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## Traffic Evolution and Competition among Italian Containers Terminals

Stefano Carrese<sup>a</sup>, Sabrina Di Giambattista<sup>a</sup>, Tiziana Murgia<sup>b</sup>, Marialisa Nigro<sup>a</sup>, Marco Petrelli<sup>a\*</sup>,  
Alessandra Renna<sup>a</sup>

<sup>a</sup>Department of Engineering, Roma Tre University, Via Vito Volterra 62, Rome 00146, Italy

<sup>b</sup> Assoport, Via dell'Arco de' Ginnasi, 6, Rome 00186, Italy

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### Abstract

In recent years, the maritime container transport has been subject to several changes. The ultra large and very large carriers involved the need for an evolution of port infrastructures and handling systems for container traffic on a global scale. Moreover, the concentration of ship companies in "Great alliances" constitutes monopolies able to impose infrastructural and management changes to the ports, generating further competitiveness in the system.

The present study investigates the evolution of the Italian port system related to container traffic with the aim to assess the impact of the above phenomena. Starting from a general overview of container movements in the Mediterranean system and in the EU Northern Range, the evolution of the container market in Italian ports has been reconstructed and analyzed also for defining the presence of competition and/or concentration market phenomena.

The existence of a complex and fragmented system has been proven with traffic sprawled in several ports in competition without relevant concentration phenomena. In such a context, the introduction of a national strategy is required to coordinate the ports, realizing cooperative port systems thus enhancing a real maritime development.

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### Introduction

In the last years, the maritime container transport has been subject to a deep change due to the choices of several players in the sector. The container freight rate is still affected by the reduction of the world trade after the global financial and economical crisis and an excess in the number of ships has further increased the sector's difficulties (Ha and Seo, 2017). Thus, the shipping companies started to create alliances: the "Great Alliances" (2M: Maersk / MSC, Ocean Alliance, THE Alliance). This horizontal integration of the supply chain allowed the companies involved to cover 81% of the global capacity of the port system and up to 99% of the traffic on the East-West routes (Italian Maritime Economy, 2018), modifying the global shipping market (Ha and Seo, 2017). In the meanwhile, the main shipping companies started also a vertical integration process of the supply chain based on the acquisition of shares of the main terminals in different ports (Ferrari and Merk, 2015). The "Great Alliances", together with the implementation of the vertical integration strategy generated monopolies in the market.

Simultaneously, the phenomenon of large and very-large shipping carriers continues with significant investments in mega-ships to achieve appropriate economies of scale: 118 new mega-ships will be put on the market until 2019 (class 10-23 thousand TEU), of which 47 will be ships of 18-23 thousand TEUs (Italian Maritime Economy, 2018). This has generated unprecedented effects,

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\* Corresponding author. Tel.: +39 06 57333383.

E-mail address: [marco.petrelli@uniroma3.it](mailto:marco.petrelli@uniroma3.it)

such as the increase of port terminals dedicated to specific navigation lines, with the aim of guaranteeing an easier sea-land transfer of goods (Parola et al., 2016).

Italy is not exempt from these phenomena: the data show that in the Mediterranean, the number of ships exceeding 3,000 TEU that transit and touch at least one Italian port has grown by 8% since 2012, while that of ships over 13,000 TEU by 56%. The problem in this scenario is that our country, characterized by a high number of ports, could not adequately respond, both from an infrastructural and logistic point of view, to the growing and different needs of shipping companies, or at least not in a comparable way with that of its neighboring competitors in Northern Europe and in the nearest Spain. The power of such monopolies to direct the traffic could induce, as also the increase in mega-ships, to the selection of a given port, imposing on the same port infrastructural and management changes (Musso et al., 2013), generating further competitiveness within the Italian port system.

Starting from these observations, the present study reconstructs an overview about container traffic in Italian ports. The proposed objective is to investigate the possible factors, relations and phenomena to measure impacts and transformations produced on the Italian port system with regard to container traffic.

## 1. Methodology

The analysis carried out in this study follows four different sequential phases, where data adopted derive mainly from statistics provided by Assoporti in the analysis period (2007-2017).

The first phase deals with the analysis of container ports in the Mediterranean Sea, the Black Sea and Northern Europe, thus comparing countries located near Italy, influenced by same phenomena and similar markets.

The reference context is represented by the Mediterranean system (Mediterranean Sea and Black Sea ports) with 15 countries and 44 ports and the Northern European ports system with 4 countries (Northern France, Belgium, Holland and Germany) and 8 ports.

The second phase focuses on the analysis of container traffic in the Italian maritime system. Quantitative criteria have been set to identify the so-called "minor" ports and the so-called "main" ports on which focusing the subsequent analysis.

In the third phase, the analysis of national container traffic was structured through a breakdown of the ports with respect to the two container traffic: 1) transshipment and 2) hinterland traffic. As in Lupi et al. (2012) which defined a classification of Italian ports, distinguishing between "Gateway systems" and "Hub system", the present study defined an initial classification between the transshipment ports and the hinterland ports. The transshipment ports were identified on the basis of the annual statistics when the transshipment quota was on average above 80% of the whole traffic. This implies that hinterland ports can also have transshipment, but its contribution to the whole traffic can be about 10%. For the transshipment ports, the overall trend and that of each port were assessed to identify how the transshipment market works in Italy. For the hinterland ports, trends and market shares have been defined together with some specific indicators used to assess the concentration, instability and competition between ports on the container traffic market. Indices commonly used to study market concentration are the Herfindahl-Hirschman index (HHI) and the Gini index.

Market share  $s_{i,k}$  for port  $i$  in time  $k$  is defined as the ratio between its actual port traffic  $x_{i,k}$  at time  $k$  and the total traffic  $x_k$  of the ports system at time  $k$ . To calculate the HHI the following formulation is used:

$$H_t \equiv \sum_{i=1}^n s_{i,t}^2 \quad (1)$$

$$\text{with } s_{i,k} \equiv \frac{x_{i,k}}{x_k} \quad (i=1, \dots, n; k=0, 1, 2, \dots)$$

$$\sum_{i=1}^n s_{i,k}$$

Low values of the index indicate a competitive market, where the achievement of zero indicates a condition of perfect competition. Instead, high values of HHI, refer to the possible existence of monopoly conditions on the market.

The Gini index is computed using the following formulation:

$$G_t \equiv \frac{\sum_{i=1}^n \sum_{j=1}^n |s_{i,t} - s_{j,t}|}{2(n-1)} \quad (2)$$

The Gini index assumes values between 0 and 1. When all the ports have the same market share, the index is equal to 0 while, if the traffic is concentrated in a single port, it is equal to 1. Thus, the Gini index can be defined as the relative average market share difference (Santos and Guerrero, 2010).

Finally, a measure of market instability is provided by the instability index (Hymer and Pashigianj, 1962, Mazzucato, 1998), that is:

$$I_t \equiv \frac{1}{2} \sum_{i=1}^n |s_{i,t} - s_{i,t-1}| \quad (3)$$

Finally, in the fourth phase of the study, the dynamics of each hinterland port are analyzed. Two different types of aggregations were carried out: 1) an aggregation with respect to the containers volumes handled by each port; 2) a spatial aggregation based on port location. Each aggregation of ports has been compared to the national trends in terms of growth rate and market share. Moreover, a Growth-Share Market Matrix (GSM, Twrdy and Batista, 2017) has been exploited in order both to identify a relation between the characteristics and the market trend of the specific port and to provide clear indications of possible market interferences, competitiveness and potentialities.

## 2. Results

### 2.1. Comparison between the Mediterranean system and the Northern Range

The analysis of the Mediterranean system and the Northern Range port system (Figure 1) shows similar trend over the years with a sharp contraction of traffic in 2009 and a subsequent recovery since 2011. The Mediterranean system shows higher traffic than the northern European ports, with an increasing trend after 2012. This overtaking is even more significant, including the contribution of the Black Sea with a total movement exceeding 50 Mln of TEUs.

However, container traffic in Northern Europe is very high when compared to the number of ports involved. In fact, the Northern Range is characterized by 8 ports, while the Mediterranean and the Black Sea by 44 ports. This fragmented condition in terms of port supply in the whole Mediterranean system, generated greater attractiveness of the ports of Northern Europe by several European markets (Ferrari and Merk, 2015).

Based on the handled volumes within the Mediterranean system (Figure 2), it is possible to identify three macro groups: a first group consisting of Spain and Italy with values around 10 Mln of TEUs; a second group consisting of Turkey and Egypt between 3.5 and 4 Mln TEUs; a last group composed of the 11 remaining countries with maximum values between 2 and 4 Mln of TEUs. Greece, given the positive growth trend since 2010, can identify itself as the leader of the third group. Croatia with an average value of movements below 200K TEUs and Cyprus with an average value just over 300K TEUs represent the tail of the last group.

In relation to the two most important countries, after the crisis of 2009, Italian ports recorded a less significant recovery of traffic with respect to the Spanish ports. The growth rate of Spain, in 2011, was 12% with the result that it moves on average more than 1.5 million TEUs compared to our country.

In relation to the number of ports, in Italy 15 Italian ports for container traffic moves an average value of 10 Mln of TEUs. On the other hand, the 9 ports of Spain moves an average value of 11 Mln TEUs.

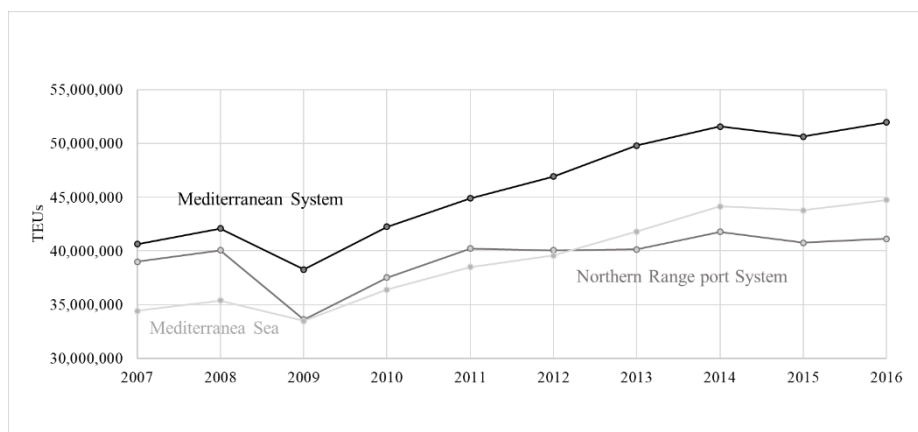


Fig. 1. Trend of annual container traffic in the Mediterranean and Northern Range systems (Assoporti data elaborated by the authors)

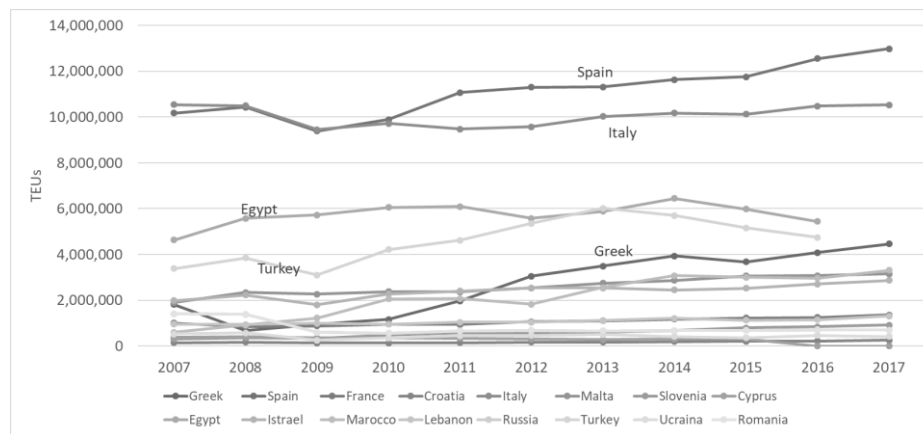


Fig. 2. Trend of annual container traffic in the countries of the Mediterranean system (Assoporti data elaborated by the authors)

This shows an excessive fragmentation of the demand, which, if assessed for each of the countries here analysed, (Table 1), underlines a situation with few ports and medium traffic values per each port (higher than one Mln of TEUs per year per port). Italy loses its leading position with an average value of about 700K TEUs per year per port, while Spain, despite its 9 ports, has an average traffic of more than 1 Mln of TEUs per year per port.

Tab. 1. Statistics of Assoporti 2016 for container ports in the Mediterranean system

Country	N <sup>o</sup> ports	TEUs 2016	Average TEUs /port
<i>Greek</i>	2	4,080,921	2,040,461
<i>Spain</i>	9	12,547,016	1,394,113
<i>France</i>	1	1,251,744	1,251,744
<i>Croatia</i>	1	214,348	214,348
<i>Italy</i>	15	10,476,478	698,432
<i>Malta</i>	1	3,080,000	3,080,000
<i>Slovenia</i>	1	844,776	844,776
<i>Egypt</i>	3	5,443,911	1,814,637
<i>Istrael</i>	2	2,708,000	1,354,000
<i>Marocco</i>	1	2,963,654	2,963,654
<i>Lebanon</i>	1	1,147,219	1,147,219
<i>Russia</i>	1	711,339	711,339
<i>Turkey</i>	4	4,739,733	1,184,933
<i>Ucraina</i>	1	464,284	464,284
<i>Romania</i>	1	711,339	711,339

### 2.1. Shipping container traffic in Italy

Container traffic in Italian ports shows a stability in the long term, given that, unlike what is shown in Figure 1 for the other European countries, traffic started to increase from 2013 surpassing the pre-crisis level only in 2016. The trend of container traffic is still having a greater recovery compared to the value of Italian GDP that is still lower than the value recorded for 2008. In detail, the container traffic market was visibly affected by the economic crisis with a clear impact on the total handled values. In fact, in 2009, there was a decrease of about one Mln TEUs from the pre-crisis period. The pre-crisis value, equal to 10.6 Mln of TEUs, was reached only after 2016.

The growth rate of TEUs handled shows an overall negative trend up to 2012. A real recovery of the container market in Italy occurred only in 2013 with a growth of 5%. In general, it can be underlined that in the following years the growth rate was always lower than 5% and therefore on growth values less significant than other countries, such as Spain.

Tab. 2. Total TEUs moved in Italian ports (2007-2017)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
<b>Total TEUs Italy</b>	10.609.108	10.549.886	9.514.891	9.777.962	9.526.808	9.618.700	10.082.030	10.221.127	10.190.597	10.573.416	10.651.399
<b>Growth rate</b>		-0,56%	-9,81%	2,76%	-2,57%	0,96%	4,82%	1,38%	-0,30%	3,76%	0,74%

A preliminary spatial analysis of the concentration of container traffic has been done with respect to the natural coastal

conformation of Italy: we used both a North-South grouping as well as an Adriatic Sea-Tyrrhenian Sea grouping as shown in Figure 3. The first grouping shows that the ports in the Tyrrhenian Sea are those contributing mostly to the traffic container of Italy, while the ports in the Adriatic Sea are decidedly less significant with a total traffic of less than 2 Mln of TEUs. The ports of the North part of Italy show an increasing trend with respect to those of the South. Indeed, in the first years, the ports of the South had a higher traffic, but this situation changed starting from 2010 (Figure 4).

These results highlight the possible influence of the different types of traffic on the distribution between individual ports. It can be anticipated that transshipment traffic is concentrated mainly in the Tyrrhenian Sea and this entails the imbalance of flows between the Tyrrhenian coast and the Adriatic coast.

Considering the total annual traffic of each port, there are a number of ports considered "minor" for container traffic. These "minor" ports have been deleted by the following analyses, since they can be considered as a noise for the study of the container market.

The selection of the "minor" ports is derived by the following quantitative criteria: those ports that, during the analysis period, move individually less than 1% of the Italian container traffic and overall never exceed 3% of the total movement. It is translated in a threshold value of a handling volume of less than 100K TEUs. Both Ancona for a single year and Savona in the last few years would fall below the threshold value. However, their presence in the statistics for at least 50% of the years of analysis requires their inclusion in the group of the "main" ports.

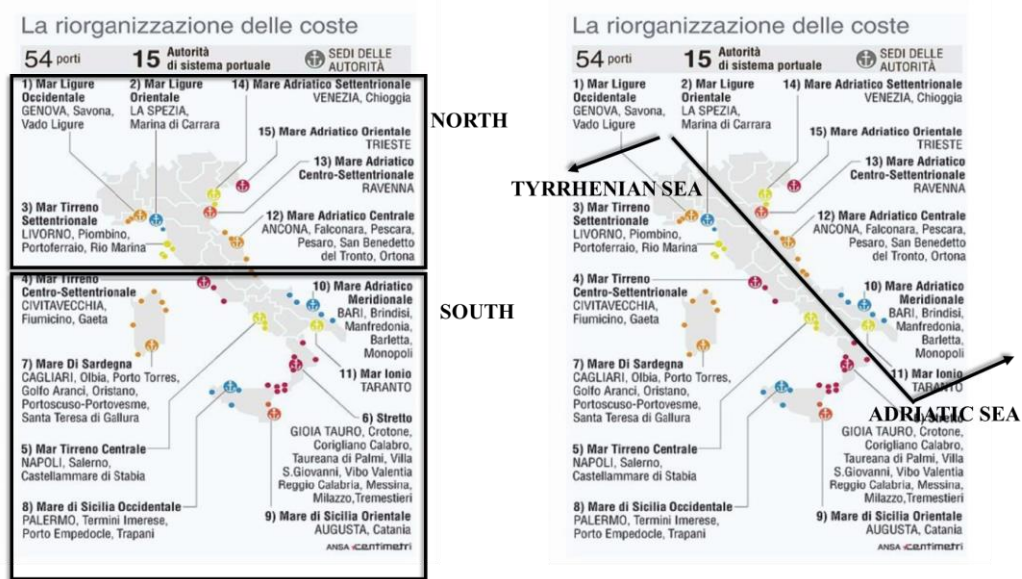


Fig. 3. Spatial grouping (North-South grouping and Mar Tirreno-Mar Adriatico grouping) for container traffic analysis

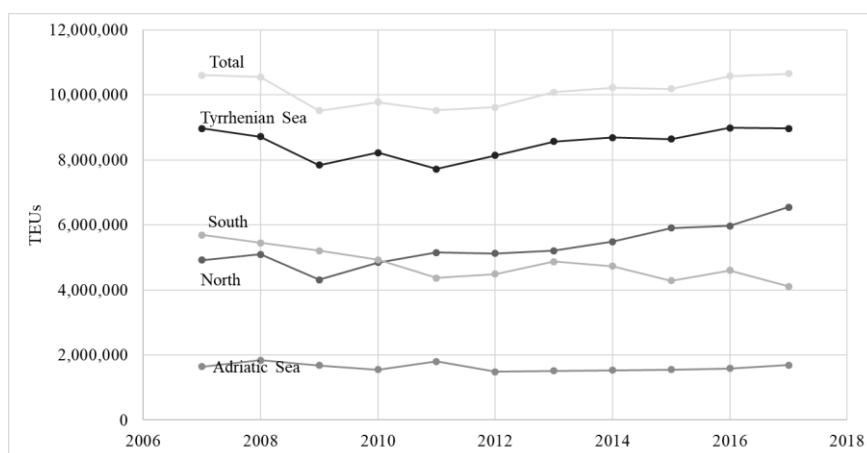


Fig. 4. Annual trend of container traffic in Italy divided by spatial grouping (Elaboration from Assoportti data)

In conclusion, the selection involved the identification of the following 13 ports: Genoa, Savona-Vado, La Spezia, Livorno, Naples, Salerno, Gioia Tauro, Cagliari, Trieste, Venice, Ravenna, Ancona and Taranto.

The significant ports are therefore 13 until 2015, when the closure of the container terminal of Taranto has led to the removal of the latter one from the statistics. As already noted before, the number of ports is high, especially considering their individual location, with ports very close to each other. This is a further peculiarity of the Italian port system in addition to the existing fragmentary nature (i.e. high number of ports, grouped in nearby locations).

## 2.2. Shipping container traffic in Italy divided by transshipment and hinterland

The division between transshipment and hinterland traffic derives from different moving quantities and from different operations and services required in the port hosting the traffic. Applying this distinction to the Italian case, the transshipment ports are Gioia Tauro, Taranto and Cagliari, i.e. those ports for which at least 80% of container traffic is of transshipment type.

While the trend of the hinterland container traffic is congruent with the Italian trend (Figure 5), transshipment is characterized by a decreasing trend, especially up to 2011 and in the last 2 years. The overall moved volume is therefore conditioned by the decrease in transshipment traffic which suffered a 32% contraction between 2007 and 2017. Although the Hub ports are only 3, at the beginning of the analysis period they moved more than 40% of the national traffic. This trade was maintained until 2011 when the increasing contraction of flows led to an incidence rate of 30% on the Italian traffic (year 2017). The drop in traffic in recent years confirms what was already highlighted in 2015 by Ferrari and Merk: Italian ports have lost market share to ports such as Algeciras and Valencia.

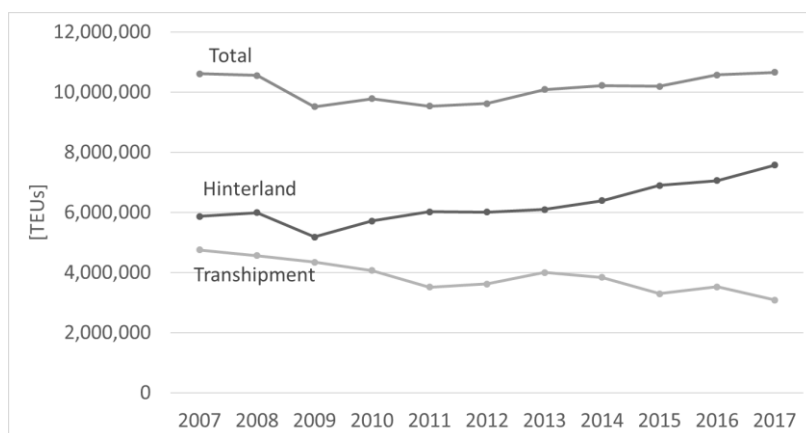


Fig. 5. Annual trend of container traffic in Italy divided by hinterland and transshipment (Elaboration from Assoporti data)

The crisis of transshipment traffic in Italy derives by multiple factors. The closure of the Taranto container terminal, which took place in 2015 (Table 3), derives from the moving of the Taiwanese company Evergreen to Piraeus (Greece). This process, ended in 2014, started to show its trend since 2012, where a 67% decrease in traffic in Taranto compared to the previous year corresponds to a significant increase in traffic in Greece. A limited part of those traffics have been transferred to the port of Bari which, in 2015, showed the increase of almost twice of its movements, absorbing about 30K TEUs of Taranto, for the activation by the same Evergreen of a connection service between the port of Bari and Piraeus.

Tab. 3. TEUs by transshipment's Ports in Italy (2007-2017)

	<i>Transshipment's Ports</i>			<i>Total Transshipment [TEUs]</i>	<i>Total Italy [TEUs]</i>
	<i>Gioia Tauro [TEUs]</i>	<i>Cagliari [TEUs]</i>	<i>Taranto [TEUs]</i>		
<b>2007</b>	3445337	547336	755934	4.748.607	10.609.108
<b>2008</b>	3.467.824	307.527	786.655	4.562.006	10.549.886
<b>2009</b>	2.857.440	736.984	741.428	4.335.852	9.514.891
<b>2010</b>	2.852.264	629.340	581.936	4.063.540	9.777.962
<b>2011</b>	2.304.987	603.236	604.404	3.512.627	9.526.808
<b>2012</b>	2.721.108	627.609	263.461	3.612.178	9.618.700
<b>2013</b>	3.094.254	702.143	197.317	3.993.714	10.082.030
<b>2014</b>	2.969.802	717.016	148.519	3.835.337	10.221.127
<b>2015</b>	2.546.805	748.647	-	3.295.452	10.190.597
<b>2016</b>	2.797.070	723.037	-	3.520.107	10.573.416
<b>2017</b>	2.622.187	463.940	-	3.086.127	10.651.399

The port of Cagliari in 2017 entered into a period of crisis in conjunction with the acquisition of one of the services managed by Hapag Lloyd from Maersk, which has as its preferred base the port of Tangier (Morocco), generating a further reduction in traffic (36%) in the Sardinian port. Cagliari is therefore suffering despite the depth of the seabed, the length of the docks and the very favourable geographical position.

The port of Gioia Tauro with an average traffic of 2.5 Mln of TEUs per year is, in Italy, a leader in the transshipment traffic. However, the port saw a progressive decrease in traffic reaching the 2017 with about 2.6 Mln TEUs compared to 3.5 Mln

of TEUs in 2007. Gioia Tauro contributed mostly to the general reduction of transshipment trades. This port suffered from two important phenomena as highlighted by Musso et al. (2013): the progressive growth of competitiveness of other Mediterranean ports such as Tangier, Port Said, Valencia, Algeciras and Marsaxlokk; the transformation underway by shipping companies to logistics operators, as in the case of Maersk, with the consequent strengthening of their strategic position in some Mediterranean ports.

Moving to the hinterland container traffic, it was made by the ports of Genoa, La Spezia, Livorno, Savona-Vado, Naples, Salerno, Ancona, Ravenna, Trieste and Venice. These ports maintained the same ranking over the years in terms of TEUs handled. The ports of Genoa, La Spezia and Livorno preserved, in the last decade, the first three positions and Genoa certainly identifies itself as the leader of container traffic, with an increasing trend that reaches over 2 Mln of TEUs from 2012. Naples maintained its fourth position until 2013. Then, it was overpassed by the ports of Venice and Trieste.

Finally, it is possible to identify the ports of Salerno, Savona-Vado, Ravenna and Ancona: while the port of Salerno showed a positive growth trend, the last three ports kept both their position and the TEUs moved unchanged.

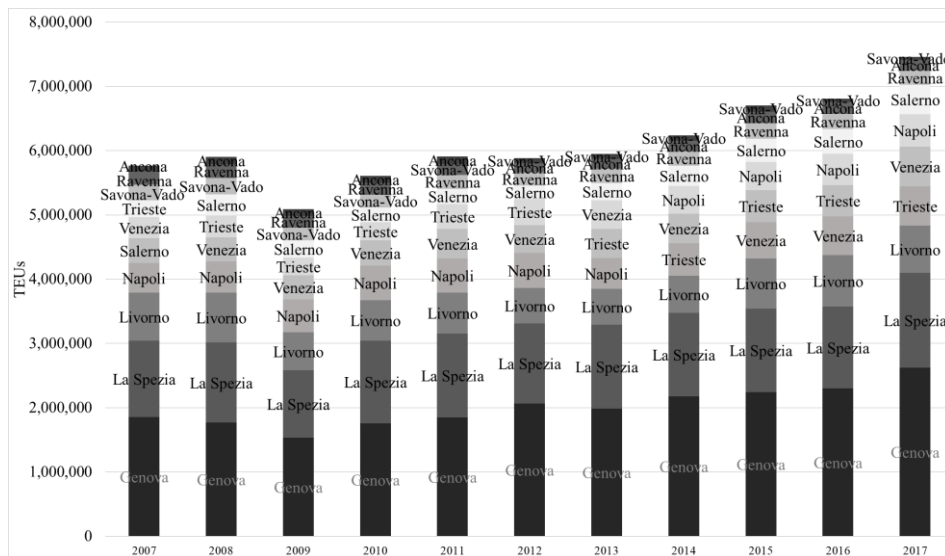


Fig. 6. Position of hinterland ports with respect to annual TEU volumes (Elaboration from Assoporti data)

### 2.3. Competition and concentration of in Italy ports

Starting from the above data, indicators as HHI and Gini Index were used to analyze the concentration and instability on the market of container traffic with regard to the hinterland market (Twrdy and Batista, 2017).

From both the adopted indices (Table 4), there is no concentration of the container market both for the distribution of data in the years as well as for the low values assumed by the same statistics.

Tab. 4. Concentration indexes for hinterland container traffic

Concentration Index	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
<b>HHI</b>	0,18	0,18	0,17	0,17	0,18	0,18	0,20	0,19	0,19	0,19	0,19	0,20
<b>Gini index</b>	0,04	0,25	0,24	0,24	0,25	0,25	0,27	0,26	0,26	0,25	0,26	0,26

Moving to the indicator commonly used to evaluate the instability of traffic over time (Farris, 2009), the hinterland market for containers in Italy is generally stable (Table 5) as the fluctuations over the years of the index  $I_t$  amounted to a maximum of 5% and an average of 3.3%. Furthermore, it is necessary to underline how low values of such indicator seem to indicate a fragmentation of the current port supply.

Tab. 5. Market Instability Index for hinterland container traffic

Market Instability	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
<b><math>I_t</math></b>	2%	3%	3%	4%	3%	5%	3%	3%	4%	2%	4%

The hinterland ports can be grouped according to their spatial location. It allows the identification of 4 groups: 1) a first group located in the North-West area of Italy, they are Genoa, La Spezia, Savona-Vado and Livorno; 2) a second group in the South-West area including the ports of Salerno and Naples; 3) a third group consisting of the ports of Trieste and Venice in the North-East; 4) a fourth group represented by the ports of Ravenna and Ancona in the eastern part of the country. For each group, an analysis was carried out evaluating both the general trend with respect to the Hinterland volumes and the market share of each

port, represented by the Growth-Share Market Matrix (GSM).

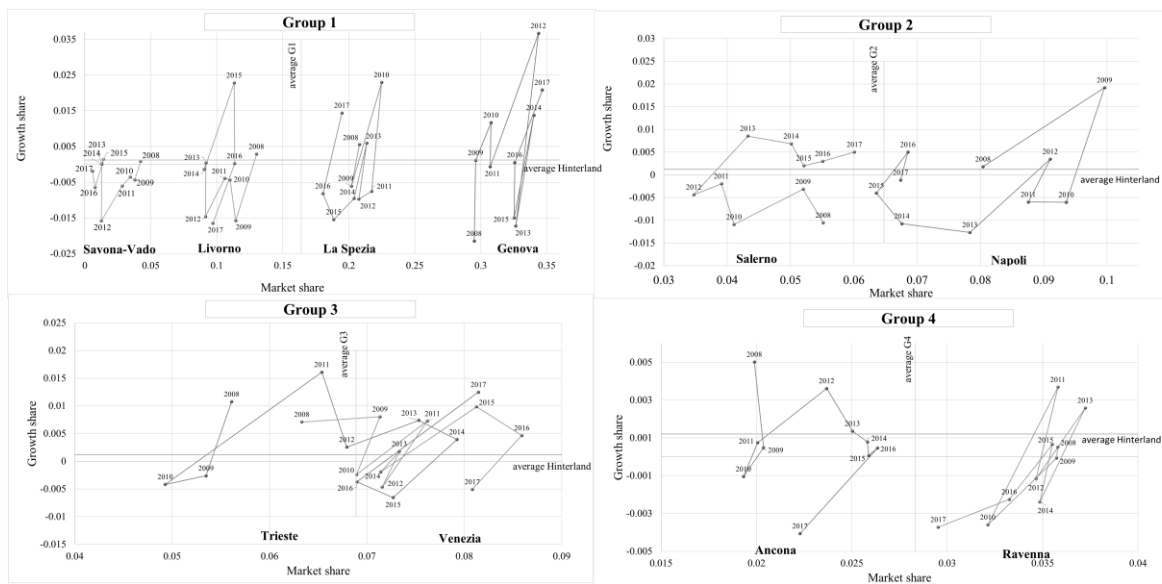


Fig. 6. Growth-Share market Matrix for clustering of hinterland ports

The trend of each group and each port differs significantly from the ideal one, corresponding to the positioning in the upper right quadrant of the X-Y axes of Figure 6. Instead, the trends show variations with respect to the average volume, higher for the ports that have relevant traffic such as Genoa. Moreover, the trends tend to turn on themselves, alternating phases of contraction to others of movements growth.

In detail, the ports of group 1 (Genoa, La Spezia, Livorno and Savona-Vado) are in a well-defined market segment, in line with their differences in the existing traffic. The ports that have a greater market share are those that, in the considered period of time, have a greater variation in quantities moved between one year to another.

In Genoa, from 2008 to today, there is a constant increase in traffic with a peak in 2012 followed by a contraction in 2013 and 2015. Based on this representation, it can be defined as a growing port, with growth rates often above the average value. La Spezia has undergone a reduction of both parameters since 2010 with a slight recovery from 2016. Even in Livorno there is a steady growth like that of Genoa. Indeed, in 2017 a further contraction is shown compared to the other years. The traffics of the port of Savona-Vado depart from 2008 below the average threshold and continue to contract until 2017.

Also with regard to Group 2, the representation makes it possible to highlight that both ports do not have a particular evolution. Container traffic in the port of Salerno reduces its market share in the first years of analysis while, since 2012, there has been an initial recovery culminating in 2017 with the achievement of a greater share of traffic compared to 2008. The port of Naples on the other hand shows a decline in the traffic market share, going from around 10% of the Italian hinterland traffic in 2009 to around 7% in 2017.

The ports of Group 3, Trieste and Venice, move similarly, still often over the national average rate. Starting from different market shares, there is a convergence towards a similar value attested in 2017 of about 8%. Trieste has gradually acquired market share thanks to its draft that allows it to accommodate the largest container ships in the world (Musso et al., 2013).

Container traffic in the port of Ancona closes 2017 with a market share lower than in previous years and an annual decrease higher than that observed in the analysis period. The same negative trend is visible for the port of Ravenna in which, starting from 2015, we observe a reduction in market share and below-average growth rate.

The results obtained from this analysis are confirmed working for volume levels instead of geographical position. The competitiveness of the specific port in its influence area is evidence of market interference between ports working in the same range of volumes. For example, the 3rd group (Venice and Trieste) consists of ports that both fall into the same level of volumes and these ports embrace the same market area.

### 3. Conclusions

The study investigates the evolution of the Italian port system related to container traffic, taking into account the phenomena of large shipping carriers and great alliances.

Starting from a general overview of container movements in the Mediterranean system and in the EU Northern Range, the evolution of the container market in Italy has been reconstructed and analyzed.

It derives that Italy, placed within the Mediterranean system, assumes a prominent position moving with Spain the largest quantities of containers. However, the comparison with the port supply and the traffics of each country shows for Italy an excessively fragmented reality with an average annual movement by each port lower than countries such as Turkey, Greece, Morocco and Egypt.



In the years of analysis, the limited growth of the container market in Italy is certainly associated with the gradual reduction in transshipment trades. Instead, the analyses conducted on the hinterland traffic showed both a low growth share as well as fragmentation of traffic on a large number of ports.

Results of the study clearly underline a need to change the management approach of the Italian port sector: to identify targeted strategies at national level to coordinate the ports and replace the competition/interferences with a cooperative approach. This process seems to be required to support investments to remain on the market (e.g. to realize infrastructural measures and to increase the sector sustainability). Furthermore, the cooperation between ports should generate a certain resilience to the increasing role of the main shipping companies. Finally, the large and very large shipping carriers (capacity up to 18,000 TEUs) are generating the exit from the market of smaller ships and the increase of the ship average size in the feeder services. In this framework, the cooperation at national level can be the solution given the little opportunity of several ports to accommodate such trends.

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