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Nothing focuses the mind on productivity quite like the fear of liquidation: Changes in airline productivity in the United States, 2000–2004

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Abstract

Using data envelopment analysis and the Malmquist productivity index, this paper examines changes in the productivity of the major United States passenger airlines from 2000 to 2004. The analysis finds that there was a significant improvement in the productivity of the carriers at transforming labor, fuel and passenger seating capacity into available seat-miles during this period. Most of the productivity improvements came about from the efficiency laggards catching up with the efficiency leaders in the industry. To a lesser extent, the adoption of new technologies improved productivity over this period.

Keywords: Airline industry; Productivity; Efficiency; Malmquist productivity index; Data envelopment analysis

1. Introduction

The year 2000, the last profitable year for the passenger airline industry in the United States, was followed by one of the most financially traumatic periods in the industry's history. Buffeted by the horrific events of nine-eleven and the ensuing recession, airlines bled red ink on a scale never seen before. By 2004, a number of the older legacy carriers found themselves on the verge of bankruptcy, if not already in it.

It is said that nothing focuses the mind on productivity quite like the fear of liquidation. If there ever were a time when it was a matter of life and death for the airlines to boost the productivity of their inputs in order to reduce their operating costs, the opening years of the 21st century were just such a period. This paper assesses the extent to which the airlines boosted the productivity of their inputs from 2000 to 2004. Data envelopment analysis (DEA) and the Malmquist productivity index are used to undertake this assessment. The inputs used

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in the analysis are labor, fuel, and fleet-wide passenger seating capacity. The output is available seat-miles (ASMs).[1] This study measures the extent to which the airlines included in the sample increased the productivity of these three inputs at producing ASMs from 2000 to 2004.

There exist a number of previous studies on airline efficiency and productivity that employ DEA and/or the Malmquist productivity index. Examples include Schefczyk (1993), Banker and Johnston (1994), Coelli et al. (2002), Fethi et al. (2002), Capobianco and Fernandez (2004), Ray (2004b), Scheraga (2004), Chiou and Chen (2006), Greer (2006) and Scheraga (2006).[2] However, this study is the first to examine changes in US airline productivity during the turmoil of the early 2000s. It is also the first to employ the Malmquist productivity index using the specific set of input and output variables used in this study.

The remainder of the paper will proceed in the following manner: The next section describes the Malmquist productivity index. After this has been accomplished, an overview of DEA and how it can be used to estimate the Malmquist productivity index will be presented. The subsequent section will elaborate on the sources and uses of data for this study, after which the results of the analysis will be presented. A concluding section wraps-up the paper.

2. The Malmquist productivity index

2.1. Overview

The Malmquist productivity index is based on the measurement of efficiency introduced by Farrell (1957) and the concept of a distance function introduced by Malmquist (1953). Caves et al. (1982) subsequently developed the index in the direction used in this study. The overview of the Malmquist productivity index presented here follows closely the more contemporary treatments found in Fare et al. (1992), Coelli et al. (1998), Murillo-Melchoir (1999) and Ray (2004a).

The Malmquist productivity index measures the change in the productivity of a decision-making unit (DMU) over time. Productivity change, in turn, is rooted in two separate causes: a change in efficiency and technical change, a distinction which is central to the Malmquist productivity index. In the input-oriented view of efficiency used in this paper, an improvement in efficiency occurs when there are decreases in the quantities of inputs used to produce a given set of outputs, using a given production technology. This can occur through a more judicious and rational use of inputs.[3] In the case of the airline industry, efficiency enhancements can take place through changes in work rules that reduce the amount of labor needed to produce a given number of ASMs. For example, by having flight attendants help prepare the aircraft cabin between flights, which reduces the requirements for separate cleaning staff, less labor is needed to generate the same number of ASMs. In addition, this kind of work rule change, insofar as it allows a shorter turnaround time at the gate, will also reduce the fleet-wide seating capacity needed to produce a given number of ASMs.

In contrast to a change in efficiency, productivity-enhancing technical change occurs through the adoption of new technologies that reduce the minimum quantities of inputs needed to produce a given level of output. In the airline industry, productivity-enhancing technical change can occur through the incorporation of more modern, fuel efficient aircraft into an airline's fleet and Internet-based reservations and ticketing systems.

There is every reason to believe that the airline companies endeavored to adopt productivity-enhancing measures in order to reduce their costs in the tumultuous period of 2000–2004. The Malmquist indexes calculated here will allow us to measure the combined effect of efficiency enhancements and technical change

[1] An available seat-mile is one seat, whether occupied or not, flown one mile. The production process of an airline involves transforming fuel, labor and seating capacity into an inventory of ASMs, which are offered for sale. The extent to which this inventory is sold, and ASMs are converted to revenue passenger-miles, is a selling and marketing function, which is not part of the production process of the airline. Therefore, this study of airline productivity defines industry output as ASMs, not revenue passenger-miles flown.

[2] Using stochastic frontier analysis in lieu of DEA, a recent paper by Inglada et al. (2006) evaluates the technical efficiencies of a number of international air carriers. Cullinane et al. (2006) provide a study of the container port industry indicating that stochastic frontier analysis results in efficiency estimates that are similar to those obtained from DEA, though.

[3] Of course, a reduction in efficiency would occur over time if, using a given technology, there were increases in the quantities of inputs used to produce a fixed set of outputs. This could occur through a weakening of managerial competence and focus on efficiency, or a decline in morale within an organization.