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# DYNAMIC MODEL OF PERFORMANCE MEASUREMENT OF MIDDLE EAST AIRLINES

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**Abstract**

Over the past decades, the rapid development of the airline industry has occurred in the Middle East and particularly in the United Arab Emirates. The need for the development of the aviation sector has emerged due to the strategically important position that Middle East occupies as the central point between the eastern and western hemispheres. Its major airlines, so called *Middle East Big Three (MEB3*) - *Emirates, Etihad* and *Qatar Airways*, have become dominant in the region, as well as across the globe, primarily thanks to the high quality of their services and globally recognized brand. The focus of the assessment are the airlines' non-financial performance indicators, such as: the number of carried passengers and cargo, number of employees, serving destinations, fleet size, etc. The analysis covered a period of twelve years, starting from 2005 until 2016, which was characterized by the expansion of these airlines. For each observed company, the efficiency was first separately measured using the Data Envelopment Analysis (DEA) method, followed by the dynamic analysis and measurement of their efficiencies using the DEA Window analysis. In both cases, *Emirates Airlines* had the best performance.

**Key words**: performance evaluation, efficiency assessment, Middle East airlines, DEA

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# ДИНАМИЧКИ МОДЕЛ МЕРЕЊА ПЕРФОРМАНСИ БЛИСКОИСТОЧНИХ АВИО-КОМПАНИЈА

**Апстракт**

Последњих деценија дошло је до наглог развоја авио-индустрије на Блиском истоку, првенствено у Уједињеним Арапским Емиратима. Потреба за развојем авио-сектора јавила се услед стратешки важног положаја који Блиски исток заузима као средишња тачка између источне и западне хемисфере. Велике авио-компаније, попут *Emirates*, *Etihad* и *Qatar Airways*, постале су доминантне на својим локалним и међународним тржиштима, првенствено захваљујући квалитету услужне понуде и глобално препознатљивом бренду. У оквиру емпиријског истраживања нагласак је на оцени ефикасности поменутих авио-компанија, имајући у виду њихове нефинансијске индикаторе пословања као што су: број путника, број дестинација, количина превезеног терета итд. Анализа разматра период од дванаест година, конкретније од 2005. до 2016. године, који карактерише експанзиван развој све три авио-компаније. За сваку посматрану компанију, ефикасност је најпре посебно мерена применом методе Анализе обавијања података (DEA), након чега је примењена динамичка анализа и мерење њихових ефикасности применом *DEA Window* анализе. У оба случаја, најбоље перформансе показала је компанија *Emirates Airlines*.

**Кључне речи**: вишекритеријумска анализа, евалуација перформанси, ефикасност авио-компанија Блиског истока, DEA.

## *INTRODUCTION*

The era of innovative technology, globalization, contemporary lifestyle and increased income has contributed to the growing importance of the air transportation globally. The high demand for air transport has led to the emergence of numerous local and international airlines across the globe, as well as towards the rapid expansion of the Middle East airlines. The three major Middle East airlines, *Emirates*, *Etihad* and *Qatar Airways* dominate nowadays not only in the region, but also globally, thanks to their extensive network coverage, superior service quality and innovative business concepts.

The subject of this research is the efficiency assessment of the three mentioned airlines over the past twelve years. For the purpose of the analysis, *DEA* methodology was applied in order to compare the systems that operate under similar conditions. The aim of the study is to conduct a comprehensive analysis of the airlines' efficiency based on the 5 non-financial parameters, i.e. the chosen key performance indicators. It is expected that the obtained results will help their senior management better understand the current airline position with regard to their past performance, as well as towards their competitors. Besides that, it is expected that the results of the analysis will indicate which performance dimensions still need to be improved and which are at a satisfactory level in case of each airline. The data set for the analysis was obtained from the

airlines' annual reports over the period of twelve years. The parameters that were taken into account are non-financial performance indicators, which together with the financial ones reflect the overall efficiency of the airlines' operations.

## *Literature review*

*DEA* is a specifically designed tool for measuring the efficiency of complex entities that have various inputs and outputs, with the aim to achieve maximum outputs with minimally engaged inputs. Banker, Cummins, & Klumpes (2010) are of the opinion that the non-parametric methods, such as *DEA*, can identify the best practices based on the performance evaluation of the organizations within a particular business area. Compared to the traditional financial indicators, *DEA* is considered to be the superior tool as it summarizes multiple performance indicators into a single measure that embraces the diversity of the observed units (companies) under one multidimensional framework. Numerous studies attempted to assess the efficiency in different business areas using *DEA* methodology, such as the banking sector (Paradi et al, 2004; Asaftei & Kumbhakar, 2008), the traffic sector where *DEA* was used to assess the efficiency of the rail network in the UK (Kennedy & Smith, 2004), as well as the road transport efficiency in Norway (Odeck & Alkadi, 2004).

When it comes to the airline industry, performance management is a crucial tool for the efficient management of all the aspects of the modern airlines' businesses. This was evidenced by the numerous previous studies that have made significant practical and theoretical contribution towards this field of research (Scheraga, 2004; Barbot et al, 2008; Tsaur, Chang & Yen, 2002; Grafton et al, 2010; Tung et al, 2011; Yayla-Kullu & Tansitpong, 2013; Groen et al 2012; Han et al, 2012; Baker, 2013). When it comes to *DEA* application in the airline industry, authors Yayla-Kullu and Tansitpong (2013) were focused in their study on the service quality evaluation of the twelve American airlines, while authors Coli, Nissi and Rapposelli (2011) implemented *DEA* in order to evaluate the performance of an Italian airline. When it comes to the evaluation of Middle East airlines, two studies can be distinguished – one by Massarat and Jha (2014) and the other by authors Surovitskikh and Lubbe (2008). Massarat and Jha (2014) were evaluating the passengers' perception of the service quality of two UAE airlines - *Etihad* and *Air Arabia*, using the SERVQUAL model. On the other hand, Surovitskikh and Lubbe (2008) were focused on the positioning of the four Middle East airlines - *Emirates, Etihad, Qatar Airways* and *Gulf Air,* in the South African business and leisure travel environment in their study. However, none of the previously conducted studies has evaluated the performance of the three aforementioned airlines using the same parameters and methodology.

## *METHODOLOGY*

The Data Envelopment Analysis (*DEA*) is a mathematical, non-parametric approach used to calculate the efficiency without requiring specific functional form (Charnes et al, 1994). Accordingly, DEA is used to evaluate decision making units ($DMU_s$) by converging multiple inputs into a single "virtual" input and multiple outputs into a single "virtual" output by using weighed coefficients. DEA has proven to be an adequate technique for assessing the efficiency of non-profit organizations, since the financial performance indicators, such as revenue and profit, cannot be used to measure the efficiency of such organizations. DEA is a measure of the relative efficiency, since it is based on the benchmarking of the observed $DMU_s$ that are being compared to each other. Within the model, all the data related to input and output variables for each $DMU_s$ are being inserted into a specific linear program in order to obtain the efficiency of $DMU_s$. The efficiency is being calculated as the ratio of the weighed sum of the outputs and weighed sum of the inputs, with the ranges from 0 to 1. Any deviation from that range is being attributed to the excess of the outputs or lack of the inputs. Within DEA, the weights are assigned to the input and output variables based on optimization, showing their significance. However, when it comes to other multi-criteria methods, it is the decision maker who determines the weights of the chosen inputs and outputs in advance. Charnes et al. (1978) also highlighted that it does not require a formal approach to determine the weights during the efficiency evaluation. What matters is the identification of the inputs and outputs that will be considered, as well as their minimum weights. More about the basic principles of *DEA* application can be found in Dyson (2001), Sarkis, (2002), Sherman, H. D., Zhu, J. (2006), Cook and Seiford (2009).

Unlike the majority of the previously conducted studies that were using financial indicators to evaluate airline efficiency (Scheraga, 2004; Barbot et al, 2008; Fethi et al, 2000), this study focuses on the non-financial ones. Accordingly, three inputs (number of employees, aircrafts and destinations) and two outputs (number of carried passengers and cargo) were identified, which appear in every airline annual report, as well as in the literature related to performance evaluation of the airlines (Singh, 2011; Barros, Peypoch, 2009). The chosen parameters are the most common non-financial indicators, which together with the financial ones, provide a composite picture of the overall airline operations. The conducted analysis covers a period of twelve years, which represent twelve decision-making units ($DMU_s$). In order to carry out the analysis, *DEAFrontier* software was used.

## *THE STRUCTURE OF THE RESEARCH PROBLEM*

### *The Impact of the Middle Eastern Airlines on the Development of the Contemporary Air Transport*

The three major Middle Eastern airlines - *Emirates, Qatar and Etihad Airways*, so called *MEB3,* have been in the limelight of the world's aviation scene during the past three decades primarily thanks to their innovative business concepts and rapid expansion. Their local markets have developed from small seaports to the big contemporary metropolis, which possess large international airports operated by air carriers from all over the world. Their hubs that operate on the 24/7 regime is what significantly distinguishes them from their competitors, as they do not close even during night hours. All of them were established by the local governments that provide extensive financial and operational support in every aspect.

Thanks to their unique geographical position, as well as the rapid modernization of the region, Middle Eastern carriers enjoy numerous benefits comparing to the carriers from other continents. According to Al-Sayeh (2014), *Etihad* and *Qatar Airways* will double the number of carried passengers by 2020, while *Emirates* will continue to be the largest airline in terms of the carried passengers, although with a bit of a slower growth rate (Table 4).

*Table 1. The expected number of carried passengers in 2013-2020 by MEB3 carriers*

| | 2013 | 2020 | Increase (%) |
|---|---|---|---|
| Emirates | 49,963,632 | 88,023,780 | 76% |
| Etihad | 13,505,634 | 27,907,404 | 107% |
| Qatar | 21,581,064 | 47,401,579 | 120% |

Source: Al-Sayeh, 2014

In the past decades, *MEB3* carriers have completely changed the image of the contemporary aviation thanks to the innovative business concepts and the high level of service quality, leaving a significant impact on other airlines around the world. Considering their wide network coverage, they have mainly impacted the routes across the Middle East region, as well as in Asia and some parts of Africa, which were previously controlled by other airlines.

Below are some of their common characteristics:

- Their individual size matches or exceeds the size of the major European airlines, such as *British Airways* and *Lufthansa*;
- Massive future fleet orders of *Airbus A380 & 787 Boeing Dreamliner*;
- Favorable geographic position;
- The availability of government financial support;

- Competitive fares;
- Modernized fleet and high quality products and services;
- The fiscal, economic and planning constraints do not exist for the three Gulf carriers;
- Their home base airports operate on an unrestricted 365 days 24/7 regime;
- They rely on the long lasting internationally accepted concept of bilateralism to achieve their business goals;

Thanks to the SWOT analysis conducted by the Mott MacDonald Company (2011), the following strengths, weaknesses, opportunities and threats were observed for *MEB3* carriers:

*Strengths*

- Concerted backing and direction for the airline and airports of the three airlines from their respective governments;
- Availability of financial backing;
- High standard of service and established reputations;
- Geographic position in relation to the major world markets;
- Lack of organized labour;
- Identification of hitherto underserved markets;
- Modern fleets and committed forward order books;
- Unconstrained home bases with commitment for future expansion and development and ability to leverage hub model at limited cost, but with maximum benefit;

*Weaknesses*

- Small home markets;
- Heavy reliance on ex-patriot labour;
- Inability to serve some major markets: Europe to North America and South America;
- Growing competition for same markets from hubs only a few hundred kilometres apart;

*Opportunities*

- Deregulation of world air transport market;
- Changes to the airline ownership and control rules in Europe and the USA allowing one or more of the carriers to buy a US or European affiliate;
- Continued constraint on the development of the airport infrastructure, particularly runways in Europe at the major hub airports;
- Association with major oil producing states;

*Threats*

- Any extension of the Arab spring rebellion into the Gulf region;
- Instability in Iran and Saudi Arabia.

The development of the ME airlines has taken place simultaneously with the growing demand for air transport globally, as well as the expansion and modernization of the region. With an average growth rate of 7.1% annually, the Middle East is currently the fastest-growing region in terms of air transport (IATA Press Release, *Moderating Demand Trend Continues*, 2016). Bearing in mind the currently unfavorable economic situation on the global market scene, these air carriers are also facing certain difficulties and challenges, such as the drop in oil prices on the global market, the political unrest in the region, restrictive legislation and strong competition from European, American and Asian airlines. However, despite the mentioned regulatory constraints and challenges on the global market, the new millennium is characterized by the rapid development of the Middle East airlines, amongst which *Emirates, Etihad* and *Qatar Airways* should be particularly singled out.

### *Descriptive Statistics*

In order to evaluate the efficiency of the mentioned airlines, three inputs (the number of employees, number of airplanes and number of destinations) and two outputs (the number of carried passengers and transported cargo) were identified. The time span in which the efficiency has been measured covers the period of twelve years, from 2005 to 2016 (12 $DMU_s$), which is shown below for each airline individually (Tables 1-3).

*Table 2. Structuring DEA model for efficiency evaluation of Emirates airlines*

| Year | No of employees (I1) | No of aircrafts (I2) | No of destinations (I3) | Passengers carried (O1) | Cargo tonnage (O2) |
|---|---|---|---|---|---|
| 2005 | 17.296 | 85 | 70 | 14.497.000 | 1.018.000 |
| 2006 | 20.273 | 96 | 78 | 17.544.000 | 1.155.000 |
| 2007 | 23.650 | 109 | 82 | 21.229.000 | 1.282.000 |
| 2008 | 28.037 | 127 | 90 | 22.730.000 | 1.408.000 |
| 2009 | 35.812 | 142 | 89 | 22.731.000 | 1.580.000 |
| 2010 | 36.652 | 148 | 95 | 27.500.000 | 1.767.000 |
| 2011 | 38.797 | 169 | 98 | 31.400.000 | 1.796.000 |
| 2012 | 42.422 | 197 | 111 | 33.900.000 | 2.086.000 |
| 2013 | 47.678 | 217 | 123 | 39.400.000 | 2.250.000 |
| 2014 | 52.516 | 231 | 133 | 44.500.000 | 2.377.000 |
| 2015 | 56.725 | 251 | 142 | 48.100.000 | 2.509.000 |
| 2016 | 61.205 | 260 | 144 | 51.900.000 | 25.100.000 |

Source: The Emirates Group Annual Report (2005-2016)

*Table 3. Structuring DEA model for efficiency evaluation of Qatar Airways*

| Year | No of employees (I1) | No of aircrafts (I2) | No of destinations (I3) | Passengers carried (O1) | Cargo tonnage (O2) |
|---|---|---|---|---|---|
| 2005 | 14.323 | 46 | 61 | 3.300.000 | 178.909 |
| 2006 | 14.787 | 55 | 68 | 4.600.000 | 250.333 |
| 2007 | 15.000 | 61 | 75 | 6.000.000 | 290.090 |
| 2008 | 15.808 | 65 | 79 | 8.000.000 | 340.121 |
| 2009 | 17.505 | 76 | 80 | 10.000.000 | 389.090 |
| 2010 | 18.100 | 96 | 90 | 12.000.000 | 500.321 |
| 2011 | 19.000 | 109 | 100 | 14.000.000 | 580.443 |
| 2012 | 22.000 | 124 | 110 | 16.000.000 | 620.392 |
| 2013 | 22.600 | 133 | 120 | 17.000.000 | 680.900 |
| 2014 | 23.500 | 152 | 130 | 18.000.000 | 710.555 |
| 2015 | 24.000 | 172 | 140 | 22.352.000 | 764.324 |
| 2016 | 31.000 | 192 | 150 | 26.654.000 | 954.191 |

Source: Qatar Airways Group, Annual Report (2005-2016)

*Table 4. Structuring DEA model for efficiency evaluation of Etihad Airways*

| Year | No of employees (I1) | No of aircrafts (I2) | No of destinations (I3) | Passengers carried (O1) | Cargo tonnage (O2) |
|---|---|---|---|---|---|
| 2005 | 2.116 | 12 | 23 | 1.000.000 | 115.000 |
| 2006 | 3.468 | 22 | 43 | 2.800.000 | 121.000 |
| 2007 | 5.563 | 37 | 50 | 4.600.000 | 175.000 |
| 2008 | 7.058 | 42 | 59 | 6.000.000 | 194.000 |
| 2009 | 7.828 | 53 | 69 | 6.300.000 | 219.000 |
| 2010 | 7.855 | 57 | 79 | 7.100.000 | 263.000 |
| 2011 | 9.038 | 64 | 81 | 8.300.000 | 310.000 |
| 2012 | 10.656 | 70 | 86 | 10.200.000 | 368.000 |
| 2013 | 13.600 | 89 | 102 | 11.500.000 | 487.000 |
| 2014 | 17.593 | 110 | 111 | 14.300.000 | 569.000 |
| 2015 | 26.566 | 121 | 116 | 17.000.000 | 591.000 |
| 2016 | 26.635 | 122 | 112 | 18.500.000 | 592.700 |

Source: Etihad Airways, Facts & Figures (2005-2016)

### *Correlation Analysis*

One of the vital steps in DEA model is to correctly identify input and output parameters. The general rule is to have three $DMU_s$ for each input and output variable, which means that the total sum of the input and output variables must be smaller than the number of defined $DMU_s$. Cooper et al (2007) are of the opinion that the product of inputs and outputs should be smaller than the number of evaluated $DMU_s$. Therefore,

there is a potential risk that the majority of the $DMU_s$ will show as effective units due to DEA tendency to show each unit (DMU) as efficient as possible (Martić & Savić, 2001). In addition to that, the input and output variables must be precisely defined, operatively significant and fully reflect the performance of the defined units.

Besides that, it is necessary to determine whether a correlation exists between the input and output variables. Therefore, the correlation analysis should be conducted in order to find the strength of the connection between the input and output variables for each of the three Middle Eastern airlines. In order to calculate the relationship between the input and output values of the model, Pearson's correlation coefficient (R) has been used with a value range from +1 (perfectly positive correlation) to -1 (perfectly negative correlation). The tables below show the obtained correlation coefficient for each pair of the observed inputs/outputs for each of the airlines.

*Table 5. The correlation between input and output variables in DEA – Emirates Airlines*

| Variable vs. Variable | R |
|---|---|
| No of passengers (O1) vs. No of destinations (I3) | 0,9936 |
| No of aircrafts (I2) vs. No of employees (I1) | 0,9908 |
| No of passengers (O1) vs. No of aircrafts (I2) | 0,9904 |
| No of destinations (I3) vs. No of aircrafts (I2) | 0,9901 |
| No of passengers (O1) vs. No of employees (I1) | 0,9817 |
| No of destinations (I3) vs. No of employees (I1) | 0,9774 |
| Cargo (tonnage) (O2) vs. No of passengers (O1) | 0,5830 |
| Cargo (tonnage) (O2) vs. No of employees (I1) | 0,5603 |
| Cargo (tonnage) (O2) vs. No of destinations (I3) | 0,5472 |
| Cargo (tonnage) (O2) vs. No of aircrafts (I2) | 0,5304 |

Source: author

*Table 6. The correlation between input and output variables in DEA – Qatar Airways*

| Variable vs. Variable | R |
|---|---|
| No of passengers (O1) vs. No of destinations (I3) | 0,9962 |
| No of aircrafts (I2) vs. No of employees (I1) | 0,9932 |
| No of passengers (O1) vs. No of aircrafts (I2) | 0,9915 |
| No of destinations (I3) vs. No of aircrafts (I2) | 0,9880 |
| No of passengers (O1) vs. No of employees (I1) | 0,9856 |
| No of destinations (I3) vs. No of employees (I1) | 0,9838 |
| Cargo (tonnage) (O2) vs. No of passengers (O1) | 0,9746 |
| Cargo (tonnage) (O2) vs. No of employees (I1) | 0,9723 |
| Cargo (tonnage) (O2) vs. No of destinations (I3) | 0,9702 |
| Cargo (tonnage) (O2) vs. No of aircrafts (I2) | 0,9629 |

Source: author

*Table 7. The correlation between input and output variables in DEA – Etihad Airways*

| Variable vs. Variable | R |
|---|---|
| No of passengers (O1) vs. No of destinations (I3) | 0,9918 |
| No of aircrafts (I2) vs. No of employees (I1) | 0,9879 |
| No of passengers (O1) vs. No of aircrafts (I2) | 0,9777 |
| No of destinations (I3) vs. No of aircrafts (I2) | 0,9767 |
| No of passengers (O1) vs. No of employees (I1) | 0,9765 |
| No of destinations (I3) vs. No of employees (I1) | 0,9603 |
| Cargo (tonnage) (O2) vs. No of passengers (O1) | 0,9589 |
| Cargo (tonnage) (O2) vs. No of employees (I1) | 0,9575 |
| Cargo (tonnage) (O2) vs. No of destinations (I3) | 0,9429 |
| Cargo (tonnage) (O2) vs. No of aircrafts (I2) | 0,8921 |

Source: author

Based on the obtained values, it can be concluded that there is a high and positive correlation among all inputs and outputs for all the three airlines, demonstrated by the correlation coefficient close to one. Accordingly, an increase in the inputs (the number of aircraft, number of destinations and number of employees) will lead to the simultaneous increase of the output (number of carried passengers and cargo tonnage).

## *DEA IMPLEMENTATION IN AIRLINES' EFFICIENCY EVALUATION*

Unlike some conventional methods, DEA analyzes decision making units that are characterized by a larger number of inputs and outputs. The input and output specification is crucial for the effective evaluation, interpretation and implementation of the obtained results. The number of chosen $DMU_s$ that are being compared depends on the purpose of the study, as well as the number of homogeneous units whose performance is being evaluated. The efficiency is reflected in the obtained results (outputs) that are achieved with the correct amount of resources (inputs) and the corresponding technology. In this context, the efficiency can be calculated by comparing achieved and target values for both inputs and outputs. Therefore, the achieved output should be compared to the maximum possible output (output-oriented model) that can be obtained from the defined inputs, while the actual input should be compared to the minimally required input (input-oriented model) that is required in order to produce the desired output level. Thus, in the input-oriented model the efficiency can be improved via input reduction, while in the output-oriented model by output increase. In this study the output-orientation has been adopted, given the fact that the airline interest is to increase the output, rather than to reduce the input. Table 8 shows the

achieved input and output values for *Emirates* during observed period of 12 years, while Table 9 is showing its target (optimal) values.[1]

*Table 8. The achieved input and output values for Emirates*

| Year | No of employees (I1) | No of aircrafts (I2) | No of destinations (I3) | Passengers carried (O1) | Cargo tonnage (O2) |
|---|---|---|---|---|---|
| 2005 | 17.296 | 85 | 70 | 14.497.000 | 1.018.000 |
| 2006 | 20.273 | 96 | 78 | 17.544.000 | 1.155.000 |
| 2007 | 23.650 | 109 | 82 | 21.229.000 | 1.282.000 |
| 2008 | 28.037 | 127 | 90 | 22.730.000 | 1.408.000 |
| 2009 | 35.812 | 142 | 89 | 22.731.000 | 1.580.000 |
| 2010 | 36.652 | 148 | 95 | 27.500.000 | 1.767.000 |
| 2011 | 38.797 | 169 | 98 | 31.400.000 | 1.796.000 |
| 2012 | 42.422 | 197 | 111 | 33.900.000 | 2.086.000 |
| 2013 | 47.678 | 217 | 123 | 39.400.000 | 2.250.000 |
| 2014 | 52.516 | 231 | 133 | 44.500.000 | 2.377.000 |
| 2015 | 56.725 | 251 | 142 | 48.100.000 | 2.509.000 |
| 2016 | 61.205 | 260 | 144 | 51.900.000 | 25.100.000 |

Source: DEAFrontier

*Table 9. The target input and output values for Emirates*

| DMU No. | Year | $I_1$ | $I_2$ | $I_3$ | $O_1$ | $O_2$ |
|---|---|---|---|---|---|---|
| 1 | 2005 | 17,296 | 85 | 70 | 14,497,000 | 1,018,000 |
| 2 | 2006 | 20,273 | 96 | 78 | 17,544,000 | 1,155,000 |
| 3 | 2007 | 23,650 | 109 | 82 | 21,229,000 | 1,282,000 |
| 4 | 2008 | 26,756 | 121 | 85 | 22,730,000 | 1,408,000 |
| 5 | 2009 | 32,660 | 135 | 84 | 24,779,851 | 1,580,000 |
| 6 | 2010 | 36,652 | 148 | 95 | 27,500,000 | 1,767,000 |
| 7 | 2011 | 38,797 | 169 | 98 | 31,400,000 | 1,796,000 |
| 8 | 2012 | 42,422 | 197 | 111 | 33,900,000 | 2,086,000 |
| 9 | 2013 | 47,678 | 217 | 123 | 39,400,000 | 2,250,000 |
| 10 | 2014 | 52,516 | 231 | 133 | 44,500,000 | 2,377,000 |
| 11 | 2015 | 56,676 | 247 | 142 | 48,100,000 | 2,509,000 |
| 12 | 2016 | 61,205 | 260 | 144 | 51,900,000 | 2,510,000 |

Source: DEAFrontier software

By observing the achieved and target values from the previous tables, it can be noticed that they are mostly aligned, except for the years: 2008, 2009 and 2015. If 2008 was observed in isolation, it could be noticed that the airline could optimally operate with 26,756 employees, 127 planes and 85 destinations, as these were its target values having in mind

[1] All calculations were made using DEA Frontier software package

reference years, where the relative efficiency was equal to 1. However, that year the airline operated with slightly higher inputs compared to the target ones, which led to lower efficiency that year.

In this study the output-oriented *CCR* model with a constant yield on volume was implemented, and this tends to increase the output at the existing input level. One of DEA characteristics is that it uses mathematical programming to develop efficiency frontier and estimate the relative distance from it. Accordingly, it can be determined how many units are ineffective and by how much the output should be increased to render these units effective. Therefore, the efficiency measure that DEA gives is relative. The corresponding dual model, as a multiplier version of the output-oriented CCR DEA model, with three inputs and two outputs for *j* DMU (in year *j*) is shown below:

$$\min h_{j0} = \sum_{i=1}^{3} v_{ij0} \times x_{ij0},$$

$$S.t. \sum_{r=1}^{2} u_{rj0} \times y_{rjo} = 1$$

$$\sum_{i=1}^{3} v_{ij0} \times x_{ij0} - \sum_{r=1}^{2} u_{rj0} \times y_{rj0} \geq 0, \quad j = 1,..,12$$

$$u_r \geq 0$$

$$v_i \geq 0$$

where:
$y_{rj}$ - the value of output in year *j*;
$x_{ij}$ - the value of input in year *j*;
$u_{rj0}$ – weights of the output variables in year *j*;
$v_{ij0}$ - weights of the input variables in year *j*;

The following table shows the results of *DEA* analysis with different yields on volume: constant, increasing and decreasing. The *constant return to scale* (*CRS*) represents the situation when the output increases proportionally with the input increase, which can be spotted during each efficient year (*RTS* column). However, if the output increases to a lesser extent comparing to increase in inputs, it is considered *decreasing return to scale* (DRS), which was noticed in 2008 and 2015. On the other hand, if the output increases to a greater extent compared to the increase in input, it is considered *increasing return to scale* (IRS) and it was achieved in 2009.

*Table 10. The efficiency of the Emirates Airlines in period 2005-2016.*

| DMU No. | Year | Efficiency | Sum of lambdas | RTS | Optimal Lambdas with Benchmarks | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2005 | 1,00000 | 1,000 | Constant | 1,000 | 2005 | | | | |
| 2 | 2006 | 1,00000 | 1,000 | Constant | 1,000 | 2006 | | | | |
| 3 | 2007 | 1,00000 | 1,000 | Constant | 1,000 | 2007 | | | | |
| 4 | 2008 | 0,95432 | 1,007 | Decreasing | 0,118 | 2005 | 0,651 | 2007 | 0,138 | 2010 |
| 5 | 2009 | 0,95274 | 0,870 | Increasing | 0,738 | 2010 | 0,132 | 2012 | | |
| 6 | 2010 | 1,00000 | 1,000 | Constant | 1,000 | 2010 | | | | |
| 7 | 2011 | 1,00000 | 1,000 | Constant | 1,000 | 2011 | | | | |
| 8 | 2012 | 1,00000 | 1,000 | Constant | 1,000 | 2012 | | | | |
| 9 | 2013 | 1,00000 | 1,000 | Constant | 1,000 | 2013 | | | | |
| 10 | 2014 | 1,00000 | 1,000 | Constant | 1,000 | 2014 | | | | |
| 11 | 2015 | 0,99914 | 1,066 | Decreasing | 0,055 | 2007 | 0,750 | 2014 | 0,261 | 2016 |
| 12 | 2016 | 1,00000 | 1,000 | Constant | 1,000 | 2016 | | | | |

Source: DEAFrontier

Based on the results, it can be concluded that *Emirates* operated efficiently in almost every year during the observed period, as indicated by value 1 in the *Efficiency* column, except in 2008, 2009 and 2015. For each inefficient unit, its efficient reference unit was determined (*ERS - Efficient Reference Units*) comparing to which it was considered ineffective. Therefore, for year 2008 its reference years were 2005, 2007 and 2010, for year 2009. it was 2010 and 2012, while for 2015 the reference years were 2007, 2014 and 2016. The same type of analysis was done for *Qatar* and *Etihad Airways*, as shown in the following tables.

*Table 11. The achieved input and output values for Qatar*

| Year | No of employees (I1) | No of aircrafts (I2) | No of destinations (I3) | Passengers carried (O1) | Cargo tonnage (O2) |
|---|---|---|---|---|---|
| 2005 | 14.323 | 46 | 61 | 3.300.000 | 178.909 |
| 2006 | 14.787 | 55 | 68 | 4.600.000 | 250.333 |
| 2007 | 15.000 | 61 | 75 | 6.000.000 | 290.090 |
| 2008 | 15.808 | 65 | 79 | 8.000.000 | 340.121 |
| 2009 | 17.505 | 76 | 80 | 10.000.000 | 389.090 |
| 2010 | 18.100 | 96 | 90 | 12.000.000 | 500.321 |
| 2011 | 19.000 | 109 | 100 | 14.000.000 | 580.443 |
| 2012 | 22.000 | 124 | 110 | 16.000.000 | 620.392 |
| 2013 | 22.600 | 133 | 120 | 17.000.000 | 680.900 |
| 2014 | 23.500 | 152 | 130 | 18.000.000 | 710.555 |
| 2015 | 24.000 | 172 | 140 | 22.352.000 | 764.324 |
| 2016 | 31.000 | 192 | 150 | 26.654.000 | 954.191 |

Source: DEAFrontier

*Table 12. The target input and output values for Qatar*

| DMU No. | Year | $I_1$ | $I_2$ | $I_3$ | $O_1$ | $O_2$ |
|---|---|---|---|---|---|---|
| 1 | 2005 | 5,856 | 33 | 31 | 4,315,197 | 178,909 |
| 2 | 2006 | 8,194 | 47 | 43 | 6,037,908 | 250,333 |
| 3 | 2007 | 9,495 | 54 | 49 | 6,996,828 | 290,090 |
| 4 | 2008 | 11,133 | 63 | 58 | 8,203,551 | 340,121 |
| 5 | 2009 | 12,696 | 75 | 64 | 10,000,000 | 389,090 |
| 6 | 2010 | 16,377 | 93 | 86 | 12,067,496 | 500,321 |
| 7 | 2011 | 19,000 | 109 | 100 | 14,000,000 | 580,443 |
| 8 | 2012 | 20,240 | 120 | 102 | 16,000,000 | 620,392 |
| 9 | 2013 | 22,209 | 130 | 116 | 17,000,000 | 680,900 |
| 10 | 2014 | 22,769 | 147 | 125 | 19,094,696 | 710,555 |
| 11 | 2015 | 24,000 | 172 | 140 | 22,352,000 | 764,324 |
| 12 | 2016 | 31,000 | 192 | 150 | 26,654,000 | 954,191 |

Source: DEAFrontier software

*Table 13. The efficiency of the Qatar Airways in period 2005-2016.*

| DMU *No.* | *Year* | Efficiency | Sum of lambdas | RTS | Optimal Lambdas with Benchmarks | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2005 | 0,73037 | 0,308 | Increasing | 0,308 | 2011 | | | |
| 2 | 2006 | 0,85472 | 0,431 | Increasing | 0,431 | 2011 | | | |
| 3 | 2007 | 0,89304 | 0,500 | Increasing | 0,500 | 2011 | | | |
| 4 | 2008 | 0,98262 | 0,586 | Increasing | 0,586 | 2011 | | | |
| 5 | 2009 | 0,98991 | 0,561 | Increasing | 0,392 | 2011 | 0,169 | 2016 | |
| 6 | 2010 | 0,97869 | 0,862 | Increasing | 0,862 | 2011 | | | |
| 7 | 2011 | 1,00000 | 1,000 | Constant | 1,000 | 2011 | | | |
| 8 | 2012 | 0,96896 | 0,885 | Increasing | 0,601 | 2011 | 0,285 | 2016 | |
| 9 | 2013 | 0,98271 | 1,092 | Decreasing | 0,937 | 2011 | 0,055 | 2015 | 0,10 |
| 10 | 2014 | 0,96892 | 1,056 | Decreasing | 0,555 | 2011 | 0,474 | 2015 | 0,03 |
| 11 | 2015 | 1,00000 | 1,000 | Constant | 1,000 | 2015 | | | |
| 12 | 2016 | 1,00000 | 1,000 | Constant | 1,000 | 2016 | | | |

Source: DEAFrontier

In the case of *Qatar Airways*, the efficiency was achieved in 2011, 2015 and 2016, as indicated by the obtained values in the *Efficiency* column. This is a weaker result comparing to *Emirates* which achieved efficiency during the period of nine years. In case of *Qatar Airways*, the remaining years were considered ineffective in relation to their benchmark units, thus their input/output level needs to be adjusted in order to operate at the margin of efficiency. For example, in 2014. the number of carried passengers could reach 19 million, which was its target value having in mind the level of used inputs that year, but the achieved figure was one million less.

When it comes to *Etihad Airways*, the efficiency was achieved in the following five years: 2005, 2012, 2013, 2014 and 2016, while the rest of the years were relatively inefficient in comparison. This is a slightly better result compared to *Qatar* and a somewhat weaker result comparing to *Emirates*.

*Table 14. The achieved input and output values for Etihad*

| Year | No of employees (I1) | No of aircrafts (I2) | No of destinations (I3) | Passengers carried (O1) | Cargo tonnage (O2) |
|---|---|---|---|---|---|
| 2005 | 2.116 | 12 | 23 | 1.000.000 | 115.000 |
| 2006 | 3.468 | 22 | 43 | 2.800.000 | 121.000 |
| 2007 | 5.563 | 37 | 50 | 4.600.000 | 175.000 |
| 2008 | 7.058 | 42 | 59 | 6.000.000 | 194.000 |
| 2009 | 7.828 | 53 | 69 | 6.300.000 | 219.000 |
| 2010 | 7.855 | 57 | 79 | 7.100.000 | 263.000 |
| 2011 | 9.038 | 64 | 81 | 8.300.000 | 310.000 |
| 2012 | 10.656 | 70 | 86 | 10.200.000 | 368.000 |
| 2013 | 13.600 | 89 | 102 | 11.500.000 | 487.000 |
| 2014 | 17.593 | 110 | 111 | 14.300.000 | 569.000 |
| 2015 | 26.566 | 121 | 116 | 17.000.000 | 591.000 |
| 2016 | 26.635 | 122 | 112 | 18.500.000 | 592.700 |

Source: DEAFrontier

*Table 15. The target input and output values for Etihad*

| DMU No. | Year | $I_1$ | $I_2$ | $I_3$ | $O_1$ | $O_2$ |
|---|---|---|---|---|---|---|
| 1 | 2005 | 2,116 | 12 | 23 | 1,000,000 | 115,000 |
| 2 | 2006 | 3,234 | 20 | 27 | 2,800,000 | 121,000 |
| 3 | 2007 | 4,928 | 32 | 40 | 4,600,000 | 175,000 |
| 4 | 2008 | 6,852 | 40 | 47 | 6,000,000 | 210,490 |
| 5 | 2009 | 6,581 | 43 | 53 | 6,300,000 | 227,294 |
| 6 | 2010 | 7,510 | 49 | 61 | 7,100,000 | 263,000 |
| 7 | 2011 | 8,814 | 57 | 71 | 8,300,000 | 310,000 |
| 8 | 2012 | 10,656 | 70 | 86 | 10,200,000 | 368,000 |
| 9 | 2013 | 13,600 | 89 | 102 | 11,500,000 | 487,000 |
| 10 | 2014 | 17,593 | 110 | 111 | 14,300,000 | 569,000 |
| 11 | 2015 | 25,347 | 117 | 112 | 17,419,187 | 591,000 |
| 12 | 2016 | 26,635 | 122 | 112 | 18,500,000 | 592,700 |

Source: DEAFrontier

*Table 16. The efficiency of Etihad Airways in period 2005-2016.*

| DMU No. | Year | Efficiency | Sum of lambdas | RTS | Optimal Lambdas with Benchmarks | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2005 | 1,00000 | 1,000 | Constant | 1,000 | 2005 | | | | |
| 2 | 2006 | 0,93254 | 0,503 | Increasing | 0,257 | 2005 | 0,241 | 2012 | 0,005 | 2016 |
| 3 | 2007 | 0,88592 | 0,554 | Increasing | 0,115 | 2005 | 0,440 | 2012 | | |
| 4 | 2008 | 0,97094 | 0,523 | Increasing | 0,443 | 2012 | 0,080 | 2016 | | |
| 5 | 2009 | 0,84078 | 0,618 | Increasing | 0,618 | 2012 | | | | |
| 6 | 2010 | 0,95612 | 0,774 | Increasing | 0,087 | 2005 | 0,688 | 2012 | | |
| 7 | 2011 | 0,97524 | 0,934 | Increasing | 0,134 | 2005 | 0,801 | 2012 | | |
| 8 | 2012 | 1,00000 | 1,000 | Constant | 1,000 | 2012 | | | | |
| 9 | 2013 | 1,00000 | 1,000 | Constant | 1,000 | 2013 | | | | |
| 10 | 2014 | 1,00000 | 1,000 | Constant | 1,000 | 2014 | | | | |
| 11 | 2015 | 0,96709 | 1,317 | Decreasing | 0,397 | 2005 | 0,920 | 2016 | | |
| 12 | 2016 | 1,00000 | 1,000 | Constant | 1,000 | 2016 | | | | |

Source: DEAFrontier

*DEA Window Analysis of Efficiency of All Three Companies*

In order to determine the performance and monitor the performance trends of the decision-making units over a specific time period, it is possible to use an extended DEA. In literature, this analysis is known as the Window DEA method and represents a variant of a traditional DEA approach that can be described as a moving average technique which establishes efficiency measures by observing the DMU at different time periods as a separate unit (Wang et al., 2013). Each unit is treated as a different DMU in a different time period, while the performance of the observed DMU is compared with its performances over other periods of time and with the performance of all other units encompassed by a single window (Yang and Chang, 2009; Cooper et al, 2011). According to Kutlar et al. (2015), in this analysis, a smaller window size can lead to a smaller number of $DMU_s$, which in combination with a large number of variables, reduces the discriminatory power of the analysis. On the other hand, the larger the size of the window the higher risk of erroneous results, because important changes that happen at a certain point can be ignored because of the oversized window. In this extended DEA model, $n$ DMU ($j$ = 1,..,$n$) in time intervals ($t$ = 1, ...,$P$) is observed and all are used from the input to obtain the $m$ output. The observed set consists of $n$ *x* $P$ entities and one entity in the period $t$. A window that starts at the moment l, $1 \leq l \leq P$ and has a width $w$, $1 \leq w \leq P$-1, and is denoted by $lw$, and consists of $n \times w$ observations (Jia and Yuan, 2017).

Using the DEA Window analysis, for the three observed airlines, with nine windows, each length $w = 4$[2], average efficiency was calculated

[2] Charnes et al, 1994, proposed that a window length of three or four time periods tend to yield the best balance of informativeness and stability of the efficiency measure.

in the observed period, 2005-2016, formation and application of 3 x 12 x 4 = 144 models (Table 18)[3].

*Table 17. Descriptive statistics of input and output variables*

| Variable | $I_1$ (No of employees) | $I_2$ (No of aircrafts) | $I_3$ (No of destinations) | $O_1$ (Passengers carried) | $O_2$ (Cargo tonnage) |
|---|---|---|---|---|---|
| max | 61205 ($EA_{2016}$) | 260 ($EA_{2016}$) | 150 ($Q_{2016}$) | 51900000 ($EA_{2016}$) | 25100000 ($EA_{2016}$) |
| min | 2116 ($ET_{2005}$) | 12 ($EA_{2005}$) | 23 ($ET_{2005}$) | 1000000 ($ET_{2005}$) | 115000 ($ET_{2005}$) |
| mean | 23240,6111 | 114,22 | 94,13 | 17803805,55 | 1516454,69 |
| SD | 14966,13 | 64,63 | 30,05 | 13060547,5 | 4102300,35 |

*Table 18.Average efficiency: variation through windows*

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Emirates* | 1 | 1 | 1 | 1 | | | | | | | | | 1 |
| *Airlines* | | 1 | 1 | 0,97 | 1 | | | | | | | | 0,99 |
| | | | 1 | 0,95 | 0,95 | 1 | | | | | | | 0,97 |
| | | | | 1 | 0,95 | 1 | 1 | | | | | | 0,98 |
| | | | | | 0,95 | 1 | 1 | 1 | | | | | 0,98 |
| | | | | | | 1 | 1 | 1 | 1 | | | | 1 |
| | | | | | | | 1 | 1 | 1 | 1 | | | 1 |
| | | | | | | | | 1 | 1 | 1 | 1 | | 1 |
| | | | | | | | | | 0,96 | 0,99 | 0,99 | 1 | 0,98 |
| *Qatar* | 0,36 | 0,42 | 0,50 | 0,63 | | | | | | | | | 0,48 |
| *Airways* | | 0,42 | 0,50 | 0,63 | 0,67 | | | | | | | | 0,56 |
| | | | 0,50 | 0,63 | 0,67 | 0,73 | | | | | | | 0,63 |
| | | | | 0,66 | 0,70 | 0,78 | 0,86 | | | | | | 0,75 |
| | | | | | 0,70 | 0,75 | 0,83 | 0,83 | | | | | 0,78 |
| | | | | | | 0,75 | 0,82 | 0,82 | 0,84 | | | | 0,81 |
| | | | | | | | 0,81 | 0,81 | 0,83 | 0,84 | | | 0,82 |
| | | | | | | | | 0,80 | 0,82 | 0,83 | 1 | | 0,86 |
| | | | | | | | | | 0,84 | 0,84 | 1 | 0,95 | 0,90 |
| Etihad | 0,92 | 0,89 | 0,92 | 0,94 | | | | | | | | | 0,92 |
| Airways | | 0,89 | 0,92 | 0,94 | 0,89 | | | | | | | | 0,91 |
| | | | 0,91 | 0,94 | 0,89 | 1 | | | | | | | 0,93 |
| | | | | 0,97 | 0,88 | 0,98 | 1 | | | | | | 0,96 |
| | | | | | 0,84 | 0,95 | 0,96 | 1 | | | | | 0,94 |
| | | | | | | 0,95 | 0,96 | 1 | 0,92 | | | | 0,96 |
| | | | | | | | 0,96 | 1 | 0,92 | 0,88 | | | 0,94 |
| | | | | | | | | 1 | 0,92 | 0,87 | 0,74 | | 0,88 |
| | | | | | | | | | 0,92 | 0,89 | 0,74 | 0,81 | 0,84 |
| Average | 0,76 | 0,77 | 0,80 | 0,85 | 0,84 | 0,91 | 0,93 | 0,93 | 0,91 | 0,90 | 0,91 | 0,92 | |

[3] All DEA Window calculations were made using Solver LV8 software package

*Table 19. Average efficiency: variation through windows*

| | 2005-2006-2007-2008 | 2006-2007-2008-2009 | 2007-2008-2009-2010 | 2008-2009-2010-2011 | 2009-2010-2011-2012 | 2010-2011-2012-2013 | 2011-2012-2013-2014 | 2012-2013-2014-2015 | 2013-2014-2015-2016 |
|---|---|---|---|---|---|---|---|---|---|
| Emirates Airlines | 1 | 0,99 | 0,97 | 0,98 | 0,98 | 1 | 1 | 1 | 0,98 |
| Qatar Airways | 0,48 | 0,56 | 0,63 | 0,75 | 0,78 | 0,81 | 0,82 | 0,86 | 0,90 |
| Etihad Airways | 0,92 | 0,91 | 0,93 | 0,96 | 0,94 | 0,96 | 0,94 | 0,88 | 0,84 |

*Table 20. Average efficiency through term*

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emirates Airlines | 1 | 1 | 1 | 0,98 | 0,96 | 1 | 1 | 1 | 0,99 | 0,99 | 0,99 | 1 |
| Qatar Airways | 0,36 | 0,42 | 0,50 | 0,63 | 0,69 | 0,75 | 0,83 | 0,81 | 0,83 | 0,84 | 1 | 0,95 |
| Etihad Airways | 0,92 | 0,89 | 0,91 | 0,95 | 0,87 | 0,97 | 0,97 | 1 | 0,92 | 0,88 | 0,74 | 0,81 |

The dynamic analysis of the achieved efficiency, in case the set of decision-making units, takes the observed periods for all three companies together in consideration, and shows significant deviations from the previous analysis, but gives comparable results in the observed period. The results show that for Emirates, in that sense, in 2005, 2006, 2007, 2010, 2011, 2012 and 2016, they were efficient in the use of available resources, for Qatar it was only in 2015, and for Etihad 2012 (Table 19). The graphic presentation of the efficiency movement (Figure 1) illustrates the relatively stable efficiencies in the observed period for Emirates, the rising trend for Qatar and the declining trend for Etihad (Figure 1 and 2) The combined average efficiency of all three companies, over the observed period, first shows growth, and then slight decline, but a relatively stable trend, in the amount of 76% to 93% efficient use of available resources (Table 17)[4]

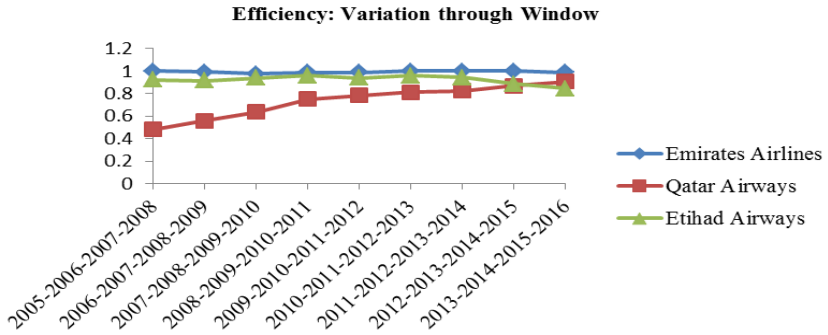


*Figure 1. Efficiency score: Variation through Window*

[4] All calculations were made using DEA Solver LV8 software package

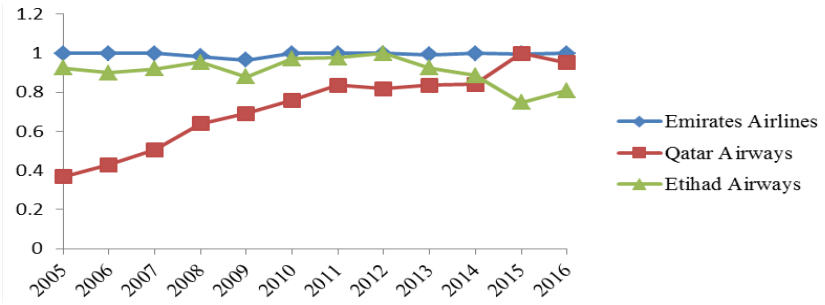


*Figure 2. Average efficiency score: Variation by Term*

### *Effect of Efficiency on Airline Profits*

After comparing the three airlines' efficiency results, the achieved values were also compared with the business results, expressed in terms of profit, for *Emirates* airlines (graph). For the other two airlines, a similar analysis could be performed, but due to the lack of the data this analysis was omitted.

*Table 21. The comparison of normalized profit values with achieved efficiency for Emirates*

| Year | Profit (normalized) | Efficiency (DEA CRS model) |
|---|---|---|
| 2005 | 0,61 | 1 |
| 2006 | 0,75 | 1 |
| 2007 | 1,22 | 1 |
| 2008 | 1,07 | 0,95 |
| 2009 | 0,61 | 0,95 |
| 2010 | 0,85 | 1 |
| 2011 | 1,31 | 1 |
| 2012 | 0,44 | 1 |
| 2013 | 0,68 | 1 |
| 2014 | 1,03 | 1 |
| 2015 | 1,43 | 0,99 |
| 2016 | 2,014 | 1 |

Source: author

Based on the results it can be concluded that the *Emirates'* profit movement was in line with the global economic situation and the impact of the external factors, such as the global financial crisis that occurred in October 2008. Although the UAE economy started to turn around in 2011, the real effect of the growth was felt throughout 2012, especially in trade, aviation, tourism and retail sectors — the key drivers of economic growth in addition to oil. The above implies that even though *Emirates* used its resources efficiently, as indicated by the straight red efficiency

line, the external factors and circumstances that were beyond airline's control nevertheless had an impact on the achieved profit values.

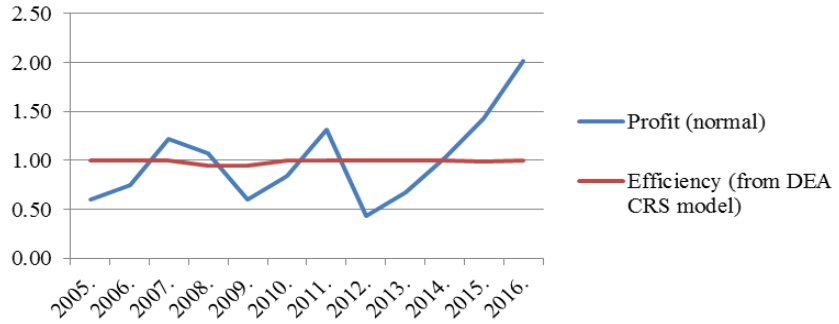


*Figure 3. Graphical presentation of normalized profit values and achieved efficiency for Emirates (2005-2016)*

The correlation analysis was conducted as well for the *Emirates* airline, in order to examine if there is a correlation between the two observed variables - profit and efficiency from *DEA CCR* model (table).

*Table 22. The Correlation Coefficients Matrix*

| | | Profit (normal) | Efficiency (from DEA CRS) |
|---|---|---|---|
| Profit (normal) | R | 1,0000 | |
| | *R Standard Error* | | |
| | *T* | | |
| | *p-value* | | |
| | *H0 (5%)* | | |
| Efficiency (from DEA CRS model) | R | 0,1260 | 1,0000 |
| | *R Standard Error* | 0,0984 | |
| | *T* | 0,4015 | |
| | *p-value* | 0,6965 | |
| | *H0 (5%)* | *accepted* | |

| R | | |
|---|---|---|
| *Variable vs. Variable* | *R* | *No# of valid cases* |
| *Efficiency (DEA CRS model) vs Profit (normal)* | 0,1260 | 12 |

Source: Authors

Based on the results of the conducted analysis it can be concluded that the correlation doesn not exist ($p$ = 0,6965; *H0(5%)* accepted) between the two observed variables when it comes to the *Emirates* airline,

which supports the previously obtained results. However, this does not mean that the correlation does not exist between the efficiency and some other performance indicator for this airline, if that was chosen for the purpose of the analysis.

## *CONCLUSION*

Based on the conceptual framework of the research, the efficiency evaluation of the three Middle Eastern airlines was carried out by implementing *DEA* methodology. Accordingly, *DEA* efficiency model was created and applied, where the achieved and target performance values were quantified and compared as part of the efficiency evaluation of the three ME airlines. The results of the carried analysis indicated that the *Emirates Airline* achieved the highest level of operations efficiency when it comes to the observed ME airlines. It operated efficiently in nine out of twelve observed years, *Etihad Airways* in five and *Qatar Airways* in only three years within the given period. The results also showed that *Qatar Airways* has the lowest efficiency when it comes to the input/output ratio, while *Emirates* and *Etihad* are considered to be relatively efficient. DEA Window analysis showed that Etihad had the best performance and best practice in the observed period.

Besides that, for the *Emirates* airline an additional analysis was performed in order to examine whether the correlation exists between the efficiency from DEA CCR model and the achieved profit during the observed period of twelve years. For the other two airlines such data could not be found, so the analysis was omitted. The results showed that the correlation did not exist between the two observed values, which is in line with the results of the previous analysis. However, this does not imply that the correlation will not exist between the efficiency and some other performance indicator for this airline, such as revenue, etc. Based on the achieved level of efficiency, further measures will be undertaken to improve their business in the future.

When it comes to the constraints and shortcomings of the conducted research, one of them is that only five performance indicators were taken into account during the assessment, which partly reflected in the results of the analysis. Besides that, a time period of twelve years was considered during the performance evaluation, while a longer time span could have given more comprehensive and reliable results. Bearing that in mind, the analysis could be more detailed and complete if the number of the preselected performance indicators was greater and the observed time period longer, which is also one of the useful implications for future research. However, despite these shortcomings, the conducted study provides a theoretical and practical contribution to the further development of the aforementioned research area, bearing in mind that until now the same

analysis has not been conducted when it comes to the three ME airlines using the same parameters and methodology. Therefore, the obtained results can provide an important guideline for the future operations of the Middle Eastern airlines, as well as for other airlines around the globe.

## *REFERENCES*

Al-Sayeh, K. (2014). *The Rise of the Emerging Middle East Carriers: Outlook and Implications for the Global Airline Industry*, Massachusetts Institute of Technology, http://hdl.handle.net/1721.1/89852

Asaftei, G., Kumbhakar, C. S. (2008). Regulation and efficiency in transition: the case of Romanian banks, *Journal of Regulatory Economics*, 33, 253-282, https://doi.org/10.1007/s11149-007-9041-0

Baker, D. A. (2013). Service Quality and Customer Satisfaction in the Airline Industry: A Comparison between Legacy Airlines and Low-Cost Airlines, *American Journal of Tourism Research*, 2(1), 67-77, https://doi.org/10.11634/216837861403317

Banker, R., Cummins, D., Klumpes, P. (2010). Performance Measurement in the Financial Services Sector, *Journal of Banking & Finance*, 34 (7), 1413-1728, https://doi.org/10.1016/j.jbankfin.2010.02.024

Barbot, C., Costa, A., Sochirca, E. (2008). Airlines performance in the new market context: A comparative productivity and efficiency analysis, *Journal of Air Transport Management*, 14 (5), 270-274, https://doi.org/10.1016/j.jairtraman.2008.05.003

Barros, C. P, Peypoch, N. (2009). An evaluation of European airlines' operational performance, *International Journal of Production Economics*, 122, 525–533, https://doi.org/10.1016/j.ijpe.2009.04.016

Charnes, A., Cooper, W.W., Rhodes, E. (1978). Measuring the efficiency of decision making units, *European Journal of Operational Research*, 2(6), 429-444, https://doi.org/10.1016/0377-2217(78)90138-8

Coli, M., Nissi, E., Rapposelli, A. (2011). Efficiency Evaluation in an Airline Company: Some Empirical Results, *Journal of Applied Sciences*, 11 (4), 737-742, DOI: 10.3923/jas.2011.737.742

Cook W.D., Seiford L.M. (2009). Data Envelopment Analysis (DEA) – Thirty Years On // – Thirty Years On, *European Journal of Operational Research*, 192(1), 1–17, https://doi.org/10.1016/j.ejor.2008.01.032

Cooper, W.W., Seiford, L.M., Tone, K. (2007). *Data Envelopment Analysis: A Comprehensive Text with Models, Applications*, References and DEÀ-Solver Software, 2nd ed., New York, Springer, DOI: 10.1007/978-0-387-45283-8.

Cooper, W. - Seiford, L. - Zhu, J. (2011): *Handbook on Data Envelopment Analysis*. Springer Science+Business Media, New York.

Dyson, R.G., Allen, R., Camanho, A.S., Podinovski, V.V., Sarrico, C.S., Shale, E.A. (2001). Pitfalls and protocols in DEA, *European Journal of Operational Research* 132, 245-259, https://doi.org/10.1016/S0377-2217(00)00149-1

Fethi, M. D., Jackson, P., Weyman-Jones, T. G. (2000). Measuring the efficiency of European airlines: an application of DEA and Tobit Analysis, *EPRU Discussion Papers*, http://hdl.handle.net/2381/370

Grafton, J., Lillis, M. A., Widener, K. S. (2010). The role of performance measurement and evaluation in building organizational capabilities and performance,

*Accounting, Organizations and Society*, 35, 689-706, https://doi.org/10.1016/j.aos.2010.07.004

Groen, B. A. C., Wouters, M. J. F., Wilderom, C. P. M. (2012). Why do employees take more initiatives to improve their performance after co-developing performance measures? A Field study, *Management Accounting Research*, 23, 120-141, https://doi.org/10.1016/j.mar.2012.01.001

Han, S., Ham, S. S., Yang, I., Baek, S. (2012). Passengers' perceptions of airline lounge: Importance of attributes that determine usage and service quality measurement, *Tourism Management*, 33(5), 1103-1111, https://doi.org/10.1016/j.tourman.2011.11.023

Jia, T. - Yuan, H. (2017): The application of DEA (Data Envelopment Analysis) window analysis in the assessment of influence on operational efficiencies after the establishment of branched hospitals. *BMC Health Services Research*,17:2-8, DOI:10.1186/s12913-017-2203-6

Kennedy, J., Smith, A.S.J. (2004). Assessing the efficient cost of sustaining Britain's rail network – perspectives based on zonal comparisons, *Journal of Transport Economics and Policy*, 38(1), 17-23, www.jstor.org/stable/20173052.

Kutlar, A. - Kabasakal, A. - Babacan, A. (2015): Dynamic Efficiency of Turkish Banks: a DEA Window and Malmquist Index Analysis for Period of 2003-2012. *Sosyoekonomi*, 23(24): 71-97.

Martić, M., Savić, G. (2001). An application of DEA for comparative analysis and ranking of regions in Serbia with regards to social-economic development, *EJOR*, 129 (3), 344-355, https://doi.org/10.1016/S0377-2217(00)00156-9

Masarrat, G., Jha, S. (2014). Assessing Customer Perception of Service Quality: Comparative Study of Airlines in UAE, *World Review of Business Research*, 4(2), 291-303.

Mimović, P., Krstić, A. (2016). The Integrated application of the AHP and DEA methods in evaluating the performances of higher education institutions in the Republic of Serbia, *Economic horizons*, 18 (1), 71-85, DOI:10.5937/ekonhor1601071M

Odeck, J., Alkadi, A. (2004). The performance of subsidized urban and rural public bus operators: Empirical evidence from Norway, *Annals of Regional Science*, 38(3), 413-431, https://doi.org/10.1007/s00168-003-0152-y

Paradi, J. C., Schaffnit, C. (2004). Commercial branch performance evaluation and results communication in a Canadian bank— a DEA application, *European Journal of Operational Research*, 156(39), 719-735, https://doi.org/10.1016/S0377-2217(03)00108-5

Sarkis, J. (2002). Preparing Your Data for DEA, Chapter 4 in Avkiran N.: *Productivity Analysis in the Service Sector with Data Envelopment Analysis*, 2nd edition, N K Avkiran, UQ Business School, The University of Queensland, Australia.

Sherman, H. D., Zhu, J. (2006). *Service Productivity Management: Improving Service Performance Using Data Envelopment Analysis (DEA)*, Springer Science & Business Media: Boston, MA, USA, DOI: 10.1007/0-387-33231-6

Singh, A. K. (2011). Performance Evaluation of Indian Airline Industry: An Application of DEA, *Asia-Pacific Business Review*, 7(2), 92-103, https://doi.org/10.1177/097324701100700209

Surovitskikh, S., Lubbe, B. (2008). Positioning of selected Middle Eastern airlines in the South African business and leisure travel environment, *Journal of Air Transport Management*, 14(2), 75-81, https://doi.org/10.1016/j.jairtraman.2007.12.001

Scheraga, C.A., (2004). Operational efficiency versus financial mobility in the global airline industry: a data envelopment and Tobit analysis, *Transportation*

*Research Part A: Policy and Practice* 38 (5), 383–404, https://doi.org/10.1016/j.tra.2003.12.003

Tsaur, S.H., Chang, T.Y., Yen, C.H (2002). The evaluation of airline service quality by fuzzy MCDM, *Tourism Management*, 23, 107-115, https://doi.org/10.1016/S0261-5177(01)00050-4

Tung, A., Baird, K., Schoch, P. H. (2011). Factors influencing the effectiveness of performance measurement systems, *International Journal of Operations & Production Management*, 31(12), 1287-1310, https://doi.org/10.1108/01443571111187457

Wang, K. - Shiwei, Y. - Zhang, W. (2013): China's regional energy and environmental efficiency: A DEA window analysis based dynamic. *Mathematical and Computer Modelling*, 58:1117-1127, https://doi.org/10.1016/j.mcm.2011.11.067

Yang, H. - Chang, C. (2009): Using DEA window analysis to measure efficiencies of Taiwan's integrated telecommunication firms. *Telecommunication Policy*, 33:98 – 108, https://doi.org/10.1016/j.telpol.2008.11.001

Yayla-Kullu, H.M., Tansitpong, P. (2013). A Critical Evaluation of U.S. Airlines' Service Quality Performance: Lower Costs vs. Satisfied Customers, *Journal of Management and Strategy*, 4(4), 1-11, https://doi.org/10.5430/jms.v4n4p1

# ДИНАМИЧКИ МОДЕЛ МЕРЕЊА ПЕРФОРМАНСИ БЛИСКОИСТОЧНИХ АВИО-КОМПАНИЈА

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**Резиме**

У раду је извршена оцена ефикасности пословања три авио-компаније Блиског истока, при чему је примењена метода анализе обавијањем података. Дефинисањем модела за оцену ефикасности пословања, као и квантификацијом и компарацијом остварених и циљаних перформанси – извршена је евалуација ефикасности пословања три поменуте авио-компаније у посматраном периоду. Добијени резултати представљају вредну информацију за менаџмент поменутих авио-компанија, самим тим што пружају увид у ефикасност тренутног пословања, те се наоснову поменутог креирају мере за побољшање пословања у будућности. Поред тога, добијени резултати указују на перформансе које су на задовољавајућем нивоу ефикасности, као и на оне које треба побољшати како би се постигла оптимална ефикасност пословања све три авио-компаније. Након спроведене анализе, дошло се до закључка да је авио-компанија Emirates постигла најбољу ефикасност пословања, и то у девет од дванаест посматраних година, Etihad Airways у пет, а Qatar Airways у свега три године у датом периоду. Добијени резултати су такође показали да авио-компанија Qatar Airways остварује најмању ефикасност односа улаза и излаза, док се авио-компаније Emirates и Etihad сматрају релативно ефикасним. Поменуто је потврђено и на основу односа остварених и циљаних улазних и излазних величина које су код авио-компанија Emirates и Etihad изједначене, док се код авио-компаније Qatar Airways

разликују. На основу добијених резултата, свака авио-компанија има увид у досадашњу ефикасност пословања, те се на основу тога могу предузети одговарајуће мере за побољшање пословања у будућности.

Када су у питању ограничења и недостаци спроведеног истраживања, познато је да је само пет перформанси узето у обзир приликом оцене, што се делом одразило на добијене резултате, те је стога важно истаћи ову чињеницу. Као још један од недостатака може се навести то што је током евалуације перформанси разматран временски период од дванаест година. Имајући у виду наведено, анализа би била знатно комплетнија и свеобухватнија, а самим тим и резултати веродостојнији, уколико би број посматраних перформанси пословања био већи, а посматрани период дужи, што је такође једна од корисних импликација за будућа истраживања. Међутим, упркос наведеним недостацима, спроведено истраживање пружа теоријски и практични допринос даљем развоју поменуте истраживачке области, имајући у виду да до сада нису мерене исте перформансе код три поменуте авио-компаније користећи исту методологију. Самим тим, добијени резултати могу послужити као важна смерница у будућем пословању авиокомпанија Блиског истока, као и других авио-компанија широм света.