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Efficiency of US airlines: A strategic operating model

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ABSTRACT

This paper applies the *unoriented* DEA network methodology to measure US airlines' performance relative to that of peer airlines and identifies the sources of its inefficiency. The analysis of the results suggests that major US airlines are more efficient than national US airlines in spending operating expenses and gaining operating revenue, but there is no significant difference in their service supply and demand efficiencies.

1. Introduction

This paper presents a strategic operating model that measures the operating efficiency of each US domestic passenger airline and identifies the sources of inefficiency within each airline. The model provides organizational efficiency measures and separate measures for each individual sub-process. This research allows airline managers, funding agencies, and regulatory bodies such as the Federal Aviation Administration (FAA) to understand the sources of poor operating performance and set practical goals to improve US airlines. In addition, the proposed model can be useful for operational decision-making and for the development of regulatory policy.

This paper contributes to the existing literature by presenting an *unoriented* network Data Envelopment Analysis (DEA) methodology in which we seek to simultaneously decrease operating expenses and increase operating revenues in a balanced fashion. Unlike most of the previous literature, this study measures all inputs and outputs in their original physical quantities. The model presented in this paper uses the classical DEA radial objective and does not require the specification of subjective weights. The model handles multiple critical airline parameters by developing a unified three-stage sequential model that measures the relative efficiency of US airlines and allows for detailed scrutiny of operational processes to identify the sources of inefficiency.

The rest of this paper is organized as follows. Section 2 describes the motivation and contextual setting of this paper. Section 3 gives a literature survey on airline efficiency measurement. Section 4 describes the proposed three-stage model. Section 5 describes the methodology and formulates the mathematical model. Section 6 gives relatively recent data to measure and compare the operating efficiency and performance ratios of 14 major and 13 national US airlines. The results present the target supply and demand levels that should be achieved for successful future operations. Section 7 analyzes and discusses the performances of major and national US airlines in 2012. Section 8 provides the conclusion.

2. Motivation and contextual setting

US domestic passenger airlines are a critical mode of transportation and play an important role in modern society. In 2012, US domestic airlines served 642.3 million passengers and provided fulltime employment to 379,571 people while spurring businesses at and around the airports (Bureau of Transportation Statistics, 2013b). However, in 2012, the net income of 10 major US passenger airlines – Alaska, Allegiant, American, Delta, Hawaiian, JetBlue, Southwest, Spirit, United and US Airways together, declined by 64 percent from 2011 (Airlines for America, 2013). The cumulative profit for these 10 airlines decreased from 318 cents per passenger in 2010 to 21 cents per passenger in 2012 (Heimlich and Elwell, 2013). In 2012, US airlines' operating expenses increased by 4.7% and operating revenues declined by 4.5% when compared to 2011 (Airlines for America, 2013).

In the past, due to hard economic situations and the steady inception of new airlines (Choi et al., 2013; Merkert and Hensher,

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Table 1
Literature summary.

Author(s)	Airlines	Study period	Methodology	Remarks and propositions
Caves et al. (1984)	15 US airlines	1970–81	Translog Cost Function	Density of air traffic within an airline's network impacts cost of operation. Small airlines incur higher costs.
Schmidt and Sickles (1984)	12 US airlines	1970–78	Stochastic Frontier-Production Function	Compared efficiencies across the airlines but not relative to an absolute standard.
Sickles et al. (1986)	13 US airlines	1970–81	Generalized-Leontief Profit Function	Deregulation reduced total costs.
Bauer (1990)	12 US airlines	1970–81	Total Factor Productivity	TFP growth has been negative and it is difficult to explain the cost inefficiency.
Gillen et al. (1990)	7 Canadian airlines	1964–81	Total Cost Function	Economies of traffic density indicate that the smaller carriers have a higher unit cost than the largest carrier.
Cornwell et al. (1990)	8 US airlines	1970–81	Stochastic Frontier Function with Flexible Function of Time	Airline efficiency changes across regulatory environments.
Schefczyk (1993)	15 international airlines	1989–92	Standard DEA	High operational performance is a key factor of high profitability. Other factors are efficient resource acquisition, marketing and sales activities.
Good et al. (1993)	12 European and US airlines	1976–86	Cobb–Douglas Cost Function	Liberalization in Europe resulted potential efficiency gains.
Distexhe and Perelman (1994)	33 US and European airlines	1977–88	Standard DEA and Malmquist Productivity Index	Three sources of potential airline growth are: technological progress, efficiency change, and route network characteristics.
Banker and Johnston (1994)	16 US airlines	1981–85	Maximum Likelihood DEA Framework	DEA captures relationships between inputs and outputs, and efficiency and operating characteristics, which influence efficiency.
Ehrlich et al. (1994)	23 international airlines	1973–83	Cobb–Douglas Production Function and Total Factor Productivity	State ownership can lower the long-run annual rate of productivity growth or cost decline, but not necessarily their levels in the short run.
Ray and Mukherjee (1996)	21 US airlines	1983–84	Standard DEA and Fisher Productivity Index	Permits to attribute the measured change in productivity between two periods to separate factors such as shifts in the cost function due to technical change.
Baltagi et al. (1995)	24 US airlines	1971–86	Translog Variable Cost Function and Zellner Efficient Estimation	Airline deregulation has stimulated technical change due to more efficient route structures.
Good et al. (1995)	16 European and US airlines	1976–86	Standard DEA and Stochastic Frontier Approach	European carriers under deregulation are as productively efficient as their American counterparts.
Oum and Yu (1998)	22 international airlines	1986–93	Translog Variable Cost Function and Multilateral Index	Asian air carriers were generally more cost competitive than the major US carriers
Sengupta (1999)	14 international airlines	1988–94	Dynamic DEA	Dynamic DEA model considers expected changes of inputs over time. Changes in airlines' efficiency over time have been very significant.
Coelli et al. (1999)	32 international airlines	1977–90	Stochastic Frontier Production Function	Asian airlines are technically more efficient than European and US airlines
Semenick Alam and Sickles (2000)	11 US airlines	1970–90	Standard DEA and Full Disposal Hull	Competitive pressure enhances efficiency.
Sickles et al. (2002)	16 European airlines	1977–90	Standard DEA, Stochastic Frontier Approach, and Malmquist Productivity Index.	Semi- and nonparametric methods indicate significant slack in resource utilization in the East European carriers relative to their Western counterparts.
Scheraga (2004)	38 international airlines	2000	Standard DEA and Regression Analysis	Expenses focusing on passenger service had a negative impact and expenses focusing on sales and promotion had a positive impact on operational efficiency.
Tsikriktsis and Heineke (2004)	10 US airlines	1987–98	Standard DEA and Time-Series Regression	Relationship between process variation and customer dissatisfaction is contingent upon an airline's average performance.
Capobianco and Fernandes (2004)	53 international airlines	1993–97	Standard DEA	Large airline companies use capital efficiently to generate return with a low level of fixed assets. Airlines performance depends on their management.
Inglada et al. (2006)	20 international airlines	1996–00	Stochastic Parameter Cost Function	

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