europe: it was the first year of the recovery in airlines results after the 2008 crisis, and it was also the benchmarking year for the allocation of free allowances to aircraft operators according to the civil aviation EU-ETS. On the other hand, 2013 is the first year of growth (in yearly basis) in airlines results, after the decay in 2011 and 2012. The period 2010–2013 covers the second part of the economic crisis initiated in 2008, a complicated business environment for airlines in Europe, with rising fuel costs and a weakening demand. The objective of this paper is to analyze how the main air traffic indicators evolved during that period, reflecting how airlines adapted to the harsh environment, and resulting in the evolution of the fuel efficiency parameter. The results may serve as a base for developing new potential scenarios and give an orientation on how changes in relevant parameters affect airline behavior and civil aviation emissions in the EU and some of its larger Member States.

In the first section of the paper the structure of air traffic evolution is investigated, both for passenger and cargo traffic, comparing the main indicators in 2013 with respect to their values in 2010. The evolution of traffic in the six largest European markets is compared, as well as the distribution of traffic in terms of flights distances and aircraft types. The second part of the paper analyzes the evolution of CO_2 emissions for the same period, and from the same perspective: comparison of the evolution per country, per distance band, and per aircraft type. Then, an efficiency parameter is defined, in terms of kg CO_2/RTK, and its evolution analyzed, trying to identify the potential reasons for the changes, particularly the fleet evolution along the last ten years, an expanded period (compared to the 2010–2013 reference period for the evolution of traffic, emissions and efficiency) because the effects of the changes in airlines' fleets usually take time to materialize.

2. Traffic evolution

Air transport data for all flights from EU and associated Member States airports have been collected from the European Commission's Eurostat Air Transport Statistics (Eurostat, 2013). The following information is extracted directly, for each airport pair: total commercial passenger flights, total passengers on board and total passenger seats available for passenger transport; all-freight and mail total commercial air flights and total freight and mail on board in tons for freight and mail air transport. The following parameters are derived: number of RPKs (revenue passenger kilometers) and ASKs (available seat kilometers) for passenger transport; number of FRTKs (freight revenue ton kilometers) for freight and mail transport and total RTKs for both passenger and cargo. Finally, data were segmented by country and per distance bands, at intervals of 500 km, which is the EU scale for classifying the activities of the different transportation modes. See Alonso et al. (2014) for a detailed description of the methodology.

From the study performed about traffic and emissions in 2010 (Alonso et al., 2014), the concentration of traffic in the EU was apparent: the 6 largest countries in terms of traffic (France, Germany, Italy, The Netherlands, Spain, United Kingdom) represented 79.7% of the total RTKs in 2010 for passenger traffic and 82.3% for cargo traffic. Therefore, in the present study about the evolution of 2013 air traffic, preferential attention is given to these six largest markets as a good representation of the traffic evolution in the whole EU.

The results showing the evolution of passenger traffic are shown in Table 2, where the main figures in 2013 are given and compared to the 2010 corresponding ones: number of flights, passengers, RPKs, Load Factor and the average number of passengers per flight. Analyzing those results, it can be seen that the UK remains the largest market by far in terms of RPKs, representing 29% of the total for the six countries, followed by Germany (21%), France (19%) and Spain (15%). With the exception of Italy and The Netherlands, both the number of flights and the number of passengers grew in all countries, resulting in an overall increase in the number of flights

Table 1
Evolution of the fuel expenses of airlines (IATA, 2015).

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015(f)	2016(f)
Brent (USD/b)	65.1	73.0	99.0	62.0	79.4	111.2	111.8	108.8	101.4	55.0	51.0
Fuel expenses (BUSD)	127	146	205	135	152	192	227	228	226	180	135
% of expenses	28	30	36	28	28	31	33	33	32	27	21

(f) forecast; USD/b US Dollars per oil barrel; BUSD billions of US Dollars.

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