Energy Economics 46 (2014) 224–235

Contents lists available at ScienceDirect

Energy Economics

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

Aviation fuel demand development in China

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ARTICLE INFO

Article history:
Received 25 April 2013
Received in revised form 6 September 2014
Accepted 12 September 2014
Available online 22 September 2014

Keywords:
L98
L93
P48
Q43
Q47
R41

Keywords:
Aviation fuel demand
Aviation fuel efficiency
ETS
ARIMA
Bayes

ABSTRACT

This paper analyzes the core factors and the impact path of aviation fuel demand in China and conducts a structural decomposition analysis of the aviation fuel cost changes and increase of the main aviation enterprises' business profits. Through the establishment of an integrated forecast model for China's aviation fuel demand, this paper confirms that the significant rise in China's aviation fuel demand because of increasing air services demand is more than offset by higher aviation fuel efficiency. There are few studies which use a predictive method to decompose, estimate and analyze future aviation fuel demand. Based on a structural decomposition with indirect prediction, aviation fuel demand is decomposed into efficiency and total amount (aviation fuel efficiency and air transport total turnover). The core influencing factors for these two indexes are selected using path analysis. Then, univariate and multivariate models (ETS/ARIMA model and Bayesian multivariate regression) are used to analyze and predict both aviation fuel efficiency and air transport total turnover. At last, by integrating results, future aviation fuel demand is forecast. The results show that the aviation fuel efficiency goes up by 0.8% as the passenger load factor increases 1%; the air transport total turnover goes up by 3.8% and 0.4% as the urbanization rate and the per capita GDP increase 1%, respectively. By the end of 2015, China's aviation fuel demand will have increased to 28 million tonnes, and is expected to be 50 million tonnes by 2020. With this in mind, increases in the main aviation enterprises' business profits must be achieved through the further promotion of air transport.

1. Introduction

The air transport industry is rapidly developing in China and around the world. According to the CAAC (Civil Aviation Administration of China), by 2030 it is expected that 1.5 billion passengers annually will be travelling by air. The Promotion of Civil Aviation Industry Development report issued by the State Council in 2012 estimated that the total aviation transport traffic in China would reach 170 billion km in 2020, at 12.2 percent annual average growth. Because of the rapid growth in the aviation industry in China, the total aviation fuel consumption is also expected to increase significantly.

Air transport is a capital and technological intensive industry. The homogeneity of the products and the excessive competition have resulted in a less than average profit for the entire industry. Therefore, improving fuel efficiency and reducing running costs have become important to enhance the enterprises' competitive power. Annual reports for 2011 for Air China Limited, Hainan Airlines Company Limited, China Eastern Airlines Company Limited and China Southern Airlines Company Limited reported that the fuel costs for Air China were RMB 33.787 billion, an increase of RMB 10.326 billion with 44.01 percent growth year-on-year and exceeded the net profit of RMB 7.477 billion in that year. In the same year, China Eastern Airlines' running costs were RMB 70.448 billion, of which the fuel cost alone was RMB 29.229 billion, resulting in a 9 percent profit decline to RMB 4.887 billion. At present, the fuel costs of the three state-owned enterprises, Air China, China Eastern Airlines and China Southern Airlines account for 40 percent of the overall running costs.

Along with economic growth and the increase in air transport volume, the negative environmental impact of the aviation transport industry is also being paid increasingly serious attention. The IPCC (Intergovernmental Panel on Climate Change) released "Aviation Activities and Global Climate" in 1999, which comprehensively analyzed the impact of aviation activities on the environment for the first time. This report pointed out that emissions were expected to continually increase with economic growth. At the same time, the EU aviation carbon tax is another challenge for aviation-caused environmental pollution. With rising oil prices and the increasing fixed costs for energy-saving airplanes, an analysis of the aviation fuel demand is important to explore improved fuel efficiency, to control aviation fuel costs and to reduce aviation industry carbon emissions.

With this background, this paper attempts to analyze and forecast the aviation fuel demand trends by analyzing the current aviation fuel demand in China. This paper has five parts. In the Introduction, we describe

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http://dx.doi.org/10.1016/j.eneco.2014.09.007
0140-9883/

the realistic background for the research topic. In Part 2, we present the research on aviation fuel demand which introduces the academic background for the research topic. In Part 3 we provide an aviation fuel consumption structural decomposition analysis. We analyze in detail the structural decomposition on the aviation fuel efficiency, the air transport total turnover and the aviation fuel costs. In Part 4 we also analyze and forecast aviation fuel demand, aviation transport total turnover and aviation fuel efficiency using a univariate and multivariate analysis. In the final section we give the conclusions and some recommendations.

2. Research on aviation fuel demand

Aviation traffic is expected to grow at an annual rate of about 5 percent until 2026 and aviation fuel demand is expected to increase by 3 percent per annum. Therefore, aviation fuel is expected to be in short supply by or before 2026 (Nygren et al.,2009). In the OECD (Organization for Economic Co-operation and Development) data for North America, Europe, the Pacific region and individual developing countries, Mazraati (2009) built an aviation fuel demand model. The results showed that aviation fuel demand rises by less than 1 percent with 1 percent point rise in passenger transport turnover. The aviation industry consumes approximately 12.7 percent of all transportation sector oil in 2005, and has experienced a 2.32 percent annual growth in recent years from 1995 to 2004 in the world. Mazraati and Faquih (2008) built aviation fuel demand models for two different markets, among which the USA was identified as a mature market and China as a rapidly developing market. Based on data such as aviation passenger transport turnover, freight transport turnover and the airline load factor in these two countries, in combination with economic growth and oil price fluctuations, a constant elasticity logarithmic model was developed. The findings demonstrated that aviation transport demand has greater price elasticity and is more sensitive to short-term economic waves in mature markets like the USA compared to the rapidly developing aviation industry in China. The World's aviation industry accounts for 11.2 percent of oil demand across the transportation industry, making it the second largest oil consumer. Aviation oil consumption accounts for 5.8 percent of the world oil consumption. The regional calculation economic model, built by Mazraati (2010), showed that aviation fuel demand lacked price elasticity, but there was a strong functional relationship between this demand and economic growth. While aviation fuel demand intensity across the world is continually reducing, it is expected that aviation fuel demand will increase to 2.7mb/d by 2030, quite a significant proportion of which (0.75mb/d) will come from China.

Using quarterly data from 1998 to 2009, Boshoff (2010) used an auto regression distribution lagging model and an ordinary particular method to estimate the price and income elasticity of aviation kerosene demand in South Africa. The results showed that aviation kerosene demand had low price elasticity but much higher income elasticity. Wadud et al. (2009) classified American citizens into five groups by income level, and estimated the oil demand elasticity of these groups to examine the inhomogeneity of oil demand changes in different income levels. The research found that the oil demand elasticity in different population groups was different , with the demand elasticity by income level from low to high showing a U type pattern. Chèze et al. (2011) deployed a dynamic faceplate data calculation model to pre-determine the aviation fuel demand worldwide and across eight classified geographic regions, and demonstrated that global aviation transport demand would increase by 100 percent from 2008 to 2025 with an annual average growth rate of 4.7 percent, while global aviation fuel demand was estimated to grow by 38 percent with an annual average growth rate of 1.9 percent. According to such findings, as aviation transport demand increases, improvements in aviation fuel efficiency could reduce aviation fuel demand. However, unless aviation technology changes, employs new energy sources, or aviation travel demand is restricted, there is little possibility that aviation fuel demand will decrease. Through an investigation focused on aviation fuel manufacturers and sellers in China, Zhao and Hu (2002) came to some important conclusions. Primarily, it was found that the aviation fuel production and delivery costs in China were much higher, and concluded that if resource distribution efficiencies were not improved, aviation fuel demand would continue to grow and would exceed supply in the first decade of the 21st century.

The above research review indicates that aviation fuel demand has obvious driving factors. Economic development boosts aviation demand growth (Bernstein (2002), Vedantham and Oppenheimer (1998), Wells(1988)), which increases aviation fuel consumption. However, there are some factors which can lead to a reduction in the aviation fuel consumption, such as pollutant emission controls, intelligent aviation technology, improvements in three aviation activity efficiencies and engine fuel efficiency improvements (Babikian et al. (2002), Kick et al. (2012)). Further, changes in aviation fuel prices (Ryerson and Hansen (2013), Adams and Gerner (2012)) and fuel fee policies could also influence aviation fuel demand. Thus, when forecasting aviation fuel demand, the changing trends in related areas need to be considered.

In sum, aviation fuel forecasting techniques can be classified as univariate and multivariate. Univariate forecasts primarily focus on time series forecast analysis, while multivariate forecasts focus on scenario analysis regression models and structure time series models. The factors that impact aviation fuel demand can be grouped into two: first, the influence on aviation demand, namely, aviation total turnover, and second, the influence on aviation fuel efficiency from such areas as aviation transport control technology, engine technology and advanced aircraft materials.

Research on China's aviation fuel demand and related issues has been sparse. This paper delves into this question further. To forecast fuel demand, a univariate prediction method is used to improve the prediction accuracy and a multivariate prediction is used to emphasize the significance of the economic analysis. The purpose of this paper, however, is to provide a decision-making reference, so the analysis needs to consider the advantages of the univariate- and multivariate- prediction methods. Given this, we first conduct a structural decomposition of aviation fuel demand based on the principle of decomposition and multiple predictions and then conduct a predictive analysis with each decomposition variable using univariate prediction technology. Multivariate prediction is used on the decomposition variables to gain insights into the formation of China's aviation fuel demand change path. By examining changes in the core influencing factors, an in-depth analysis of possible novel research ideas and structures is conducted and predictions for the object variable are determined.

3. Structural decomposition analysis on aviation fuel consumption and cost

After conducting a related effect factors analysis, Mazraati (2009) and Mazraati and Faquih (2008) built direct models for aviation fuel demand and obtained sound results. In this paper, from a more detailed analysis and investigation of the aviation fuel consuming power, we build a model using an indirect method.

According to Vedantham and Oppenheimer (1998), aviation fuel demand (ten thousand tonnes) = air transport total turnover (megatonne km) × aviation fuel efficiency (kg/tonne km) × 10^{-1}. This paper uses a path analysis method to make an intensive study of the air transport total turnover and aviation fuel efficiency using annual data, data from the China Statistics Year Books, the China Transport Statistics Year Books, the WIND Database and the CEIC Database.

In structural decomposition analysis, many variable selection methods, such as co-integration analysis, granger causality test, autocorrelation analysis, partial correlation analysis cannot be used to comprehensively process the multiple influencing factors for crude oil price at the same time. Therefore, a path analysis model is introduced to extract the core factors to allow for the calculation and analysis of the direct and indirect relationships between the various variables. In addition,