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# Has airline efficiency affected by the inclusion of aviation into European Union Emission Trading Scheme? Evidences from 22 airlines during 2008–2012

Ye Li [a], Yan-zhang Wang [a], Qiang Cui [b, *]

[a] Faculty of Management and Economics, Dalian University of Technology, No. 2 Linggong Road, Dalian City, 116024, China
[b] Transportation Management College, Dalian Maritime University, No. 1 Linghai Road, Dalian City, 116026, China

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ABSTRACT

We investigate the impacts of including aviation into European Union Emission Trading Scheme on airline efficiency since 2008. Airline efficiency is divided into three stages: Operations Stage, Services Stage and Sales Stage, and Greenhouse Gases Emission is treated as an undesirable output of Services Stage. Two models, Network Slacks-Based Measure with weak disposability and Network Slacks-Based Measure with strong disposability, are established to evaluate the efficiencies of 22 international airlines from 2008 to 2012. The results show that: (1) Most airlines' efficiencies have increased in the period. (2) The average efficiency of European airlines is much higher than that of non-European airlines. (3) The model with weak disposability is more reasonable in distinguishing the airline efficiency while strong disposability is a more reasonable way in treating undesirable outputs.



## 1. Introduction

Airlines are an important part of transportation system and have a huge impact on the development of modern society. On the other hand, the development of airlines suffers a lot from the overall economic situation. Since 2008, global airline industry has been greatly influenced by the weak global economy and the changing oil price. The changing situation of profit, revenue, Revenue Passenger Kilometers and Flight Tonne Kilometers can be shown in Fig. 1. The data comes from the annual reviews of International Air Transport Association [1].

As shown in Fig. 1, in 2008, global airlines were hit by an unprecedented spike in oil price and by a precipitous drop in revenues. The revenue drop was caused by the collapse in world trade. The Freight Tonne Kilometers and Revenue Passenger Kilometers of 2008 had collapsed 22% and 4.6% below 2007, respectively. In 2009, airlines lost $4.6 billion, the Revenue Passenger Kilometers fell by 2.1% and Freight Tonne Kilometers dropped by 9.8%. Industry revenues fell by 15%to $479 billion. However, in 2010, airlines made $19.2 billion in profits and recovered to $554 billion in revenues in 2010. The Revenue Passenger Kilometers improved 6.1%. In 2011, the Revenue Passenger Kilometers flown grew 5.9% to a new high of 5.2 trillion. However, despite the passenger demand increased, airlines struggled to make profits. The profits of global airlines in 2011 fell by almost half compared with 2010, to $8.8 billion. In 2012, the profits of global airlines continued to fall to $7.6 billion while the Revenue Passenger Kilometers had increased by 5.3%.

The increasing Revenue Passenger Kilometers and the fluctuant profit indicate that airline efficiency is important to airline development. In a worse case, European Union enacted the 2008/101/EC decree in November 2008, in which international airline business was brought into the carbon emission trading system. From January 1st, 2012, each international flight taking-off and landing in European Union (EU) will be given an emission permit (see details in Anger and Köhler [2]). This policy caused great controversy all over the world. In the face of the great diplomatic pressure, EU suspended the emission taxes of non-EU airlines and continued to levy taxes on the EU airlines. On March 4th, 2014, EU formally decided to exempt the carbon emission taxes of non-EU airlines.

Despite all these, this policy reflects the significance of aviation emissions to a great degree. According the annual review of International Air Transport Association [1], air transport is responsible for 2% of man-made carbon emissions annually. But the industry recognizes that it must work ever harder on behalf of the

* Corresponding author. Tel.: +86 411 84728486; fax: +86 411 84726939.
*E-mail address:* cuiqiang1011@163.com (Q. Cui).

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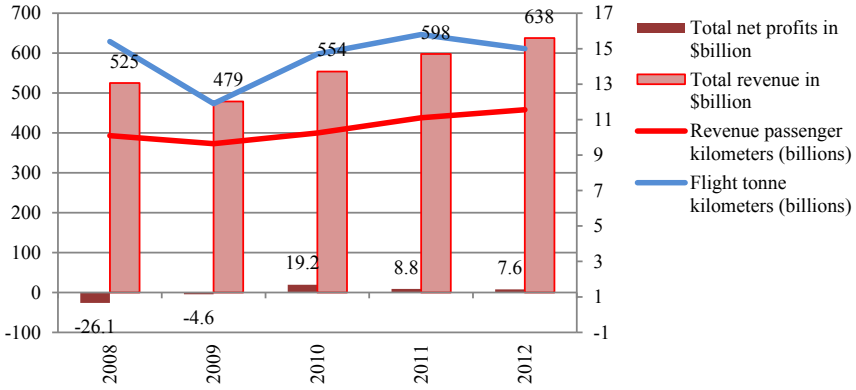


**Fig. 1.** Changing situation in 2008–2012.

environment to achieve long-term sustainability, which will give the industry a license to grow. There are many ways to control or decline the carbon emissions, in which efficiency improvement is an important part (Anger and Köhler [2]; Mendes and Santos [3]). In that way, it is meaningful to measure the airline efficiency roundly since European Union announced the policy, especially during the period of 2008–2012, the grace period defined by EU. Cui and Li [4,5] have focused the energy efficiency and safety efficiency of airlines in this period, respectively. However, these two kinds of efficiencies can evaluate airline efficiency from a certain point of view but have not considered the network structure of airline efficiency, which will be introduced in the following parts. Hence, has the airline efficiency affected by the EU aviation emission policy? How to measure airline efficiency more comprehensively? Aiming at these problems, we focus on analyzing the impacts of the EU ETS on airline efficiency.

The remainder of this paper is organized as: Section 2 is literature summary; Section 3 proposes the method. Section 4 is the case study. Section 5 summarizes the conclusions.

## 2. Literature summary

### 2.1. The impacts of EU ETS

In this part, we will summarize the literature on analyzing the impacts of the inclusion of aviation in the European Union Emissions Trading Scheme (EU ETS).

In the realm of aviation energy consumption and emission, Zhang et al. [6] found that the proportion of airway to total transportation energy consumption of China was from 1.4% in 1980 to 4.3% in 2009, and its energy efficiency changed from 0.382 in 1980 to 1.207 in 2009. Motasemi et al. [7] analyzed Canada's energy, exergy and emission performance for four different modes of transport (road, air, rail, and marine) from the year 1990–2035, and got that aviation gasoline would have a significant drop while the consumption of aviation turbo fuel would increase.

In the realm of how to allocate the emission permits, Morrell [8] focused on the allocation of emission permits in the EU context, three UK airlines were selected to evaluate three main types of allocation: grandfathering, auctioning and benchmarking. Kopsch [9] clarified some important design points of the forthcoming emissions trading scheme for aviation under the EU ETS and found that initial allocations of emission permits and the trade barrier between the aviation sector and EU ETS needed to be carefully examined.

In the realm of analyzing the impacts, Ernst & Young [10] claimed that the proposal from the European Commission (EC) would jeopardize the long term viability of the European aviation sector if non-European airlines were only subjected to $CO_2$ emissions limits when their flights entered the EU. Albers et al. [11] simulated the cost and demand implications for some airlines based on the proposal of including the aviation sector into the European Emission Trading Scheme. Anger [12]discussed the possible impacts of including aviation into the EU emission trading scheme on the aviation industry and found that air transport $CO_2$ emissions were expected to decrease by up to 7.4%. Anger and Köhler [2] summarized the possible environmental and economic impacts in the studies reviewed for the year 2020 and thought that the effects were small. Scheelhaase et al. [13] presented the model to analyze the impact of including aviation into the EU ETS on the competition between European and non-European network airlines. Zhang and Wei [14] reviewed the research on the impacts of EU ETS on different industries including aviation sector. Vespermann and Wald [15] analyzed the economic and ecological impacts that were caused by an inclusion of the aviation industry into the proposed ETS, and found that the financial burden on the aviation industry would be rather modest in the first years and therefore induced only low competition distortions. Ares [16] analyzed the impact of EU ETS on the development of airline industry from the aspects of ticket price, emission reduction and subsidies acquisition, etc. Buhr [17] examined the temporal conditions for institutional entrepreneurship and did an empirical case study of how aviation was targeted for its climate change impact by inclusion in the EU ETS. Malina et al. [18] estimated the economic impacts on US airlines that may arise from the inclusion of aviation in the EU ETS from 2012 to 2020, and concluded that the Scheme would only have a small impact on US airlines and emissions. Tsai et al. [19] presented a mixed activity-based costing decision model for green airline fleet planning under the constraints of the EU ETS, and found that the cost trends of carbon emissions and the changes in profits of different flight routes appeared to be similar. Derigs and Illing [20] analyzed the profit situation and the emission reduction prospect after aviation was included in the EU ETS.

The above analyses indicate that many scholars have undertaken substantial initiatives to do qualitative and quantitative study on the impacts of including aviation into EU ETS. However, it is unfortunate that little research has focused on its impacts on airline efficiency.

### 2.2. Evaluation of airline efficiency

In recent years, many papers have focused on the efficiency measures of airlines, such as operating efficiency represented by Barbot et al. [21] and Mallikarjun [22], energy efficiency or fuel