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Assessing the fuel burn and CO_2 impacts of the introduction of next generation aircraft: A study of a major European low-cost carrier

Thomas Budd *, Pere Suau-Sanchez

Centre for Air Transport Management, Cranfield University, MK43 0TR, United Kingdom

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ABSTRACT

The introduction of more fuel-efficient 'next generation' aircraft has the potential to yield benefits for fuel burn and CO_2 emissions over current generation aircraft. This has important implications in terms of airline fuel costs and competition, but also for compliance with future environmental legislation and market based incentive schemes. In Europe, major low-cost carriers such Ryanair, easyJet, and Norwegian Air Shuttle have been active in updating their fleet, and they now operate some of the youngest fleets in the industry. Subsequently, the paper assesses the possible fuel burn and CO_2 impacts of the introduction of next generation aircraft by employing OAG data and EUROCONTROL's 'Small Emitters Tool' to determine the annual fuel burn and CO_2 emissions for easyJet, a major European low-cost carrier. Estimations were then made regarding the potential impacts on fuel burn and CO_2 emissions from the introduction of the airline's next generation of aircraft under three fleet plan scenarios. Analysis indicates that while new aircraft may allow airlines to increase the capacity in their network with only a marginal increase in overall fuel burn and CO_2 emissions, this is unlikely to lead to substantial overall reductions in total fuel burn and emissions, at least in the short term.

1. Introduction

The environmental impacts of air travel are well known, and the role of low-cost air travel in particular has come under public and political scrutiny in recent times (Lee et al., 2009). While the growth of low-cost air travel in many regions of the world has yielded considerable economic and social benefits, this has come at the price of increased levels of emissions from aircraft and population exposure to noise. As Nilsson (2009, p126) concludes, "*from a global, environmental perspective the development of low-cost aviation is nothing less than disastrous.*" Thus there remains considerable debate regarding the seemingly incompatible nature of environmental sustainability on the one hand, and the low-cost business model and growth in air travel on the other hand (see Graham & Shaw, 2008). As well as stimulating increased demand, low-cost operations have traditionally been seen as particularly environmentally damaging due to their short-haul nature. During a flight proportionally more fuel is burnt during the take-off and ascent phase than when the aircraft is at its cruising altitude (Doganis, 2009).

In Europe, low-cost carriers now operate some of the youngest fleets of aircraft in the industry[1] and have been quick to embrace new aircraft technologies, since the economics of new aircraft generations contribute to keep costs down and achieve better density economies (Tembleque-Vilalta & Suau-Sanchez, 2015; Bowen, 2010).[2] This has potentially important implications in terms of fuel burn and emissions, as well as compliance with environmental regulation such as the EU-ETS.

The following section addresses the changing nature of the low-cost business model in more detail. This is followed by a discussion of the regulatory and policy implications in the context of increased environmental legislation and market based incentive measures. This section is in turn followed by an outline of the research methodology and choice of study airline, before the results of the analysis are presented. In light of these findings, a discussion is provided at the end of the paper along with an outline of the various management implications that arise from the analysis.

1.1. The nature of the low-cost business model: focus on reducing costs

A growing body of research attests to the changing nature of the low-cost business model, low-cost business practices, and their networks (for example, see Mason & Morrison, 2009; Klophaus, Conrady,

* Corresponding author.
E-mail address: t.m.budd@cranfield.ac.uk (T. Budd).

[1] This has not always been true. As highlighted by Chapman (2007), 10 to 15 years ago these LCC fleets were commonly dominated by older, less fuel efficient aircraft.

[2] Density economies are considered unequivocal in the airline industry (Caves, Christensen, & Tretheway, 1984). Density economies imply the decrease in the average costs from increasing traffic at the route level. This usually comes from using bigger aircraft (that are more cost efficient) at higher load factors. Density economies can also be achieved by improving aircraft technology.

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Table 1
Average fleet age comparison between major European low-cost carriers and full-service network carriers.

	Airline	Scheduled passengers 2014 (thousands)[a]	Fleet size[b]	Average fleet age (years)[b]
Low-cost carriers	Ryanair	86,370	328	5.5
	easyJet	62,309	241	6.2
	Air Berlin	29,911	132	7.6
	Norwegian Air Shuttle[c]	24,260	64	3.6
	Vueling[c]	20,703	102	6.7
Full-service network carriers	Lufthansa	59,850	264	11.2
	Turkish Airlines	53,384	267	6.6
	Air France	45,406	225	11.7
	British Airways	41,164	266	12.7
	KLM	27,740	115	11.1

[a] Source: IATA, 2015
[b] Correct as of February 2016, source: company websites.
[c] Air Berlin, Norwegian Air Shuttle and Vueling are often considered as representing a 'hybrid' business model as opposed to a 'pure' low-cost one. However, they are included here as they exhibit greater similarity to low-cost carriers in a number of key business areas (see Klophaus et al., 2012 and Fageda et al., 2015).

& Ficher, 2012; Dobruszkes, 2013; Daft & Albers, 2015, and Fageda, Suau-Sanchez, & Mason, 2015). One important aspect of this includes the increasing focus on reducing operating costs and, therefore, the adoption of newer, more fuel-efficient aircraft and the replacement of older, more polluting aircraft.

Table 1 shows a comparison of the average fleet age of the five largest European low-cost carriers with the five largest European full-service network carriers (in terms of scheduled passengers handled). With the exception of Turkish Airlines, it can be seen that the average fleet age of the low-cost carriers is significantly younger than their full-service network counterparts.[3] As of 2016, Ryanair, the largest low-cost carrier in Europe, operate a fleet of 328 latest generation B737–800 aircraft, with an average fleet age of 6.7 years. The airline has a further 183 of these aircraft on order up to 2020, and has options for purchasing 100 further next generation B737 MAX 200 aircraft (Ryanair, 2016). The aircraft manufacturer claims that the reduced weight of the new airframe, the improved aerodynamics and new engine design will result in an 8% fuel saving in comparison with similar narrow body aircraft (Boeing, 2016). Improved aerodynamic efficiency in particular is one area where fuel savings can be made. For example, it is estimated by the manufacturer that the new 737 MAX AT winglets, fitted at the end of the aircraft's wing to reduce drag, will reduce fuel consumption by 1.8% compared with winglets fitted to the current breed of aircraft (Boeing, 2016).

Similarly, Europe's second largest low-cost carrier, easyJet, operates a relatively young fleet of Airbus A319 and A320 aircraft with an average age of 6.2 years. The airline has 130 new A320neo (new engine option) aircraft on order and 56 'normal' A320 aircraft (also called A320ceo, or 'current engine option'). These are due for delivery between 2017 and 2022 (easyJet, 2015). The aircraft manufacturer claims that the new aircraft will be 13% to 15% more fuel-efficient than the previous generation of aircraft (Airbus, 2016).

The improved range and fuel efficiency of some new narrow body aircraft, such as the B787 Dreamliner, are also making long haul operations economically feasible for low-cost carriers (De Poret, O'Connell, & Warnock-Smith, 2015). Traditionally, low-cost operators have found it difficult to sustain profitable long-haul operations as the key aspects of their low-cost model, i.e. a 'no-frills' service, single class seating, no cargo, and high aircraft utilization, were generally ill suited to long-haul services (Francis, Dennis, Ison, & Humphreys, 2007; Morrell, 2009). Currently, both Air Berlin and Norwegian Air Shuttle serve long-haul transatlantic routes between Europe and North America using new Airbus A330–200 and Boeing 787 Dreamliner aircraft, respectively.

1.2. Environmental and regulatory implications

In addition to opening up new low-cost markets, the introduction of next generation aircraft may have important implications in terms of emissions and fuel burn. In 2015 the International Council on Clean Transportation published a report detailing the fuel efficiency of the top 20 airlines operating non-stop transatlantic passenger services between the US, Canada and Europe (ICCT, 2015). Using data relating to each carrier's top transatlantic city pair (in terms available seat kilometres), fuel efficiency was calculated for each carrier in terms of passenger kilometres per litre of fuel burn. The two airlines with the highest fuel efficiency were found to be Norwegian Air Shuttle (40 pax km/l) and AirBerlin (35 pax km/l). In contrast, the least fuel-efficient airlines were found to be Lufthansa (28 pax-km/l), SAS (28 pax km/l) and British Airways (27 pax km/l). While high fuel efficiency for Norwegian Air Shuttle was largely attributed to its young fleet, in the case of Air Berlin the high seat density and low levels of premium business class seating were also major contributing factors. Environmental efficiency advantages should also be felt for low-cost carriers operating short and medium haul routes.

This may have important implications for airlines not just in terms of fuel cost savings, but also in terms of future compliance with environmental regulation or market-based measures. For example, the International Civil Aviation Organisation (ICAO) already enforces stringent certification standards for aircraft in relation to noise before aircraft are allowed to operate. In February 2016, ICAO's Committee on Environmental Protection (CAEP) also established for the first time a standard for aircraft CO_2 emissions (ICAO, 2016). Under the recommendations, the CO_2 emissions standard would apply to new aircraft designs as of 2020, as well as deliveries of current in-production aircraft models by 2023. CAEP has also recommended that production aircraft that do not meet the new standards should be phased out by 2028.

While aviation is unusual in that the fuel used for international air travel is exempt from taxation, and only a small number of countries impose taxes on fuel for domestic use, various frameworks are in place for incentivizing emissions reductions for airlines. Most notably, in 2012 it was decided by the European Parliament that aviation would join the European Union Emissions Trading Scheme (EU-ETS) as part of the second phase of the programme (European Commission, 2013). Under the scheme, airlines would be free to buy and sell carbon 'permits' between operators depending on whether they were operating an emissions surplus or shortfall. While there remains a delay for full ratification of the EU-ETS for flights outside of the EU, the commencement of the full EU-ETS in the future remains a distinct possibility.[4] In this case airlines with lower emissions profiles will likely be at a significant advantage to their competitors.

The paper seeks to build on existing literature concerning aviation and the environment and the changing nature of the low-cost business model by quantifying the annual fuel burn and CO_2 emissions of easyJet, a major European low-cost carrier, and following this assessing the potential fuel and CO_2 impacts of the introduction of their new 'next generation' aircraft. The following section describes the method employed and the choice of study airline.

[3] Note that the younger average fleet age of Turkish Airlines is linked to the transformations and significant network growth undertaken by the airline. See, for example, Dursun, O'Connell, Lei, & Warnock-Smith, 2014.

[4] Besides the EU-ETS, some European governments have proactively imposed taxes on aviation emissions. For example, since May 2016, the Government of Catalonia enforces a tax on NOx emissions for commercial aviation (Act 12/2014).

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