Transportation Research Part D 50 (2017) 234–253

Contents lists available at ScienceDirect

Transportation Research Part D

journal homepage: www.elsevier.com/locate/trd

The impact of aviation fuel tax on fuel consumption and carbon emissions: The case of the US airline industry

Hideki Fukui [a,*], Chikage Miyoshi [b]

[a] Policy Research Office, Aviation Strategy Division, Civil Aviation Bureau, Ministry of Land, Infrastructure, Transport, and Tourism, 2-1-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8918, Japan

[b] Centre for Air Transport Management, School of Aerospace, Transport, and Manufacturing, Cranfield University, Martell House, Bedford MK43 0TR, United Kingdom

ARTICLE INFO

Article history:

JEL classification:
H23
R11
R48

Keywords:
Fuel tax
Fuel consumption
CO_2 emissions
US airline industry

ABSTRACT

We examine the effect of an increase in aviation fuel tax on reductions in fuel consumption and carbon emissions using data from the US airline industry. The results of simultaneous quantile regression using an unbalanced annual panel of US carriers from 1995 to 2013 suggest that the short-run price elasticities of jet fuel consumption, which are negative and statistically significant for all quantiles, vary from −0.350 to −0.166. The long-run price elasticities show a similar pattern and vary from −0.346 to −0.166, though they are statistically significant only for the 0.1, 0.2, 0.3, and 0.5 quantiles. The results suggest that the amount of the reduction of fuel consumption and CO_2 emissions would be smaller in the longer term. Our calculation, using values from 2012, suggests that an increase in aviation fuel tax of 4.3 cents, which was the highest increase in aviation fuel tax in the US during the analysis period, would reduce CO_2 emissions in the US by approximately 0.14–0.18% in the short run (1 year after the tax increase). However, perhaps due to the rebound effect, the percentage reduction in CO_2 emissions would decrease to about 0.008–0.01% in the long run (3 years after the tax increase).

1. Background

The aviation sector's contribution to global greenhouse gas (GHG) emissions has been relatively small, with a 2010 share of approximately 2.02% of total CO_2 emissions worldwide (calculation based on European Union Global Emissions EDGAR v4.2 FT2010). According to our calculation based on the 2012 data of the US Environmental Protection Agency (EPA), US carriers' domestic flights account for about 2.3% of CO_2 emissions in the US. Even if we include international flights, US carriers accounted for only about 3.5% of CO_2 emissions in the US in the same year.

However, despite advances in technology, which have improved the fuel efficiency of aircraft significantly over the past 20 years, the amount and proportion of CO_2 emissions from the aviation sector have been increasing steadily in the US. The solid line in Fig. 1 shows that the fuel consumption per mile flown by US carriers dropped from approximately 3.7 gallons in January 1990 to around 2.3 gallons in December 2013, which suggests a remarkable improvement in fuel efficiency. Although more frequent flights with smaller aircraft may have contributed to increased fuel consumption per mile flown,

* Corresponding author.
E-mail addresses: fukui-h2fs@mlit.go.jp, fukui.hideki.mb@gmail.com (H. Fukui), c.miyoshi@cranfield.ac.uk (C. Miyoshi).

http://dx.doi.org/10.1016/j.trd.2016.10.015
1361-9209/

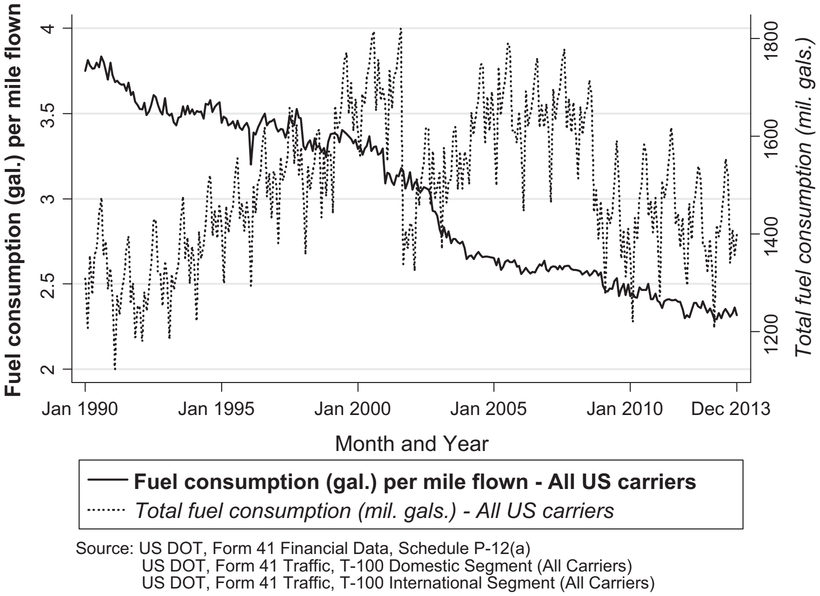

Fig. 1. Fuel consumption per mile flown by US carriers.

increased average stage lengths may have contributed to lower fuel consumption per mile flown. On the other hand, the dotted line in Fig. 1 suggests that the total fuel consumption by US carriers has not decreased as dramatically as the fuel consumption per mile flown. This may be because the significant growth in air transport demand in the US, which is shown in Fig. 2, has outpaced the fuel efficiency gains. As shown in Fig. 3, the annual total CO_2 emissions in the US have decreased since 2007, and those in 2012 (5024.7 $MMTCO_2$) were virtually at the same level of 1995 (5041.2 $MMTCO_2$). In contrast, as Fig. 4 shows, the annual CO_2 emissions from commercial flights by US carriers have increased steadily for the past 20 years, and those in 2012 (174.7 $MMTCO_2$) reached around 9.5% above the 1995 level (159.6 $MMTCO_2$). Again, this is mainly due to the ever-growing demand for international air travel, which has resulted in significant increases in fuel consumption, offsetting fuel efficiency improvements. Consequently, the proportion of CO_2 emissions from the aviation sector in the US has been rising steadily, as depicted by the bold solid line in Fig. 4. The amount of CO_2 emissions from the aviation sector remains small compared to the total amount of CO_2 emissions (approximately 3.5% of total emissions in 2012). However, in light of the strong demand for international air travel and the expected increase in demand, CO_2 emissions from the aviation sector are likely to increase rapidly without concerted efforts by policymakers and the industry to reduce emissions (see Mayor and Tol, 2010; Owen et al., 2010; Preston et al., 2012).

For the past decade, the International Civil Aviation Organization (ICAO) and its member states have been working with the aviation industry to address CO_2 emissions from international aviation by developing a global scheme for this sector. However, the aviation sector has not yet been fully subject to any greenhouse gas (GHG) regulations, perhaps only except for those of the European Union (EU). The EU launched its Emissions Trading System (EU ETS) in 2005. Since the beginning of 2012, the system has covered the CO_2 emissions produced by aviation activity, including all flights within the EU and between countries participating in the EU ETS (European Commission (EC), 2006; EC, 2009). Later, in 2013, EC directives regarding the EU ETS were amended to include aviation activities within the scheme for GHG emission allowance trading by 2020, although the scheme only covers activities within the EU (EU, 2014). In 2016, the ICAO decided to develop and implement a global market-based measure (GMBM) scheme in the form of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to address any annual increase in total CO_2 emissions from international civil aviation above the 2020 levels (Resolution A39-3). According to the ICAO, "As of 12 October 2016, 66 States, representing more than 86.5% of international aviation activity, intend to voluntarily participate in the global MBM scheme from its outset." (ICAO's website <http://www.icao.int/environmental-protection/Pages/market-based-measures.aspx> accessed on Novermber 6, 2016).

In terms of reducing the amount of CO_2 emissions, the cap-and-trade system and fuel tax are closely related but are different policy measures. A cap-and-trade system constrains aggregate emissions first by setting the cap on overall emissions levels and creating a monetary value of emissions for trading and then by allocating a limited number of free emission allowances. In contrast, when employing a fuel tax, it is impossible to determine the amount of the reductions in CO_2 emissions in advance. Thus, the concept of a cap-and-trade system is becoming widely accepted as a more appropriate and efficient approach to achieving environmental objectives and targets than a fuel tax.