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Evaluating the competition dynamics of container ports in the North Adriatic

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ABSTRACT

World trade has changed in the last decade and the container traffic flows are oriented towards several parts of the European continent. A European container port system is not a homogenous set of ports, but is established of several large ports (Rotterdam, Hamburg, Algeciras...) and a large number of medium- and small-sized ports. North Adriatic (NA) ports belong to this category of ports and in this paper we have analysed the container flows and the throughput attained in these ports.

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1. Introduction

Port competition is very often analysed and the analysis depends on the criteria that we take into consideration. In the UNCTAD [1] publications, the geographical location, hinterland networks, port tariffs, efficiency of land transport and port information system are selected as the most important criteria. Bichou and Gray [2] concluded that the port competition depends also on institutional and functional levels of management. All of them agree that the geographical location of a seaport is one of the most important elements and when we talk about the containerized traffic this is even more important, because more than 90% of trade of industrialized countries is transported in containers. The transit time is very important in container transport. Therefore, the location of the port must be close to the main corridors.

Port competitiveness of East Asia was analysed by Yap et al [3], Notteboom [4] analysed the European port system, Yeo et al [5] analysed the ports in Korea and China. In addition, Ducret and Notteboom [6] presented the influence of the shipping network to the port system and port spatial development.

Based on the literature related to port competition and port selection we have analysed the port system in the North Adriatic area and in accordance with this we have prepared a model to describe the ports' relations.

2. Port gateway region of the North Adriatic (NA)

European container ports can be analysed through several criteria as they present a large and different system with specific characteristics. Notteboom [7] presented a new trend in the development of the European container port system and port hierarchy that includes the formation of multi-port gateway regions. According to this formulation, the ports of Rijeka, Koper, Trieste, Venice and Ravenna form a Multi-port gateway region of the North Adriatic. Each of these ports has different development plans but they have a partly common hinterland and the costumers.

In such conditions a co-opetition is a natural way for surviving. Branderburger et al [8] defined co-opetition as a mix of verb cooperation and verb competition. It is a synonym for the "win-win" strategy for the ports which are very close one to another and they have to cooperate but in the same time they are in competition for the market share.

In this paper, we have analysed the throughput in the NA ports – Koper, Trieste, Venice, Ravenna and Rijeka in the last twenty four years.

3. Analysis of the container throughput in the na ports

In the twenty-four year long analyzed period (Fig. 1), that is from 1990 to 2013, the total container traffic in the

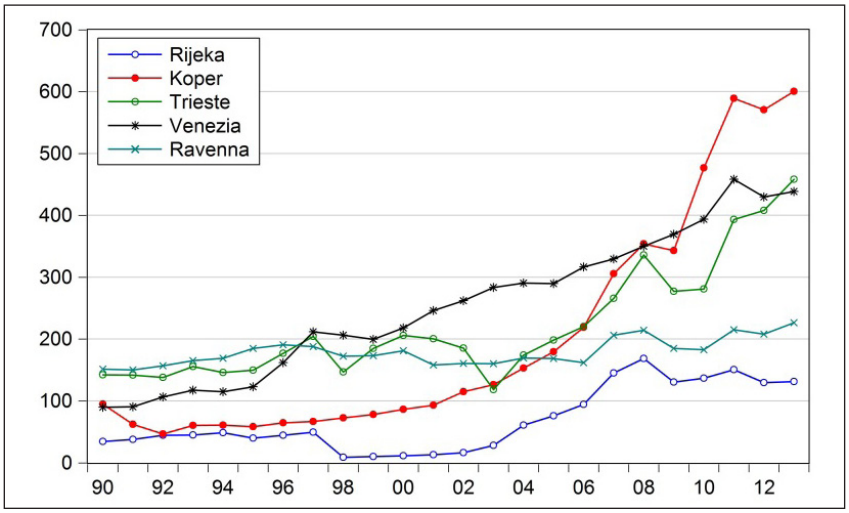

Fig. 1 Containers throughput in 1000 TEU at the North Adriatic ports from 1990 to 2013

NA ports has increased almost exponentially, on an average of 7% per year (however, this was lower than the average of all European ports), but the rate has varied among ports. According to Twrdy and Batista [12], there is a relatively high probability that these ports will also have a further container growth. We can observe an accelerated growth in the port of Koper, a steady growth at the port of Venice, and stagnation at the Ravenna port. In the year 2013, the highest throughput was obtained in the port of Koper (600,441 TEU) and this presented the growth of 5.2% in regard to the previous year. The highest growth was in the port of Venice (11.5%) and the lowest in the port of Rijeka (1.3%).

The years 2008 and 2009 – the worst years of the global economic and financial crisis – offer some interesting results. In Venice, during this period, the port of Venice kept its throughput steadily increasing by 5% per year, while the other four ports in the area experienced a decrease averaging to 15%. The largest drop in traffic was recorded in Trieste: it was a decrease of more than 58,000 TEUs (17.5%). In terms of a relative decrease, the port of Rijeka performed the worst; it registered the decline of 22.5% (38,000 TEUs less). The shift-share analysis, proposed by Notteboom [2], was used in this analysis with the absolute growth of container traffic (ABSGR) and the share effect among ports included.

Table 1 Absolute growth of the container throughput and the total shift of containers to the NA Ports (1991–2013)

Period		Koper	Rijeka	Trieste	Venezia	Ravena
		Absolute growth in TEU				
1991	1995	-3758	2000	8200	32300	34600
1995	1999	19821	-29866	35163	76703	-11595
1999	2003	48033	18164	-66765	83864	-13045
2003	2007	179411	116742	147465	45845	46220
2007	2011	283666	5637	127323	128851	8756
2011	**2013**	11127	-19367	65311	-19534	11424
1991	2013	538300	93310	316697	348029	76360
		Containers shift in TEU				
1991	1995	-11851	-4065	-12307	16801	11422
1995	1999	10121	-34235	10592	51003	-37481
1999	2003	38067	16572	-84646	59706	-29698
2003	2007	68289	71020	37144	-124752	-51700
2007	2011	125743	-50263	8739	-16309	-67910
2011	2013	-4804	-23092	53883	-31527	5540
1991	2013	236230	-9248	-8873	-31385	-185777

Based on Figure 1, we have prepared Table 1, where we can see the absolute growth of container throughput and the total shift of container among the ports of North Adriatic.

From Table 1 we can see that, at the beginning, the absolute growth was the smallest in Koper (red colour), but at the end of the analysed period it became the highest among all NA ports (green colour). A completely opposite situation appeared in Ravenna where the largest growth was recorded in the period between 1991 and 1995, but at the end this port registered the smallest absolute growth of throughput expressed in TEU. In the second part of Table 1, the container shift between the ports has been presented, and it clearly indicates that Ravenna has lost a great part of the market.

The distribution of containers is not equal in all ports within the NA port region. The concentration index known as the HH index (Hirschman-Herfindahl index) is a convex function of a number of market players and is therefore susceptible to their inequality [9]. It represents the sum of potency of individual market shares of ports in one port region, in our case it is in the NA region.

The HHI takes into account the number of ports and the inequality of market shares. The principle is very simple: the higher the index is the more concentration is in one port and the less open is the market competition [10]. In Figure 2, the HHI is between 0.21 and 0.27. This indicates the presence of a normal competition. Spanning the1995–2003 year period (Table 1), Venice has benefited more than other ports in this region.

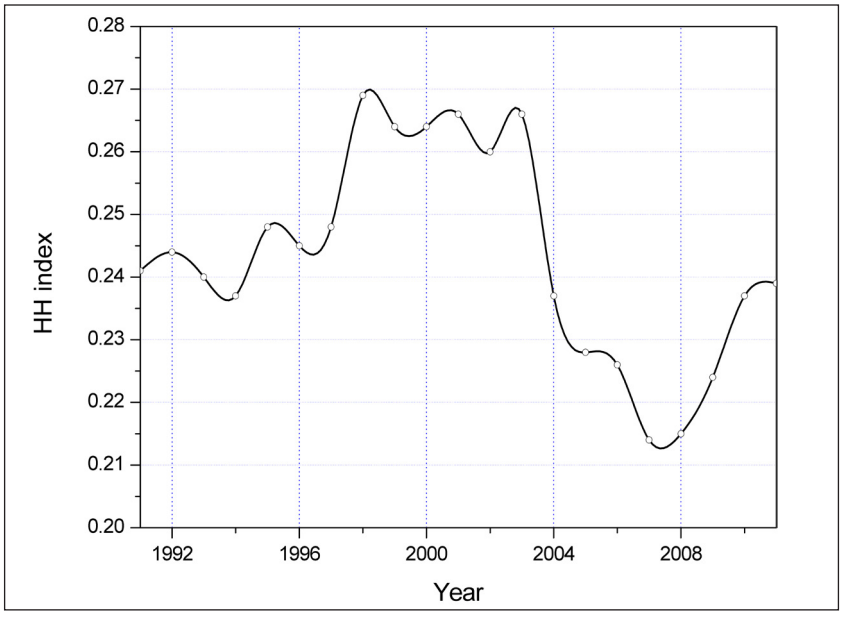

Fig. 2 Evaluation of the Hirschman-Herfindahl index for the NA ports (1991–2011)

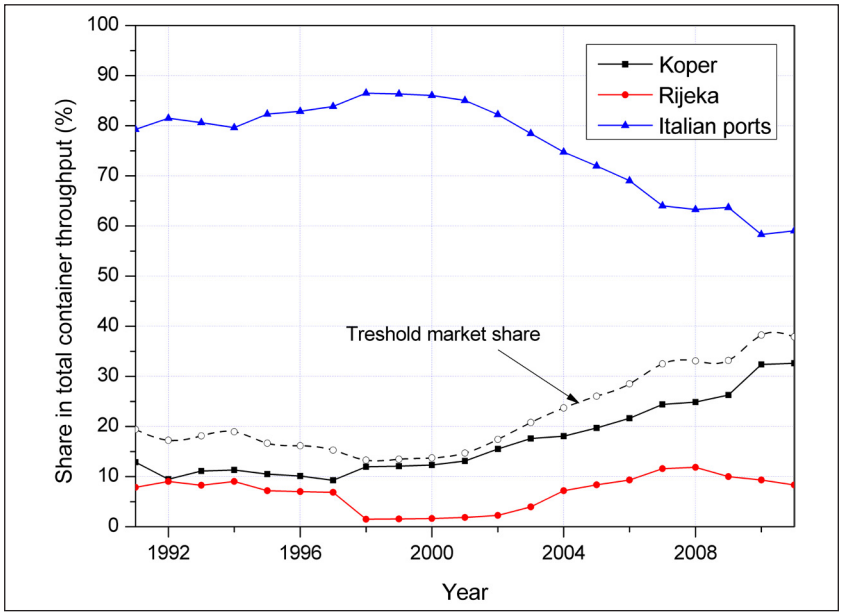

Fig. 3 Evaluation of Market Shares in the NA Ports (1991–2011)

This is also shown in Figure 3, where the evaluation of the market shares in the NA ports per country can be seen.

The Figure 3 shows that only the port of Rijeka retains its share position. We can see almost a mirror image which shows that the decline in the market share of Italian ports is the reason for the increase of the market share of the port of Koper. The market share of the ports of Ravenna, Venice and Trieste was at the beginning (1991) approx. 80% (now it is approx. 60%). At the same time, the share of the port of Koper increased from approx.10% to approx. 30%.

The estimated market potential for the NA ports for the year 2030 appears to be ambitious in the segment of container traffic. In fact, it implies a 348% growth in terms of the absolute numbers of TEUs in comparison to the year 2010, while only 73% growth is estimated for the market as a whole. At the same time the market share should grow from the current 4.3% to 11.3% in 2030 [11].

In order to identify possible competition behavior among the discussed ports, the fraction of the total throughputs for each port was calculated. The result is shown on Figure 4, where we can see that the port of Koper has shown an almost constant growth of the container market, while the port of Ravenna has registered an almost constant fall. Other three ports show a kind of oscillatory trends.

Figure 5 represents the BC-matrix for the NA ports with growth figures and market shares relating to the 1991–2011 period. In the last period E, the port of Koper was near to the "stars", but at the beginning of the observed period A,

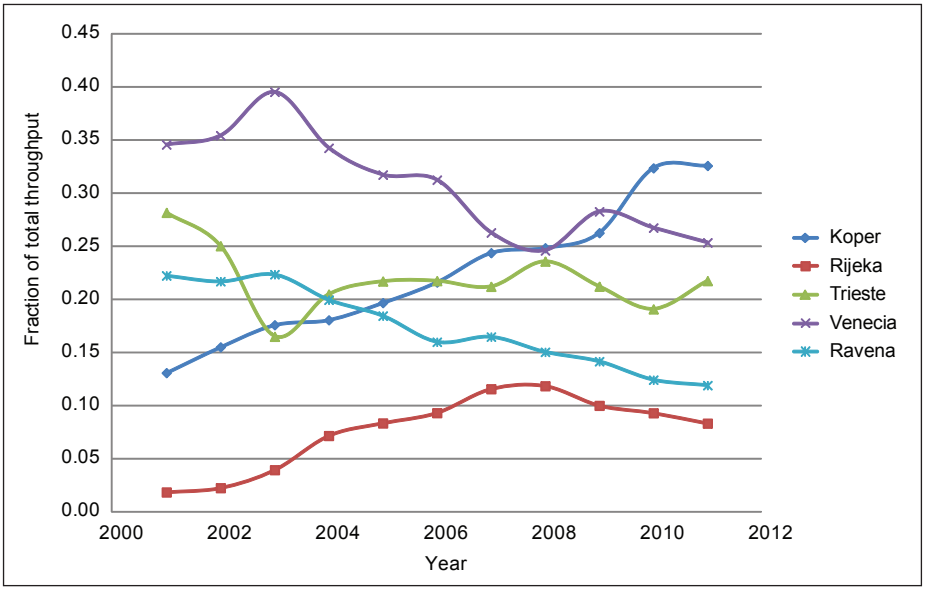

Fig. 4 Trends of fraction of the total throughputs for the NA ports in the last decade (spline fitting)

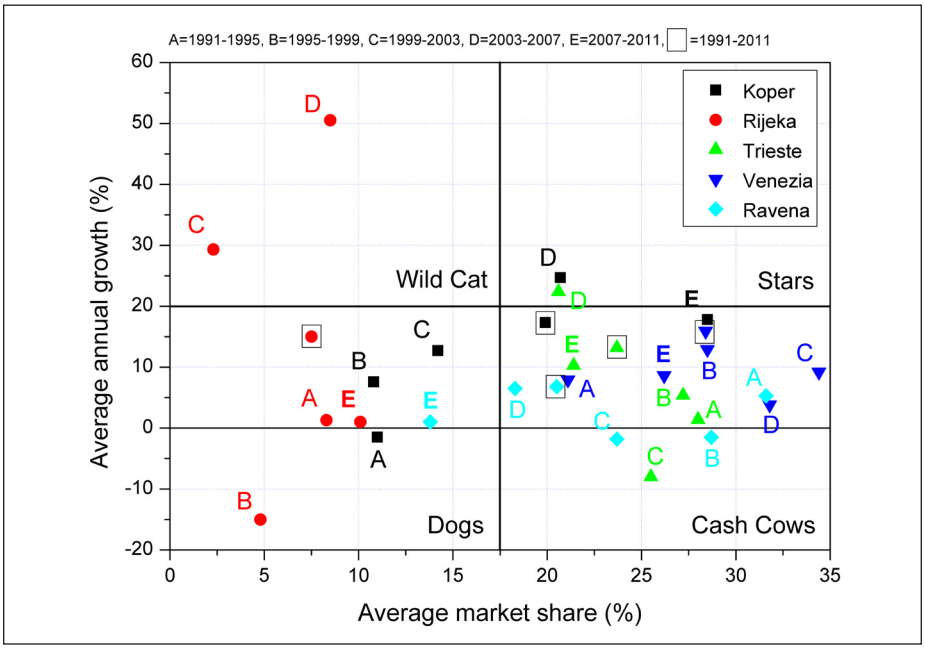

Fig. 5 Dynamic positioning of the NA ports (1991-2011)

the port of Koper was only a "dog". Only the port of Rijeka has never been in the square of "cash cows", that means that only this port has never obtained growth and market share at the same time.

The presented assessment gives us only a first indication of dynamics concentration within the NA ports. For a more thoroughly analysis, we have built a dynamical model, which serves to identify possible competition among the ports.

4. The dynamical model

To get some insight into cooperation/competition relationship among the ports, we have set up a simple dynamical model in which we chose the ports' market share fraction for each port as a dynamic variable. We have assumed a simple linear competition model of the form

$$\frac{dx}{dt} = A'x \quad x(0) = x_0 \tag{1}$$

where t is time, x is vector of fractions, A' is system matrix we wanted to identify and x_0 is vector of initial values. In our case, the dimension of all vectors has been 5. We have identified the diagonal coefficient of this matrix as natural decay/growth rates. We have also regarded the ports connected by a positive matrix coefficient as cooperative one, and by a negative coefficient as a competitive one.

Now, this system of equation has an analytical solution. However, for a future analysis, we have replaced a continuous system with a discrete one. By using a simple difference approximation of the derivative, we have, instead of (1), obtained for each time step Δt the following relations

$$y_n = Ax_n \quad y_n \equiv x_{n+1} - x_n \quad A \equiv \Delta t A' \tag{2}$$

This system can be rewritten as

$$y_n = X_n a \tag{3}$$

where $a \equiv [a_1, a_2, ..., a_N]^T$ is now an unknown vector of dimension 25, consisting of a_k which are the columns of matrix A, and X_n is a 5×25 system matrix of the form

$$X_n \equiv \begin{bmatrix} x_{1,n} & & & \ddots & & & x_{5,n} & & \\ & \ddots & & & \ddots & & & \ddots & \\ & & x_{1,n} & & & \ddots & & & x_{5,n} \end{bmatrix} \tag{4}$$

Now, if the observed data are taken as the solution, then we can obtain an overdeterminated system, which may be solved by the least-square method.

$$\|\tilde{X}a - \tilde{y}\| = \min \tag{5}$$

Minimization yields a system of equations

$$\tilde{X}^T\tilde{X}a = \tilde{X}^T\tilde{y} \tag{6}$$

from which **a** can be calculated. We note that the formally described procedure yields the same result as the one-lag VAR (vector autoregressive) model.

For practical calculation, we have used the market shares of the ports in the period 2001–2011. From graphs on Figure 6, we can see that the actual and predicted evaluation of the market shares for the ports is similar.

The matrix of the dynamical system shown in Table 2 can be used to determine the cooperation/competition relationships among ports in the NAP system in the observed period. First, we can see from the diagonal values given in

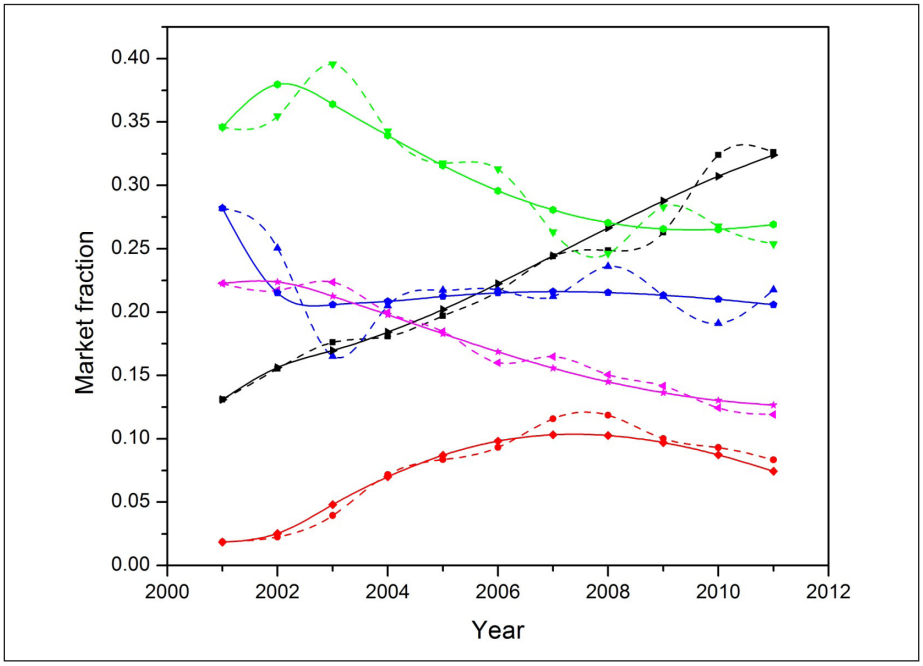

Fig. 6 Trends of fraction of the total throughputs for the NA ports in the last decade predicated by a linear model (solid line) compare to the observed one (dash line)

Table 2 Coefficient of matrix A for a dynamical model of market share in the 2001–2011 period

	Koper	Rijeka	Trieste	Venice	Ravenna
Koper	-0.296	0.228	0.361	0.582	-1.094
Rijeka	-0.186	0.138	-0.129	0.339	-0.235
Trieste	0.224	0.350	-0.790	-0.124	0.733
Venice	0.289	-0.557	0.358	-0.891	0.959
Ravenna	-0.031	-0.158	0.200	0.095	-0.364

Table 3 Cooperative/competitive relations among the NA ports in the 2001–2011 period

	Koper	Rijeka	Trieste	Venice	Ravenna
Koper		cooperate	cooperate	cooperate	Competitive
Rijeka	competitive		competitive	cooperate	Competitive
Trieste	cooperate	cooperate		competitive	Cooperate
Venice	cooperate	competitive	cooperate		Cooperate
Ravenna	competitive	competitive	cooperate	cooperate	

the Table that only the port of Rijeka has a natural tendency to grow, all other ports have a natural tendency to decay.

From Table 3, which is derived from Table 2, we can identify three possible relations among the ports:

- Mutual cooperative relation: Koper-Trieste, Koper-Venice, Ravenna-Trieste, Ravenna-Venice,
- Mutual competitive relation: Koper-Ravenna, Rijeka-Ravenna,
- Asymmetric cooperative/competitive relation: Koper-Rijeka, Trieste-Rijeka, Venice-Trieste, Rijeka-Venice.

Based on this Table, we can conclude that the ports of Koper and Ravenna are true competitors (red), but in mutual cooperation (blue) relationships with the ports of Trieste and Venice which are competitors. Ravenna is also a competitor of Rijeka. It is also to be noted that the port of Rijeka was in no mutual cooperation relationship with any port over the observed period.

5. Conclusion

Although the total container traffic in the NA ports has increased in recent years, it still represents a negligible proportion in the total throughput of the European ports. The data indicate that the container traffic in the NA ports in the European Common throughput has shown a slight increase – in 2008 it was 1.6% and it amounted to almost 2% in 2011. In the proportion – the throughput of all NA ports present just 15.2% of the throughput, which was created by the Europe's largest port, the Port of Rotterdam in 2011, and 16% of the throughput in 2013.

New trends in maritime transport favour the use of large container ships (economy of scale) and the ports in the NA will have to join the forces to attract shipping lines to this part of the Mediterranean. Consequently, collaboration and competition among the NA ports will remain, and, even more, it will probably be intensified in the future. The study and identification of the relationships among the NA ports will thus continue to be an interesting field of research, both from the theoretical as well as from the practical point of view.

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