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Vessel Port Dues: An Influence from Path Dependency rather than Geography of Ports

Alexandre LAVISSIERE^a

^a Assistant Professor, EM Normandie, Metis Lab, France, E-mail: alavissiere@em-normandie.fr (Corresponding Author)

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Clarkson Research Services Limited vessel monitoring systems was used to compute vessel calls data.

ABSTRACT

Port dues have a limited impact on the door-to-door international decision making process. They are, however, a major source of revenue for port authorities. Their objective is to balance budgets (recovery pricing, marginal cost pricing, external cost pricing, etc.) and enable financing of infrastructure. As such, while they may not have a direct impact on the attractiveness and competition of ports, their indirect impact is unquestionable.

This study investigates vessel port dues, which follow diverse formulas of calculation that complicate comparisons. Therefore, we classify vessel port dues into two categories: Gross Tonnage based, and Cubic Meter based. These categories are essential insofar as they correspond to two geographical realities of ports: bay ports for the former, and channel ports for the latter.

An empirical study on ports located in Western Mediterranean Sea countries illustrates the relevance of these two models. It also exposes deviation in the application of these models implied by path dependency. Such deviation has an influence on the pricing system and fairness of invoicing. This work demonstrates the necessity for improving port pricing in several ports on both banks of the Western Mediterranean Sea, as well as the necessity for fairer application of port dues.

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1. Introduction

Port pricing is an old topic, as Acciario (2013) shows in his review of the topic. There is important literature on the topic spanning several different approaches. It is also one of the topics in which research has had a great impact on policy making. Changes in the paradigms of port governance in recent decades have pushed actors to look for new ways of managing and increasing the efficiency of ports. Pricing has been a key subject within this topic, where abundant research has contributed to the

implementation of new solutions.

Port reforms made pricing research necessary as pricing is one of the marketing pillars of competitive policy (Esmer *et al.*, 2016; Fedi and Lavissiere, 2013). In the same way, the importance of terminals in competitiveness (Heaver, 1995) with concentration of players, as well as vertical and horizontal concentrations in terminal operations (Notteboom and Rodrigue, 2005; Wilmsmeier and Monios, 2013; Lee *et al.*, 2014),

have pushed the market to react in a strategic way.

In such a context, port pricing, and specifically port dues, became a controversial issue for commercial ports in need of both competitiveness and recovery of investment costs (Haralambides, 2002). Port dues, as in any pricing system, are composed of a pricing basis, with factors related to service provided, and a pricing level that represents the balancing of cost recovery and market price. The conversation on port dues focuses on the level of pricing strategies (Activity Based Costing, Marginal Cost Pricing, etc.) and their consequences for ports and shipping lines (Bandara et al., 2013; Pettersen Strandenes and Marlow, 2000).

The basis of pricing is often considered less controversial since cargo dues are more easily comparable and port dues are dominated by the GT system. Nevertheless, French ports, including Marseille, the largest port in terms of tonnage on the Mediterranean Sea, and Haropa (Havre-Rouen-Paris) the fifth largest port in Europe, still use the cubic meter system, which is different from the GT system. More surprisingly, Tanger-Med, one of the leading port creation projects of the 21st century, chose to base its pricing system on cubic meters as well. These two facts are raising questions, especially since there is a gap in the port pricing literature on this subject. Why would region-leading ports use a different system? Is it relevant to do so? If it is, then what is the benefit of such system compared to the GT system?

To our knowledge, literature on port pricing does not provide any answers to these questions. The present paper aims to fill part of the gap by offering: firstly, an extensive literature review on port dues, pricing strategies in logistics infrastructures, and the influence of path dependency on pricing policies; and finally, a case study of port dues policy in the Western Mediterranean Sea where both systems are found.

2. Port dues has been a topical subject for a long time, with areas still to be studied

Notteboom and Yap (2012) argue that port competitiveness is a function of several factors, including port costs. In fact, competitiveness is the result of a matrix of the price and service advantage that is provided (Hugos, 2011). The port is no exception, and price advantage is composed of several expenses related to the services provided (e.g., pilots, tug, moorage, handling, infrastructure, navigation, anchorage, etc.).

2.1. Port dues are negligible for shippers, but vital for ports

The total cost may be a factor of competitiveness when it comes to the shipper’s choice, but port dues are not a directly material factor in the larger equation. Studies (Dowd and Fleming, 1994; Sibue, 2012; ALG, 2012) have shown that port dues represent around 15% of the total port costs, and that this part of door-to-door transportation is negligible in comparison to land transportation costs, as demonstrated by Carriou (2014).

However, these same studies (Sibue, 2012; ALG, 2012) show the importance of port dues for the port authority, since these represent around two-thirds of the income of the *landlord* port authority, while the remaining income comes from concessions. Such an amount represents an indirect factor of competitiveness insofar as it pertains to financing construction and maintenance of infrastructure.

Port dues are important to port authorities because they enable indirect attractiveness, especially in developing countries (Clark, Dollar and Micco, 2002). This attractiveness is built upon confidence and fairness

(ALG, 2012). Shipping lines ask for a fair system to recover the costs of the infrastructure. This cost includes building the infrastructure, such as the quays and the breakwater, and the costs of maintenance, which includes dredging. On the other hand, congested ports might represent another paradigm insofar as they function in terms of the economic efficiency of the infrastructure. A marginal cost of congestion could be levied on the users to achieve an efficient outcome (marginal cost pricing). The fixed cost of infrastructure (mostly the construction cost) should be levied more heavily on those users who are less price sensitive (Meersman et al., 2010). This principle applies Ramsey pricing (Ramsey, 1927) in which the cost allocation reflects the elasticity of demand as well as recovery of the costs. Hence, a port dues system could be efficient while it heavily charges larger vessels whose operators would be less price sensitive.

In detail, from the port perspective, there are different approaches to port dues. Following Acciaro (2013), we would like to emphasize four main approaches: strategic pricing, pricing and market conditions, pricing and infrastructure cost recovery, and pricing and external costs.

Strategic pricing involves the way that the port charges for the services it brings. This affects both shippers and stakeholders such as the commercial balance, the local industry, etc. This means that pricing depends on the types of cargo or vessels (Ashar, 2001) the port, on behalf of its stakeholders, wishes to attract. This assumes a certain elasticity in the demand of port services.

The Market Conditions approach of port pricing highlights competition between ports. Pricing strategies and levels will differ depending on the ports’ market situation. Monopolies, duopolies and oligopolies will have different impacts on pricing strategies. Moreover, highly competitive areas (e.g., the North Range or the Mediterranean Sea) will create different conditions for pricing strategy.

The Infrastructure Cost Recovery approach of port pricing is linked to the service provided. With modern pressure on prices, Activity Based Costs-type approaches have risen to cover the real costs of the service provided. Several calculation methods of this nature exist for port pricing. Among these, Marginal Cost Pricing is the method that best covers capacities in order to optimize planning of infrastructures (Haralambides, 2002; Meersman et al, 2003).

The External Costs Pricing approach takes into consideration the social (Abbes, 2007) and environmental (Acciaro, 2015) costs of operating a port, placing particular emphasis on issues that impact these two pillars of sustainable development, e.g., congestions.

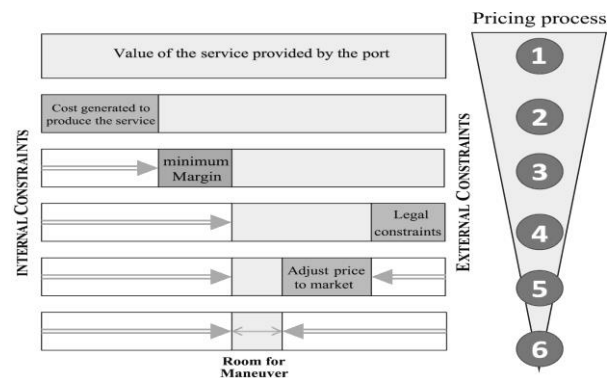


Fig. 1. Creation of a tariff system is constrained by minimum internal profitability and maximum accepted price

Source: Authors’ drawing adapted and developed from UNACTD (1975)

These four approaches, emphasized by Acciaro (2013), cover strategies of stakeholders, competition, internal costs, and externalities of port infrastructure. They complement one another, which further complicates port pricing, as illustrated in Figure 1. The process of port pricing often incorporates all of these elements in six steps (UNCTAD, 1975):

1. Availability of port infrastructure creates a trade value for a given territory and for given actors.
2. Management of infrastructure generates a cost, which revenue must exceed. This is an internal constraint.
3. Long-term management requires that a minimum margin be extracted from operation. This margin secures operations from risk and represents an internal choice within the organization.
4. Local legal framework, as well as international provision, create constraints for pricing and operation that constitute an external constraint on the pricing system.
5. Balance between supply and demand within the pressure of competition is an external constraint on price, and therefore on the pricing system.
6. There is little room for manoeuvring within pricing policy once we aggregate all of the external and internal constraints alongside their consequences.

Bandara et al. (2016) also identify four major factors of importance considered by port authority managers from more than 150 international ports. These factors are Port Demand, Pricing Knowledge and Applicability, and Tariff Objective and Cost Recovery. Since this study is based on surveys concerning port pricing perception, knowledge of port pricing is an important factor. But apart from this, we find agreement with the same concepts as outlined in the previous studies: competition, strategy, feasibility and cost recovery.

2.2. Port dues are a dynamic lever for ports

We would suggest summarizing the mechanism of port dues in a dynamic manner, which is not directly a competitive factor, but is an indirect influence on infrastructure by way of the two sub-mechanisms of virtuous circle and vicious circle.

If port infrastructure is sufficient to absorb the flow (See Figure 2), it provides for its own funding through the growth of port dues. In fact, positive outlook for flows is expected to increase imports, exports, and free trade agreements. The effectiveness of ports, as the main gateway of a given country, depends on future demand. This means when a state invests in a port infrastructure, this infrastructure is effective when future flows fill the infrastructure, so that neither the local authorities nor the State need to subsidise port activities (Meersman et al, 2014). If these captive flows pass through the ports, they will allow the establishment of a virtuous circle with increases in profitability, and incomes provided by port dues and attractiveness. This mechanism will attract new flows and finance the need for the infrastructure they require.

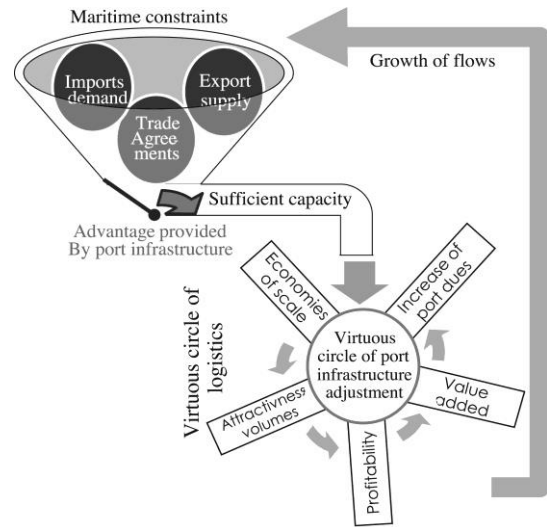


Fig. 2. virtuous circle of port dues

Source: Authors' drawing

The opposite mechanism is also true (see Figure 3): if port infrastructure is not sufficient to absorb the flow, it hinders development, and reduces the revenue from the port dues that finance this infrastructure.

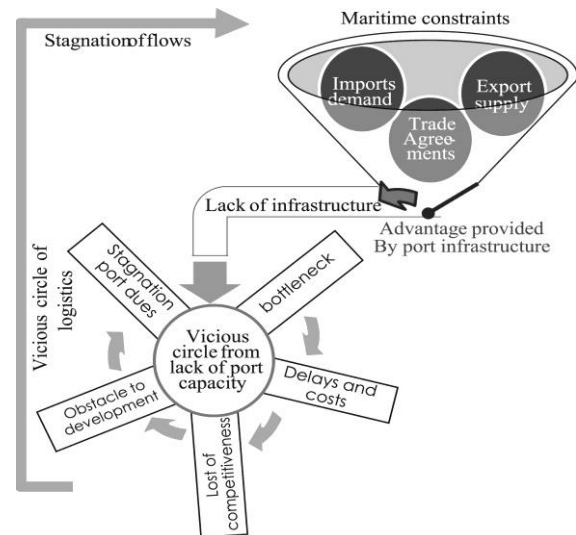


Fig. 3. Vicious circle of port dues

Source: Authors' drawing

When outlook for the development of flows predicts an excessive increase in imports and exports for port infrastructure, access to the country will be congested. This congestion will result in a decline in competitiveness and a brake on development. Thus, there is a vicious circle with difficulties in financing the infrastructures that slow down the flows, and hence revenue. This mechanism regulates the system, but in the context of port growth and development and international competition, it is important to prevent such a mechanism.

What this tells us is that port dues are the counterpart of an efficient port service, and the mechanism for financing this efficiency in a self-regulating system. Moreover, port dues are a lever for port strategy in such a dynamic perspective, as shown by Figure 4, which sums up the two regulatory mechanisms of the system illustrated in Figures 2 and 3.

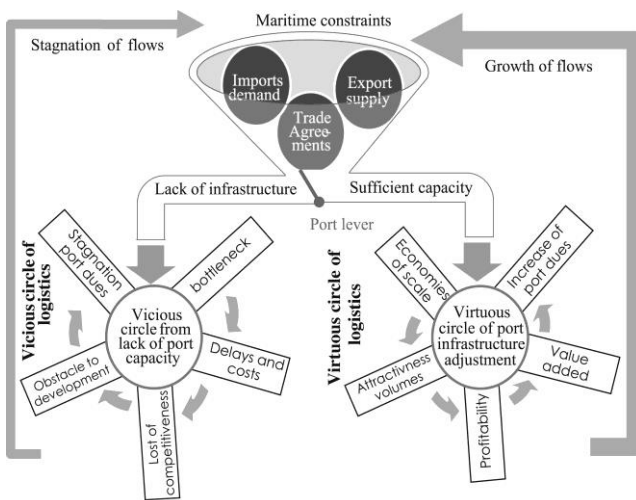


Fig. 4. Port dues indirect lever for port infrastructures

Source: Authors' drawing

2.3. Two main port dues

Now, what is interesting in such a complex system is understanding how this lever works. There are two main components: port dues on cargo, and port dues on vessels. Port dues on cargo cover the berth and its quay. Different types of vessels (RoRo, Container Carriers, tankers, cruise, etc.) need different berthing, and therefore should pay differently in terms of cost recovery (Bennathan and Walters, 1979; Martín-Budria et al., 2001). Moreover, they have different strategic value for both the country and the port itself, which in turn influence the pricing. Cargo dues cover the land line of the interface a port represents. They are, in general, easy to compare because they represent an amount that multiplies the volume of cargo in tons, vehicles, TEU, and passengers. Cargo dues represents a percentage of the price of the cargo for the shipper. Since this is a visible and much targeted part of the pricing, port authorities have promotion plans targeting this part of the pricing system. For instance, the port of Marseille does not charge as much on imported goods as those that are exported. Gioia Tauro does not charge containers, and the ports of Rouen and Le Havre, when they joined in the HAROPA consortium, lowered the price on cereals in Rouen and increased it in Le Havre, in order to redirect flows to Rouen (ALG, 2012).

Vessel dues target the waterline of the port land-water interface. The space the vessel occupies represents the basis of payment with draft, quay occupancy and/or round basin. The cost recovery is therefore based on the water infrastructure, including the quay and sometimes the maintenance of such infrastructure.

The debate in literature on infrastructure and services to infrastructures to be covered by vessel dues is still open, with the US Harbour Maintenance Tax (HMT) being a particularly vivid example (McIntosh and Skalberg, 2010). Furthermore, the comparison of vessel dues is complicated, as these follow very different rules depending on ports. Not only do these not necessarily cover the same costs, but they do not follow the same calculation rules. Despite the insistence of UNACTD (1995) to standardize port dues for better transparency, Bandara et al (2013) have found that 72% of 119 ports in four continents use Gross Registered Tonnage (GRT) and 21% use Length OverAll (LOA) of the vessel. In addition, the study did not mention the cubic meter system that is the

alternative to the GRT/LOA approach, and is used in many French-speaking countries, particularly in Africa.

One generally assumes that, historically, there have been two competing systems: one in barrels (the English system), and the other in metric (the French Napoleonic system). Since the British fleet gained control of the seven seas, the British system spread, leaving no room for the metric. This is probably why, in port dues literature, there is no mention of such a system that is widely used in the Mediterranean Sea and African coasts.

2.4. Port policy and path dependency

The historical aspect mentioned above directs the research toward systemic influences on the policy decision-making process and more specifically path dependency (Pearson, 2000; Kay, 2005). Path dependency involves reaching the field of transportation and logistics with recent studies in seaports (Debrue et al., 2007; Jacobs, 2007; Ng and Pallis, 2010; Dooms et al., 2013) and free ports (Lavissière and Rodrigue, 2017). Path dependency represents the influence of past decisions or events that have been experienced on actual decisions. Notteboom et al. (2013) emphasized three streams of research in port literature that are related to the path dependent evolution of ports. The first stream of research on port evolution does not deal with path dependency, but rather with the long term evolution of port systems (Bird, 1973). The second stream deals with the structure of the port community around clusters (De Langen, 2004) and implicitly considers a path dependent on the specific aggregation of clusters within the port. The third stream deals with port actors as a community of practice (Hall, 2003; Jacobs, 2007) in which actors influence each other and generate local port specific path dependency. Path dependency in ports results from sunk costs of infrastructure, place-specific institutions, historically developed routines of actors, and forces of agglomeration (Notteboom et al. 2013), and it is ontologically an explanatory factor rather than a phenomenon to explain (Notteboom et al. 2013).

If we consider port as a system, and moreover port community as a system, the evolution of this system is subject to three main elements which are the history of the system, its structure, and its function (Donnadieu and Karsky, 2002; Durand and Nuñez, 2002). The three streams of research described above fall into the structural and historical elements, but the functional aspect seems less explicative, even though it may be the important factor to investigate in terms of port dues, since port dues systems are meant to cover a specific service. Path dependency may result from a tension between the structure of the port dues system, the influence made by the history of the port community, and the function it is supposed to have.

3. The case of western Mediterranean countries

The methodology used for this research is based on complementary port case studies within the same area in order to induct theoretical aspects (Eisenhardt, 1989). Case studies enable deep and detailed analysis with rich qualitative and quantitative data, and they are longitudinal as well as process-oriented (Harrison et al. 2010). In addition, both Acciaro (2013) and Bandara (2013) emphasize the lack of field research in port pricing literature.

The Western Mediterranean Sea is the area chosen to evaluate the significance of the metric system of vessel dues. We chose this area

because there is an abundance of flows with gateway ports as well as hubs. There are management differences between the North and South banks, and Spain uses the GT system, France uses the metric system, while countries like Morocco use both. Therefore, we chose Spanish, French, Tunisian, and Moroccan ports, including some ports on the Atlantic shore, to see if there were any differences.

Tariffs systems were available online, and the Clarkson Research Services Limited vessel monitoring systems enabled us to establish some real case comparisons. For some considerations we included Italian and Algerian ports, but detailed tariff information was not available.

These secondary data have also been completed with interviews of port managers in most of the ports included in the study, and more specifically in Morocco where participant observation had been conducted (Yin, 2009).

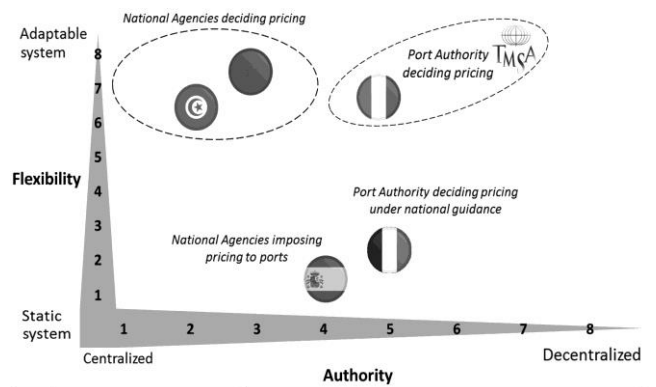
3.1. Aligning strategy and port dues

The first aspect to consider when comparing systems of port dues is regulation. Fedi and Lavissiere (2013) demonstrated that there has been a movement of port reform in the Western Mediterranean Sea ports. This movement was followed by adaptation, and then reform of port pricing policy, including port dues. Creation of Puertos del Estado in Spain (1992), pre-reform in France (1992) and then port reform (2008); a centralized authority; privatisation of port handling in Italy (1994); separation between port operators and regulators in 2006 in Morocco (Agence Nationale des Ports – regulator- & Marsa Maroc – operator –) are all followed by port dues reforms (Spain in 2004 – France in 2008 – Italy in 2009 – Tunisia in 2002 – Morocco initiated in 2011).

These reforms give different powers to ports. In some places, authority is in the hands of a centralized agency regulating ports (Office de la Marine Marchande et des Ports in Tunisia, Agence Nationale des Ports in Morocco, with the exception of TangerMed, and Puertos del Estado in Spain), in other places authority is decentralized to port authority, as in France and Italy, and in the special case of TangerMed. The more local the authority is, the more decentralized it becomes.

Another aspect of port dues pricing is the ability for the port to determine its pricing policy. Three factors are taken into account. First, the local port dues system is the standard or it has to be designed under national regulation. Second, the port dues basis is scalable and therefore either adapted to the specificities of ports or unique and applicable to all in the same way. Third, either the pricing level is given or it is adaptable.

In the case of Morocco and Tunisia, the state agency in charge is free to decide, and manages the ports accordingly. In the case of Spain, port authorities have little flexibility, and follow the pricing established in Madrid by Puertos del Estado. In the case of France, there is a calculation system established in the code of ports, but port authorities are free to apply the price they consider appropriate. Italian Ports and Tanger (TMSA) are free to establish pricing as they wish.



Scale	Authority location	Flexibility to set pricing of port dues
8	Terminal	multiple basis and adaptable levels of port dues being regulation
7	Port	multiple basis and given level of port dues being regulation
6	Regional	unique basis and adaptable levels of port dues being regulation
5	Port under National guidelines	unique basis and given level of port dues being regulation
4	National with port declinations	multiple basis and adaptable levels of port dues under national law
3	National with exceptions	multiple basis and given level of port dues under national law
2	National	unique basis and adaptable levels of port dues under national law
1	Supra national	unique basis and given level of port dues under national law

Fig. 5. Port pricing policies organisations

Source: Authors' drawing

Figure 5 maps port authorities on these two characteristics of the centralized/decentralized power of the authority and flexibility to set port dues systems. This illustration shows three groups of port authorities: national agencies (Tunisian and Moroccan) that are centralized but freely determine port dues, local port authorities (Tanger-Med and Italian ports) that are decentralized and freely determine the port dues, and port intertwined with governance where either authority may determine port dues under national governance (French ports), or National authority imposing port dues on local ports (Spain).

This means strategy can be applied with different degrees of precision depending on whether pricing is set in ports or solely at a national level. In order to study this, we looked at 2011 annual reports of ports, with the three main strategic statements for each port, and compared port dues pricing policies (Table 1).

Table 1

Comparison between announced strategy and pricing policy

	Announced Strategy	Port dues policy
Marseille, Fr	<ul style="list-style-type: none"> Massification of containers Develop liquid bulk Becoming a RoRo hub 	<ul style="list-style-type: none"> Reduction for Mega carriers Reduction for energy liquid bulk (volumes et import) Reduction for RoRo from E.U.
Le Havre, Fr	<ul style="list-style-type: none"> Attract more containers Develop synergies on Seine River Axis (Rouen & Paris) 	<ul style="list-style-type: none"> Reduction to all container vessels Reduction to dry bulk except cereals (Rouen main market)
Rouen, Fr	<ul style="list-style-type: none"> Keep European #1 position on cereals Develop Western African lines Develop synergies on Seine River Axis (Le Havre & Paris) 	<ul style="list-style-type: none"> Very low price on cereals Reduction on creation of new lines Reduction on fluvial-maritime vessel (to Seine river ports)
Barcelona, Sp	<ul style="list-style-type: none"> Becoming #1 port in South of Europe by 2015 Becoming leader in Mediterranean for liquid bulk Consolidate Top5 for cruise in the World 	<ul style="list-style-type: none"> No direct port dues incitation on these markets No reduction targeting specifically these markets
Valencia, Sp	<ul style="list-style-type: none"> Keep #1 Iberic Gateway for trans-oceanic flows Becoming THE multimodal hub in western Med Reach 68Mt capacity including 4 M EVP by 2015 	<ul style="list-style-type: none"> Increase in port dues compared to other Spanish ports on vessels dues (+17%) and cargo dues (+15%)
Bilbao, Sp	<ul style="list-style-type: none"> Target short sea shipping market. Target new niche markets Providing multimodal service 	<ul style="list-style-type: none"> No direct port dues incitation on these markets No reduction targeting specifically these markets
Naples, It	<ul style="list-style-type: none"> Develop all types of port services Boost strategic activities Become a multimodal hub 	<ul style="list-style-type: none"> Reduction on passenger dues (except cruise) Reduction for all regular lines
Gioia Tauro, It Cagliari, It	<ul style="list-style-type: none"> Gioia Tauro : develop container offer Cagliari : favor transshipment and tourism 	<ul style="list-style-type: none"> Gioia Tauro : drastic decrease of prices on containers (almost 0) Cagliari : drastic decrease on transshipment prices (almost 0)
Tunis, Tn	<ul style="list-style-type: none"> Keep #1 position for RoRoin the area Reach a multimodal capacity Develop tourism 	<ul style="list-style-type: none"> No reduction in Tunis, which is station of the national pricing policy, but reduction on bulk in others ports of Tunisia.

From this comparison, we conclude that in Spain there is a clear, inflexible system with low alignment between pricing and port strategy. There are independent ports, but under the authority of a state agency the system is homogeneous and transparent, and the margin for adaptation of pricing is at the level of tax categories with no or very limited authority from the port to change it. Here bonuses are not easily adaptable to the strategic choices of the ports. France developed a system designed as a strategic lever with strong alignment between pricing and port strategy. Ports are independent, the port dues system is clear, the pricing policy is freely determined within a range for each category, and bonuses are framed by national rules and a range of application. In Italy, there is a complex system that encompasses local choices, and provides a strong alignment between pricing and port strategy. Ports appear highly independent, with a large range of action for port dues.

In the south bank of the Mediterranean Sea, both Tunisia and Morocco have developed a flexible, national system. This means that there is no real declination at the level of the port. There is, as a result, a weaker alignment between pricing and individual port strategy, but a stronger alignment at a national level. Consequently, we see that budget (e.g., cost recovery) is balanced at a national level rather than port-by-port. Such policy gives more room for commercial and promotional actions.

Another conclusion is that price level is the main factor for the pricing strategy. This confirms the importance of the methods, such as Marginal Cost Pricing, presented in the literature. However, the system of port dues is not at the heart of the strategy, even though it seems to be strongly influenced by the infrastructure itself. There should be two levers: what service is billed (system of port dues), and to what level (level of prices).

3.2. Comparable pricing policies on cargo dues

Some cargo price levels depend on strategy (Spain taxes the goods more than the ship, Marseilles does not tax the imports, Marseilles always favours the transit towards Corsica, Rouen favours the export of cereals), as shown in Table 1. However, port dues on cargo are easily comparable from one port to another because they are a factor of unit and price. We looked at the 12 categories of cargo described in the Moroccan system (Table 2) and compared prices of these goods with the ports of Marseille, Le Havre, Rouen, Valencia, Barcelona/Bilbao (that have same pricing policy), Tunisian ports and Moroccan ports (with the exception TangerMed).

Table 2
List of categories of cargo dues used for benchmark

Vessel Name	Beauty Star	Ouzoud	Ever Prosperity	Soraya
GT	4 192	17 879	35 392	24 836
Length (unit: meters)	114,56	148,9	224,5	217,11
Width (unit: meters)	16	23,98	32,2	26,66
Draft (unit: meters)	5	5,5	9,8	10
Original port of Call	Agadir	Nador	Casablanca	Casablanca
Original duration of call	38h30min	8h30	60h35min	15h52
Type of Cargo	Fruits & Veg	RoRo/Pax	Phosphates	
Cargo unloaded	1752 t	582 cars 6 trucks 2 173 Passengers		74 units (20') 44 units (35'/40')
Cargo Loaded		2 310 cars 15 trucks 8 819 passengers	59 487 t	41 units (20') 17 units (35'/40')

Figure 6 benchmarks the prices of these 12 categories in the panel of ports studied. Each category is represented by a box plot with distribution of price levels converted to EUR. What we can conclude from Figure 6 is that countries on the southern shore have very low price levels compared to countries of the northern Mediterranean, (they were both in the process of recasting) and this could represent a price related to the level of service if it was proved that they were less efficient. On minerals for instance, the ANP has prices per ton sometimes ten times cheaper than the European countries. Only prices on cereals are roughly comparable (0.64 euros per tonne for 0.75 in France). On the other hand, the price level is higher for containers (21 euros per TEU against 7 euros in Le Havre, 10 in Marseille, and 24 in Barcelona). In Morocco, passenger fares are a real shortfall as they are low (0.38 euro per passenger compared to 1.4 in Tunisia, 2.5 in Le Havre, and 3.4 in Spain). The same passenger from Europe to Morocco will pay ten times more in Spain (for instance embarking) than in Morocco (disembarking) during the same trip. We can conclude that despite the comparability of systems, there is no real alignment in prices.

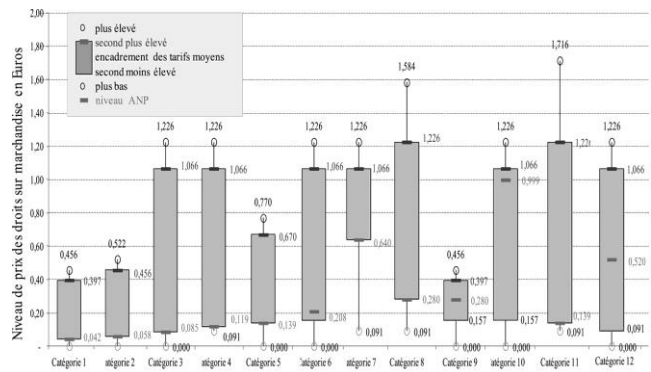


Fig. 6. benchmark of cargo dues in Western Mediterranean Sea
Source: Authors' drawing

3.3. Heterogeneous systems of vessel dues

Comparing the port dues systems of Western Mediterranean ports, we have considered the misleading approach of Napoleonic versus British barrels a mistake because these two systems do not cover the same services, and they both address different needs from modern port pricing issues.

The difference between the GRT system and the metric system does not lie in the unit of measurement, but rather in what is measured. GRT measures a ship's total internal volume expressed in "register tons", each of which is equal to 100 cubic feet (2.83 m3). GT (Gross Tonnage), replacing GRT, is the universal tonnage measurement system introduced by the The International Convention on Tonnage Measurement of Ships, adopted by IMO in 1969, and coming to force on July 1982. GT is different than GRT because it is a nonlinear measure of a ship's overall internal volume. Gross tonnage is calculated based on "the moulded volume of all enclosed spaces of the ship".

On the other hand, the metric system calculates the cubic volume in which the immersed hull of a vessel would fit. Such volume of the vessel is established using the formula: $V = L \times b \times Te$, where: V is expressed in cubic metres; L, b and Te represent respectively the overall length of the ship, its maximum breadth, and its maximum summer draught, and are expressed in metres and decimetres. In the French system, for instance, the value of the maximum summer draught of the ship taken into account

in order to apply the above formula shall in no case be less than a theoretical value equal to $0.14 \times \sqrt{(L \times b)}$. (L and b being the LOA and maximum beam of the vessel).

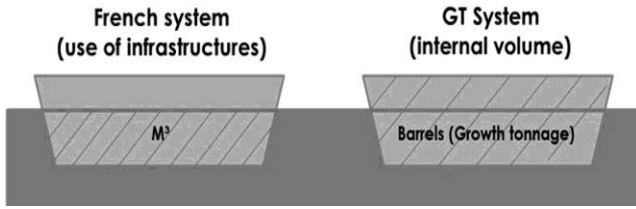


Fig. 7. Two main calculation of vessel dues

Source: Authors' drawing

One system seems to measure the cargo capacity of the vessel, while the other measures the use of the infrastructure (Figure 7). What is interesting, however, is a calculation of port dues that is based on these two models because—most of the time—the GT system measures a volume that is multiplied by the length of the call (in time). And depending on the type of vessel, there is a price factor. This means there is a price for the volume staying in the basin, which also include the length and duration of use of the quay line.

The metric system does not take this time into account (see Figure 8). There is a price at the entrance, and another at the exit. Pricing is a factor of the cubic meter volume and a ratio of tonnage over this volume. This latter ratio provides a reduction of the port dues if the vessel does not embark/disembark/tranship cargo. This means a vessel that is simply delivering cargo to the port will pay normal port dues at the entrance, and when it leaves empty the cost will be minimal. This is not a commercial system, it is a system based on the use of the infrastructure, particularly the draft. The heavier the vessel, the more it sinks, the more the channel needs to be dredged, the more the vessel pays to cover the cost. Promotion and rebate policies apply only with the frequency of calls, because dredging is worth the repetition of calls. If we consider that the main French ports, with the exception of Dunkirk and part of Marseille's modern facilities, are all located in estuaries, this system makes sense because what needs to be financed is not room in a basin but the dredging of the channel.

We have, therefore, a basin-based system with the use of space within the port during a certain time, and a channel system with the need for dredged capacity as illustrated by Figure 8. This is a key reason for using this metric system, and this answers the first part of our questioning.

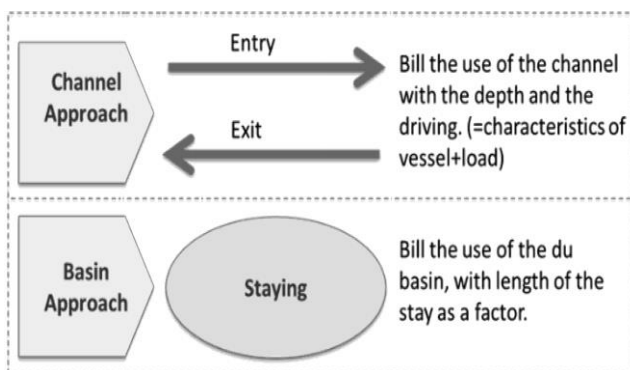


Fig. 8. Two main systems for calculating vessel dues

Source: Authors' drawing

GT and metric vessel dues are difficult to compare because each system is different in its application—with the exception of Spain where basis and prices are the same in each port. We could take a standard vessel with cargo to compare how much it will pay in each port for the same call, understanding that the length of the call may be different, and the type of vessel could be incentivized in one port and not another. We leave this type of comparison for further studies dedicated to this part of port dues.

For our purposes of comparison between GT system and metric system, we have taken the call of real vessels and calculated the amount of port dues it would have paid depending on the duration of the call in two comparable ports. In order to avoid bias, the real calls are calls in Moroccan ports since this country uses both systems. The two ports of comparison are Valencia and Marseille because they are both on the Mediterranean Sea, they clearly belong to one of the systems and they are economically comparable. Data from the calls come from the ALG (2012) study and extra vessels data come from Clarkson Database. The vessel calls are of different natures; that is, vessels are different (e.g., a refrigerated ship, a RoPax ship, a bulk ship, and a container ship) and call length is accordingly different (see Table3).

Table 3

Characteristics of calls used to compare between GT and metric port dues

Vessel Name	Beauty Star	Ouzoud	Ever Prosperity	Soraya
GT	4 192	17 879	35 392	24 836
Length (unit: meters)	114,56	148,9	224,5	217,11
Width (unit: meters)	16	23,98	32,2	26,66
Draft (unit: meters)	5	5,5	9,8	10
Original port of Call	Agadir	Nador	Casablanca	Casablanca
Original duration of call	38h30min	8h30	60h35min	15h52
Type of Cargo	Fruits & Veg	RoRo/Pax	Phosphates	
Cargo unloaded	1752 t	582 cars 6 trucks 2 173 Passengers		74 units (20') 44 units (35/40')
Cargo Loaded		2 310 cars 15 trucks 8 819 passengers	59 487 t	41 units (20') 17 units (35/40')

When applying the vessel port dues of both Le Havre and Valencia ports, to these four calls, and varying the duration of the call, it is possible to compare both systems (Figure 9). Port dues of the Valencia port are calculated as a Product of GT/100 minimum 100 GT), hours of stay, correcting coefficient (0.8 for Beauty Star and Ouzoud; 0.8 for Ever Prosperity and Soraya), applicable basic amount (1.5€) and Puertos del Estados coefficient (1.17). Marseille port dues are being determined by the geometric volume of the vessel, by applying the rates for entrance and exit in euros per cubic metre, then a factor of loading determined per type of vessel by the ratio of product loaded; additionally, volume of the vessel may be applicable.

Figure 9 shows that port dues in Valencia increase with duration of port call, while port dues in Marseille are stable with respect to time. The break-even point, where both lines cross, show the duration where port dues are the same for both ports. What we see from these four examples is that these break-even points are close to the real duration of the call. We conclude that both systems are calibrated for the same pricing, even if the calculation method is not the same.

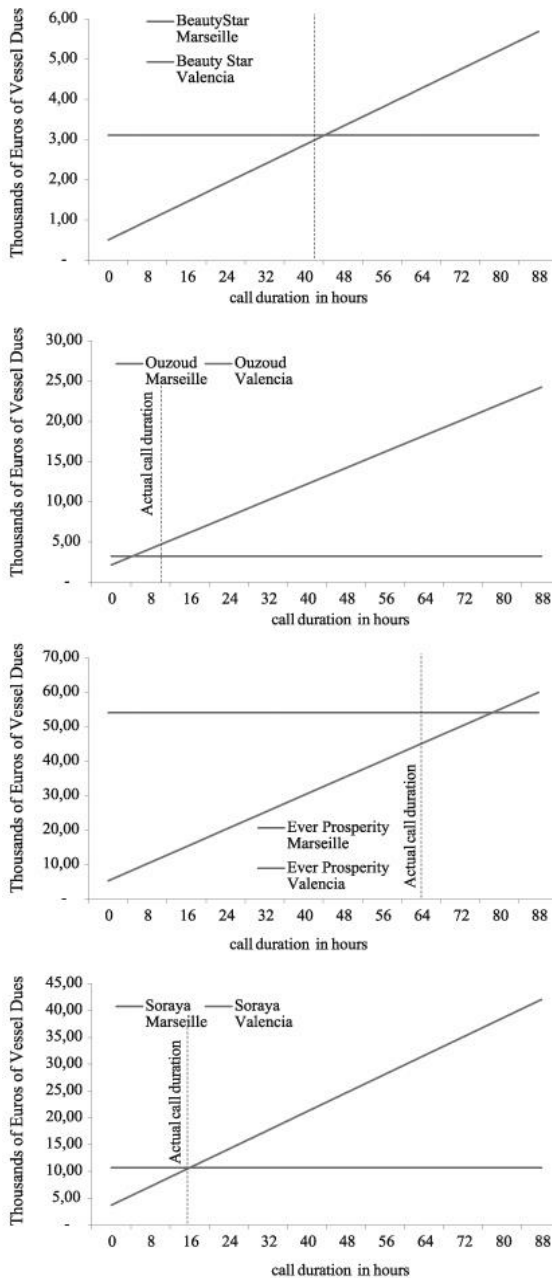


Fig. 9. Break-even point between metric and GT systems

Source: Authors' drawing

3.4. Two vessel dues systems with no consistent geographical application

What the studied comparison of GT and metric vessel dues systems shows is two different application for two different geographical realities and port infrastructure solutions: estuary and basin.

When looking at the ports studied, the geographical characteristics of the port infrastructure, and the system they are based on, we can however conclude there is no match (see Table 4). Ports in estuary follow both systems. Additionally, ports with gained basin on the ocean also follow both systems. In addition, one country, Morocco, follows both systems, and the chosen ports for one or the other of the systems is not dependant on geographical characteristics.

Table 4

Comparison between geographic situation and port dues systems

Port	Country	Geography	System	Match geo/system
Marseille	France	Basin	m3	no
Le Havre	France	Estuary	m3	yes
Rouen	France	Estuary	m3	yes
Bilbao	Spain	Estuary	GT	no
Barcelona	Spain	Basin	GT	yes
Valencia	Spain	Basin	GT	yes
Tunis	Tunisia	Estuary	m3	yes
Algier	Algeria	Basin	m3	no
TangierMed	Morocco	Basin	m3	no
Kenitra	Morocco	Estuary	GT	no
Mohammedia	Morocco	Basin	m3	no
Jorf Lasfar	Morocco	Basin	m3	no
Casablanca	Morocco	Basin	GT	yes
Safi	Morocco	Basin	GT	yes

Hence, history seems to offer an explanation. France follows the cubic meter system because of its numerous estuaries. Following France, its former colonies and protectorate use the same cubic meter system, while Morocco, which had more independence from France as well as more influence from Spain, follows both systems. In more detail, Morocco uses the GT system for most of its 34 ports. Only two of them—the most recent ones (except TangerMed that is not managed by ANP)—follow the cubic meter system. What is more, the application of this system is the only influencing part of the system because there is entrance and exit billing, but the volume embarked, transhipped, or disembarked is not taken into account. This means that there is a misuse of the system that leads us to conclude that imitation of certain countries, rather than the logical weighing of options, has influenced the decisions of certain ports. As demonstrated by Dowd and Fleming (1994), there are “*always cases of mismanagement and misguided policies*” in the port pricing process.

Structure of the port dues system should match the function of port dues that is related to the geography of the port, but historical factors have influenced policy decision making. This path dependency on the choice of the system of vessel dues is confirmed by a random look at the port systems in Western and Central Africa. French-speaking countries (e.g., Togo, Benin and Congo) use the cubic meter system, while English-speaking countries (e.g., Ghana and Nigeria) use the GT system. Moreover, it seems as though Africa, which has been strongly influenced by France, is the only place outside of France using the metric system. In the Caribbean, all the ports (to which we had access) use the port dues system employed the GT system. This includes Haiti, which has adapted to its competitive environment. The situation is comparable in Asia, where Vietnamese ports, like their neighbours, use a GT system. It seems there is room for improvement with respect to approaching real cost recovery beyond economic efficiency of the level of price, with fairness to systems where vessels pay for the infrastructure they use.

4. Conclusion

As highlighted in recent literature (Acciaro, 2013; Bandara et al., 2013), there is an abundance of literature on port pricing and port dues. However, there is still much to be investigated. Research has compelled us to look for a proper way to assess dredging cost recovery in ports, especially with

US Harbour Maintenance Tax (McIntosh and Skalberg, 2010). As a result of this research, we find that the metric system is not as similar, and thus replaceable, as the GT system. Instead, it answers in a topical manner the issue of maintenance and the dredging costs of channels. The same reason it has been forgotten in analysis is also the source of its flaws in terms of application (i.e., path dependency). The system was imitated from ports with different geographical characteristics. This constitutes a misuse. And this misuse has contributed to make the whole system appear obsolete and confined in some French speaking areas.

Such a system, as well as its application, would require further investigation, both in terms of quantitative and qualitative aspects. One of the major questions left to answer is whether such a system should be applied in estuary ports. And if answered in the affirmative, whether or not it should be combined with a GT system that measures space occupied in a basin, including quay length. The port of Le Havre, for instance, is an estuary port with a new deep-sea container terminal basin. What system would therefore fit?

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