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Market share modeling in airline industry: an emerging market economies application

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Abstract

For an airline, the ability to accurately predict market share of its competitors at specific airports could be crucial for an efficiently tailored business strategy. The model developed in this paper deals with the issue of airline market share at specific airport. Several explanatory variables, such as: number of competitors, frequency of flying, membership to specific alliances etc., have been considered by the model. Traditional techniques and fuzzy logic have been applied to estimate the model. The model is illustrated with real data and is applicable to demonstrate how it could be used for calculating an airline's market share.

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Keywords: market share; airline industry; soft computing; competition;

1. Introduction

Deregulation and liberalization of market primarily set up in the United States, had its response in European countries mainly throughout establishing European Commission's three phase „packages" which enabled the aviation market to evolve. Newly arisen conditions that ensured fair competition were a positive stimulus for new start ups to enter the market hereby triggering the fierce competition among airlines. The consequence of these structural changes in the industry has been the shift the competitive focus in various directions but with the general result that the traditional European major airlines no longer enjoy the dominance they once had, (Dennis, 2010).

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National carriers that were privileged for long time by receiving substantial amount of financial aid granted by their national governments had to face intense competition by new carriers' entry. In such condition, the role of European national carrier as dominant at their respective country's main airport has been diminished. In addition to emergence of airlines that followed the traditional business model but were able to exert some price leadership and/or offer a superior quality of service (Lijesen et al, 2002), the pop up of low cost carriers had led to tremendous changes in European air travel industry. Adopting the business model that exploit economy of scale benefits using unique fleet and offering no frills product and services, LCC became a serious threat to flag carriers. Although low cost carriers represent rivals only to some extend due to the fact that their network is focused on point-to-point routes, they certainly had significant impact on national carriers to reduce their fares, increase their efficiency and therefore sustain market share on specific airport.

Thus, in order to maximize their profits all carriers on the market struggle to increase their market share which is in high correlation with the number of passengers carried from certain airport. Boreinstein (1991) presents an approach to estimate the advantages of a dominant firm in the airline industry that allows one to effectively control cost and quality heterogeneity. This author argues that an airline with dominant presence at an airport will have higher opportunity in attracting customer whose trips originate at that airport, regardless of the specific route on which the customer is travelling. Furthermore, Suzuki et al. (2001) develop a model that represents the relation between service quality and market share in the airline industry assuming that the relationship is characterized by a non-smooth curve. Among many authors who analyze the factors that affect air carrier's market share, it is important to underline the work of Proussaloglou & Koppelman (1995) who adopt an individual traveller choice approach. The authors identify distinct air travel groups based on frequency, purpose, and destination of air travel, examining the relation between frequent-flyer program participation and traveller and market characteristics, and studying travellers' carrier choice behavior.

The goal of the paper is to identify the essential factors that determine market share of a dominant carrier on an airport which will be subsequently used as inputs into the designing a general robust market share model. For this purpose, regression model for each dominant airline at specific market was employed to estimate the importance of factors that could have influence on its market share. Furthermore, fuzzy logic robust model for estimating market share was created by using those variables which showed as significant in the previous regression model. In previous researches, Kalić et al. (2003, 2012a, 2012b, 2013), fuzzy logic is seen as an appropriate tool in planning process, giving the initial impetus for employing it for the purpose of market share modeling. The paper is organized as follows. The statement of the problem is given in Section 2, while in Section 3 the market share model is presented. Section 4 presents a model application for the several flag carriers at primary airports located in countries of Central and Southeast Europe. Finally, conclusion is given is Section 5.

2. Statement of the problem

The value of market share of a specific airline, although a rough parameter, could be very valuable information for the airline top management who, in every moment, has to be aware of the airline position against its competitors in certain segments of market or even in the overall market. As mentioned above, by gaining higher portions of markets, airlines have a chance to maximize their revenue. Airline may adopt several strategies in order to fulfil this goal. An airline may opt to increase frequency on certain routes while others may offer more seats by using bigger airplanes. The strategy used will highly rely on management decision who will tailor the product in the way to satisfy their customers and to sustain profitable growth. However, the market share will also depend on the airline competitors and their ability to perform efficiently on the market. Generally, market share can be expressed in several different ways depending on the variable taken into account (total number of passengers, frequencies, number of available seats, etc). The paper considers market share as a value between 0 and 1 computed by dividing total number of passengers carried by an airline by the total number of passengers transported at specific airport.

The paper investigates which factors, among many known in the literature, could affect an airline market share on a certain airport. Although, it is obvious that the same set of explanatory factors could have different impact on different airlines due to diversities of markets (characterized by population size, country economy, LCC penetration, (non)existence of domestic air traffic, etc) the paper tends to detect common factors in order to design a robust

model. Subsequently, the model built in such a way could be applied to estimate market share for any selected airline.

3. Market share model

The research presented in this paper has two objectives. First, analysis of main factors affecting market share of the flag airline at the specific airport will be performed. Second, the estimation of the market share of any airline at the emerging airport will be modeled. The first question will be answered using a multiple linear regression analysis. The second question could be answered using fuzzy logic.

3.1. Multiple linear regression

The level of market share indicates the carrier's degree of monopoly power. High market share provides higher monopoly power, while low market share leads to little or none, (Boreinstein, 1990). This is why it is important to explore the factors that affect it. The final list of these factors is hard to perceive, but what is more important is to recognize the one with highest influence on the particular market. Regression analysis was used in the process of selecting the most suitable set of explanatory variables to be included in the model. Having in mind the purpose of this model (market share estimation for dominant airline at the particular airport) and the aim of developing the robust model, too many variables could be very hard to understand, analyze and very expensive to maintain. Additional problem with large number of variables is the existence of multicollinearity that may decrease the accuracy of the model. The research initially started with the list of potential variables consisted of more than 10 variables, but after many trials the research is limited only to most influential ones. The criterion for selecting the explanatory variables was to maximize F statistics. The regression analysis presented in this paper is based on panel data. The dependent variable is the market share (MS) of flag airline at the airport. It is measured as a percentage of the number of passengers carried by the flag airline at selected airport, annually.

The explanatory variables used in the multiple linear regression models were:

- The average ticket price on the network (ATP) calculated as flag airline annual revenue divided by the total number of passengers in that year.
- The frequency share of the flag airline at that airport (FS) measures the number of flights offered by flag airline on the particular airport in regard to total number of flights offered by all airlines operating at that airport.
- The number of competitors per destination at that airport (CPD) measures the level of competition at the airport and is calculated as the total number of airlines operating at the airport divided by the total number of destinations offered from that airport.
- The load factor of flag airline (LF) measures the amount of utilization of the total available capacity of the flag airline. It is calculated as the number of revenue passenger-kilometers (RPK) divided by the total available seat-kilometers (ASK).
- The dummy variable AL to take into account alliance membership. It aims to capture a potential influence of service quality improvement (with respect to better connections, more available destinations, etc.) on flag airline market share.
- The dummy variable LCC to take into account presence of low cost carriers. It aims to capture a potential influence of low cost carriers on flag airline market share reduction.

The chosen variables that explain the value of market share could roughly be grouped into two sets. First set encompasses variables which describe some characteristics of airline (ATP, FS, AL, LF) and the second set includes variables which account for market characteristics related to competitors (CPD, LCC). The regression analysis is done for each airline independently and the estimation equation is given as a linear function by:

$$MS = \beta_0 + \mu_1 ATP + \mu_2 FS + \mu_3 AL + \gamma_1 CPD + \gamma_2 LCC + \delta_1 LF \quad (1)$$

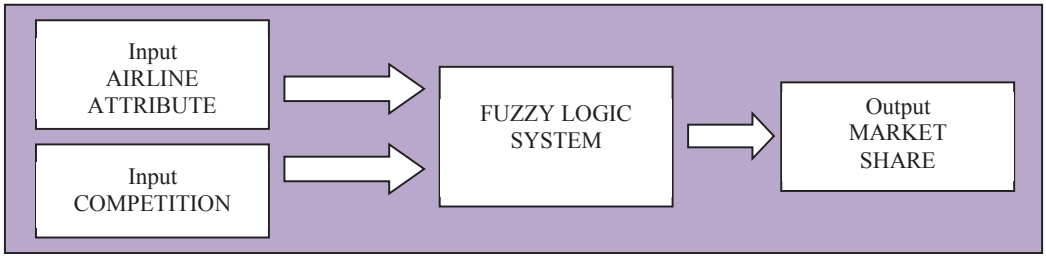

Fig. 1. Fuzzy logic model of market share

3.2. Fuzzy logic system

The robust market share model is based on fuzzy logic. In order to estimate airline market share at the primary airport in selected countries (MS), two input variables are introduced: one from the set describing airline supply and another from the set comprising characteristics of competition at respective airports (Fig. 1).

The selection of variables is based on results obtained by regression model that were carried out for each airline at specific airport. In other words, the variables which showed to have high value of significance across all airlines are used as inputs in fuzzy logic system. Selection of variables in this manner enables creating a robust fuzzy logic system, which was authors' primarily intention.

4. Case study

4.1. Socio-economic environment of selected countries in Southeast and Central Europe

The proposed model has been illustrated by several airlines which represent flag carriers of countries located in the region of Southeast and Central Europe and those are: Olympic Airlines (Greece), Tarom (Romania), Malev (Hungary), Jat Airways (Serbia) and Croatia Airlines (Croatia).

The development of air travel market of these regions significantly differs from those in the rest of Europe due to political and economic circumstances that occurred during the last few decades. All airlines considered in this paper represent a national flag carrier of their respective country. Likewise other national carriers in West Europe, all of them have been supported by national governments who did not allow their flag carriers to fail. In spite of different socio-economic environment in which the abovementioned airlines persist, they have sufficiently in common to draw several important conclusions: all of these airlines had poor performance in terms of low partial productivity results, quality of service offered to customers and profitability (Akbar et al., 2014). Still, their market share remained surprisingly high for a long period of time thanks to state aid that covered majority of their costs allowing them to retain supreme position on the market. However, catchment areas of the airports where these airlines have their bases are in high correlation with the number of inhabitants of the respective countries and economic condition therein. As it can be observed from Fig. 2a, Greece is the leading country concerning the number of passengers, with approximately 33 million passengers in 2011 representing the growth by 18% compared to 2003. Tourism highly contributes to the country's overall GDP thanks to the sea coast and large number of islands (around 100) which need regular air transport service for the passenger mobility all year round especially during the summer season. This country has also developed domestic air travel market due to huge territory covered and tourist flows induced by domicile travellers. Second country with intense tourism attraction is Croatia, the coast of witch visited by a large number of Western-European tourists. Total number of passengers in this country has almost doubled in eight years mainly due to tourism sector (Fig. 2a). Romania has had the most significant growth in terms of total number of passengers with the value almost quadrupled in the period from 2003 to 2011. Romania's aviation sector, especially after accession to the European Union in 2007, has played an important role in intensifying emigrants' homeland relations. This country has domestic air travel and several airports in use. Serbia is a country with the lowest value of GDP among these five, which certainly has a profound impact on the total number of passengers who travel by air. Nevertheless, ratification of Open Sky agreement enabled the development of open market and penetration of

low-cost carriers which offer significantly lower fares compared to legacy carriers. Ethnic migrations represent a potent driver of demand for air travel in Serbia likewise in all the countries of these regions.

The further common denominator for all selected countries is that they are all emerging markets except Greece that has been a liberalized market from before. Although, the liberalization of Greek market started back in the '90s, the government protected its flag carrier up to 2008 when they put the carrier in private hands. The result was an unfair competition at Athens airport that puts Olympic Airlines in favored position.

The rest of the selected countries are all liberalized or still in the process of liberalization in the period from 2003, depending on in which year each of the countries joined the EU. Serbia is not yet the member of the EU, but the process of liberalization of the air transport is ongoing. Also, all selected countries have in common that the flag airline had close or over 50% (except Olympic Airlines, the share of which was around 20% in 2003) of the total market share which was reduced over time (Fig. 2b). Not all of the selected airlines experienced the same amount of market share reduction, so that was the reason why the regression model was used in the first part of the research: to identify the main drivers of the market share of the flag airline at the specific airport. For all selected markets, it is also common that the industry financial performance since 2008 was poor, largely because of fuel price increases and recession. However, it would have been worse had the regulation still been in effect. It is worth noting that some of the selected countries have more than one international airport that is used by their flag airline (Greece, Croatia and Romania), but they are excluded from this research. Only the main airport and the traffic from this airport were taken into account for modeling, viz. Athens airport, Belgrade airport, Bucharest airport, Budapest airport and Zagreb airport. Also, Bucharest has two international airports (Henri Coanda-Otopeni International Airport and Aurel Vlaicu - Baneasa International Airport). During the period from 2003 to 2011, Otopeni was the main Bucharest airport used by full service airlines and Baneasa was a low cost airport used by low cost airlines. In 2012 all the flights from Baneasa were moved to Otopeni and since then it operates with mixed flights. Having in mind their vicinity, the airlines from both airports could be considered as direct competitors, so the traffic from both airports was used for the observed period.

4.2. Data

Data for this research comes predominantly from the official sites of the corresponding airports and airlines, CAPA centre for aviation, Association of European Airlines and other relevant sources. The data set covers the period from 2001 to 2012, except for Malev, Hangarian airline (Malev went bankrupt in 2012 and this year is excluded from the research). There are 12 consecutive annual observations of the 5 international airports and 5 flag airlines.

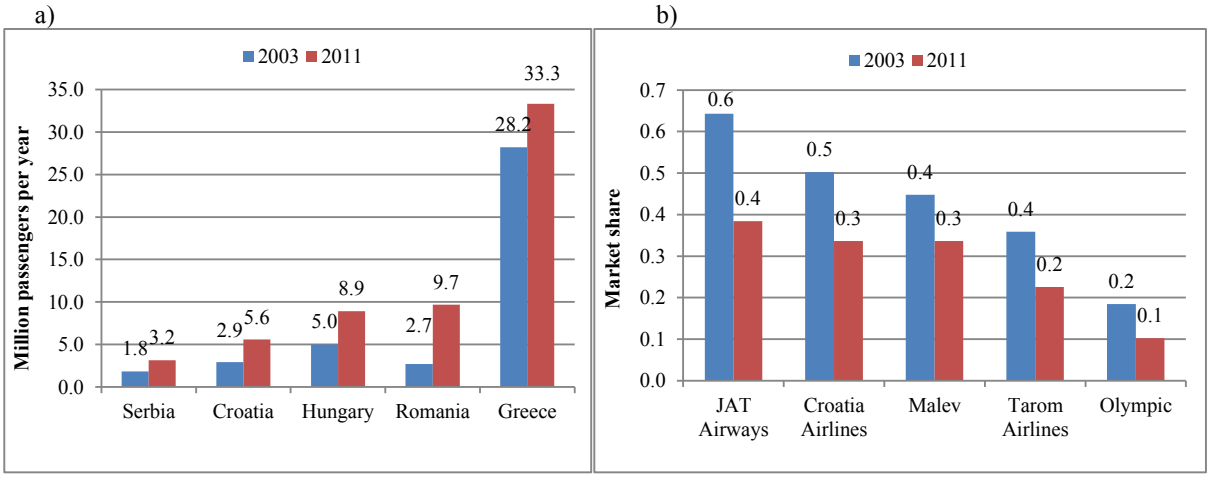

Fig. 2. a) Total number of passengers of some countries in Southeast and Central Europe, Source: Eurostat (January, 2014); b) Market share of selected flag carriers at country level in 2003 and 2008

4.3. Results

The summary results of descriptive statistics are presented in Table 1. According to statistics R and R2 variables have a good fit. The results indicate that the best fit is achieved for Olympic Airlines. The values of R2 suggest that the large proportion of flag airline market share could be explained by selected variables. The F statistic in all regressions shows that the variables are significant, except for Croatia Airlines where the F statistic shows no significance. This result should be interpreted more in a sense that the number of observations is too low to indicate any relationship between selected explanatory variables and dependent variable, than that the selected explanatory variables has no influence on the market share of Croatia Airlines.

Olympic Airlines. The results from regression analysis for Olympic Airlines show that among all selected explanatory variables, FS and LCC are only significant according to t test (Table 1). This means that the Olympic market share at the Athens airport was driven by its frequency share and this is expected, having in mind the dependency between market share and frequency share (the airline with higher frequency share will have disproportionately higher market share measured by number of passengers carried). Positive sign of the LCC coefficient means that the presence of low cost carriers at this market had positive influence on Olympic market share and it could be interpreted as other things been equal the competition from LCC will increase Olympic market share by 0.12 units. The answer for this unexpected result should be sought in the market situation at the Athens airport. Namely, after liberalization of the Greek airline industry, many new airlines entered the market, but at the beginning low cost carriers were avoiding Athens airport due to the high air navigation charges and have been using other airports in the country. That explains very low LCC share at this airport in spite of their long presence in the Greek market (LCC share in 2012 at Athens airport was 7%). Stronger competition Olympic experienced from full service airlines which offered services similar to its. To be more precise, Olympic's greatest competitor was a domestic carrier, Aegean Airlines that attracted great part of its market, especially on the domestic one. During the observed period, those two airlines together had almost 60% of the market share, constantly (while Olympic's share decreased, Aegean's share increased). Nowadays, those two airlines are operating as one carrier after their merging in 2013. The AL variable for Olympic is zero due to the fact that this airline is not a member of any alliance which could be an additional explanation why Olympic failed in attempts to attract non-Greek passengers to use its service in the years of Greek market expansion[†]. The LF variable is not significant according to the results, but it shows some interesting observation. Its coefficient is negative implying that if the airline wants to increase its load factor its market share will decrease because the increment of load factor will probably be at the expense of the frequency and service quality offered to passengers.

JAT Airways. The results for JAT Airways show that CDP is only significant according to t test (Table 1). Its coefficient has a negative sign, implying that if this parameter increases (whether number of destination is decreasing or number of airlines is increasing) the market share of JAT will decrease. This was expected, because this parameter measures the level of competition which normally has negative influence on the market share of the airline especially if that airline previously operated on the regulated market. Negative coefficient of LCC shows that the impact of the competition was even stronger when low cost carriers entered the market in 2006. This is also in accordance with the recent situation in the Serbian market, where JAT was still a leading carrier with around 48% of the capacity share, followed by Wizz Air and Montenegro Airlines, which account respectively for 14% and 8% of capacity (CAPA, 2014). Along with Wizz Air, there are five more low cost carriers operating in the Serbian market (Pegasus Airlines, Norwegian Air Shuttle, flydubai, easyJet and Germanwings) which collectively account for about 21% of total capacity, (Belgrade airport, 2014). Positive coefficient of LF for JAT Airways implies that its increment of load factor goes along with the increment of service quality and not with lowering the frequency. JAT Airways is not a member of any alliance, so the coefficient of AL is equal to zero.

[†] According to data in the period from 2001 to 2012 Olympic terminated a large number of its destinations and most of them were international.

Table 1. Regression Analysis Results

		Intercept	ATP	FS	AL	CPD	LCC	LF	*Multiple R*	*R Square*	*Standard Error*	*F*
Athens/ Olympic Airlines	*Coefficients*	-0.39	-0.00	1.46	0	0.12	0.13	-0.11	0.96	0.98	0.02	41.59
	t Stat	-1.47	-0.44	6.91	65535	0.48	3.19	-0.74				
Belgrade/ JAT Airways	*Coefficients*	0.33	0.00	0.34	0	-0.71	-0.03	0.34	0.98	0.96	0.03	27.84
	t Stat	0.99	0.94	1.16	65535	-3.28	-0.91	1.06				
Bucharest/ TAROM	*Coefficients*	-0.08	-0.00	0.71	-0.02	-0.13	0.02	0.63	0.97	0.93	0.03	11.55
	t Stat	-0.21	-1.54	2.99	-0.47	-1.22	0.54	1.13				
Budapest/ Malev	*Coefficients*	0.27	-0.00	0.69	-0.05	0.35	-0.08	-0.14	0.99	0.97	0.01	20.10
	t Stat	1.76	-1.72	3.80	-4.01	2.57	-5.35	-0.53				
Zagreb/ Croatia Airlines	*Coefficients*	1.06	-0.00	0.03	0	0.32	-0.03	-0.59	0.88	0.77	0.03	1.33
	t Stat	2.44	-0.62	0.04	65535	0.61	-0.19	-1.14				

TAROM. The results for TAROM show that among all explanatory variables, only FS and LCC are significant according to t test (Table 1). TAROM market share at the Bucharest airport was driven by its frequency share. Also, it could be noticed that the LCC coefficient has the positive sign, which means that the presence of low cost carriers at this market had positive influence on TAROM market share and as other things been equal the competition from low cost carriers will increase TAROM market share by 0.01 units. Having in mind that Romania is the one of the biggest markets for Wizz Air, this could be interpreted in the sense that low cost carrier competition forces TAROM to improve its service quality and that further leads to improvement of its market share. TAROM is a member of Sky Team alliance since 2006, but according to results and the sign of AL this would decrease its market share. Being a member of an alliance means that the airline has to coordinate its flight schedule with other alliance partners, especially if it is someone's feeder. In most cases it has to increase its flight frequency to provide certain level of service. Alliance membership brings more benefits to an airline than detriments and in the case of TAROM the coefficients of AL do not reflect the right impact on the market share. The reason for this result could be found in the fact that the period when TAROM entered the alliance was characterized by significant LCC expansion that achieved more than 30% share of traffic at Bucharest airport (Bucharest airport, 2014). TAROM experienced remarkably increased competition not only from LCC but from other airlines, too, after the accession of Romania to the European Union in 2007. The rest of the variables have the expected coefficient sign, CPD is negative and LF is positive, implying that TAROM improved its load factor by improving service quality.

Malev. According to results from the regression analysis for Malev, it could be concluded that all selected variables have strong influence on its market share and are significant, due to t statistic (except LF), Table 1. It is worth noting that the positive sign of CDP and negative sign of LCC could be implying that Malev experienced stronger competition from low cost carriers than from the other airlines operating at Budapest i.e. competitive environment has positive impact on Malev market share as long as it does not come from low cost carriers. This statement is verified by the fact that in 2009, Malév operated 50 routes (in 34 countries) from Budapest airport, 29 of which are operated as a monopoly with no direct competition. Further 18 routes featured just one competitor, while just three faced competition from two other carriers (Budapest airport, 2014). Even though Malev had a strong position as a leader at the Budapest airport, the wrong government decisions and the high impact from the low cost carriers (in 2011 LCC had 25% of the market share) led this carrier to bankruptcy.

It can be observed from Table 1 that regression models reveal two most significant variables: frequency share (FS) and the number of competitors per destination at that airport (CPD). As it was mentioned above, these two variables are deemed as most significant for all selected airlines and therefore are taken into consideration for model design. Fuzzy logic system is used in order to specify market share of an airline expressed as the ratio between number of passengers carried by the airline to total number of passengers at the respective airport. Membership functions of input and output variables are defined as follows: the membership functions of fuzzy sets Low, Medium and High is related to FS, the membership functions of fuzzy sets Very low, Low, Medium, High and Very High is

related to CPD. The membership functions of fuzzy sets Low, Medium and High are related to market share of an airline (MS). The fuzzy rule base is complete and consists of 15 rules. Some of them are presented below:

Rule 1: If FS is High and CPD is Very low, then MS is High, else
Rule 2: If FS is High and CPD is Low, then MS is High, else
…
Rule 8: If FS is Medium and CPD is Medium, then MS is Medium, else
…
Rule 14: If FS is Low and CPD is High, then MS is Low, else
Rule 15: If FS is Low and CPD is Very high, then MS is Low.

Table 2. Comparison of real and estimated values of market share (testing set)

Airline code/Year of observation	Real values of market share	Estimated values of market share obtained by fuzzy logic
JU2002	0.68	0.67
JU2007	0.46	0.50
JU2011	0.38	0.30
OA2002	0.48	0.59
OA2007	0.36	0.31
OA2011	0.24	0.31
MA2002	0.47	0.50
MA2007	0.36	0.31
MA2011	0.34	0.50
OU2007	0.59	0.50
OU2011	0.62	0.52
RO2004	0.37	0.49
RO2005	0.42	0.44
RO2010	0.33	0.31
RO2011	0.29	0.31
RO2012	0.31	0.30

The training set consists of two thirds of the total data, i.e. 32 input-output vectors. Therefore, the rest of vectors belong to testing set, i.e. 16 input-output vectors. The results are obtained by applying MAX-MIN fuzzy reasoning and defuzzification by center of gravity. The model output for training and testing sets showed similar results in respect to differences between real and estimated values: average absolute errors are 0.07 (training set) and 0.06 (testing set) and average relative errors are 0.17 (training set) and 0.16 (testing set). Table 2 presents the results of model validation. It is worth noting that there is a very close correspondence if the real and estimated values of market share are compared.

5. Conclusion

Recognizing and understanding the factors that are the main drivers of the share for an airline at the particular market could have a crucial influence on its operational and marketing planning. Likewise, developing a general model for estimating an airline market share at the specific airport presents a challenging task due to diversities in terms of country economy, market size and structure, airport network structure, etc. This research provided a model

that is useful in both: to identify explanatory variables most affecting the market share of the considered airline and to estimate future market share in respect to most significant variables.

The model has been applied on the markets of Central and Southeast Europe, characterized by poor industry financial performance, unfair competition (protected flag carrier) and emerging low cost market. The statistics in regression analysis showed a reasonably good fit with the regression coefficients carrying the expected sign, except the result for alliance dummy variable that is very hard to interpret. Attempting to overcome the difficulties in market diversities, the fuzzy logic system was used and the results proved its robustness by taking into account narrowed set of two variables which showed to be the most influential (frequency share and number of competitors per destination). The model developed is particularly appropriate when dealing with the airlines operating in the markets passing through the process of liberalization.

The model presented could be extended in several ways. First, new parameters could be included in order to capture intermarket differences in the nature of supply, particularly among domestic and international ones, as well as low, medium and high demand. Second, the use of the number of competitors per destination, that reflects the level of competition on the network level, could be replaced with other measures that give more precise information on competition concentration, but this requires more detailed data about an airline structure at the market.

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