V. MEĐUNARODNO SAVJETOVANJE
V. INTERNATIONAL CONFERENCE
„SAVREMENI TRENDOVI U SAOBRAĆAJU, LOGISTICI I EKOLOGIJI U FUNKCIJI
ODRŽIVOG RAZVOJA"
„MODERN TRENDS IN TRAFFIC, LOGISTICS AND ECOLOGY FOR SUSTAINABLE DEVELOPMENT"
23.-24. MAJ, 2014.

EKONOMETRIJSKI MODEL ZA PROCJENU POTRAŽNJE U ZRAČNOM PUTNIČKOM PROMETU

Pupavac Drago, Phd
Polytehnic of Rijeka
Vukovarska 58, 51000 Rijeka-HR
Tel. 0038551353737 fax: 0038551673529
e-mail: drago.pupavac@veleri.hr
Zelenika Ratko, professor emeritus
Ekonomski fakultet Rijeka
Ivana Filipovića 4, 51000 Rijeka-HR
e-mail: *zelenika.ratko@gmail*.com
Rašid Zuko, Phd
Sisak,Obrazovni centar Kotva d.o.o.
Marijana Celjaka 88 b, 44 000 Sisak
e-mail: rasid.zuko@gmail.com

Sažetak: Temeljni cilj ove znanstvene rasprave jest razviti ekonometrijski model za procjenu zračnog putničkog prometa u Republici Hrvatskoj mjereno brojem prevezenih putnika. Polazna pretpostavka ovoga rada je da broj prevezenih putnika u zračnom putničkom prometu (Y) u Republici Hrvatskoj ovisi o broju dolazaka turista (DT) i bruto domaćem proizvodu (BDP). Rezultati istraživanja temelje se na statističkim metoda regresijske i korelacijske analize. Dobivene spoznaje u ovoj znanstvenoj raspravi mogu biti od pomoći zračnim kompanijama i menadžerima svih zračnih luka u Republici Hrvatskoj.

Ključne riječi: ekonometrija, model, zračni putnički promet, potražnja

ECONOMETRIC MODEL FOR FORECASTING DEMAND IN PASSENGER AIR TRANSPORT

Abstract: The basic objective of this research is to develop an econometric model to estimate passenger demand in airports, measured by number of passengers carried. The starting assumption of this study is that the number of passengers in airports (Y) depends on the movement of tourist arrivals (TA) and gross domestic product (GDP). The study results are based on statistical methods of regression and correlation analysis. The resulting knowledge in this scientific debate could help airlines companies and managers of all airports in Croatia.

Key words: econometric, model, passenger traffic, demand

1. INTRODUCTION

Deregulation of air transport market in Croatia should bring revolutionary changes to domestic airline industry. The Croatian government has given a 30-year concession of the largest Croatian airport to the French company ZAIC, thus hoping to boost air transport, modernize the domestic fleet and ensure the survival of air transport as a very important factor of Croatian economy, with huge impact on tourism. The French company ZAIC intends to increase the number of passengers for a million within the next two years. In the ninth year of

V. MEĐUNARODNO SAVJETOVANJE
V. INTERNATIONAL CONFERENCE
„SAVREMENI TRENDOVI U SAOBRAĆAJU, LOGISTICI I EKOLOGIJI U FUNKCIJI
ODRŽIVOG RAZVOJA“
„MODERN TRENDS IN TRAFFIC, LOGISTICS AND ECOLOGY FOR SUSTAINABLE DEVELOPMENT“
23.-24. MAJ, 2014.

concession, the number of passengers is expected to be 5 million (*Jutarnji List*, 10/12/2013). Such increase is to be achieved by introducing new lines and intercontinental flights to Africa and Asia and by opening an airport hub in Zagreb Airport. Croatian market of passenger air transport shows all hallmarks of a fast growing market [18], so the intention of this study is to identify the determining factors of passenger air transport demand and to make an assessment of passenger air transport demand up to 2025.

Methods of regression and correlation analyses are used to prove the hypothesis that the number of passengers (Y) depends on the number of tourist arrivals (TA) and the gross domestic product (GDP). Data analyses and numerical calculations are performed by *Statistica* software.

2. PARAMETERS AFFECTING DEMAND IN PASSENGER AIR TRANSPORT

Croatia is a small European country between the Mediterrenean Sea and Central Europe. Potential domestic air transport is limited due to small population and well connected network of modern motorways. The objective of this study is to identify the determining factors which turn the potential demand into air transport passengers. Population, gross domestic product per capita and distance are considered the main geo-economic dynamics behind the air travel demand, as depicted in Table 1.
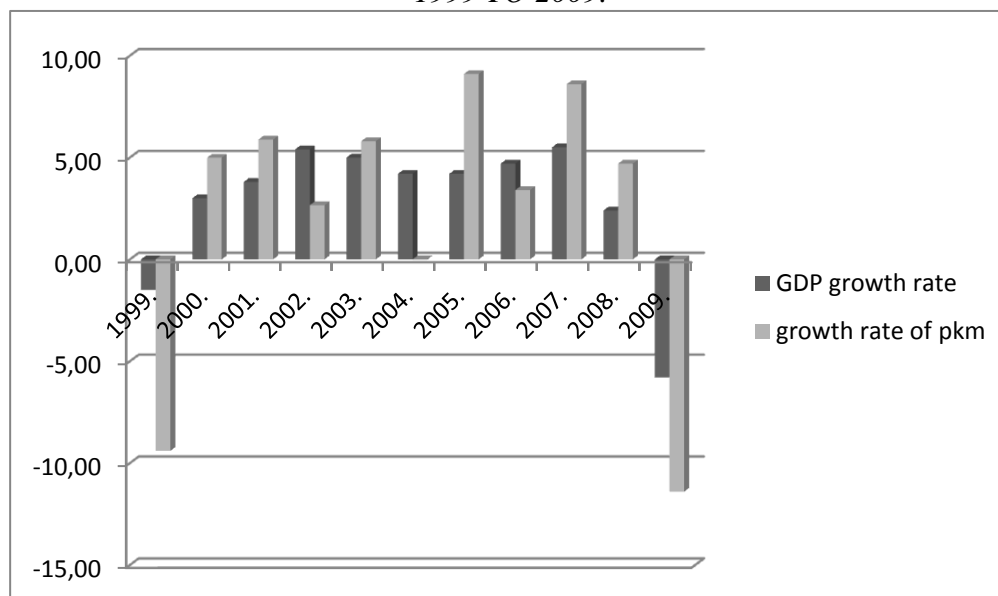
TABLE 1: COMMONALITY IN TYPES OF VARIABLES

Variable's Name*	Number of Repeat	Reference Articles
Population	11	[1,3,4,6,7,11,12,15,16,20,21]
GDP	9	[1,3,4, 6,11,12,16,19]
Distance	5	[2,11,12,16,19]
Travel Time	5	[1,15,20,21]
GDP per capita	4	[1,5,6,10]
Price	5	[10,11,16,20,21]
Service Frequency	4	[3,4,19,12]
CPI	3	[1,5,6]
Import Volume	3	[1,5,6]
Employment	2	[3,9]
Exchange Rate	2	[5,6]
Cost	2	[4,20]
Expenditures	2	[5,6]
Fuel Price	1	[9]

The most common variables are listed out of a sample of 15 different relevant articles

Transport is found to be closely related to the economic activity (ECMT, 2001). Both passenger and freight transport generally follow the rate of economic development. Passenger transport is directly influenced by increased income and quality of life. One of key impacts on traffic demand is attibuted to GDP, because it typically generates an increase in travel [17]. Recent researches within the European Union indicate a lag of growth rate of passenger transport demand compared to the GDP growth rate. Thus, for example, the passenger traffic in 2007 compared to that in 2000 has increased by only 9,33%, while the GDP of European countries in 2007 compared to that in 2000 has increased by 16,61%.

V. MEĐUNARODNO SAVJETOVANJE
V. INTERNATIONAL CONFERENCE
„SAVREMENI TRENDOVI U SAOBRAĆAJU, LOGISTICI I EKOLOGIJI U FUNKCIJI
ODRŽIVOG RAZVOJA“
„MODERN TRENDS IN TRAFFIC, LOGISTICS AND ECOLOGY FOR SUSTAINABLE DEVELOPMENT“
23.-24. MAJ, 2014.

The interrelation of annual GDP growth rates in actual prices and realized growth rates of passengers per kilometer (pkm) in all transport sectors in Croatia is presented in Chart 1.

CHART 1: THE INTERRRELATION OF ANNUAL GDP GROWTH RATES IN ACTUAL PRICES AND REALIZED GROWTH RATES OF PASSENGERS PER KILOMETER FROM 1999 TO 2009.
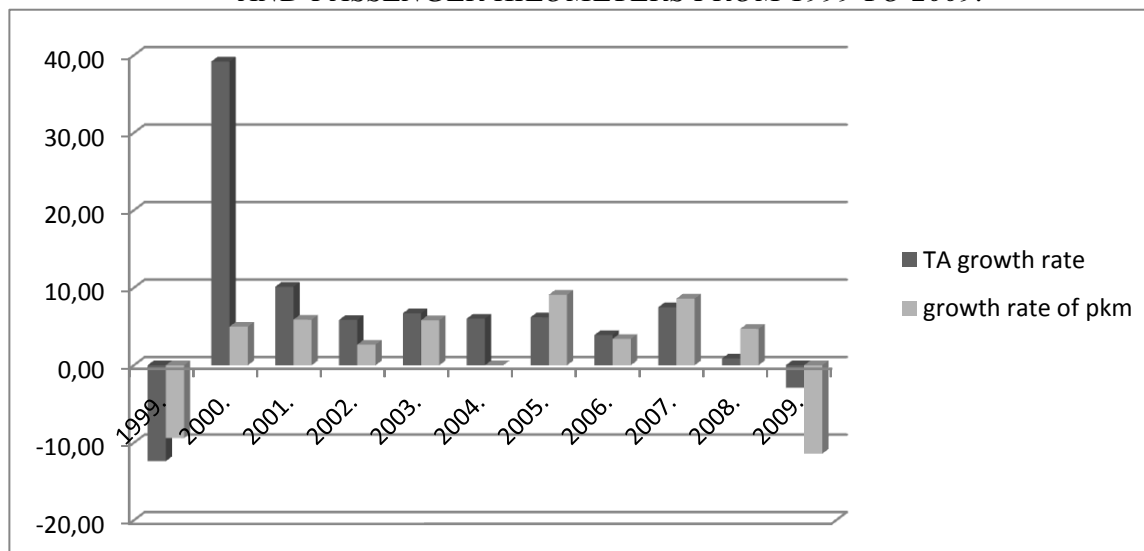

Data from Chart 1 show a correlation between the actual GDP growth rates and realized growth rates of passenger kilometers. This correlation is rather strong, as the number of realized passenger kilometers is growing at a higher rate when there is a growth in GDP. And *vice versa*, when the rate of GDP growth is negative, the total number of realized passenger kilometers shows greater negative rate.

Croatian economy is peculiar because tourism is one of the most important economic sectors, so further on, the number of tourist arrivals will be considered as a potential variable of an econometric model. Before the 90s of the past century, 60-65% of air transport was contributed to tourist travel. The number of tourists using air transport before the 90s was at a steady 20% of the total number of tourists. The latest survey conducted by the Institute for Tourism provides the following indicators: 91% of tourists arriving to destinations in Croatia use road transport, air transport is used by 8%, maritime transport by 0,7% and rail transport by 0,3%. This indicates that tourists have preferences for road and air transport on arrival in Croatian tourist destinations, while the use of maritime and rail transport lags far behind. This means that air transport dominantly depends on the movement of tourist demand. According to data obtained by the World Tourism Organization in 2010, 51% of international tourists used air travel for arrival to desired destinations (UNWTO, 2011).

Interrelation of annual percentage growth rate of tourist arrivals and growth rates of total realized passenger kilometers in all transport sectors in Croatia is presented in Chart 2.

V. MEĐUNARODNO SAVJETOVANJE
V. INTERNATIONAL CONFERENCE
„SAVREMENI TRENDOVI U SAOBRAĆAJU, LOGISTICI I EKOLOGIJI U FUNKCIJI
ODRŽIVOG RAZVOJA“
„MODERN TRENDS IN TRAFFIC, LOGISTICS AND ECOLOGY FOR SUSTAINABLE DEVELOPMENT“
23.-24. MAJ, 2014.

CHART 2. INTERRELATION OF ANNUAL GROWTH RATES OF TOURIST ARRIVALS AND PASSENGER KILOMETERS FROM 1999 TO 2009.

Data from Chart 2 show a correlation between the number of tourist arrivals and realized passenger kilometers. This correlation is rather strong, as the number of realized passenger kilometers is growing when there is a growth in the number of tourist arrivals. And *vice versa*.

3. CHOICE OF MODEL AND STATISTICAL DATA

In order to make an objective forecast of demand in passenger air transport in Croatia by 2025, a theoretical model should be defined first. This study investigates dependance of realized passenger air transport on the Croatian gross domestic product and the number of tourist arrivals. Accordingly, a model to estimate passenger air transport demand can be written as a function

$$Y = f(BDP, TA) \tag{1}$$

Where:

Y – passenger air transport demand,

GDP – Croatian gross domestic product,

TA – tourist arrivals.

Variable Y is a dependent variable, while GDP and TA are independent or explanatory variables.

Supposing that the number of passengers in air transport depends on the GDP and the number of tourist arrivals, its linear form would be as following:

$$Y = b_0 + b_1 BDP + b_2 DT \tag{2}$$

Data required for analysis are shown in Table 2.

TABLE 2. GROSS DOMESTIC PRODUCT, TOURIST ARRIVALS AND PASSENGER AIR TRANSPORT IN CROATIA FROM 1996 TO 2013.

Year	GDP (mln HRK at constant prices 1990)	Tourist arrivals in 000	Air passenger carried (in 000)
1996	215,5	4186	1755

V. MEĐUNARODNO SAVJETOVANJE
V. INTERNATIONAL CONFERENCE
„SAVREMENI TRENDOVI U SAOBRAĆAJU, LOGISTICI I EKOLOGIJI U FUNKCIJI
ODRŽIVOG RAZVOJA“
„MODERN TRENDS IN TRAFFIC, LOGISTICS AND ECOLOGY FOR SUSTAINABLE DEVELOPMENT“
23.-24. MAJ, 2014.

1997	229,5	5585	1871
1998	235,2	5852	1970
1999	233,1	5127	1821
2000	239,9	7137	2166
2001	250,4	7860	2348
2002	263,5	8320	2535
2003	274,8	8878	2921
2004	285,2	9412	3297
2005	297,5	9995	3916
2006	311,8	10385	4404
2007	329,8	11162	4895
2008	344,1	11261	5163
2009	324,1	10935	4839
2010	320,2	10604	5153
2011	320,2	11456	5550
2012	314,4	11835	5954
2013	311,3	12438	6324

Source: SLJH, various editions and authors calculation

Pearson's correlation coefficient was calculated from statistical data in Table 2 to determine the correlation between the passenger air transport demand as a dependent variable and of the gross domestic product and tourist arrivals as independent variables (cf. Table 3).

TABLE 3. CORRELATION

Variable	Means	Std.Dev.	GDP	TA	P
Correlations (Zracni_promet.sta)					

Variable	Means	Std.Dev.	GDP	TA	P
GDP	279,147	43,997	1,000000	0,957052	0,927419
TA	8686,211	2877,366	0,957052	1,000000	0,929850
P	3603,684	1618,491	0,927419	0,929850	1,000000

Correlations (Zracni_promet.sta)
Marked correlations are significant at p < ,05000
N=19 (Casewise deletion of missing data)

Data in Table 3 confirm the statistically firm correlation between the gross domestic product and the passenger air transport demand (r=0,927; p<0,05), and the number of tourist arrivals and passenger air transport demand (r=0,929; p<0,05). However, since there is a high correlation between these two independent variables, perhaps it is more suitable to apply only one of them in construction of an econometric model.

4. RESEARCH RESULTS AND DISCUSSION

After conducting correlation analysis, we decided on a one-dimensional model of linear regression in the following form:

$$Y = a + bX + u \tag{3}$$

Where:

X – independent variable,

Y – dependent variable,

u – deviation from the functional relation,

a, b – parameters.

V. MEĐUNARODNO SAVJETOVANJE
V. INTERNATIONAL CONFERENCE
„SAVREMENI TRENDOVI U SAOBRAĆAJU, LOGISTICI I EKOLOGIJI U FUNKCIJI
ODRŽIVOG RAZVOJA“
„MODERN TRENDS IN TRAFFIC, LOGISTICS AND ECOLOGY FOR SUSTAINABLE DEVELOPMENT“
23.-24. MAJ, 2014.

First, GDP was selected as an independent variable, while the parameters were evaluated based on statistical data from Table 2. In assessing the value of parameters in function (3) the method of regression analysis was applied, while the numerical computation was performed by *Statistica* software (cf. Table 4).

Table 4: Correlationa analysis between passenger air transport demand and GDP

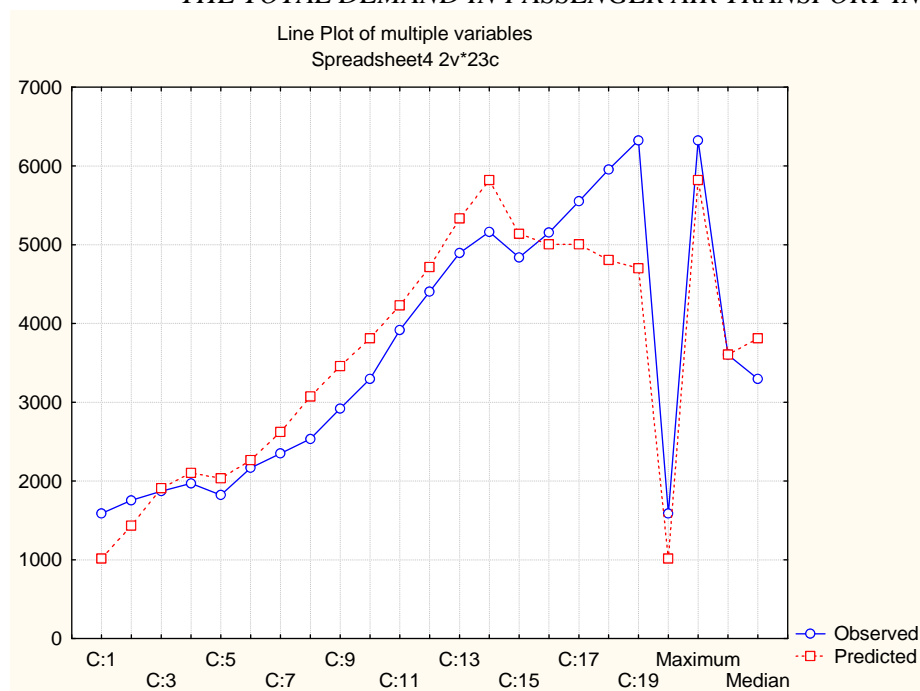|	Regression Summary for Dependent Variable: AP (Zracni_ R= ,92741932 R2= ,86010659 Adjusted R2= ,85187757 F(1,17)=104,52 p<,00000 Std.Error of estimate: 622,90					
N=19	Beta	Std.Err. of Beta	B	Std.Err. of B	t(17)	p-level
Intercept			-5919,85	942,4264	-6,28150	0,000008
GDP	0,927419	0,090714	34,12	3,3371	10,22356	0,000000

Regression analysis of the correlation between passenger air transport demand measured by the number of passengers carried and the GDP gives the following model of simple linear regression:

$$AP = -5919 + 34,12 \; GDP \tag{4}$$

Results of regression analysis (cf. Table 4) indicate that there is a statistically significant correlation between passenger air transport demand measured by the number of passengers carried and the size of GDP (R=0,927; F(1,17)=104,52; p<0,01). Correlation between the total number of passengers carried and the GDP is positive, indicating that the increase in passenger air transport demand measured by the number of passengers carried is linked with an increase in GDP. An increase in GDP of 1 million HRK leads to an increase in demand of about 34,12 thousand passengers in the first year (B=34,12; SE=3,33; p<0,01).

An increase in passenger air transport demand with 86% of variance can be explained by gross domestic product. Chart 3 shows a comparison between the actual and model predicted values of the dependent variable. Chart 3 also shows a satisfactory adaptation of the model to the real data.

CHART 3: COMPARISON BETWEEN THE ECONOMETRIC MODEL AND THE REAL DATA FOR THE TOTAL DEMAND IN PASSENGER AIR TRANSPORT IN CROATIA

V. MEĐUNARODNO SAVJETOVANJE
V. INTERNATIONAL CONFERENCE
„SAVREMENI TRENDOVI U SAOBRAĆAJU, LOGISTICI I EKOLOGIJI U FUNKCIJI
ODRŽIVOG RAZVOJA"
„MODERN TRENDS IN TRAFFIC, LOGISTICS AND ECOLOGY FOR SUSTAINABLE DEVELOPMENT"
23.-24. MAJ, 2014.

In the second case, the number of tourist arrivals was selected as an independent variable, while the parameters were evaluated on the basis of statistical data from Table 2. In assessing the value of parameters in function (3) the method of regression analysis was applied, while the numerical computation was performed by *Statistica* software (cf. Table 5).

TABLE 5: CORRELATIONA ANALYSIS BETWEEN PASSENGER AIR TRANSPORT DEMAND AND TOURIST ARRIVALS

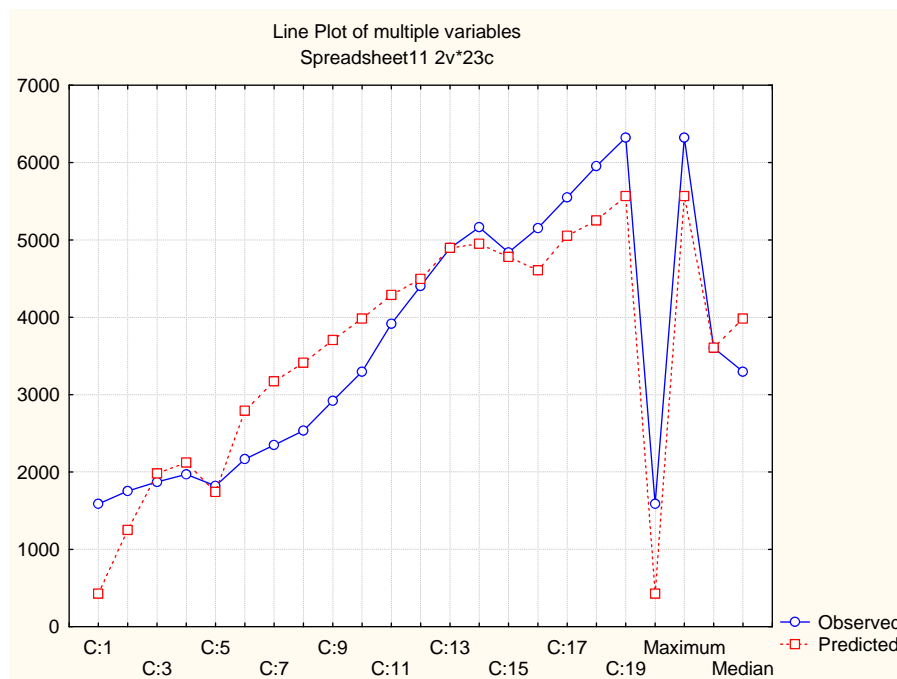| N=19	Beta	Std.Err. of Beta	B	Std.Err. of B	t(17)	p-level
Regression Summary for Dependent Variable: AP (Zracni_ R= ,92984980 R2= ,86462065 Adjusted R2= ,85665716 F(1,17)=108,57 p<,00000 Std.Error of estimate: 612,77					
Intercept			-939,478	458,1135	-2,05076	0,056034
TA	0,929850	0,089238	0,523	0,0502	10,41984	0,000000

Regression analysis of the correlation between passenger air transport demand measured by the number of passengers carried and the number of tourist arrivals gives the following model of simple linear regression:

$$AP = -939,478 + 0,523 \; GDP \tag{5}$$

Results of regression analysis (cf. Table 5) indicate that there is a statistically significant correlation between passenger air transport demand measured by the number of passengers carried and the number of tourist arrivals (R=0,929; F(1,17)=108,57; p<0,01). Correlation between the total number of passengers carried and the number of tourist arrivals is positive, indicating that the increase in passenger air transport demand measured by the number of passengers carried is linked with an increase in the number of tourist arrivals. An increase in the number of tourist arrivals of 1000 leads to an increase in demand of approximately 523 passengers in the first year (B= 0523; SE=0,0502; p<0,01).

An increase in passenger air transport demand with 86% of variance can be explained by the number of tourist arrivals. Chart 5 shows a comparison between the actual and model predicted values of the dependent variable. Chart 5 also shows a satisfactory adaptation of the model to the real data.

CHART *5: COMPARISON BETWEEN THE ECONOMETRIC MODEL AND THE REAL DATA FOR THE TOTAL DEMAND IN PASSENGER AIR TRANSPORT IN CROATIA*

V. MEĐUNARODNO SAVJETOVANJE
V. INTERNATIONAL CONFERENCE
„SAVREMENI TRENDOVI U SAOBRAĆAJU, LOGISTICI I EKOLOGIJI U FUNKCIJI
ODRŽIVOG RAZVOJA"
„MODERN TRENDS IN TRAFFIC, LOGISTICS AND ECOLOGY FOR SUSTAINABLE DEVELOPMENT"
23.-24. MAJ, 2014.

Line Plot of multiple variables
Spreadsheet11 2v*23c

Based on the two given models and the trend equation $Y=947,7+291,8X$, an estimate of demand in passenger air transport by 2025 was made (cf. Table 6). The estimates are based on the assumption that in the forth coming period the GDP will increase at an average rate of 2,3 and 4%, and that the number of tourist arrivals will increase at an annual rate of 3,4 i 5%.

TABLE 6: ESTIMATE OF DEMAND IN PASSENGER AIR TRANSPORT BY 2025 IN CROATIA

	GDP			TA			Trend
Year	*2%*	*3%*	*4%*	*3%*	*4%*	*5%*	*Y=947,7+291,8 X*
AP$_{2015}$	5131,66	5349,41	5569,27	5961,75	6096,41	6232,36	6779,412
AP$_{2020}$	6281,83	7144,17	8058,24	7060,94	7620,75	8213,81	8238,338
AP$_{2025}$	7551,70	9224,79	11086,45	8335,20	9475,35	10742,70	9697,265

CONCLUSION

This study presented a simple linear regression model for forecasting demand in passenger air transport in Croatia. Two models were made and tested. In one of them, GDP is considered as an independent variable, while in the other one the independent variable is the number of tourist arrivals. Both models show satisfactory theoretical, statistical and econometric values, and a high level of practical applicability in projecting transport demand in passenger air transport. However, as evident from the both models, the estimated values in the initial period lag behind the real values, so another forecast was made based on the trend equation. This ensured high accuracy of estimation throughout the whole period from 2015 to 2025. If the business model of air transport in Croatia remains unchanged over the next decade, the number of passengers carried should increase by 70%. Better results require a significant change of business model. And finally, it should not be forgotten that tourism and air transport in Croatia are co-dependent. Relatively inexpensive air transport has also been crucial in the rise of tourism in Croatia.

V. MEĐUNARODNO SAVJETOVANJE
V. INTERNATIONAL CONFERENCE
„SAVREMENI TRENDOVI U SAOBRAĆAJU, LOGISTICI I EKOLOGIJI U FUNKCIJI
ODRŽIVOG RAZVOJA“
„MODERN TRENDS IN TRAFFIC, LOGISTICS AND ECOLOGY FOR SUSTAINABLE DEVELOPMENT“
23.-24. MAJ, 2014.

REFERENCES

[1] Abed, S.Y., Ba-Fail, A. O., Jasimuddin, S. M. (2001). "An econometric analysis of international air travel demand in Saudi Arabia", *J. Air Transp. Manag.*, vol. 7, pp. 143-148,

[2] Aderamo, A.J. (2010). "Demand for air transport in Nigeria", *Journal of Economics*, vol. 1, pp. 23-31.

[3] Alam, J.B., Karim, D. M. (1998). "Air travel demand model for domestic air transportation in Bangladesh", *J. Civil. Eng.*, vol. 26, pp. 1-13.

[4] Asri, D.U., Sugie, Y. (2003). Simultaneous demand model for passenger travel: A case study of Indonesia, Eastern Asia Soc. *Transp. Stud.*, vol. 4, pp. 869-884.

[5] Ba-Fail, A. O. (2004). "Applying data mining techniques to forecast number of airline passengers in Saudi Arabia (domestic and international ravels)", *J. Air Transp.*, vol. 9, pp. 100-116.

[6] Ba-Fail, A. O., Abed, S. Y. (2000). "The determinants of domestic air travel demand in the Kingdom of Saudi Arabia", *J. Air. Transp.* World Wide, vol. 5, pp. 72-86.

[7] Bhadra, D. (2003). "Demand for air travel in the United States: Bottom-up econometric estimation and implications for forecasts by origin and destination pairs", J. *Air Transp. Manag.*, vol. 8, pp. 19-56.

[8] Brons, M., et al. (2002). "Price elasticities of demand for passenger air travel", J. Air Transp. Manag., vol. 8, pp. 165-175.

[9] Carson, R. T., Cenesizolu, T., Parker, R. (2011). "Aggregate demand for USA commercial air travel", *Int. J. Forst.*, vol. 27, pp. 923-941.

[10] Dargay, J., Hanly, M. (2001).``The determinants of the demand for international air travel to and from UK", *ESRC Transport Studies Unit,* Centre for Transport Studies, University College London, vol. 59, pp. 1-14.

[11] Grosche, T., Rothlauf, F, Heinzl, A. (2007). "Gravity models for airline passenger volume estimation", *J. Air Transp. Manag.*, vol. 13, pp. 175-183.

[12] Ippolito, R. A.(1981). ``Estimating airline demand with quality of service variables", *J. Transp. Econo. Poli.*, vol.15, pp. 7-15.

[13] Jorge-Calderon, D.J. (1997). ``A demand model for scheduled airline services on international European routes", *J. Air Transp. Manag.*, vol. 3, pp. 23-35.

[14] *Jutarnji List*, 10/12/2013.

[15] Kim, K.W., Seo, H. Y., Kim, Y. (2003). ``Forecast of domestic air travel demand change by opening the high speed rail", *KSCE J. Civil Eng.*, vol.7, pp. 603-609.

[16] Kopsch, F (2012). ``A demand model for domestic air travel in Sweden", *J. Air Transp. Manag.*, vol. 20, pp. 46-48, 2012.

[17] Pupavac, D. (2009): *Načela ekonomike prometa*, [Principles of Transport Economics], Rijeka, Veleučilište u Rijeci, [Polytechnics of Rijeka].

[18] Tatalović, M., Mišetić, I., Bajić, J. (2012). *Menadžment zrakoplovne kompanije* [Management of an Airline Company], Zagreb, Mate, d.o.o.

[19] Wei, W., Hansen, M. (2006). "An aggregate demand model for air passenger traffic in the hub and spoke network", Transpo. Res. A., vol. 40, pp. 841--851.

[20] Wirasinghe, S.C., Kumarage, S. (1998). "An aggregate demand model for intercity passenger travel in Sri Lanka", *Transp.*, vol. 25, pp. 77-98.

[21] Wu, C., Han, J., Hayashi, Y. (2011). Airport attractiveness analysis through a gravity model: A case study of Chubu International Airport in Japan, Eastern Asia Soc. *Transp. Stud.,* vol. 8, CD-ROM (100350).