

# Port Pricing. Considerations on Economic Principles and Marginal Costs

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*Pricing by ports and operators within ports is considered quite a complex and untransparent matter, and as such it is sometimes perceived as archaic. This often results in debates about subsidies, captive markets and the dredging and deepening of maritime access routes, raising questions concerning potential distortion of competition and/or abuse of monopolistic power. This paper starts from the most important scientific literature on port pricing (and port competition), and adds new empirical results while calculating the marginal cost of a port call. A distinction is made between four elements of marginal costs in port operations, being costs for provision of infrastructure, costs associated with the use of the transport mode, costs for supplying port services, and external costs. This material may constitute the basis for a meaningful debate on the implementation of a pricing approach that is grounded on the marginal cost principle.*

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"Existing pricing structures often suffer from trying to satisfy conflicting objectives - economists, port authorities, governments and port users will have different views on what constitutes an efficient port tariff" (Pettersen-Strandenes and Marlow, 2000).

## **1. Introduction**

We have witnessed many political initiatives lately in relation to ports, port authorities, funding of port infrastructure and pricing by ports and operators within ports. Typical examples at European level are the debate on Trans-European Networks (TENs), the Green Paper on Seaports and Maritime Infrastructure (European Commission, 1997) and the so-called Port Package (European Commission, 2001).

This political preoccupation seems quite logical at a time when discourse is dominated by an apparent interest in anything that may improve the market mechanism, result in greater competition, or induce deregulation or privatisation. It also ties in with the prevailing mental framework in which such buzzwords as 'globalisation' and 'contestability' are used all too frequently.

Pricing by ports and operators within ports is historically determined. It is often quite a complex and untransparent matter, and as such is sometimes perceived as archaic. Debates on overt or covert subsidies, captive markets and the need to constantly dredge and deepen maritime access routes undoubtedly raise questions concerning potential distortion of competition and/or abuse of monopolistic power.

This paper deals with the issue of pricing for port calls and port services. We shall deal consecutively with the questions of what a port is exactly and how port services and transshipment should be defined. After a brief survey of the most important scientific literature on port pricing, we shall dwell upon some empirical aspects. We shall consider prevailing pricing practice in various ports, econometric estimations of price elasticity, and the calculation/simulation of marginal port call costs and transshipment costs.

## **2. The 'port product', port management and port competition**

In what follows, we shall deal consecutively with the specification of the 'product' for which a port stands, with evolutions in terms of port management and with rapidly growing port competition.

### **2.1 The 'port product'**

What specifically is the 'product' that ports have to offer? In other words, what characterises the production and organisation of port services? Goss (1990, p. 208) defines a seaport as follows: "A seaport may generally be regarded as acting as a gateway through which goods and passengers are transferred between ships and the shore" (Goss, 1990, p. 208). As for the economic purpose of seaports, this is described as "to benefit those whose trade passes through them, i.e. through providing increments to consumers' and producers' surpluses" (Goss, 1990, p. 207).

Jansson and Shneerson (1982, p.9) go one step further, and propose a division into seven important sub-processes (approach and mooring, loading on quays, transit warehousing etc). In addition, they identify supplementary but not necessarily water-related functions (incl. customs, warehousing in the port area, cargo preparation, etc).

Therefore, the port product may be regarded as a chain of consecutive links, while the port as a whole may itself be seen as a link in a global logistics chain (Suykens and Van de Voorde, 1998, p. 252). Within ports, the relative importance of the separate links has clearly changed in the course of time, in part because of efficiency-enhancing technological developments (e.g. rising containerisation rate, larger vessels, speedier handling, etc). This has had (and indeed still has) consequences in terms of the cost structure. To what extent, for example, have economies of scale and costs been passed on to the various market parties?

Demand for port calls, port transshipment and supplementary services is derived from demand for the goods involved and is thus a function of economic growth, industrial production and international trade. In this context, pricing by and within ports is an important indicator, certainly with regard to the choice of port. Especially significant in this respect is the generalised cost that is associated with a port call. This generalised cost is defined as the sum of out-of-pocket costs (i.e. the price to be paid for the various services), time costs, and the risks of loss, damage and delay.

One should realise, though, that total port costs account for only a fraction of the total costs associated with the logistics chain. Consequently, overall demand for port services is inelastic, even though competition between goods handlers, port authorities and regions or countries is quite fierce. On the other hand, The possibilities of substituting one port for another are so great that demand elasticity for a specific port may be high after all (Suykens and Van de Voorde, 1998, p. 252).

The prototypical port does not exist. Indeed, no two ports are entirely similar. Ports inevitably have an heterogeneous quality, cf. the large number of possible market players involved (government, port management, shippers, forwarders, agents, shipping companies, trade unions, etc), each of which has specific objectives. A government and/or a port authority must be aware of the constant necessity to strike a compromise between the priorities of the various market players. As the relative strength of these market players may change in the course of time, so will, for example, the objectives of the port authority. This explains why we have witnessed an evolution from port authorities that used to be interested mainly in growth in throughput, employment, investment and value added to port authorities that are more concerned with finding ways of participating as (more) active market players. Typical examples of the latter are the participation of the port of Rotterdam in the container terminal operator ECT.

## **2.2 Evolutions in port management**

In recent decades, a number of obvious changes have occurred in the management of most European ports. This evolution was a consequence of technological change, but also of changes in terms of the socio-economic environment. The British port sector is a very good example in this respect: nationalised after the Second World War and grouped into the British Transport Docks Board; privatised as Associated British Ports in 1981; a government decision in 1991 that the main ports, too, may be privatised. While such sweeping change has not occurred in the case of continental ports, there has been an unmistakable trend towards

greater autonomy (cf. the autonomous status of the Port of Antwerp since 1997) and a more substantial private stake in goods handling.

Moreover, there is a continuing trend towards more automation and technological innovation, which has resulted in fewer dock workers, often combined with a reorganisation of the work itself. The capital-intensive nature of liner shipping, on the other hand, demands an optimal capacity utilisation with a view to realising an acceptable rate of return on investment. Port operators and port authorities are put under increasing pressure to continuously strive towards a further improvement in efficiency and labour productivity in particular. The port industry itself has, under this pressure, also become capital intensive, characterised as it is today by very substantial investments in both port infrastructure and cargo-handling equipment.

The playing field in which most port authorities can manoeuvre is described quite aptly by Saundry and Turnbull (1997): "It is no coincidence that the majority of the world's most successful ports conform to the landlord model, with public sector involvement in the administration of the port as both land owner and regulator. This allows the benefits of private sector management in the efficient handling of cargo to be combined with the public and (common) user interests of both customers and other important stakeholders. If port users are required to fund superstructure investment, in port or whole, this will place an immediate and effective restraint on potential over-capacity".

### **2.3 Growing port competition**

This brings us to the issue of growing port competition, which has in recent years assumed an entirely new dimension. It is, after all, no longer a matter of competition between individual ports, but between logistics chains (Meersman, Steenssens and Van de Voorde, 1997). A port either belongs to a successful logistics chain for a particular goods flow or it does not. In other words, ports clearly have an incentive to continuously improve their product. Or, as Goss puts it, "any improvement in the economic efficiency of a seaport will enhance economic welfare by increasing the producers' surplus for the originators of the goods being exported and consumers' surplus for the final consumers of the goods being imported" (Goss, 1990, p. 211).

Of course, this trend towards thinking in terms of logistics chains also implies that the success of a port no longer depends solely on its own performance, but on other variables too, including connections with the hinterland. This may provide an incentive for port management to cut port dues and to offer financial compensations for unfavourable hinterland connections in an effort to retain or increase market share. In this manner, port competition is threatening to get bogged down in a process of ever-increasing investments in additional capacity, coupled with serious underutilisation of that capacity.

In this context, De Monie (1996, p. 272) refers to container terminal operators who offer their main customers integrated package services: guaranteed high sustainable daily output rates (e.g. 1,500 moves per day per main-vessel line); an average of between 3 and 5 ship-to-shore gantry cranes simultaneously; flexible working of the vessels 24 hours a day, 7 days a week; limitation of waiting time for a container berth to the strict minimum (zero?); warrant ship entry and exit of the port without hindrance or delay. As De Monie argues, "such an extensive service package can be proposed only if political approval has been obtained and adequate funds are available for investment in over-dimensioned infrastructures, oversized superstructures and large numbers of equipment" (De Monie, 1996, p. 273).

Perhaps here lies the reason why the European Commission is showing greater interest in the port sector than before. This interest focuses particularly on four aspects, each of which has repercussions on pricing for port calls and transshipment services (Simons, 1997, p. 408). With regard to port access, there can be no abuse of a dominant position, e.g. through exclusion of third parties. Competition between ports may be restricted neither directly nor indirectly, e.g. through rail rates or shipping alliances that concentrate their activities on a limited number of ports. In respect of port services, one wants to avoid excessively high or discriminatory tariffs for handling, pilotage and towage. And with regard to government support, investments in infrastructure must be accessible to all users, without discrimination and/or preferential treatment.

In sum, ports are extremely heterogeneous environments, with many different market players, many of whom have conflicting interests. Consequently, the 'port product' is complex and untransparent to many. Furthermore, competition has increased strongly, not just between ports, but also between companies that may or may not be located in the same port. Mutual accusations of unfair competition are rife, often resulting in interventions on the part of the regulatory authorities. However, efficient intervention requires insight, particularly into the aspect of port pricing.

### **3. Port pricing: the literature**

Pricing by and within ports should be proportional to the costs generated by the ship in question. In the case of a port call, there are three cost items to take into account: cargo handling, the time in port, port dues and charges. The time spent in port is an opportunity cost that is a function of the time-related operational cost (wages, repairs, etc), plus a profit margin. Port dues are levied by the port authority in exchange for, among other things, use of a berth. The most substantial cost, however, is that of goods handling. It is usually many times higher than the port dues.

From a theoretical perspective, the pricing principle seems simple enough. All tariffs applied by and within the port should be based on the short-run marginal cost. This principle should be adhered to, even in situations where the authorities have made serious mistakes in their investment policy, or where the port is confronted with sudden and unexpected changes in demand. Bennathan and Walters (1979, p. 6) qualify this assertion to a certain extent: "strictly setting price equal to marginal cost is best only in a perfectly competitive free economy or in an efficient socialist economy. In practice, the port is confronted with organised and largely foreign-owned shipping cartels".

On the other hand, in more recent work by Haralambides et al. (2001, p. 939), it is asserted that "from a theoretical perspective, and assuming that a number of conditions are fulfilled, long-run marginal costs represent the most appropriate basis for efficient pricing". And the authors go on to say that "irrespective of the cost basis chosen, the principle that prices should accurately reflect (not to say recover) social opportunity costs is crucial" (Haralambides et al., 2001, p. 939; see also Haralambides and Veenstra, 2003).

Whether one should base the (port) pricing discussion on short run or long run marginal cost, is still under debate. Up to now at the conceptual level short run marginal cost proponents have the upper hand. The argument in favour of the short-term marginal cost is that the whole point of pricing is to confront the user with the additional cost that he causes. Only the short-

term marginal cost indicates precisely the difference in costs between acceptance and refusal of an additional user (Blauwens et al., 2002, p. 427).

However, for pragmatic reasons it may make sense also to charge for the long-term marginal cost. If one equates prices to short-term marginal cost, they will vary strongly over time, with different rates for peak and off-peak hours, different prices in the high and the low season etc. Such a strongly differentiated tariff, though desirable from the perspective of economic allocation, may meet with resistance for political or organisational reasons. It may therefore be deemed necessary to impose prices that remain constant. This price should then be a kind of average of the short-term marginal cost at different moments<sup>3</sup>. And this average can, under certain conditions, be approximated by the long-term marginal cost (Blauwens et al., 2002, pp. 427-428).

Clearly, then, there is a need for a detailed study of port pricing. As we have already mentioned, the best approach is to start from the heterogeneous nature of ports, taking into account the different market players, with different –possibly conflicting- interests. Table 1 provides an overview of potential objectives of the various players.

**Table 1. Port players and their possible objectives**

Port Player	Possible Objectives
Government	Efficient management of assets
Economists	Minimising the welfare losses
Port authorities	Maximising throughput Maximising value added Maximising employment
Users	Transparency of charges Prices should reflect the costs of the services

Based on Suykens and Van de Voorde, 1998 and Pettersen-Stranden and Marlow, 2000

Merely on the basis of the potential conflict situations that may arise from these different objectives, we may conclude that “there is no single solution to the problem which is port pricing” (Pettersen-Stranden and Marlow, 2000, p. 8).

The various possible objectives of the port players, including governments and port authorities, already indicate the large number of potential incentives to intervene through ports. Relevant consequences from a pricing point of view are market imperfections (asymmetry in information, asymmetry in contestability, scale effects in upstream port oriented industries, etc.), regional economic considerations, national economic efficiency (e.g. reducing oversupply of port facilities) and environmental issues (e.g. oil spills).

<sup>3</sup> The short-term marginal cost may either be lower or higher than the long-term marginal cost. At a time of surplus capacity, the short-term marginal cost is low. In such a case, it will certainly be smaller than the long-term marginal cost. At times of high capacity utilisation, however, the existing capital goods must be utilised in unfavourable circumstances, i.e. utilisation costs – including congestion costs – will be high. The short-term marginal cost may then be much higher than the long-term marginal cost (Blauwens et al., 2002, p. 427)

**Table 2. Pricing concepts and implementation**

Author(s)	Pricing concepts and implementation
Gardner (1977)	<ul style="list-style-type: none"> <li>• It is illogical to base pricing on the characteristics of a ship (e.g. length, draught, etc.)</li> <li>• Port prices, traditionally levied partly on ships and partly on cargo, should really only be based on the goods themselves</li> </ul>
Jansson and Rydén (1979)	<ul style="list-style-type: none"> <li>• A plea in favour of a two-part tariff structure</li> <li>• The tariff is divided into:               <ul style="list-style-type: none"> <li>○ a charge per tonne of cargo that would be differentiated with respect to the elasticity of demand</li> <li>○ a charge levied on the carrier to reflect the opportunity cost of using the facility</li> </ul> </li> </ul>
Button (1979)	<ul style="list-style-type: none"> <li>• The users of the port should be charged the full marginal social opportunity cost of the resources that they use</li> <li>• Some elements to be investigated: decreasing cost industry? What about financial deficits? How to recuperate capital expenditures (e.g. by two part tariffs)?</li> </ul>
Bennathan and Walters (1979) Vanags (1977)	<ul style="list-style-type: none"> <li>• A plea in favour of congestion pricing (note: intended mainly for ports in developing countries)</li> </ul>
Arnold (1985)	<ul style="list-style-type: none"> <li>• Port tariffs are based on a mix of pricing strategies designed to reflect the demand for port services, the competition between ports, and the cost of providing the services.</li> </ul>
Meyrick (1989) Talley (1994)	<ul style="list-style-type: none"> <li>• A plea in favour of a cost-axiomatic approach, defined as "a pricing mechanism which determines the prices of the outputs of multi-product firms by allocating the full cost of production to all the outputs</li> <li>• Further, it assumes that the demand for port services is relatively inelastic with respect to port prices</li> </ul>
Unctad (1995)	<ul style="list-style-type: none"> <li>• Considers port pricing to be a strategic issue</li> <li>• Two basic approaches may be taken to pricing policy: one economic, the other financial. The former is grounded on marginal cost pricing, while the latter bases prices on accounting costs</li> <li>• The 'cost, performance, value' (or CPV) approach allows port managers through tariffs to accomplish different sets of objectives.               <ul style="list-style-type: none"> <li>○ cost-based tariffs can maximise the use of port services;</li> <li>○ performance-based tariffs can maximise throughput and reduce congestion</li> <li>○ value-based tariffs generate sufficient revenue to cover the port's cost</li> </ul> </li> <li>• CPV indicates both the threshold and the ceiling of prices: the port must not charge less than the incremental cost of serving the user; it cannot charge more than the value received by the user.</li> </ul>
Pettersen-Strandenes and Marlow (2000)	<ul style="list-style-type: none"> <li>• Suggest a port pricing policy where price differentiation is not based on the value of the cargo</li> <li>• Port prices should be differentiated on the basis of the quality of port services provided; relevant quality factors are the time in port, and the punctuality of handling the vessel and its cargo.</li> </ul>

Source: miscellaneous authors and Pettersen-Strandenes and Marlow, 2000

What does the literature on port economics tell us about port pricing? The ATENCO project, which was carried out at the request of the European Commission, addresses precisely this question. We quote (Haralambides et al., 2001, p 939): “the main conclusion of a comprehensive academic literature review on port pricing (undertaken in the context of the ATENCO project) was that pricing in ports can and should be based on costs. The determination of which costs should be reflected in prices largely depends on the type of port organisation. Prices in service or comprehensive ports reflect a multitude of different costs - many of them joint costs, difficult to allocate in a way that is not largely arbitrary - compared to prices in landlord ports where more clear lines of responsibility and accountability exist”.

More recent research by Petteren-Strandenes and Marlow (2000, p. 4) divides the pricing principles applied in the port literature into five categories: (1) cost-based pricing; (2) methods for cost recovery; (3) congestion pricing; (4) strategic port pricing; (5) and commercial port pricing, which is applied in privatised ports.

In this context, it is quite fascinating to analyse which proposals are formulated in the rather limited literature for implementing these theoretical pricing concepts. In Table 2, we attempt to summarise the most important elements put forward in a number of important studies.

Even after a detailed analysis of Table 2, certain questions remain. How important is port pricing in relation to the total cost? Authors such as Thomas (1978) claim that it accounts for a significant proportion of the total cost, while Dowd and Fleming (1994) maintain that the costs of port transshipment comprise “a rather small fraction of total voyage costs for most long-distance inter-modal movements”.

Furthermore, a number of the pricing proposals presented in Table 2 are, first and foremost, intended for developing countries, e.g. Bennathan and Walters (1979) and UNCTAD (1995). Indeed, developing countries may potentially face a congestion problem, whereas most European ports are confronted with significant overcapacity.

In addition, insight is urgently required into the real cost structure of a port call and transshipment. Is there indeed evidence of economies of scale? And if there is, does it apply to both port infrastructure and cargo handling equipment? If it does, then marginal cost pricing will inevitably lead to port subsidising. There is an urgent need for empirical cost analysis that goes beyond the assertion that “the fixed element of port costs represents a substantial share of total costs. For container operations as much as 80 per cent of the costs are independent of the number of vessels or volume of cargo handled. For break bulk operations the fixed element typically is smaller, but still 60 per cent of the costs are independent of the volume, see Bennathan and Walters (1979). Rudolf (1995) estimates the capital costs for container cranes at 70 per cent of total costs” (Petterson-Strandenes and Marlow, 2000, p. 7).

#### **4. Port pricing in practice**

As we have previously mentioned, relatively little empirical research has been conducted on actual pricing strategies by and within ports. One of the few recent exceptions is the ATENCO project that was carried out at the request of the European Commission. The main findings of this project were presented in Haralambides et al. (2001). The study certainly indicates that there are substantial differences between the respective funding and pricing practices applied in ports across Europe. This diversity is deeply rooted in different legal and



cultural traditions. It is also a consequence of differences in terms of port management style and the related issues of competencies and degree of autonomy.

A first set of results was obtained on the basis of an analysis of survey questionnaires aimed at gathering “information on both present pricing principles and strategies, and the likely impact of introducing new pricing systems”. In this kind of research, there is always a considerable danger that the parties involved may benefit from providing biased information. Furthermore, not all ports can be analysed in the same way, as the diversity in structure, scope and type of operations is simply too great. Still, it is worthwhile considering some of the conclusions reached (Haralambides et al., 2001, p. 946 ff.):

- All port authorities supported the adoption of overall full cost recovery within the port sector. The majority of the ports supported the adoption of “user pays” principles in ports. Surprisingly, most port authorities expected that the adoption of full cost recovery pricing would have little impact on pricing levels.
- The port authorities did not consider the markets for liquid and dry bulk cargoes to be influenced by public support schemes<sup>4</sup>. However, they did for the markets for general cargo, containerised and Ro-Ro cargo. A number of ports were in favour of the adoption of general pricing principles to the extent however that adherence to these principles would still allow flexibility and that hinterland transport pricing should be subject to similar principles.
- The port users were generally aware of some impact or distortion caused by public support schemes in European ports. The users considered the impact to be of limited relevance in relation to the prices charged by the port operators to the users and of some importance in relation to the overall port user costs.

These conclusions are interesting as such, but some circumspection is nevertheless called for, if only because of the non-committal nature of this type of survey. Perhaps this is why the survey was supplemented with quantitative simulations. The purpose was to arrive at an analysis of the effect of different pricing schemes on traffic volumes in individual ports. The application concerned container traffic through the ports of the North Range. Table 3 provides an overview of the estimated elasticities.

**Table 3. Price elasticities for selected North Range container ports (10% price increase, simulation results)**

Port	Elasticity
Hamburg	3,1
Bremen Ports	4,4
Rotterdam	1,5
Antwerp	4,1
Le Havre	1,1

Source: Haralambides et al., 2001, p. 948

<sup>4</sup> Liquid bulk is often closely related to refinery and bulk chemicals for which in the past (indirect) location policies often existed. Furthermore these industries have had a strong agglomeration effect.

The findings presented in Table 3 are questionable. Irrespective of the methodology applied in estimating the elasticities, it seems very hard to interpret these figures meaningfully<sup>5</sup>. The findings reported concern container throughput. It is widely accepted that container throughput responds much more sensitively to flows that are related to transshipment via the hinterland. This greater sensitivity is due to the fact that shipping companies can switch from one transshipment port to another fairly quickly, cf. the cases of Maersk Sealand and Evergreen, who recently substituted the Malaysian port of Tanjung Pelepas for the port of Singapore. However, the proportion of transshipment in a port such as Rotterdam is much higher than in Antwerp or Hamburg. Nevertheless, the reported elasticities for the latter two ports are many times greater than that for Rotterdam, which is quite remarkable. Moreover, it would be interesting to explore in detail whether Rotterdam's declining market share in 2001 was perhaps mainly due to a loss of market power in the transshipment business relative to such Mediterranean ports as Gioia Tauro and Taranto (e.g. due to pricing and differences in generalised cost).

Despite the above reservations with regard to the estimations of the elasticities, it is interesting to see how the authors themselves interpret their findings (Haralambides, 2001, p.948):

- They observe a very substantial divergence of the elasticities among the various ports. This implies that, if the elasticities are correct, a change in price occasioned by alternative pricing schemes would, in the case of container transshipment, have fundamentally different consequences for the ports considered;
- The price elasticities appear to diverge strongly across the different goods categories, i.e. much lower elasticities for liquid and dry bulk than for containers, general cargo and Ro-Ro;
- The introduction of new pricing schemes based on the principle of overall full cost recovery per individual port may result in cross-subsidising. Ports whose income is generated for a large part by bulk transport and land letting to industrial concerns can, after all, compensate for price increases in general cargo, containers and Ro-Ro.

In the ATENCO project, two additional sets of case studies are conducted with regard to the impact of port funding and pricing on the introduction of the cost recovery approach. A first set analysed two British and one Irish port. The general conclusion speaks volumes (Haralambides et al., 2001, p. 950): "The case studies of ports practising full cost recovery demonstrates the presence of a wide variety of pricing principles used in practice. The pricing strategies of these ports exhibit substantial managerial discretion that cannot be captured fully by textbook definitions of pricing. A best practice formula for pricing in the real world clearly does not exist, not even in ports pursuing full cost recovery as a primary objective".

Equally important, however, is the conclusion that "in contrast to the widely held belief that UK and Irish ports engage in conventional full cost recovery, the study found that users in fact do not pay for past capital investments in terms of their replacement value" (Haralambides e.a., 2001, p. 949).

Formulating a conclusion in relation to the practice of pricing can only increase the confusion that presently exists. Moreover, it is clearly difficult to outline a typology into which all ports

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<sup>5</sup> We agree that port market delimitations always remain very unclear, so that each elasticity comparison should be interpreted very carefully.

will fit. It appears that the ports that ‘preach’ full cost recovery do not pass on historical costs, which may be considered as a form of covert subsidising. Thus, research on port pricing behaviour is by no means methodologically sound. Empirical research has, so far, been rather limited and there are doubts as to the accuracy of the model-based findings.

## **5. Calculating the marginal cost of a port call**

Infrastructure pricing remains a complex matter, certainly in the case of ports. It is often argued in this respect that port accounting systems provide no foundation for any other pricing method than one based on average costs. Haralambides et al. (2001, p. 939) assert that “in practice, and in the absence of ‘measurable’ marginal costs, approaches based on average costs also appear to perform reasonably well in approximating marginal costs”.

However, this assertion no longer holds. A study commissioned by the European Union (TRL Ltd et al., 2001) attempts to concretise the concept of marginal costs. After all, marginal cost pricing is only possible if the marginal costs are known and thus measurable. One of the two case studies that were carried out concerns the calculation of the marginal costs of a port call, more specifically at the port of Antwerp. By way of illustration, we shall briefly discuss a number of empirical findings.

In the view of many people, port pricing is traditionally limited to the due that is paid to the port authority or port management for the use of its services. This, however, covers only part of the port picture. Marginal costs encompass a lot more than the costs incurred by the port authority. Moreover, ports dues levied by the authority often do not reflect underlying costs, but constitute some arbitrary approximation based on comparison with other ports or experience from the past. The fact that they are often not split up according to the services actually used seems to confirm this argument.

On the one hand, and in short-term perspective, port prices are an important element in inter-port competition. As a port authority will inevitably be concerned with improving its competitiveness, it had better work on reducing the costs underlying dues charged, not only for its own services, but, if applicable, also for services provided by private companies in the port area. This will usually result in the same price-reducing effect as with a blind reduction in prices, but – importantly in the context of sustainability – in a manner that conforms to normal market operations. On the other hand, prices charged constitute the financial means that should allow the port authority to maintain quality of service through investments (in maintenance and further development)<sup>6</sup>.

Both for the short term and the long term, an understanding of marginal cost components is required. As in other transport modes, one can distinguish between four elements of marginal costs in port operations conceived as a part of the maritime mode. Leaving aside for the time being the issue of who incurs these costs, the four elements are (i) costs for provision of infrastructure, (ii) costs associated with use of the transport mode, (iii) costs for supplying port services, and (iv) external costs.

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<sup>6</sup> We have to realise that other elements could influence the port pricing discussion. If the jurisdiction of port authorities varies a lot across different ports and countries, how then would a sensible harmonisation of pricing principles be possible?

In what follows, the composition of the previous cost elements is illustrated using data for the port of Antwerp. The figures are the most recent available, with source years ranging from 1999 to 2001. All figures are expressed in terms of a base year (1988), using a factor that takes into account depreciation. Furthermore, all figures refer to an entire shipload<sup>7</sup>. Alternatively, one could calculate figures per unit of load (TEU or dwt), but some of the figures obtained would then be too small to allow comparison.

**Table 4. Overview of Cost Element Subdivision**

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Infrastructure:
<ul style="list-style-type: none"> <li>• Capital</li> <li>• Running</li> </ul>

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Transport User:
<ul style="list-style-type: none"> <li>• Time</li> <li>• Reliability</li> </ul>

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Supplier / Operator:
<ul style="list-style-type: none"> <li>• Vessel: <ul style="list-style-type: none"> <li>○ Running</li> <li>○ Time</li> <li>○ Reliability</li> </ul> </li> <li>• Service: <ul style="list-style-type: none"> <li>○ Running</li> <li>○ Reliability</li> </ul> </li> <li>• Superstructure: <ul style="list-style-type: none"> <li>○ Running</li> <li>○ Time</li> <li>○ Reliability</li> </ul> </li> </ul>

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External:
<ul style="list-style-type: none"> <li>• Accident: <ul style="list-style-type: none"> <li>○ Material</li> <li>○ Human</li> </ul> </li> <li>• Noise: <ul style="list-style-type: none"> <li>○ Amenity</li> <li>○ Human</li> </ul> </li> <li>• Air Pollution: <ul style="list-style-type: none"> <li>○ Natural Environment</li> <li>○ Human</li> </ul> </li> </ul>

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Source: TRL Ltd et al., 2001, p. 17-26

Marginal infrastructure costs mainly comprise costs of replacement and maintenance of locks<sup>8</sup>. On average, one supplementary vessel calling at the port accounts for 242 EURO in costs, irrespective of the cargo. This cost is incurred by the provider of infrastructure, in most cases the port authority or the public government, depending on the organisational structure

<sup>7</sup> We calculate costs anyhow carried by the shipper and/or the ship operator and costs that are really related to the use of the port infrastructure, which is what marginal cost pricing in ports is about.

<sup>8</sup> Theoretically other infrastructure costs such as quay walls ought to be recovered both through port dues as well as terminal handling charges (cf. the lease contracts the operators have with port authorities). We did not incorporate these costs in our marginal cost calculation, due to the fact that a quay wall lasts for the whole lifecycle of a terminal, with no or very low maintenance costs. However, it should be clear that in the long run these costs have to be recovered too.

of the port. At present, it is often the case that only part of this cost is passed on to the infrastructure users, often through the setting of arbitrary prices. It is apparent from the literature and from correspondence with port industry representatives that elements such as breakwaters, navigation lights, buoys and radar systems have no marginal cost components; nor, for that matter, do dredging and ice-breaking<sup>9</sup>.

As far as the use of the maritime transport mode is concerned, marginal costs centre on time used and reliability of service (in terms of overtime and loss of customers). This cost is incurred by the transport user calling at a port in order to convey the goods to or from his customer. As the value of the commodity in process is the main determinant of this cost category, the amount involved is largely dependent on the type of commodity transported and the volume handled. Figures for Antwerp range from 2,769 EURO per tanker (carrying 9,363 dwt) to 951,791 EURO per dry bulk vessel (carrying 28,533 dwt). For dry bulk, cost figures vary from 44,289 EURO for a 8,000 dwt-vessel to 1,367,330 EURO for a 45,000 dwt-vessel. Time costs are usually only passed on to shipowners, as they concern overtime or unreliability of service. Normal time costs (capital imbedded in the goods) are entirely for the account of the owner of the goods.

Costs for supply and operation of handling services can be subdivided into costs related to vessels, the superstructure and the actual service. The term 'vessel' is understood to include commercial vessels transporting the goods as well as pilotage and towage vessels. Spare parts and oil for maintenance and fuel for operation are the main cost components. The above items amount to a cost of 2,489 EURO per tanker (carrying 14,760 dwt) and to 9,377 EURO per container vessel (carrying 31,372 dwt), again allowing for variations in ship size. These costs are incurred by or passed on to shipowners, who in turn usually pass them on to the owners of the goods. An important element that is not included and thus not charged for is the opportunity cost of the vessel capital: while this cost is by no means negligible, it is hard to assess what would be the best alternative use of capital, as the relevant data is presently not available.

Service costs include wages for crew, handling personnel, storage personnel, shipping agency, ship repair and bunkering, both in normal circumstances and in overtime situations (due to unreliability of service). On average, they make up a cost ranging from 1,056 EURO per container vessel (unloading and loading of 29,812 dwt) to over three times this amount for dry bulk vessels (unloading and loading of 53,453 dwt). Again, figures are heavily dependent on the volume of cargo to be loaded or unloaded. Wages are usually passed on directly to the shipowners and transferred to transport users.

Superstructure costs are comparable to vessel costs, but the former concern operations on land. Note that they are non-existent for tankers (since direct supply to the refinery or a derived company applies), while they amount to about 2,199 EURO for a container vessel (unloading and loading of 29,812 dwt), and 1.5 times as much for dry bulk vessels (unloading and loading of 53,453 dwt). Again, opportunity cost of capital is not taken into account.

The external cost category, too, can be further subdivided: we may distinguish between accident costs, noise costs, and air pollution costs. Accidents cause damage to material as well as to people. Own and third party vessels and the goods transported are the most important material categories affected. Injuries to crew and workers constitute the human

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<sup>9</sup> We agree that ice-breaking could partly be an incremental activity (depending on the number of ships leaving and/or arriving in a time window) and consequently should be subject to marginal cost pricing.

cost. Overall accident costs are highest for container vessels (32,778 EURO per vessel, assuming that 747 TEU is unloaded or loaded), whereas they are non-existent for tankers. Figures vary according to cargo volume. These costs are, in principle, borne by the originator, but they are typically subject to insurance, whereby forfaitary amounts are reimbursed.

Noise costs are hard to estimate, but all studies available indicate that noise effects of port activities are very limited, so we can safely disregard their marginal cost effect. Air pollution costs are quite a different matter, though, as pollution levels are typically higher in ports than in surrounding areas. It is often emphasized that ships contribute to a very significant extent to SO<sub>2</sub> emissions in large parts of EU member states' coastal areas (European Commission, 2002). The NO<sub>x</sub> emissions of ships are significant as well. Additional research is required to clarify this matter. Monetary quantification of air pollution effects is even more complex, as further research is needed to complete the marginal cost picture. These marginal cost elements have until now hardly been passed on to the originators.

## 6. Conclusion

As we explained in the introduction, pricing by ports and operators within ports has developed historically. As such, it is often rather complex, untransparent and archaic. This has occasioned many debates on allegedly covert subsidising, captive markets, the necessity of dredging and deepening maritime access routes, and possible distortion of competition.

This contribution, which includes a brief overview of the most important scientific literature on port pricing and available empirical data, provides further confirmation that the picture is quite confusing. Ports, i.e. port authorities and port-based concerns (goods handlers, agents, etc), often go it alone when it comes to pricing. Outlining a typology of port pricing schemes is therefore more or less impossible. Even ports that preach the full cost recovery approach appear to engage in subsidising, if only by their failure to pass on historical costs.

Methodologically, research into pricing behaviour within ports certainly has some way to go. An acceptable methodological framework is absolutely indispensable for meaningful empirical research. We are, therefore, still quite far removed from the objective of developing recommendations for implementing port pricing reform based on the principle of marginal cost pricing. Nevertheless, at the request of the European Union, during recent years some steps have been made in the calculation of the marginal cost of an average port call. This material may constitute the basis for a meaningful debate on the implementation of a pricing approach that is grounded on the marginal cost principle.

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