MARINO LUPI, Ph.D.
E-mail: marino.lupi@unipi.it
ANTONIO PRATELLI, Ph.D.
E-mail: antonio.pratelli@unipi.it
ALESSANDRO FARINA, Ph.D.
E-mail: alessandro.farina@for.unipi.it
ALESSANDRA GAZZARRI, Ph.D. Candidate
E-mail: alessandra.gazzarri@for.unipi.it
Department of Civil and Industrial Engineering
University of Pisa
Largo Lucio Lazzarino 1, 56122 Pisa, Italy

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APPLICATION OF CLASSIFICATION RULES TO ITALIAN PORTS

ABSTRACT

In this paper, the existing rules commonly used for port traffic comparison are described. These rules provide weighting factors for each freight category in order to make them comparable and exploitable for port ranking. These rules are based on the value added concept related to port activities. Two new rules are proposed. The first is again based on the value added concept. The second rule is based on the assumption that ports not only create labour directly, through activities related to port operations, but they also play the role of "gates" for the existing economic activities of a region or a country, as a consistent quota of the overall international trade takes place by sea. This rule is based on the relationship among the trend of traffic volume of each freight category and the trend of the national GDP. The rules existing in the literature and the proposed new rules have been applied in ranking Italian ports; the results are discussed. The sensitivity of the ranking of Italian ports to different weighting rules has been analysed.

KEY WORDS

ranking ports; Italian ports; value added; port classification rules

1. INTRODUCTION

The ports of Gioia Tauro, Genoa and La Spezia are, according to container traffic, the most important Italian ports. The port of Livorno resulted in 2012 as the most important according to ro-ro traffic. But some other Italian ports are more important by considering bulk cargo traffic: in 2012, the most important Italian port for liquid bulk traffic was Trieste [1].

Further in the text each type of freight, such as crude oil, petroleum products, cereals, coals, iron and ores, etc. will be called "freight typology"; the grouping of freight typologies, such as: liquid bulk, dry bulk, containers, ro-ro, conventional general cargo will be called "freight category".

It can be useful to rank the Italian ports, with respect to cargo traffic, by considering all the freight typologies handled in each port. The simple sum of cargo quantity does not seem to be a proper indicator of the port importance because the handling of, say, a ton of conventional general cargo is much more labour intensive, and generates a substantially higher value added per ton, compared to major dry bulks or crude oil. So a weighting rule for the different freight categories must be used to obtain the total traffic of a port in "intrinsic cargo handling" (ICH) tons, or value tons, or equivalent tons. In literature the various freight categories are weighted through some coefficients which have been, mainly, determined according to the value added concept [2]. The value added relative to port operations, includes: labour cost, depreciation, profits or losses, provisions and other costs. Value added concept intends to assess the contribution of port activities to national Gross Domestic Product [3]. Several studies have been performed in this field [4, 5, 6]. Indeed, as stated in Haezendonck et al. [2, 7], in many countries ports are viewed as creators of economic wealth, in terms of added value to the local economy. The value added is considered with regard to ports activities; therefore, e.g. the amount of activities per ton required for liquid bulk cargo handling is much less than the amount of activities per ton required for container handling. Several rules have been developed according to the value added concept, and these rules define a weight for each freight category which can be used to determine the importance of a port respect to cargo traffic. These rules are: the Hamburg Rule, the Bremen Rule, the Rotterdam Rule, the Dupuydauby Rule, the Antwerp Rule and the Range Rule. All these rules have been obtained by considering the value added in northern European ports. Another rule, based on the value added concept again, but calibrated upon Italian ports, has been suggested by the authors.

The existing weighting rules consider the value added relative to port operations and to other activities taking place in the port's area and related, in some way, to the port itself. Instead, the ports have impacts on a much wider area; they play the role of access gates to industries and trades existing in a territory or in an entire country. This aspect is taken into account in the second weighting rule developed by the authors, where the relationship between the annual rate of growth of each freight category, and the annual rate of growth of the Italian GDP, is taken into account.

The existing rules, and the two proposed weighting new rules, have been applied to the Italian ports and the obtained results have been discussed. The main purpose of this paper is to highlight the sensitivity of the ranking of Italian ports to different weighting rules that can be found in the literature and to the proposed new weighting rules. It must be noticed that the weighting rules are also fundamental in Product Portfolio Analysis, applied to ports, which describes the performance of a port in terms of market share and growth rate [8, 9]: this type of analysis is used as a tool for strategic port planning.

2. THE EXISTING WEIGHTING RULES

As reported in Haezendonck et al. [2, 7] and Haezendonck and Winkelmans [4], the rules currently existing for ports classification are: the Hamburg Rule, the Bremen Rule, the Dupuydauby Rule, the Rotterdam Rule, the Antwerp Rule and the Range Rule. A summary of these rules is provided herewith.

2.1 The Hamburg Rule

The Hamburg Rule was developed in 1976 by the Hamburg Port Authority. It is the first rule developed and it considers the labour cost in the port of Hamburg. According to this rule, the value added created by one ton of general cargo equals five tons of dry bulk and fifteen tons of liquid bulk: at that time no distinction was proposed among: containers, ro-ro, conventional cargo. The Hamburg Rule has been replaced by the more recent Bremen Rule.

2.2 The Bremen Rule

The Bremen Rule is one of simplest but also the most known and applied one for port classification. It was developed in 1982. The Bremen Rule compares the value added created by one ton of conventional general cargo (that is general cargo neither containerized nor ro-ro carried) to other types of cargo. It was obtained after a survey among the most important port operators working in the port of Bremen. A bottom-up method has been adopted to develop this rule: data about labour cost have been collected from the port operators. Information on the labour cost has confidential quality.

The Bremen Rule states that the value added created by one ton of conventional general cargo equals the value added created by three tons of dry bulk and by twelve tons of liquid bulk. The value added created by one ton of containers or ro-ro is considered the same as the one created by one ton of conventional general cargo. Therefore, according to this rule, to obtain "intrinsic cargo handling" (ICH) tons, or value tons, or equivalent tons, the container, ro-ro and conventional general cargo traffic, expressed in metric tons, is multiplied by one, while dry bulk cargo is multiplied by 1/3 and the liquid bulk by 1/12.

Despite the fact that this rule is based on limited information gathering and that a rudimental weighting method was used, the Bremen Rule has remained until today, the main rule used by the practitioners when including value added concept in the analysis of port traffic data.

2.3 The Rotterdam Rule

The Rotterdam Rule was developed by the Rotterdam Port Authority in 1985. Data were firstly collected for the entire Rotterdam area (regionalization) and after that a focus on port activities was performed. This top-down method distinguished between location bound activities such as refining and non-location bound activities such as assembly and transport. The basic requirement of a top-down method is that "regionalizing" and allocating data to port activities is only allowed when considering uniform sectors and homogeneous products. However, cargo handling is a typical example of a heterogeneous sector.

In 1991, the method was refined. The Rotterdam Port authority differentiated value added figures for four traffic categories: liquid bulk, dry bulk, containers and conventional general cargo. In a later stage of the research, a more detailed classification of traffic categories was used as the basis for the rule. However, in differentiating cargo, top-down procedures registered several disadvantages; therefore, the necessary data for classification in traffic categories were collected in a bottom-up way by means of questionnaires.

The final rule states that the value added created by one ton of conventional general cargo equals approximately: 2.5 tons of oil products, 3 tons of containers, 4 tons of cereals, 7.5 tons of other bulk, 8 tons of ro-ro, 10 tons of coal, 12.7 tons of iron and 15 tons of crude oil.

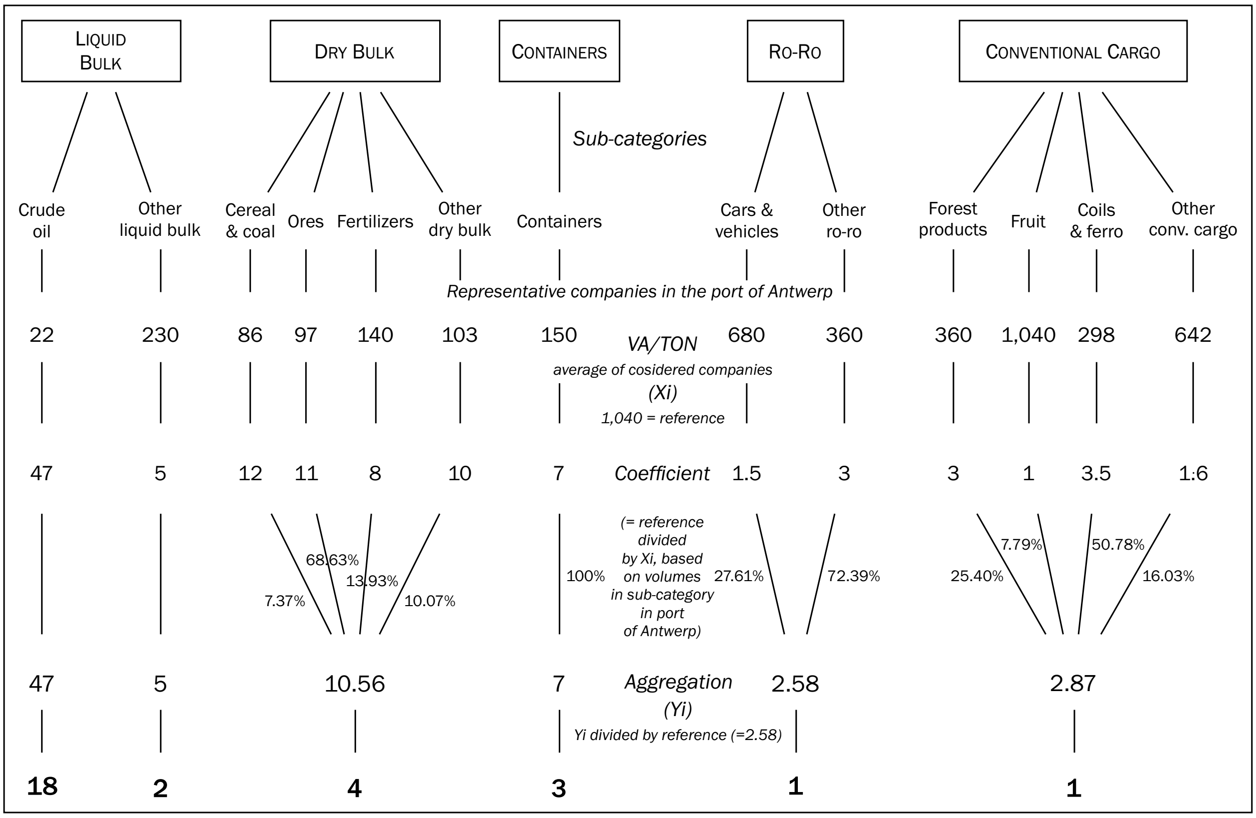

Figure 1 - The weight assumed for each freight typology and category in the Antwerp Rule [4, 7]. From the value added, having as reference the fruit, a coefficient has been determined for each freight typology (second row of numbers). From the percentages of each freight typology in each freight category, a synthetic factor for each freight category is obtained (third row of numbers). Finally, having as reference ro-ro, as it registers the smallest factor, equal to 1, the coefficients for all the other freight categories are determined (last row of numbers).

2.4 The Dupuydauby Rule

The Dupuydauby Rule was developed in 1986. It is mentioned in only a few publications and no methodological basis of this rule is provided in literature. According to this rule, one ton of conventional general cargo, assumed as reference, equals: 12 tons of crude oil, 9 of total liquid bulk (comprised crude oil), 6 of dry bulk, 3 of containers and, again, 3 of ro-ro.

2.5 The Antwerp Rule

The Antwerp Rule was developed in 1995 [7]. The selected port operators have provided: labour cost, depreciation, profits or losses, provisions and other costs related to cargo handling of incoming and outgoing traffic. Port companies have been selected by independent port experts. The reference year for these data was 1995. In order to obtain the necessary information, i.e. the value added created for each specific traffic category, data were collected in the port of Antwerp from cargo handling companies and terminals specialized in only one traffic category. Hence, problems that could occur when surveying “mixed” companies were avoided.

The Antwerp Rule states that the greatest added value is provided by fruit handling, and it is estimated equal to the former 1,040 BEF/ton (BEF is the acronyms for “Belgian Franc”). The rule is very detailed and considers 13 freight typologies: crude oil, other liquid bulk; cereals and coal, iron and ores, fertilizers, other dry bulk; containers; cars and vehicles, other ro-ro; forest products, fruit, coils and iron, other conventional general cargo.

These freight typologies have been aggregated into these main categories: crude oil, other liquid bulk, dry bulk, containers, ro-ro, conventional general cargo. The obtained synthetic factors were: 1 for conventional general cargo, 1 for ro-ro, 3 for containers, 4 for dry bulk, 18 for crude oil and 2 for other liquid bulk. The synthetic factors of the freight categories have been determined according to the percentage of each freight typology in each freight category in the port of Antwerp.

Figure 1 presents the weights assumed for each freight typology and category in the Antwerp Rule [7]. The first row of numbers below the names of freight typology, reports the value added per ton for each freight typology. From the value added, having as reference the fruit, a coefficient has been determined for each freight typology (second row of numbers). From the percentages of each freight typology in each freight category, a synthetic factor for each freight category is obtained (third row of numbers). Finally, having as reference ro-ro, as it registers the smallest factor, whose coefficient is set equal to 1, the coefficients for all the other freight categories are determined (last row of numbers) [4, 7].

2.6 The Range Rule

The Antwerp Rule was determined only with reference to a specific port, i.e. Antwerp. Actually, while labour cost is about the same in the majority of the European ports, the percentage of each freight typology in each freight category (e.g. the percentage of coils and iron in respect to the total conventional general cargo) is different in the various ports. Consequently, a new rule, i.e. the Range Rule, has been proposed [2, 7]. In this rule, the same labour costs of each freight typology used in the Antwerp Rule have been adopted, but the percentage of each freight typology, in each freight category, has been calculated as an average respect to the whole Hamburg – Le Havre port range. The synthetic factors achieved for the Range Rule are: 1 for ro-ro, 3 for containers, 1 for conventional general cargo, 5 for dry bulk, 18 for crude oil and 2 for other liquid bulk. Therefore the Range Rule differs from the Antwerp Rule only in the coefficient of dry bulk, which is equal to 5 in the Range Rule and equal to 4 in the Antwerp Rule. This fact points out the robustness of the synthetic factors used in both rules: in the sense that using the data of only one port, Antwerp, and the data of numerous ports, those belonging to the Hamburg – Le Havre range, the percentages of each freight typology in each freight category, modify the synthetic factor only slightly. The weighting coefficients proposed for all the above mentioned rules are displayed in *Table 1*; the Hamburg Rule has been neglected because no distinction is proposed among: containers, ro-ro and conventional cargo.

3. A NEW RULE BASED ON THE VALUE ADDED IN ITALIAN PORTS

A new rule, based on the value added concept, has been developed for the classification of Italian ports. This rule starts from the Antwerp Rule and follows the same methodology used to develop the Range Rule. In fact the labour costs are the same as in the Antwerp Rule for each freight typology: since in Europe the labour cost is not so different from country to country. Actually, in [7] it was stated that information collected from terminal operators and port experts indicated that at the most disaggregated level the related value added per ton for each traffic category in the northern range (Hamburg – Le Havre range) was very similar. Therefore, for each freight typology the same coefficients as in the Antwerp Rule have been used (second row of numbers in *Figure 1*). These freight typologies have been aggregated into the freight categories: liquid bulk, dry bulk, containers, ro-ro, conventional general cargo, according to the percentage of each freight typology registered in the Italian ports.

The detailed traffic data were not available for all Italian ports: only for Genoa and Livorno there were

Table 1 - Synthesis of the weighting coefficients proposed in the ports classification rules (columns 2-5) [2, 7]. The Hamburg Rule has been neglected because no distinction is proposed among: containers, ro-ro and conventional cargo. The last two columns refer to the two new proposed rules.

Freight typology/category	Bremen Rule	Rotterdam Rule	Dupuydauby Rule	Antwerp Rule	Range Rule	New rule based on the value added	New rule based on the Italian GDP
Conventional general cargo	1	1	1	1	1	1	1
Liquid bulk (°)	12		9	2	2	11	11
Dry bulk	3		6	4	5	4	4
Containers	1	3	3	3	3	2	1
Ro-ro	1	8	3	1	1	1	2
Oil products (*)		2.5					
Cereals (*)		4					
Coal (*)		10					
Iron and ores (*)		12.7					
Crude oil		15	12	18	18		
Other dry and liquid bulk (*)		7.5					

(°): Liquid bulk comprises crude oil in the Bremen Rule, in the Dupuydauby Rule and in the two proposed new rules; it excludes crude oil in other rules: for example in the Antwerp Rule the coefficient for crude oil is 18, the coefficient for other liquid bulk is 2; and instead, in the Bremen Rule 12 is the coefficient for all liquid bulk.

(*) These freight typologies regard only the Rotterdam Rule and have not been aggregated.

data about the percentages of all freight typologies. Therefore, the coefficients for each freight category have been determined according to the percentage of each freight typology in each freight category in the ports of Genoa and Livorno. An average of the percentages of the last six years (i.e. from 2005 to 2011) has been taken into account. Data have been recorded from official statistics of the two port authorities. This procedure is not wrong because Genoa and Livorno are the two of the major Italian ports; moreover, their traffic is developed in all categories of freight, differently from Gioia Tauro, for example, which is an important port, but whose traffic is developed almost exclusively in container sector.

The proposed new rule takes as reference the conventional general cargo. According to the new rule, one ton of conventional cargo is equal to: 1 ton of ro-ro, 2 tons of containers, 4 tons of dry bulk, 11 tons of liquid bulk (comprised crude oil).

The new rule is very similar to the Antwerp Rule, except for the weighting coefficient of containers, which is equal to 2 in the proposed new rule and equal to 3 in the Antwerp Rule. The differences from the proposed rule and the Range Rule regard: the coefficient for containers, equal to 2 in the proposed rule and equal to 3 in the Range Rule; and the coefficient for dry bulk, equal to 4 in the proposed rule (as in the Antwerp Rule) and equal to 5 in the Range Rule. There is also a slight difference for the weighting coefficient of liquid bulk equal to 11 in the proposed rule and equal to 13 in the Range Rule, when no distinction between crude oil and other liquid bulk has been assumed [2].

4. PROPOSED NEW RULE BASED ON THE ITALIAN GDP

All the rules exposed above have considered the computation of the weighting factors for the freight categories according to the value added created by activities, directly or indirectly related to ports. Instead, the importance of a port is not limited to simply the port area but it regards the entire country. In fact, ports also play the role of "gates" for industries and for the general economic activities of a country, as a consistent quota of international trade takes place by sea. Lupi et al. underlined [10] that the development of maritime traffic was strongly affected by the economic crisis, and, generally, it decreases in correspondence to GDP decrease, and increases in correspondence to GDP increase.

A new rule based on the Italian GDP has been developed. In the development of this rule, the variations in traffic volumes for the five freight categories in Italian ports have been related to the Italian GDP variations through a multiple linear regression model. Indeed, an amount of containers to/from Italy (particularly Northern Italy) are loaded/unloaded at the northern European ports: these were not considered in the analysis; this assumption undervalued the traffic considered in the analysis. This hypothesis is quite good as the quantity of containers to/from Italy loaded/unloaded at the northern European ports has been estimated to only 441,000 TEUs in the year 2011 according to Cassa Depositi e Prestiti [11]. This volume is a lot less than, for example, the 1.8 million TEUs registered for the only port of Genoa in the year 2011 [1]. Furthermore, some of the containers loaded/unloaded at Gioia Tauro, the main Italian hub port, are not related to the Italian GDP because they are distributed/gathered to/from other Mediterranean countries. The fact of considering all the container traffic in Gioia Tauro, that overvalue the traffic considered in the analysis can, partially, compensate the fact of not considering the traffic to/from northern European ports which undervalued it.

A multiple linear regression model has been calibrated.

$$Y_i = \beta_i X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \beta_5 X_{i5} + e_i \qquad (1)$$

where random noise variables $e_1, \ldots e_i, \ldots e_n$ are independent and identically distributed as $N(0, \sigma^2)$.

X_{ij} is the annual rate of growth in year i of freight category j ($j = 1$ for liquid bulk, $j = 2$ for dry bulk, $j = 3$ for container, $j = 4$ for ro-ro, $j = 5$ for conventional general cargo). Y_i is the annual rate of growth of the Italian GDP in year i.

In matrix form we have:

$$\mathbf{Y} = \mathbf{X}\beta + \mathbf{e} \qquad (2)$$

where $\mathbf{Y}$ and $\mathbf{e}$ are $n \times 1$ vectors, β is $k \times 1$ vector and $\mathbf{X}$ is $n \times k$ matrix, n are the number of data considered, k are the number of freight categories considered ($k = 5$).

All variables in the model are expressed in percentage (i.e.

$$X_{ij} = \frac{T_{ij} - T_{i-1\,j}}{T_{i-1\,j}}$$

where T_{ij} is the traffic in year i for freight category j,

$$Y_i = \frac{GDP_i - GDP_{i-1}}{GDP_{i-1}}$$

where GDP_i is the Italian GDP in year i). Traffic data for all Italian ports were available from 1997 to 2003 and from 2005 to 2011, therefore $n = 12$. Annual rates of growth have been used for this linear regression. Data were provided by Assoporti.

The regression has registered an adjusted R^2 equal to 0.78 (Since the addition of new explanatory variables will always increase R^2, an alternative coefficient, the "adjusted R^2", is frequently used as goodness-of-fit measure:

$$\text{"adjusted } R^2\text{"} = 1 - \frac{n-1}{n-k-1}(1 - R^2)).$$

The results of the regression are shown below. In the columns, from the first to the last one, the following is

reported: the coefficients of the regression, the standard error, the t-Student values, the p-values.
Linear model (PIL ~ LIQBULK, DRYBULK, CONTAIN, RORO, CONVEN)
Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.60087	0.50712	-1.185	0.2809
LIQBULK	-0.15844	0.16998	-0.932	0.3872
DRYBULK	0.02091	0.02896	0.722	0.4975
CONTAIN	0.14213	0.04688	3.032	0.0231**
RORO	0.08064	0.04070	1.982	0.0948*
CONVEN	0.04330	0.01819	2.380	0.0547*

Significance level: 0.01 ‘**’ 0.05 ‘*’ 0.1
Multiple R-squared: 0.8826
Adjusted R-squared: 0.7847

The regression has performed quite well, as the *adjusted* R^2 value is high. The t-Student values show that the most relevant variable is containers, which resulted statistically significant at the 5% level. This means that the empirical evidence does not support the null hypothesis of no impact on the model of the variable containers X_4. In fact, if the coefficient of the regression was $\beta_4 = 0$, to get the value $t = 3.03$ is a possible event, but very unlikely (with a probability less than 0.05). Therefore, it is said that the influence of the variable containers X_4 is statistically significant.

Ro-ro and conventional cargo have resulted statistically significant too, but at the 10% level; dry bulk cargo instead has not resulted statistically significant. Moreover, liquid bulk has shown a negative regression coefficient. The regression results clearly show that the most valuable freight category for the economy of a country are containers, but also ro-ro and conventional cargo traffic appear quite relevant. In particular, the fact that container traffic trend is heavily influenced by the national GDP trend agrees with the outcomes of [10, 12].

The linear regression model between the traffic in the five freight categories and the Italian GDP has shown the best results. Other two linear regression models have been considered by the authors:

– A linear regression model, again, among the Italian GDP and the five freight categories but in which a distinction between transhipment container traffic and non-transhipment container traffic has been carried out. In this case there were six regression independent variables: liquid bulk, dry bulk, transhipment containers, non-transhipment containers, ro-ro, conventional general cargo; the dependent variable was, as before, the Italian GDP.
– A linear regression model among the Italian IPI (Industrial Production Index) and the five freight categories.

In these two last regressions, as in the previous one, all variables were expressed as annual rate of growth. However, the statistical results obtained from these two latter regressions have been much poorer: for example the R^2 resulted much lower, therefore they have not been considered here.

The assigned weights to each freight category have been determined according to the regression results. Following [13] the relative importance of the explanatory variables could be determined comparing their t-values. Containers are then taken as reference in the new rule: the chosen weights, in the proposed rule based on Italian GDP, are equal to the ratio between the t-Student values of containers and the t-Student values of other freight categories. In the case of liquid bulk, whose regression coefficient is negative, the weight determined in the proposed rule, based on the value added concept, has been adopted.

A synthesis of the coefficients adopted in the proposed two new rules is provided in *Table 1*.

The fact that the weighting factors obtained with a regression based on GDP are not so different from those obtained with a very different approach, i.e. based on value added, can be considered as confirmation of both methods.

5. APPLICATION OF THE WEIGHTING RULES TO CLASSIFY ITALIAN PORTS

The existing rules, based on the value added concept, and the new rules, proposed by the authors, have been applied to determine the ranking of Italian ports. More in detail, the following rules have been considered:

– Unweighted sum of tons, called also “nominal tons” or “absolute tons”, in all freight typologies (hereinafter called UST),
– Bremen Rule (hereinafter called BRR),
– Rotterdam Rule (hereinafter called ROR),
– Range Rule (hereinafter called RAR),
– The proposed new rule based on the value added (hereinafter called NRVA), and
– The proposed new rule based on the Italian GDP (hereinafter called NRGDP).

The Hamburg Rule has been neglected because no distinction is proposed among: containers, ro-ro and conventional cargo. All the results obtained by applying the five rules are expressed in “equivalent tons”.

In order to understand the sensitivity of the ranking of Italian ports to the rule used to classify them an analysis based on the time series of traffic in 2005-2011 was carried out. The ranking of Italian ports has been analyzed according to the different rules, based not on the traffic of a single year, but on the average traffic, for all freight typologies, in an interval of seven years.

The classification of Italian ports results quite different according to the chosen rule. *Table 2* shows the ranking of Italian ports, according to average traffic volumes carried out by each port in the years 2005–2011. The average traffic for each freight category in these years has been calculated for each port, and then the different rules have been applied to it. The results shown in *Table 2* substantially underline that there is high sensitivity of the ranking of Italian ports with respect to the rule adopted.

In the following, the focus is on the results of the comparison among: UST, BRR, RAR (which is the newest and it has been considered the best because it is based on a range of ports [9]), NRVA, NRGDP.

According to UST Genoa is the most important port; Genoa is also the first in the ranking based on the BRR and RAR and in the NRVA. The second port according to the UST is Trieste, the third is Taranto, the fourth Cagliari, the fifth Augusta, the sixth Livorno and the seventh is Gioia Tauro.

According to the BRR, as stated above, Genoa is the first Italian port. The second port is Gioia Tauro, the third is Taranto, the fourth is Livorno, the fifth is La Spezia and the sixth is Napoli. The Bremen Rule provides the highest importance equally to containers, to ro-ro and to conventional general cargo (i.e. the weighting factor is equal to 1 for all); therefore, the most important ports are those whose traffic is mainly developed in this type of cargo. The result of Genoa is expected, as well as the result of Gioia Tauro, whose container throughput was much greater than that of the other Italian ports during the period 2005-2011.

According to the RAR, again the first port is Genoa, the second port is Livorno, the third is Taranto, the fourth Napoli, the fifth Venezia and the sixth Cagliari. The Range Rule gives the highest importance to conventional general cargo and to ro-ro (the weighting factor is equal to 1 for both), while the weight factor for containers is equal to only 3. This actually explains why Gioia Tauro is at the ninth position. Moreover, the position of Livorno, the second Italian port according to this ranking, is not surprising, as Livorno is the Italian port with the highest ro-ro traffic.

The NRVA provides a similar ranking to the RAR. In fact, it differs from the RAR only for the coefficient of containers, which is 2 in the NRVA and 3 in the RAR, and for the coefficient of dry bulk, equal to 4 in the NRVA and equal to 5 in the RAR. According to the NRVA the first port is Genoa, the second is Livorno and the third is Taranto, similarly to the results obtained by the RAR, Gioia Tauro instead occupies the fourth position while based on the RAR it occupies the ninth position

Table 2 - Ranking of Italian ports, based on the average traffic in the years 2005-2011, according to different classification rules [1, 15]

Port	Unweighted sum	Bremen Rule	Rotterdam Rule	Dupuydauby Rule	Range Rule	Proposed rule based on the value added	Proposed rule based on the Italian GDP
Ancona	17	20	18	21	19	18	19
Augusta	5	22	8	14	10	20	17
Bari	21	19	22	22	18	17	22
Brindisi	14	17	17	20	20	21	21
Cagliari	4	10	7	8	6	10	9
Civitavecchia	18	16	16	17	16	15	16
Genova	1	1	2	2	1	1	2
Gioia Tauro	7	2	3	4	9	4	1
La Spezia	12	5	9	9	14	12	5
Livorno	6	4	5	3	2	2	4
Messina	10	12	15	12	11	9	13
Monfalcone	22	21	14	16	22	22	18
Napoli	11	6	11	10	4	6	10
Olbia + Sassari	16	13	19	15	12	13	14
Palermo	20	15	21	18	15	14	15
Piombino	19	18	20	19	21	19	20
Ravenna	9	7	4	5	7	7	6
Salerno	15	11	13	11	13	11	11
Savona	13	14	12	13	17	16	12
Taranto	3	3	1	1	3	3	3
Trieste	2	8	10	7	8	5	8
Venezia	8	9	6	6	5	8	7

(this result must be expected because the coefficient of containers is 2 in NRVA and 3 in the RAR and Gioia Tauro is the first Italian port for container traffic). The fifth port is Trieste, and the sixth is Napoli, which were otherwise eighth and fourth, respectively, based on the RAR.

The NRGDP, instead, provides a different ranking from the NRVA. Indeed, the NRGDP yields the highest importance to container traffic; therefore, the ports with mainly developed container traffic register higher ranking. As a result, based on this rule, the first port in the ranking is Gioia Tauro. According to the NRGDP, the second port is Genoa. The third is Taranto, the fourth is Livorno, the fifth is La Spezia and the sixth is Ravenna. Also La Spezia traffic is developed mainly in containers; therefore this port registers low ranking in the RAR and in the NRVA, but a higher one in NRGDP.

6. CONCLUSIONS AND FUTURE WORK

Italian ports have been ranked according to the most common rules present in literature which are based on the added value concept related to port operations. These rules have been studied and developed for the northern European ports, and they are: the Hamburg Rule, the Bremen Rule (BRR), the Rotterdam Rule (ROR), the Dupuydauby Rule, the Antwerp Rule (ANR), the Range Rule (RAR). These rules provide some weighting coefficients for each freight category. The weighting coefficients proposed by these rules are quite different from rule to rule.

Other two rules have been proposed by the authors. The first proposed new rule (NRVA) is based, again, on the value added concept of port activities, and it has been developed starting from the ANR and the RAR. The added value associated to handling each freight typology has been assumed the same as in the ANR (as it was done for deriving the RAR). The synthetic coefficients associated to each freight category have been obtained aggregating the various freight typologies according to their percentages registered in two of the major Italian ports, i.e. Genoa and Livorno. The coefficients proposed in this rule rather agree to the coefficients proposed by the latest classification rules, i.e. the ANR and the RAR.

The second rule, proposed by the authors, (NRGDP), is based on the regression of the rate of growth of the Italian GDP, against the rate of growth of the various freight categories. The coefficients of the NRVA and NRGDP give much more importance to containers, ro-ro and conventional general cargo, than to liquid bulk and dry bulk. The only difference among the coefficients of the NRVA and NRGDP regards the weighting coefficients of container traffic and ro-ro traffic. The weighting coefficients are equal to 2 for containers and 1 for ro-ro in the NRVA and the opposite in the NRGDP. Actually, this seemingly slight difference causes a more marked difference in ranking of the ports whose traffic is mainly developed in containers or in ro-ro.

The rules existing in literature, and the two proposed new rules, have been applied to classify Italian ports according to the average of traffic in the years 2005-2011.

The implementation of the rules to the average traffic in the years 2005-2011 has shown that the ranking of Italian ports is rather different based on the various rules considered. Apart from Genoa, which usually occupies the first (but sometimes the second) position, and Taranto, which usually occupies the third (but a couple of times the first) position, the other Italian ports show strong difference in the ranking according to the rule used. Therefore, for example, Gioia Tauro results in the ninth place based on the RAR, and instead results in the second place based on the BRR and in the first place basing on the NRGDP. The ranking of Cagliari, Trieste and La Spezia varies highly in ranking from one rule to another. In general, ports like Genoa and Livorno, whose traffic is developed in all freight categories, do not show great difference in ranking from rule to rule. Also Taranto does not show significant differences in ranking, but this occurs because its traffic is mainly developed in conventional general cargo, whose weighting coefficient is equal to 1 in all rules. As far as the two proposed new rules are concerned, NRVA and NRGDP, quite different results have been obtained as well. For example, La Spezia and Gioia Tauro, which are mainly container ports, register a higher ranking in the NRGDP, while Livorno, which is the most important Italian ro-ro port, registers a higher ranking in the NRVA: actually, Livorno is the second Italian port if we apply the NRVA and the fourth if we apply the NRGDP.

The results show that there is, generally, a strong sensitivity of the ranking of Italian ports with respect to the rule used, but some ports, like Genoa, Taranto and Livorno are not strongly affected, regarding the position occupied, by the rule used. With regard to the sensitivity of the ranking with respect to the rule used, it must be noted that the common usage of integers for the weighting factors may partly explain the sensitivity of the ranking with respect to the rule used. Port ranking based on UST (unweighted sum of tons) appears not to be correct; port classification based on "equivalent tons" is more correct, particularly if the approximation of the method is clearly known to the users. Furthermore, weighting rules are also fundamental in Product Portfolio Analysis. Actually, this analysis is used as a tool for strategic port planning because it describes the performance of ports in terms of market share and growth rate.

As far as the new proposed rules are concerned, the NRVA allows the value added concept to be utilized in a better way to the Italian ports. The simple utilization of the RAR, which is based exclusively on the Northern European ports, without any checking, could have been incorrect. But, based on our analysis, it must be noticed that indeed the NRVA weighting factors are not much different from the RAR weighting factors.

The proposal of a rule that broadens the vision of port value added, which is certainly important, but still restricted to only port system, allows all port stakeholders to see the port as a node of a transport network system that is at the service of a wide area and, in particular, of a nation. It allows the identification of the priorities for port planning in terms of the interests of the entire system served by the ports, which may coincide with one or more nations, not taking into account only the value added generated in the ports themselves. The NRGDP meets this target, although it must be seen as a first step in this direction, since the data available, for the calibration of the model, were not particularly numerous. The importance given to the container traffic in the NRGDP confirms the international habit of giving often port ranking taking into account only container traffic, next to port ranking based on the UST [14].

Further research in the field is needed. For example trying to repeat the reasoning used for calibrating the Range Rule for Northern European ports to trying to determining a Range Rule for Mediterranean port and to compare the weighting factors resulting in both RAR and NRVA. For this purpose it is necessary to determine the coefficient for each freight category from the percentages of freight typologies in the main Mediterranean ports. It could be also desirable to generalize the NRGDP to the European scenario. Regarding the NRGDP in fact the main problem was the small amount of data available: therefore, it can be desirable to collect data also about port traffic and GDP of other European countries.

Prof. **MARINO LUPI**
E-mail: marino.lupi@unipi.it
Prof. **ANTONIO PRATELLI**
E-mail: antonio.pratelli@unipi.it
Dr. **ALESSANDRO FARINA**
E-mail: alessandro.farina@for.unipi.it
Dr. **ALESSANDRA GAZZARRI**
E-mail: alessandra.gazzarri@for.unipi.it
Dipartimento di Ingegneria Civile e Industriale
Università di Pisa
Largo Lucio Lazzarino 1, 56122 Pisa, Italy

SINTESI

APPLICAZIONE DELLE REGOLE DI CLASSIFICAZIONE DEI PORTI AL CASO ITALIANO

In questo articolo vengono descritte le regole comunemente utilizzate per la classificazione dei porti. Queste regole forniscono dei coefficienti di omogeneizzazione per ogni categoria di merce, in modo tale da poterle confrontare ai fini della classificazione dei porti. Queste regole sono basate sul concetto di valore aggiunto, che viene determinato sulla base delle attività portuali. Si propongono due nuove regole. La prima è di nuovo basata sul concetto del valore aggiunto. La seconda regola, invece, si basa sull'ipotesi che i porti non creano soltanto lavoro direttamente, tramite le attività collegate alle operazioni portuali, ma svolgono anche il ruolo di porte di accesso per le attività economiche esistenti in una regione o in una nazione, poiché una quota consistente del commercio internazionale ha luogo via mare. Questa regola è basata sulla relazione tra l'andamento del volume di traffico di ciascuna categoria merceologica e l'andamento del PIL nazionale. Le regole esistenti in letteratura e le due nuove regole proposte sono state applicate alla classificazione dei porti italiani; sono poi stati commentati i risultati di tale classificazione. E' infine stata analizzata la sensibilità dei risultati della classificazione dei porti italiani a seconda della regola utilizzata.

PAROLE CHIAVE

Classificazione dei porti; porti Italiani; valore aggiunto; regole di classificazione dei porti

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