Impact of carbon fees on mobility of passengers

Changes in the mobility pattern of air passengers due to the introduction of a CARBON FEE

Other titles

1. Estimating air travel demand under the implementation of an emission trading scheme
2. Passenger air travel demand and carbon emission fee impact assessment
3. The effect of environmental policies on consumer's preferences for air travel
4. How could environmental policies change air travel pattern in US?
5. GMM estimation of a supply-and-demand model for air travel and the effects of the introduction ofa carbon fee (for the journal)
6. Incorporating a carbon trading scheme in supply-and-demand model for air travel

Titlos TRB: AIR TRAVEL DEMAND IN U. S.: THE EFFECTS OF A CARBON EMISSIONS FEE

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Aviation environmental policies aim to mitigate emissions generated from air transportation through the use of policy tools. These may include Regulatory Measures, such as aircraft emissions/noise certification standards, Technology/Operational Measures, such as improvements in engine and aircraft technology and Market-based Measures which include emissions trading, emissions charges and taxes and emissions offsetting.

A wide range of market-based measures are currently implemented in aviation sector. Within these measures, a price is set on the “ non-priced” emissions in order to account for the negative environmental externality of aviation. The scope is to create incentives for aviation stakeholders to implement fuel-efficient techniques to reduce aircraft emissions. The result is an extra cost to the airlines which may in-turn be reflected in the ticket price in case the airlines decide to pass-through this cost to the passengers.

The most known market-based measure for aviation is the European Emissions Trading Scheme (EU-ETS) which was launched in 2012 and initially planned to cover every flight landing in or departing from the EU, regardless of where the operator is incorporated. After serious international opposition, mainly by American and Canadian airlines, and in expectation of a global market-based mechanism, EU proposed that only emissions from the proportion of the flight within EU territory are to be charged until 2016.

In this context, several U. S. and Canadian airlines have already taken action. Delta, Air Canada and United have introduced a voluntary carbon offsetting program, where the passengers can offset the carbon dioxide (CO_2) emissions resulting from their travel by making charitable contributions to several environmental projects, such as forest conservation and renewable energy. Based on the United’s on-line carbon calculator, a passenger travelling from New York (JFK) to San Francisco (SFO) would pay a carbon offset cost of $12. 59 to support forest conservation in California. Furthermore, major U. S. airlines, including Delta, United and American Airlines introduced a $3 surcharge per passenger for European flights so as to cope with the EU-ETS.

Motivated by these actions, this paper identifies room to research the implementation of a carbon fee on U. S. airlines. Such a policy may influence many aspects of the aviation system, including ticket prices and demand. Various studies have examined the impact of environmental policies on air travel. However, most of these studies use price elasticities of demand based on previous studies. This paper contributes to the existing literature by incorporating the carbon emissions' cost into a structural model with a discrete choice modeling for consumers' demand and an airline supply side to investigate the impacts on airlines' market share and their competition strategies after the introduction of a carbon fee in United States. Airlines offer differentiated products (airline-route specific) in each market (O-D city pairs) and the passengers choose to " buy" one product or take the outside option of not " buying" (not flying). In each market, prices and product shares are determined in Bertrand-Nash equilibrium. The carbon fee is then included in the model as it is believed that it will affect costs, prices and demand.

Demand specification plays a critical role when examining policy measures. We estimate a two-level Nested Logit (NL) model for air travel demand using aggregate Origin-Destination data. We incorporate a NL model, instead of a multinomial logit (MNL) in order to capture correlations among airline products and differentiate them from other travel modes (rail, car etc). This feature helps overcome the limitation of the Independence from Irrelevant Alternatives (IIA) property of MNL that may lead to incorrect elasticities and choice probabilities.

For the supply side, we establish the airline's profit function which is equal to the airline's revenues from ticket sales minus the airline's costs. We assume that airlines conduct differentiated Nash competition to determine ticket prices. It is noted that after the implementation of the carbon fee, the airline's costs include the " carbon cost" which depends on the unit carbon price (per tn CO_2) and the amount of emitted CO_2 .

Overall the model is solved in two " steps": first, we estimate the model to find the determinants of traveler's and airline's behavior. Several variables were included in the demand (such as ticket price, frequency, delays, airline dummies etc) and cost equations (such as distance, number of connections etc). Other variables that have not been examined by previous papers are also included in the model and are found to be statistically significant. The model is jointly estimated by the Generalized Method of Moments (GMM) to correct for bias caused by the endogenous variables of ticket price and market shares. Next, we modify the airline's costs by introducing the carbon cost and simulate changes in the equilibrium behavior of players.

To estimate the model we use publicly available data provided by the U. S. Department of Transportation. A variety of databases are merged to construct our sample for estimation: the Airline Origin and Destination Survey (DB1B), the T-100 Domestic Segment for U. S. Carriers and the On-Time Performance database. The analysis is conducted on market level (Origin-Destination city pairs) where routes provided by different airlines (unique combination of Origin-Connecting-Destination airports and airline) compete with each other. One important part of this work is the computation of CO_2 emissions. The computation is done flight-by-flight using fuel burn data from ICAO Engine Exhaust Emissions Databank and EUROCONTROL's Base of Aircraft Data. The results are presented for different markets so as to identify the impact of the various degrees of competitiveness in the marketplace (monopoly, oligopoly etc) on the examined carbon policy.

The results indicate that price adjustment is a reactive measure as it is intended to eliminate the impact of the carbon fee on airline costs. Across different markets, the effects vary, depending on the size and number of firms serving the market and the prevailing ticket prices. It is also found that the implementation of a carbon fee will be effective only if the market carbon price reaches a sufficiently high level to create incentives for airlines to invest in abatement measures and thus reduce carbon emissions.

Keywords: discrete choice, nested logit, generalized method of moments, carbon fee, Nash equilibrium