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An analysis of African airlines efficiency with two-stage TOPSIS and neural networks

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ABSTRACT

This paper presents an efficiency assessment of African airlines, using the TOPSIS – Technique for Order Preference by Similarity to the Ideal Solution. TOPSIS is a multi-criteria decision making technique, which similar to DEA (Data Envelopment Analysis), ranks a finite set of units based on the minimisation of distance from an ideal point, and the maximisation of distance from an anti-ideal point. In this research, TOPSIS is used first in a two-stage approach, in order to assess the relative efficiency of African airlines using the most frequent indicators adopted by the literature on airlines. During the second stage, neural networks are combined with TOPSIS results, as part of an attempt to produce a model for airline performance which has effective predictive ability. The results reveal that network size-related variables – economies of scope, are the most important variables for explaining levels of efficiency in the African airline industry, although the impact of fleet mix and public ownership cannot be neglected.

1. Introduction

This paper analyses the efficiency of African airlines with TOPSIS. Past airline research has adopted several methods, such as the factor productivity approach; stochastic econometric frontier models; the Turnquist total factor productivity index; and DEA models. These studies have analysed airlines from different countries and regions worldwide. However, to the best of our knowledge, African airlines have yet to be fully analysed. Therefore, this paper contributes to the literature on airline efficiency, by analysing African airlines and by using TOPSIS and neural networks for the first time in this context.

The paper is structured as follows: After this introduction, the contextual setting is presented, describing the African airlines. Next, the literature survey is provided, followed by a section on TOPSIS methodology. Section 5 presents the data and the prediction of efficiency levels using neural networks, followed by the discussion of the results and the conclusion.

2. Contextual setting

In 1961, eleven West and Central African countries signed a treaty setting up a joint airline association at the Heads of State Summit in the Cameroonian capital of Yaounde. The Yaounde countries were all former colonies of France that had recently gained independence. The members agreed to coordinate their economic activities, in addition to forming a social and political alliance. The African Airlines Association (AFRAA) was established in 1968 at Accra, in Ghana, as a trade organisation for African airlines. Later, African civil aviation ministers met at Yamousoukro in the Ivory Coast in 1999, and agreed to liberalise African air transport and to establish a common airline market.

Since then competition has increased amongst African airlines. The African airline industry is split between African companies which operate in the national or domestic market, with those that provide regular or scheduled flights to European countries, usually to the capital of the former colony. The absence of common code share agreements was frequent in the past, but this is now starting to be developed. For example, SAA-South Africa Airways has a code-share agreement with 27 other airlines across the markets that it serves. Moreover, separation on a national basis restricts competition between airlines. The airlines tend to operate as a monopoly in a national context for domestic destinations and inter-

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African destinations. However, international destinations are sometimes open to competition. For example, in the case of Angola, there is competition between TAAG Angola Airlines and TAP for the Lisbon – Luanda route, yet there is no competition for the Luanda-Lobito route, neither the Luanda-Lusaka one and all internal destinations are monopolised by the national airline. Subsidies for national airlines are also common and almost all African State-owned airline have received a subsidy in the past.

The recent development of Asian countries has resulted in a degree of growth of African airlines with regards to the Asian market. For example in 2013, Air Mauritius started flying to the United Arab Emirates, Ethiopian Airlines started flying to Singapore and Kenyan Airways launched a direct flight to Guangzhou in China. Emirates Airlines signed a deal with TAAG Angola Airlines in 2013 to manage the carrier for 10 years and to cooperate for "commercial opportunities" in Africa. Emirates has appointed four senior members of staff to work for TAAG. This management agreement is perceived as the start of the independence of the airline and the end of being dependent on recurrent public subsidies, which were so frequently demanded in the past by the State-appointed managers of TAAG. Furthermore, some European airlines have recently launched flights to remote cities in Africa, an example being Turkish Airlines to Kano in Nigeria, and Ndjamena in Chad.

There have been signs of improved management practices aimed at increasing market share, through growing African routes, such SAA-South Africa Airways re-alignment of its African network, which now flies from Johannesburg to Kinshasa (Congo), Dar Es Salaam (Tanzania), Whindoek (Namibia), Ndola (Zambia) and Lusaka (Zambia). Ethiopian Airways started to fly to Niamey (Republic of Niger) and also to Enugu, Nigeria, in 2013. Code sharing agreements were set up between SAA and RwandAir in 2013 and between SAA and TAM Brazilian Airline, and Air Uganda and RwandaAir. The German low cost carrier, Air Berlin and Air Seychelles also expanded their code sharing in 2010. It can therefore be seen that integration is expanding in the African airline market.

Finally, some market instability has been created by new airlines such as in South Africa, where, in 2012, three new low-cost carriers – FastJet, Skywise, FlySafair – entered the market, and introduced some competition in the market that had been formerly split between the State-owned South SAA and the privately-owned Comair. However, bankruptcies were also observed in 2013 (Air Malawi) and 2012 (Gabon Airways and Air Zimbabwe), but such changes have also been seen in other continents. Therefore the African market displays dynamism and growth. All the African airlines that have been analysed during this research are members of the African Airlines Association (AFRAA), as shown in Table 1.

3. Literature review

Airline research has adopted several methods, such as the factor productivity approach of Bauer (1990), adopted by Oum and Yu (1995) and Barbot et al. (2008); stochastic econometric frontier models (Good et al., 1993; Baltagi, 1995), the Turnquist total factor productivity index (Coelli et al., 2003, p. 27; Barbot et al., 2008) and DEA models (Merkert and Hensher, 2011; Barros et al., 2013; Barros and Peypoch, 2009; Barros and Couto, 2013). These studies analysed US airlines (Barros et al., 2013; Greer, 2008; Sjögren and Söderberg, 2011), Canadian airlines (Bauer, 1990; Assaf, 2009), European airlines (Greer, 2008; Barros and Peypoch, 2009) and Asian airlines (Baltagi et al., 1995).

A number of different issues have been addressed by this research within these countries or regions. Besides efficiency rankings and slack comparisons, the impacts of network size, ownership, and regulatory measures on the performance of the airline industry have also been assessed by incorporating contextual variables with a two-stage approach (Barros et al., 2013). Recent papers have maintained this focus. Table 2 presents a

Table 1
Characteristics of African airlines.

Unit	Name	Country	Start year	Degree of public ownership (%)	Number of employees
1	Afriqiyah Airways	Libya	2001	100	1062
2	Air Algerie	Algerie	1947	100	9750
3	Air Botswana	Botswana	1947	100	355
4	Air Burkina	Burkina	1967	5	262
5	Air Madagsacar	Madagascar	1962	89.56	1296
6	Air Mauritius	Mauritius	1985	44.42	2355
7	Air Namibia	Namibia	1946	100	463
8	Air Seychelles	Seychelles	1978	60	878
9	Air Zimbabwe	Zimbabwe	1946	100	399
10	ASKY Airlines	Togo	2009	0	228
11	Air Tanzania	Tanzania	1977	100	171
12	Camair-Co	Cameroon	2008	100	228
13	Ceiba Intercontinental Ailrlines	Equatorial Guinea	2007	100	206
14	ECAir	Brazzaville, Republic of Congo	2011	100	123
15	EgyptAir	Egypt	1932	100	31725
16	Ethiopian Airlines	Ethiopia	1946	100	6201
17	Interair SA	South Africa	1993	0	729
18	Kenya Airways	Kenya	1977	23	4834
19	LAM Mozambique Airlines	Mozambique	1936	100	710
20	Libyan Airlines	Libya	1965	100	1521
21	PrecisionAir	Tanzania	1991	0	684
22	Royal Air Maroc	Morroco	1977	96.8	7250
23	RwandAir	Rwanda	2002	99	442
24	South African Express	South Africa	1994	100	1015
25	South African Airways	South Africa	1934	100	9209
26	Starbow	Ghana	2011	0	213
27	Sudan Airways	Sudan	1947	51	1840
28	TAAG Angola Airlines	Angola	1938	100	3281
29	Tunisair	Tunisia	1948	74	3028

Source: AFRAA – The African Airlines Association.