THE DETERMINANTS OF MARITIME PASSENGER TRANSPORT TO CROATIAN ISLANDS

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Abstract

The paper shows the determinants of passenger transportation to and off major Croatian islands based on correlations. Due to lacking time series, we use the simplest statistical associations based on cross-section correlation. The results show that major determinants of passenger transportation to and off Croatian islands are the number of island inhabitants, the number of registered tourist arrivals, as well as the number of registered beds, while the number of vehicles transported to the islands is statistically associated to the economic activity on the island represented by total on-island company revenues. The purpose of the paper is to help predict and plan future maritime transportation requirements of Croatian islands.

Key words: islands development planning, maritime passenger transport, cross-section correlation

1. INTRODUCTION

Insular Croatia numbers more than thousand islands and islets, 48 of which permanently inhabited and 38 of these are regularly connected to the mainland either by a bridge or by an all year long maritime line. For these, we have limited statistical data, while for a smaller group of 12 larger islands we have a more detailed statistical database. The goal of the paper is to use all the available data to help predict and plan future maritime transportation requirements of Croatian islands.

Maritime passenger transport is an essential transportation service for the development of any coastal area. In this paper, we analyse statistical associations between data of the maritime passenger transport connecting Croatian islands and data

representing industries, services, and activities regarded as determinants of island economies. We concentrate on simple statistical associations and Ordinary Least Square (OLS) correlations due to data limitations, i.e. lacking longer time series.

Specifically, we analysed both the number of passengers and the number of vehicles transported to the islands by daily, all year maritime lines as well as to the islands having a bridge to the mainland (Krk and Pag). Islands interconnected by a bridge (Cres and Lošinj, Ugljan and Pašman) were analysed as an island group. Because of missing data, we excluded the island of Sućurać from the analysis.

2. LITERATURE REVIEW

Maritime passenger transport represents an essential service necessary for development of Croatian coastal area (Debelić, 2018), thus requires special attention from the public policies perspective (Debelić et al., 2015 & 2016). The quality of public port management system represents one of the key action areas necessary for achieving economic development goals (Debelić et al. 2018). Provision of public maritime passenger transportation services represents the other one, and its determinants are the main research focus presented in this paper. The port service complexity and quality was researched by Bendeković et al. (2010) providing wider insight to the problem of port services quality while Gaur (2005), Grosso & Monteiro (2008), Notteboom (2011) and Duran et al. (2017) provided more insight into port planning and quantitative analysis approaches into the field. In the maritime passengers, transport research the strong focus on port management was presented in the Kesić (2003) while Kesić & Jugović (2006) elaborated on specificities of maritime passenger ports management. Kesić & Debelić (2014) provided analysis of competitiveness growth possibilities and limitations of Croatian ports. Paixao Casaca et al. (2010) analysed port choice in the European short sea shipping market from different port authorities' perspectives while Rak et al. (2016) performed research on modelling of railway port infrastructure management systems offering more insight into modern management approaches applicable to port infrastructure.

3. DATA AND METHODS

The first cross-section analysis encompassed the inhabited Croatian islands with available statistical data: the sample of 38 island groups having regular maritime lines. The analysis does not include the island of Krk, the southern half of the island of Pag and the peninsula of Pelješac, because of lack of data. We aggregated the data for the two island groups of Cres-Lošinj and Ugljan-Pašman because of their bridge interconnectedness.

The second cross-section analysis encompassed the 12 largest islands only having a larger and better database suitable for a more thorough statistical analysis.

We tested all available variables, but used only the ones that were statistically significant at $p < 0.05$ in further analyses. The dependent variable of primary interest are “passengers” and “vehicles” i.e. number of passengers and number of vehicles in regular maritime transport. All calculations were performed in E-views 9.0 statistical-

econometric package. The data sources are the Central Bureau of Statistics, the Agency for Coastal Maritime Traffic, and county port authorities and captains.

To find the determinants of passenger transport to and off major Croatian islands, we tested the Ordinary Least Squares (OLS) Pearson correlations between the dependent variables of interest: the transportation of passengers and the transportation of vehicles, and several independent variables that were collected. The data shortcomings are obvious: no time series were available, so no sophisticated time series, cross correlation or pooled data analysis was possible. Thus, no falsification of causal conjectures was possible, only statistical associations (Gujarati, 2009; Maddala, 2001).

4. RESULTS AND DISCUSSION

The two dependent variables of interest that were extensively tested for statistical associations were passenger and vehicle transportation.

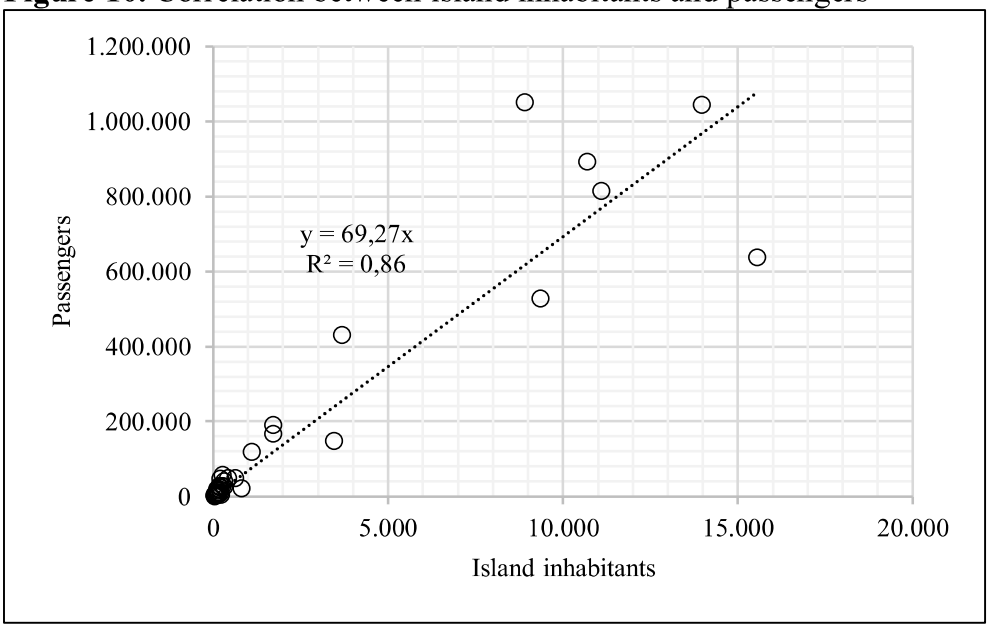
4.1. Passenger Transport

The most important dependent variable is the number of passenger landings on an island by means of liner shipping. The most important variable for explaining island maritime passenger transport landings is the number of island inhabitants (Table 1). Not only are the shipping lines here to serve domestic population requirements, but also, the shipping transport to the islands is relatively evenly distributed in relation to the number of inhabitants on the islands. We can read in Table 1 that passenger transport onto the islands may be explained with 86% by the variable of registered local population (R^2=0.86). The value of the independent population variable coefficient of 69.27 means that for one inhabitant on the island we have 69 passengers in maritime transport and this ratio is significant at the level of $p<0.0001$. On average, this means that the best individual predictor of passenger transport is exactly the number of inhabitants on an island. Figure 1 shows this relationship.

The number of inhabitants of an island is the best individual predictor of the number of passengers in maritime transport to that island:

$$\text{PASSENGERS} = 69.27 \cdot \text{INHABITANTS} \quad [R^2=0.86, p<0.001]$$

Figure 10. Correlation between island inhabitants and passengers



Source: Authors

Maritime passenger transport to islands is mostly explained by a population variable (R2=0.697, p<0.001). The value of the coefficient of the population variable is 69,271, meaning that an island inhabitant uses maritime transportation on average 69 times a year with a standard error of ± 3.87 (Table 1). Unfortunately, a strict separation between tourist passenger travellers and domicile population travellers was not possible, and our attempts to arrive to a statistically significant model were not successful. We shall try to explain the passenger transport according to the needs and identify those variables that are at the same time statistically significant and possess certain explanatory power. It is obvious that the function of line shipping to and off the Croatian islands has the primary function of providing the transportation to the domestic population continuously throughout the year and not only as required by the tourist season.

Table 14. Correlation between the number of passengers and the number of inhabitants

Dependent Variable: PASSENGERS
Method: Least Squares
Included observations: 38

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INHABITANTS	69.27101	3.874403	17.87915	0.0000
R-squared	0.862184	Mean dependent var		174324.8
Adjusted R-squared	0.862184	S.D. dependent var		308240.4
S.E. of regression	114430.0	Akaike info criterion		26.15928
Sum squared resid	4.84E+11	Schwarz criterion		26.20237
Log likelihood	-496.0263	Hannan-Quinn criter.		26.17461

Source: Authors' calculation using Eviews 9.0.

Tourism is the basic economic activity on the islands and the need for transport of tourists is well included in the number of registered beds on an island for tourism purposes that we added to the basic population variables in Table 2.

Table 15. Correlation between the number of passengers, beds and inhabitants

Dependent Variable: PASSENGERS
Method: Least Squares
Included observations: 38

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BEDS	8.344920	3.296315	2.531590	0.0159
INHABITANTS	52.00238	7.721787	6.734501	0.0000
R-squared	0.883011	Mean dependent var		174324.8
Adjusted R-squared	0.879761	S.D. dependent var		308240.4
S.E. of regression	106883.8	Akaike info criterion		26.04807
Sum squared resid	4.11E+11	Schwarz criterion		26.13426
Log likelihood	-492.9133	Hannan-Quinn criter.		26.07873

Source: Authors' calculation using Eviews 9.0.

However, private needs of inhabitants continue to explain the greatest part of maritime passenger linear transport to islands:

$$PASSENGERS = 8.34 \cdot BEDS + 52.00 \cdot INHABITANS \quad [R^2=0.88, p<0.001]$$

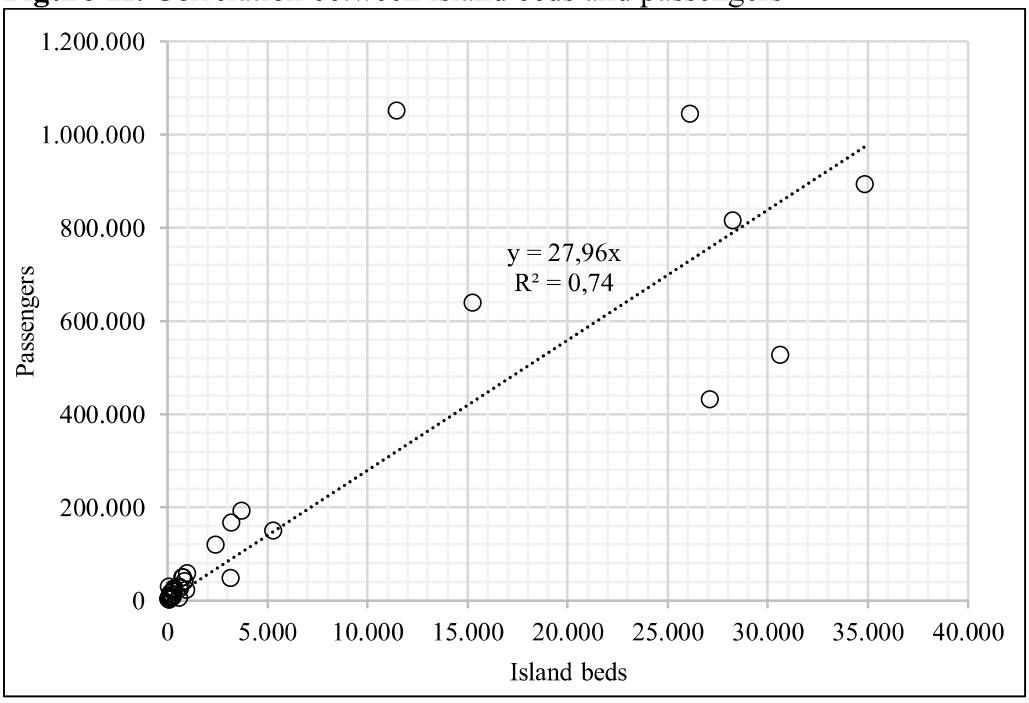
What we immediately observe, is the non-linearity and heteroscedasticity of the relationship between main variables. However, this does not change the fact that the number of inhabitants and the number of beds are still best common predictors of the number of tourists on the islands. Regardless of heteroscedasticity, the Ordinary Least Squares (OLS) is still the Best Linear Unbiased Estimator (BLUE).

From the line shipping and passenger reasons of travel point of view, two basic passenger categories self-evidently pop out: the islands' inhabitants and tourists.

From the statistical relation between the number of beds and the number of passengers on the islands, it is obvious that tourist activity generates a significant part of maritime passenger transport on islands. However, inverse causality creates multicollinearity between variables. In other words, tourist activity on islands is the most important activity on the islands that allows the local population to live there. The only form of transport communication with the shore for the islanders is line shipping. However, this communication has two purposes: private and business. The major business activity on islands is tourism. The number of beds is the only statistically significant variable correlated with the number of passengers.

The number of beds best represents tourist passenger activity (Figure 2).

Figure 11. Correlation between island beds and passengers



Source: Authors

The following relation from Table 3 best describes the relationship between the number of passengers and the number of beds on an island:

$$PASSENGERS = 27.96 \cdot BEDS \qquad [R^2=0.74, p<0.001]$$

With 28 passengers per year per bed, the number of beds is also a very good predictor of the number of line shipping passenger travels. From the table, it follows that without considering other variables; the number of registered beds for tourism purposes on the island explains 74% of the number of passengers bound to the islands. On average, there are almost 28 passengers in shipping line passenger travels per registered bed (Table 3).

Table 16. Correlation between the number of passengers, and the number of beds

Dependent Variable: PASSENGERS
Method: Least Squares
Included observations: 38

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BEDS	27.95506	2.290736	12.20353	0.0000

R-squared	0.735626	Mean dependent var	174324.8
Adjusted R-squared	0.735626	S.D. dependent var	308240.4
S.E. of regression	158489.0	Akaike info criterion	26.81072
Sum squared resid	9.29E+11	Schwarz criterion	26.85382
Log likelihood	-508.4037	Hannan-Quinn criter.	26.82605

Source: Authors' calculation using Eviews 9.0.

Since data was not available for all 38 islands of interest, it was necessary to reduce the sample to only 12 islands. We excluded the island of Krk because of its bridge connection to the mainland and missing accurate data. In addition, we considered the islands of Cres and Lošinj, as well as the islands of Ugljan and Pašman as common transport-economic units. A somewhat larger set of data was available for these 12 islands enabling us better analysis. To begin with, we were able to confirm previous measurements and statistical associations (Table 4).

As in the previous case of 38 islands, maritime passenger transport to the 12 largest islands is mostly explained by the population variable (R^2=0.697, $p<0.001$). The value of the coefficient of the population variable is 69,207, which means that an island inhabitant uses maritime transportation on average 69 times a year with a standard error of ±7. The larger standard error is due to a smaller sample. The previous disclaimer still applies: it was not possible to separate tourist arrivals from the inhabitants, but we shall seek to collect some additional data in the future and deduce the number of tourist passenger transport from that.

Table 17. Correlation between the number of passengers and the number of beds

Dependent Variable: PASSENGERS
Method: Least Squares
Included observations: 12

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INHABITANTS	69.20672	7.065517	9.794998	0.0000

R-squared	0.697470	Mean dependent var	505769.8
Adjusted R-squared	0.697470	S.D. dependent var	379151.5
S.E. of regression	208543.5	Akaike info criterion	27.41334
Sum squared resid	4.78E+11	Schwarz criterion	27.45375
Log likelihood	-163.4800	Hannan-Quinn criter.	27.39838

Source: Authors' calculation using Eviews 9.0.

After the number of inhabitants, the beds registered for tourism purposes are the next most significant variable statistically related to the number of passengers in ship passenger transportation.

From table 5 it is visible that the total number of passengers in maritime transport is explained with 42% by the number of beds: on average, almost 28 ± 4 passengers per bed (Table 5).

Table 18. Correlation between the number of passengers and the number of beds

Dependent Variable: PASSENGERS
Method: Least Squares
Included observations: 12

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BEDS	27.95239	4.189216	6.672464	0.0000

R-squared	0.417289	Mean dependent var	505769.8
Adjusted R-squared	0.417289	S.D. dependent var	379151.5
S.E. of regression	289427.1	Akaike info criterion	28.06885
Sum squared resid	9.21E+11	Schwarz criterion	28.10926
Log likelihood	-167.4131	Hannan-Quinn criter.	28.05389

Source: Authors' calculation using Eviews 9.0.

These results, carried out on a smaller sample of only 12 large islands, fully correspond to previous data carried out on more than 38 islands. Unlike the 38 islands sample, a 12 large islands sample is available for recorded tourist arrivals, which have proved to be statistically significant in explaining the number of passengers in liner shipping (Table 6).

Table 19. Correlation between the number of passengers and tourist arrivals

Dependent Variable: PASSENGERS
Method: Least Squares
Included observations: 12

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TOURIST ARRIVALS	2.644405	0.460559	5.741724	0.0001

R-squared	0.264156	Mean dependent var	505769.8
Adjusted R-squared	0.264156	S.D. dependent var	379151.5
S.E. of regression	325241.2	Akaike info criterion	28.30218
Sum squared resid	1.16E+12	Schwarz criterion	28.34259
Log likelihood	-168.8131	Hannan-Quinn criter.	28.28722

Source: Authors' calculation using Eviews 9.0.

The most important individual variable for explaining the number of inhabitants on an island is its surface (R^2=0.417, p<0.001) (Table 7).

Table 20. Correlation between the number of inhabitants and island area

Dependent Variable: INHABITANTS
Method: Least Squares
Included observations: 12

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ISLAND AREA IN KM^2	31.70600	4.921535	6.442299	0.0000

R-squared	0.417170	Mean dependent var	6819.167
Adjusted R-squared	0.417170	S.D. dependent var	5335.669
S.E. of regression	4073.426	Akaike info criterion	19.54201
Sum squared resid	1.83E+08	Schwarz criterion	19.58242
Log likelihood	-116.2521	Hannan-Quinn criter.	19.52705

Source: Authors' calculation using Eviews 9.0.

In contrast to the domicile island population that uses maritime transport on average 69 times a year (parameter value = 69 ± 7, R2 = 0.417, p <0.001), tourist arrivals affect the realization of maritime passenger transport with a value of 2.6 ± 0.5 (R2 = 0.264, p <0.001). This argues in favour of the fact that maritime passenger transport for tourism purposes is statistically significant, but in total, rather small and explained by only 26% of the dependent variable of the total number of passengers:

PASSENGERS = 2.64 · TOURIST ARRIVALS [R^2=0.264, p<0,001]

Although at first glance this seems a rather small number, a single tourist arrival generates on average 2.6 ± 0.5, hence between 2 and 3 passenger travels.

4.2. Vehicle Transport

Crossing to the second most important variable coastal line shipping on Croatian islands: transport, ie the number of recorded arrivals of vehicles on islands or island groups (Cres-Lošinj and Ugljan-Pašman). The two most statistically significant variables were population ($p < 0.001$) and number of beds ($p = 0.004$) with $R^2 = 0.897$. The needs of the local population and the needs of tourists explain 90% of the demand for ship vehicle transport (Table 8).

Table 21. Correlation between the number of vehicles, number of inhabitants and beds

Dependent Variable: VEHICLES
Method: Least Squares
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BEDS	3.097198	0.989227	3.130926	0.0041
INHABITANTS	13.13171	2.315081	5.672247	0.0000
R-squared	0.896605	Mean dependent var		56253.07
Adjusted R-squared	0.892913	S.D. dependent var		97661.65
S.E. of regression	31958.98	Akaike info criterion		23.64663
Sum squared resid	2.86E+10	Schwarz criterion		23.74005
Log likelihood	-352.6995	Hannan-Quinn criter.		23.67652

Source: Authors' calculation using Eviews 9.0.

The variable “business income” is a better predictor of the number of vehicles than any other tested variable. Thus, vehicle transport in and from the islands can best be explained by a combination of variables representing the number of inhabitants on the island and the income of the entrepreneurs on the islands. One of the reasons why this combination of variables has a higher R^2 is that the transport of vehicles on islands is an indicator of both island population and economic activity. On the downside, there is multicollinearity between these variables as income of entrepreneurs correlates with the number of inhabitants. The most important variable influenced by the total number of vehicles transported by ferries is “business income”, an aggregate economic activity variable, which is also closely related to the island size and population (Table 9).

Table 22. Correlation between the number of transported vehicles and business income

Dependent Variable: VEHICLES
Method: Least Squares
Included observations: 12

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BUSINESS INCOME in mil. kn	235.0743	23.51658	9.996111	0.0000

R-squared	0.735982	Mean dependent var	139028.4
Adjusted R-squared	0.735982	S.D. dependent var	112626.5
S.E. of regression	57870.57	Akaike info criterion	24.84946
Sum squared resid	3.68E+10	Schwarz criterion	24.88987
Log likelihood	-148.0968	Hannan-Quinn criter.	24.83450

Source: Authors' calculation using Eviews 9.0.

Business income is the best single indicator of vehicle transportation to the islands:

$$VEHICLES = 235.07 \cdot BUSINESS\ INCOME \qquad [R^2=0.74,\ p<0{,}001]$$

Income is the best indicator of economic activity and the consequent need for mobility. Tourism is the most important island economic activity, and thus it is not surprising that the income of the entrepreneurs is collinear with the variables related to tourism. This somewhat complicates the modelling.

In continuation, we also analysed the ratio of the number of passengers and the number of vehicles transported (Table 10).

Table 23. Correlation between the number of passengers and transported vehicles

Dependent Variable: PASSENGERS
Method: Least Squares
Included observations: 12

Variable	Coefficient	Std. Error	t-Statistic	Prob.
VEHICLES	3.325185	0.349194	9.522444	0.0000

R-squared	0.656259	Mean dependent var	505769.8
Adjusted R-squared	0.656259	S.D. dependent var	379151.5
S.E. of regression	222294.5	Akaike info criterion	27.54105
Sum squared resid	5.44E+11	Schwarz criterion	27.58146
Log likelihood	-164.2463	Hannan-Quinn criter.	27.52609

Source: Authors' calculation using Eviews 9.0.

Vehicle transportation statistics shows that for every vehicle registered on the island, there were 3.3 passengers on the ferry, irrespective of whether they came to the island by car, as there is no separate record of passengers in and off the vehicles.

The following is an attempt to unite several statistically significant variables to explain the number of passengers. The two variables highlight the mutual non-linearity. This is entrepreneurial income of millions of kuna and the number of inhabitants of the island (Table 11).

Table 24. Correlation between number of passengers, business income and inhabitants

Dependent Variable: PASSENGERS
Method: Least Squares
Included observations: 29

Variable	Coefficient	Std. Error	t-Statistic	Prob.
BUSINESS INCOME in mil. kn	301.6566	113.5698	2.656135	0.0131
INHABITANTS	46.52616	9.466079	4.915040	0.0000

R-squared	0.879614	Mean dependent var	225912.3
Adjusted R-squared	0.875156	S.D. dependent var	337490.3
S.E. of regression	119246.6	Akaike info criterion	26.28225
Sum squared resid	3.84E+11	Schwarz criterion	26.37654
Log likelihood	-379.0926	Hannan-Quinn criter.	26.31178

Source: Authors' calculation using Eviews 9.0.

The first variable associates economic activity and the economic need with the transport service while the variables of the population encompass private citizens' needs.

4.3. Research limitations and prospectives

The limitations of this study are lacking comprehensive time-series data and incoherent cross-sectional data across islands. We had to reduce our sample from 38 to 12 islands to be able to have a common set of cross-section variables.

In the future we envision to be able to construct a set of panel/pooled data and to be able to gain more information both on individual islands, but also by using panel/pooled data statistical methods to gain better overview on behaviour that is common to all Croatian islands. This knowledge may be used to improve future policy recommendations.

5. CONCLUSION

The results show that major determinants of passenger transportation to and off Croatian islands are the number of island inhabitants, the number of registered tourist arrivals, as well as the number of registered beds, while the number of vehicles transported to the islands is statistically associated to the economic activity on the island represented by total on-island company revenues.

We conclude that passenger and vehicle transportation to and from Croatian islands is predominantly determined by the number of inhabitants on the island. Larger islands have larger populations, and larger populations are able to accommodate a larger number of tourists. Main economic activities on islands closely relate to tourism. After the number of inhabitants, tourist arrivals are the next most

significant variable describing the number of passengers in line shipping to the islands. Entrepreneurial income best describes car transportation in Ro-Ro ferry transport. Together with the number of inhabitants, economic activity expressed in million kuna of entrepreneurial income is the best determinant of the number of vehicles in maritime transport to the islands. Entrepreneurial income is the variable statistically most closely related to tourism.

This paper represents a humble start of what we hope to be a thorough and systematic future econometric analysis of the maritime transportation to Croatian islands.

6. ACKNOWLEDGMENTS

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