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Profitability change in the global airline industry

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ABSTRACT

This paper studies airline profitability change computed through a Bayesian estimation of a cost function. The stochastic frontier is applied to a dataset including the largest worldwide airlines in the period 1983–2010. We show that productivity change is mainly driven by technical change becoming continuously positive from early 1990s. Furthermore, in the last decade profitability change is mainly driven by input price change which exhibits a similar pattern to output price change. In presence of productivity growth, the output price increase is lower than the input price increase suggesting that part of productivity gains are transferred from airlines to consumers.

1. Introduction

Airline profitability was not a main concern at the dawn of commercial aviation when state-owned carriers used to be supported by government subsidies and seats and fares were set according to inter-governmental agreements (The Economist, 2014). This led to weak incentives for cost reduction at the industry level until air transport liberalization waves (1980s in United States, early 1990s in Europe) dramatically changed airlines' condition, fostering (i) privatisations, (ii) competition and (iii) new business models. This new scenario, coupled with both a low countervailing power in the air transport vertical channel (Button, 2005; Button and McDougall, 2006) and a structural vulnerability to outside shocks (Scotti and Volta, 2015), determined poor airline financial performances – despite their exponential growth in terms of traffic volumes (Brugnoli et al., 2015) – bringing to prominence the issue of airline profitability. As a result, several contributions focused on different issues such as (i) the relationship between profit fluctuations and industry value generation (IATA report, 2013), (ii) the cyclical dynamics of airline earnings (e.g. Hansman and Jiang, 2005; Pierson and Sterman, 2013), (iii) the link between profitability and business models (e.g. Lawton, 2002; Franke and John, 2011) and (iv) the implication of different operations management practices (e.g. Barnhart et al., 2009).

Nevertheless, since the 1980s the transportation economics literature on airline performance focuses mainly on technical efficiency and total factor productivity (for a comprehensive review see Yu, 2016). Studies have traditionally sought to establish how technical efficiency and productivity have changed over time and which factors have mainly driven such changes (Good et al., 1995; Oum and Yu, 1995). Other studies investigate airline cost efficiency (Oum and Zhang, 1991; Oum and Yu, 1998) or both productivity and cost competitiveness (Oum and Yu, 2012; Windle, 1991).[1] However, looking only at efficiency and productivity tells only part of the story. This is confirmed also by (i) Windle and Dresner (1992) who show that total factor productivity is a poor proxy for profitability, (ii) Oum and Yu (1995) who state that airline productive efficiency alone does not lead necessarily to the success, and (iii) Heshmati and Kim (2016) who point out that the general lack of profitability among airlines is not always due to poor performance alone.

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[1] For a substantial review of the literature regarding cost functions in transportation industries see Oum and Waters (1996).

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Our intent is to fill the gap in the literature regarding airline performance by computing airline profitability at the industry level and identifying the drivers of its change. Indeed, apart from efficiency and productivity, changes in profitability may be also related to other causes such as input price reduction and output price increase (i.e. airlines' mark-up increase). Hence, studying industry profitability and its decomposition may provide further significant information, especially from the regulatory point of view. On one hand, it may indicate whether airlines improving their performance are passing such gains to passengers. On the other hand, a complete knowledge of recent historic trends in industry profitability may reveal the most appropriate policy targets. As an example, if airlines are by now close to the efficient frontier it may be time to shift the incentive schemes towards technological improvements or input prices reduction. Analysing a group of 53 world's major airlines in the period 1983–2010, the aim of this paper is to compute and untangle airline productivity and profitability quantifying the contribution of its different components. In order to do so, we adopt a cost function approach according to the following steps: (i) we estimate a stochastic cost function, (ii) we compute total factor productivity and its components, and (iii) we compute profitability and its components. A further merit of our paper is mainly methodological. Indeed we impose regularity conditions in a Bayesian estimation framework contrasting with the majority of the existing studies, which check the proportion of times the conditions are violated (Kumbhakar et al., 2015). In this work, the cost function regularity conditions are locally imposed following Terrell (1996).

2. Methodology

2.1. Cost function

As pointed out by Chua et al. (2005) the empirical estimation of airline cost functions has a long and recognized tradition in the literature (e.g. Oum and Yu, 1998; Oum and Zhang, 1991; Kumbhakar, 1992, etc.). Hence, according to previous contributions, we specify a technology where each airline minimizes the production cost given outputs and input prices. Since capital input is not always in equilibrium in the industry (Caves et al., 1984; Gillen et al., 1990), we estimate a short-run cost function relaxing the assumption of optimal capital stock treating the capital as a quasi-fixed input. The general short-run cost function becomes as follows:

$$VC = f(Y, \vec{W}, K, \vec{Z}), \tag{1}$$

where Y is the output, W a vector of input prices, K the quasi-fixed capital input and Z a set of characteristic variables describing the heterogeneous nature of the airline networks (average stage length and number of destinations served). Due to its flexibility, the function form (f) we apply is a translog so that the model is a second-order approximation to any general cost function. Finally, the short-run cost function is estimated under a stochastic frontier framework, thus allowing deviation from the cost minimization objectives due to process inefficiencies. Different studies support the idea of airlines operating above the cost minimizing curve. Kumbhakar (1992) and Bitzan and Peoples (2014) show that airlines, acting as shadow cost minimizers, fail to meet the condition of actual cost minimization due to the existence of allocative distortion – namely the difference between shadow and market input prices.[2] Considering I firms ($i = 1, \ldots, I$) and T periods ($t = 1, \ldots, T$) the short-run cost function could be defined as follows:

$$\ln(VC_{it}) = TL(Y_{it}, \overrightarrow{W_{it}}, K_{it}, \overrightarrow{Z_{it}}, t; \vec{\beta}) + v_{it} + u_{it}, \tag{2}$$

where v_{it} is the common error component independently and identically distributed as $N(0, \sigma_v^2)$, while u_{it} is the time varying inefficiency term estimated as $u_{it} = \exp(\eta(t - T)) * u_i$ (Battese and Coelli, 1992) with $u_i \sim E(\lambda)$.[3] Analysing the estimated eta (η), it is possible to observe if the industry is on average increasing (negative eta) or decreasing (positive eta) the cost efficiency level.

Our specification involves a non-neutral and non-monotonic time trend. In order to be consistent with the cost minimization, the short-run cost function needs to satisfy the common conditions of non-negativity in costs, non-decreasing in input prices and in output, homogeneity and concavity. While the homogeneity condition can be easily included by normalizing both input prices and the short-run costs by one of the input prices, the monotonicity and the concavity conditions, especially, are not easily implementable in the estimation. The Cholesky decomposition method introduced by Lau (1976) is widely used to impose economic regularity, however it could destroy the flexibility properties of the functional form and it is not always possible to ensure that the regularity conditions are satisfied (Coelli et al., 2006). In order to avoid these difficulties, it is common practice to estimate an unrestricted model to assess the violations severity ex-post. However, ignoring the concavity violations could lead to unreliable results (Chua et al., 2005).[4] Viable alternatives are to impose local concavity involving a reparameterization (Ryan and Wales, 2000) or to implement an accept/reject algorithm into a Bayesian estimation framework (Terrell, 1996). In this research we use the latter method since its relative easiness to be implemented into a stochastic framework. As noted in van den Broeck et al. (1994), and lately reported by Griffin and Steel (2007), the advantages of applying a Bayesian estimation for the stochastic frontier methods are (i) the exact inference on the inefficiencies, (ii)

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[2] Kumbhakar (1992) finds evidence of labour overutilization among US carriers in the period immediately following the US deregulation. Bitzan and Peoples (2014) analyse a longer post-deregulation period and point out that work rules rigidities inflate the price of labour above its market price leading to capital and fuel overutilization by US airlines.

[3] We attempted to estimate the inefficiency term following the two approaches presented in Cuesta (2000) and Kumbhakar (1990) in order to improve the flexibilities in the inefficiencies computations. However, given the low estimation performance due to the increased number of parameters we decided to apply the more parsimonious Battese and Coelli approach.

[4] In our case, the estimation of the unrestricted model led to concavity violations for more than 50% of the observations.