



STUDIECENTRUM VOOR ECONOMISCH EN SOCIAAL ONDERZOEK

VAKGROEP TRANSPORT EN RUIMTE

**Container Throughput, Port Capacity
and Investment**

H. Meersman

C. Steenssens

E. Van de Voorde

report 97/353

November 1997

Universitaire Faculteiten St.-Ignatius
Prinsstraat 13 - B 2000 Antwerpen

D/1997/1169/020

Abstract

In this paper we claim the need for accurate forecasting methods as to future demand for (container) traffic in ports to determine the feasibility of investments. In order to develop a methodology of forecasting container throughput, we analysed a set of variables relevant to the struggle for market share between the container ports of the Hamburg-Le Havre range. We dealt in dept with a number of partial indicators of growth potential in container traffic such as capacity and capacity utilisation and the degree of containerisation. We revised the existing research material on forecasting port traffic flows. Finally we present a methodology for container throughput demand forecast.

CONTAINER THROUGHPUT, PORT CAPACITY AND INVESTMENT

Meersman, H., Steenssens, C. and E. Van de Voorde

1. INTRODUCTION

The continuing increase in container transport, and throughput activity associated with it, offers new or additional growth perspectives for ports. Within their particular range, ports are often keen to rake in as large as possible a share of traffic. This has, among other things, led to a fierce competitive struggle between ports in the Hamburg-Le Havre range to attract goods flows, shipping lines, and investment in infrastructure and industry.

Two elements are very noticeable in this respect. On the one hand, port competition is fierce, and growth figures for container throughput vary greatly from port to port. On the other, most ports seem eager to build additional container terminals and provide greater throughput capacity. The fierce struggle for investment and subsidies often seems to unfold regardless of the capacity usage ratio and existing terminal infrastructure.

But public funds are becoming ever more scarce, while there is also growing awareness that the European Commission is intent on establishing some degree of control on (acceptable or unacceptable) subsidising of ports. This partly explains why national authorities are increasingly inclined to make use of research instruments (e.g. cost-benefit analyses) in determining port policy and strategy. However, this approach will not resolve all problems, as it is, for instance, not easy to obtain accurate forecasts of demand for container traffic. Such forecasts are clearly necessary, as any analysis of an investment project must be based upon projections of activity in and around the port.

It is in the interest of any (local) port authority wishing to obtain public funds for an investment project to present as favourable as possible a demand trend. Usually, the (subsidising) body lacks scientific instruments to check the reliability of demand prognoses and prospective yields of the project as presented by the port. In addition, it is often the case that different ports within the same range are competing for the same goods flows and therefore have similar investment plans. Such situations often lead to a significant degree of excess capacity.

The purpose of this paper is to gain insight into a number of key-variables relevant to the debate on port competition. After an analysis of the growth and trends in market shares in the Hamburg-Le Havre range, we shall deal in more depth with a number of partial indicators of growth potential (e.g. capacity and capacity utilisation, degree of containerisation,...). Subsequently, we shall deal with port competition, or, in the case of container traffic, the struggle for market share. Finally, we shall give an overview of existing research and present a method of forecasting container throughput.

2. MARKET SHARE ANALYSIS : COMPETING FOR GROWTH

The internationalisation of the economy, continuing economic growth and the increase in world trade are resulting in greater demand for transport in general and container transport in particular.

Table 1 gives an overview of the average annual growth rates in container throughput per 5-year period. It appears from the table that the average annual growth rate for Europe is somewhere in between the explosive growth seen in Asia and the rather moderate growth rate in America.

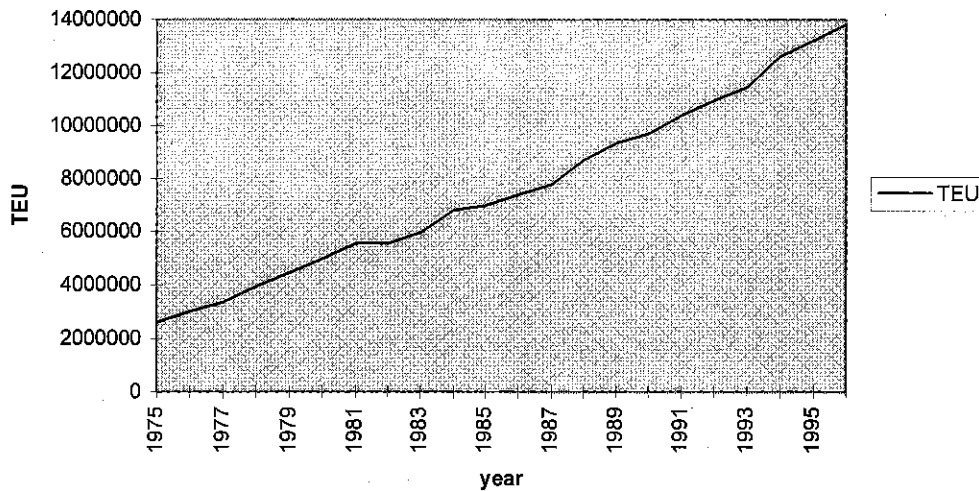
Table 1: Average annual growth in container throughput

	1975-1980	1980-1985	1985-1990	1990-1995
World	15.1	8.6	8.9	9.6
Asia	15.6	11.9	16.6	13.5
America	8.3	6.4	5.1	5.1
Europe	12.3	7.5	7.4	7.8
Hamburg- Le Havre range	14.0	7.0	6.9	6.1
Antwerp	14.4	10.7	6.1	9.5
Zeebruges	4.0	3.6	6.3	12.1
Le Havre	12.0	3.4	0.9	-0.7
Dunkirk	18.0	3.6	8.6	3.7
Hamburg	12.0	6.3	4.5	4.9
Bremen	20.0	8.2	11.2	7.6
Amsterdam	n.a.	-5.1	-3.7	13.6
Rotterdam	11.0	7.1	6.3	4.6

Source : Containerisation International (1975-1997)

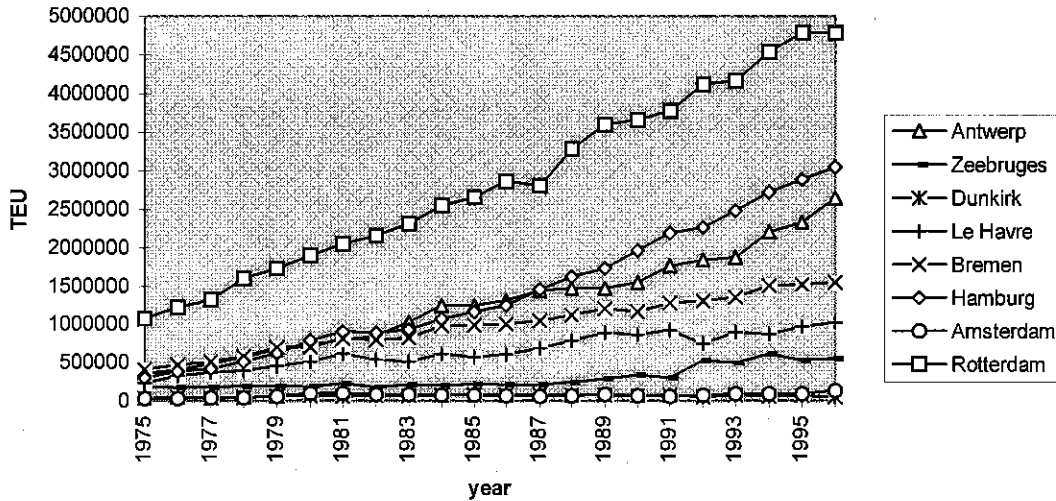
Within the Hamburg-Le Havre range, container throughput has increased fivefold between 1975 and 1996 (figure 1). Clearly, container transport is a growth market. There are eight ports that are more or less competitors in this particular range: Rotterdam, Amsterdam, Antwerp, Zeebruges, Hamburg, Bremen, Dunkirk and Le Havre. In 1996, 87.2% of the container throughput market in the range was controlled by four ports, i.e. Rotterdam (4.78 mio TEU), Hamburg (3.04 mio TEU), Antwerp (2.64 mio TEU) and Bremen (1.54 mio TEU) (Figure 2). The other ports are smaller players in the competitive struggle (Table 2).

Figure 1 : TEU- throughput in the Hamburg-Le Havre range (1975-1996)



Source: Calculations based on statistics from the Antwerp Port Authority

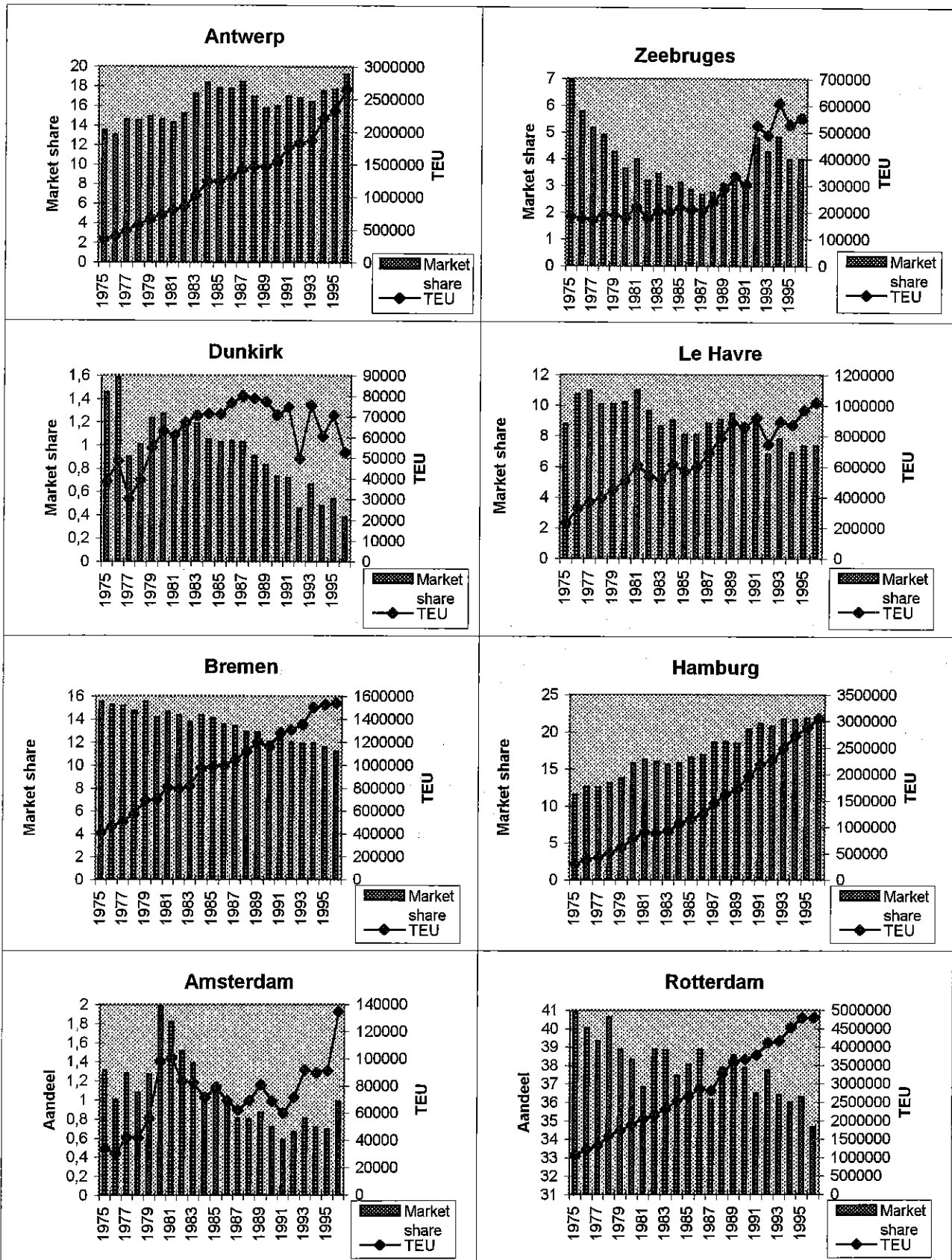
Figure 2 : TEU-throughput in different ports of the Hamburg-Le Havre range (1975-1996)



Source : Calculations based on statistics from the Antwerp Port Authority

Most ports in the range saw throughput increase in absolute terms in the period 1975-1996, though trends did not always run parallel (cf. table 1). Figure 3 combines throughput in TEU and market share for the respective ports in the period concerned. It is striking how the general upward trend in throughput in absolute terms in Rotterdam and Bremen coincides with a drop in their market share. Antwerp and Hamburg, on the other hand, increased their share within the range.

Figure 3: Throughput in TEU and market shares of the ports in the Hamburg-Le Havre range (1975-1996)



Source : "Antwerp Port Authority"

The fact that throughput trends in absolute terms as well as market share trends for the four smaller ports are much more erratic is largely due to their being much more sensitive to minor influences (e.g. industrial dispute at Le Havre-Dunkirk) and to changes in company policy by a single important shipping company (e.g. CAST swapped Antwerp for Zeebruges as its main port for its North Atlantic services).

Table 2: Market shares of container ports in the Hamburg-Le Havre range and absolute figures for the range.

	1975	1980	1985	1990	1996
Antwerp	13.5	14.6	17.8	16.0	19.2
Zeebruges	7.0	3.6	3.1	3.5	4.0
Dunkirk	1.5	1.3	1.0	0.7	0.4
Le Havre	8.8	10.2	8.1	8.9	7.4
Bremen	15.5	14.2	14.1	12.0	11.2
Hamburg	11.5	15.8	16.6	20.3	22.1
Amsterdam	1.3	2.0	1.1	0.7	1.0
Rotterdam	40.9	38.3	38	37.9	34.7
Total	100	100	100	100	100
Range (TEU)	2603021	4960637	6977719	9679628	13799155

Source: Calculations based on statistics from the Antwerp Port Authority

It is clear from the divergent trends in market share that the ports in the Hamburg-Le Havre range have so far responded differently to the continuing growth in container transport. Gaining an insight into future container throughput activity per port therefore requires a thorough, individual analysis. It is important to know whether there is room to deal with short-term growth and expand the port's market share. This can be determined by means of a number of indicators such as capacity usage and degree of containerisation.

3. PARTIAL INDICATORS OF THE GROWTH POTENTIAL

The growth of container throughput in a port is usually the result of three distinct types of growth. Firstly, there is autonomous growth of container traffic, which is similar to growth in other types of transport and is closely linked to an increase in economic activity. Secondly, there is the phenomenon of containerisation in the general cargo market, a kind of substitution effect, which has been increasingly prevalent in recent times. And thirdly, there is growth due to increased port competition. The latter concerns throughput activity which has been pinched from competing ports.

The upper limit of short-term growth in throughput that a port can realise is determined by the available capacity and the capacity usage ratio. The available capacity for container throughput partly determines the containerisation level. It represents the supply side, which will be confronted with demand. The degree of containerisation of a port provides an indication of the importance of container throughput to overall traffic and of the port's priorities.

In the following section, we shall elaborate on two aspects. Firstly, we shall deal with the concepts of capacity and capacity usage. These indicate what is possible, where there is room for short-term growth, and where ill-considered investments may have been made in the past. Subsequently, we shall go into the concept of containerisation and study it empirically.

3.1 Capacity and capacity usage

In the short term, the available capacity undeniably represents the upper limit of throughput that can be realised at a port. In the long term, it represents the most significant variable for a port. Attaining the right capacity is of crucial importance to any company in terms of the generation of profit and overall survival, and so too to a port. Only if sufficient capacity is available is it possible to benefit from growth in the container transport market. However, the notion of 'capacity' is not always interpreted in the same way.

But whatever definition is used in the literature on this subject, two elements always seem to be present. Firstly, it is pointed out that a distinction must be made between the overall capacity of the port and the capacity of its constituting parts. In addition, emphasis is put on the variable nature of port capacity.

Often, a distinction is made between physical capacity, effective capacity and economic capacity (Vlaamse Havencommissie, 1992, p. 94). The physical capacity refers to the maximum capacity at which the port infrastructure could be used on a permanent basis if no external limitations were imposed. This capacity is, in other words, fixed; it is intrinsic and determined solely by the size and other physical characteristics of the port. The effective capacity may be described as the greatest possible capacity at which the port can operate in the real world; in other words, it takes into account external limitations on the physical capacity (working hours, maintenance, repairs, legal constraints,...). The economic capacity, finally, represents that part of the effective capacity which can be utilised with maximum economic and commercial return.

A port consists in a number of interlinked elements: maritime accessibility, locks, docks, services supplied, terminals, hinterland connections. The capacity of the port will, therefore, depend on all of these elements put together. The weakest link in the chain ultimately determines the capacity of the port or the terminal.

Determining the capacity of a port and/or terminal is, in other words, a complex matter. There are a number of factors that interfere with any objective comparison (Vlaamse Havencommissie, 1992, p. 100 ff.): the limited possibilities for substitution between capacity;

the multi-dimensionality of port capacity; the fact that detailed data on capacity is often lacking. It has quite rightly been pointed out that a study of capacity is preferably carried out within the framework of a concrete investment project. By making use of various methods, or perhaps a combination of methods, one should be able to discover imbalances between the different elements that determine the capacity of a terminal (capacity of cranes, terrain, quays).

On the one hand, the rapid growth in the container transport market is creating a strong demand for additional capacity and investment credit and/or subsidies. On the other hand, the scarcity of budgetary means is resulting in pressure on factors such as the usage of existing capacity and, as such, it is affecting terminal productivity. Any expansion of terminal facilities is directly linked to the problem of capacity usage. In the first instance, one needs to examine whether the need for additional capacity cannot be met by an increase of productivity (cf. a number of indicators such as TEUs handled per running metre of quay and/or per square measure unit, the vessel-shift per berth, the moves per crane, the moves per crane-hour).

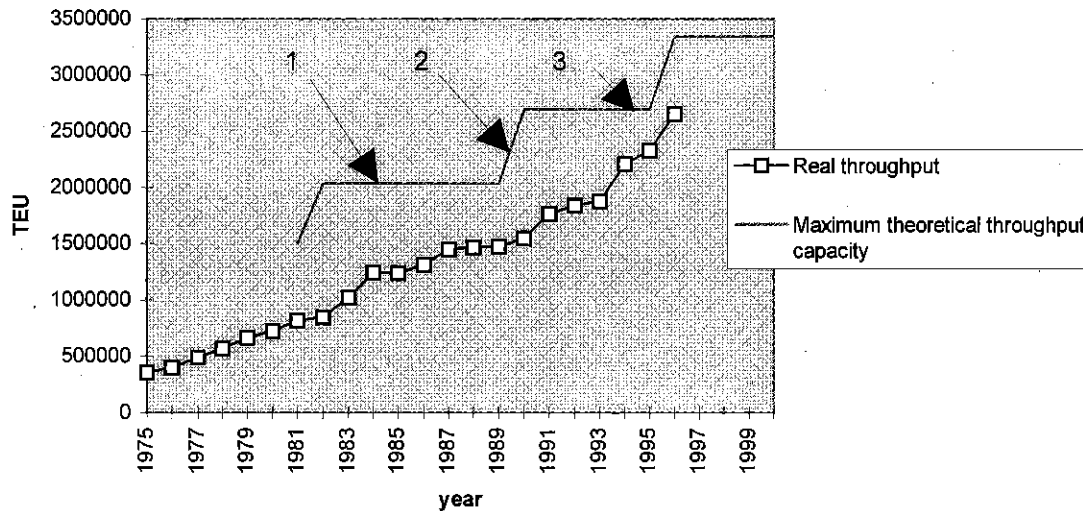
From an empirical perspective, it is interesting to consider the make up of port capacity. As far as Belgium is concerned, one often gets the impression that each port is eager to maintain a certain degree of excess capacity. There are indeed quite obvious reasons for doing so: avoiding any bottleneck that would result in loss of time, for instance; by the same token, one prevents scarce investment credit going to a competing port. In the next section, we shall deal in more detail with the build up of capacity in the port of Antwerp.

In Figure 4, a comparison is made between the theoretical throughput capacity as it developed over the years for all terminals in Antwerp and the real throughput. The graph representing the theoretical throughput does not go back any further in time than the moment the terminals at the Delwaide Dock were put into service (1981), for reason that no detailed information is available about older terminals.

In addition, we have indicated the various moments at which a decision was taken to build a new terminal. It is striking that these decisions were taken in increasingly rapid succession. While plans for the construction of a container terminal outside the locks -the so-called Europa Terminal- were taking shape two years after the opening of the Delwaide Dock (Figure 4, 1), the decision to study the possibility of building a second container terminal outside the locks was taken the same year that the first became operational (Figure 4, 2). When the first ship docked at this second container terminal -the Noordzee Terminal- in 1996, the decision to build a container terminal on the left bank was already a year old (Figure 4, 3).

This increasingly rapid succession of decisions is justifiable if one looks at the decreasing margin between theoretical throughput capacity and real throughput in TEUs. In 1989, just before the opening of the Europa Terminal, terminals were operating at 72% of capacity, while in 1995, the year that the Noordzee Terminal was opened, a capacity usage of 86% had been reached.

Figure 4: Comparison of real TEU-throughput and theoretical TEU-throughput of container terminals in the port of Antwerp



Source: Vlaamse Havencommissie, Containerisation International (1975-1996)

Though the theoretical capacity is certainly a simplified instrument for establishing the true capacity usage, the comparison with the real throughput indicates how important it is to estimate correctly the required future capacity.

3.2 Containerisation rates

The containerisation rate may be defined as the ratio of container traffic to overall general cargo traffic. In most ports, part of the remaining traditional general cargo, too, is eligible for container transport. This substitution will continue to be a factor in explaining the increase of container throughput.

Table 3 provides an overview of the degree of containerisation in the Hamburg-Le Havre range. Figure 4 gives an overview for the period 1980-1996 of containerisation rates in the four leading container ports. In Bremen and Rotterdam, the containerisation rate appears to have stagnated at just over 70%. In Hamburg it has passed the 80%-mark, while in Antwerp the containerisation rate is much more modest, though it is increasing rapidly. Figure 5 provides an overview of the remaining general cargo in each of the ports.

In comparison to the other important container ports, such as Rotterdam and Hamburg, the port of Antwerp has a relatively low containerisation rate, and, theoretically speaking, it therefore has a significant growth potential in terms of container throughput. This is due to the fact that neo-bulk (iron and steel, fruits, forest products, cars, ...) constitutes a significant share of overall general cargo handled in Antwerp.

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Table 3: Containerisation rates in the Hamburg-Le Havre range

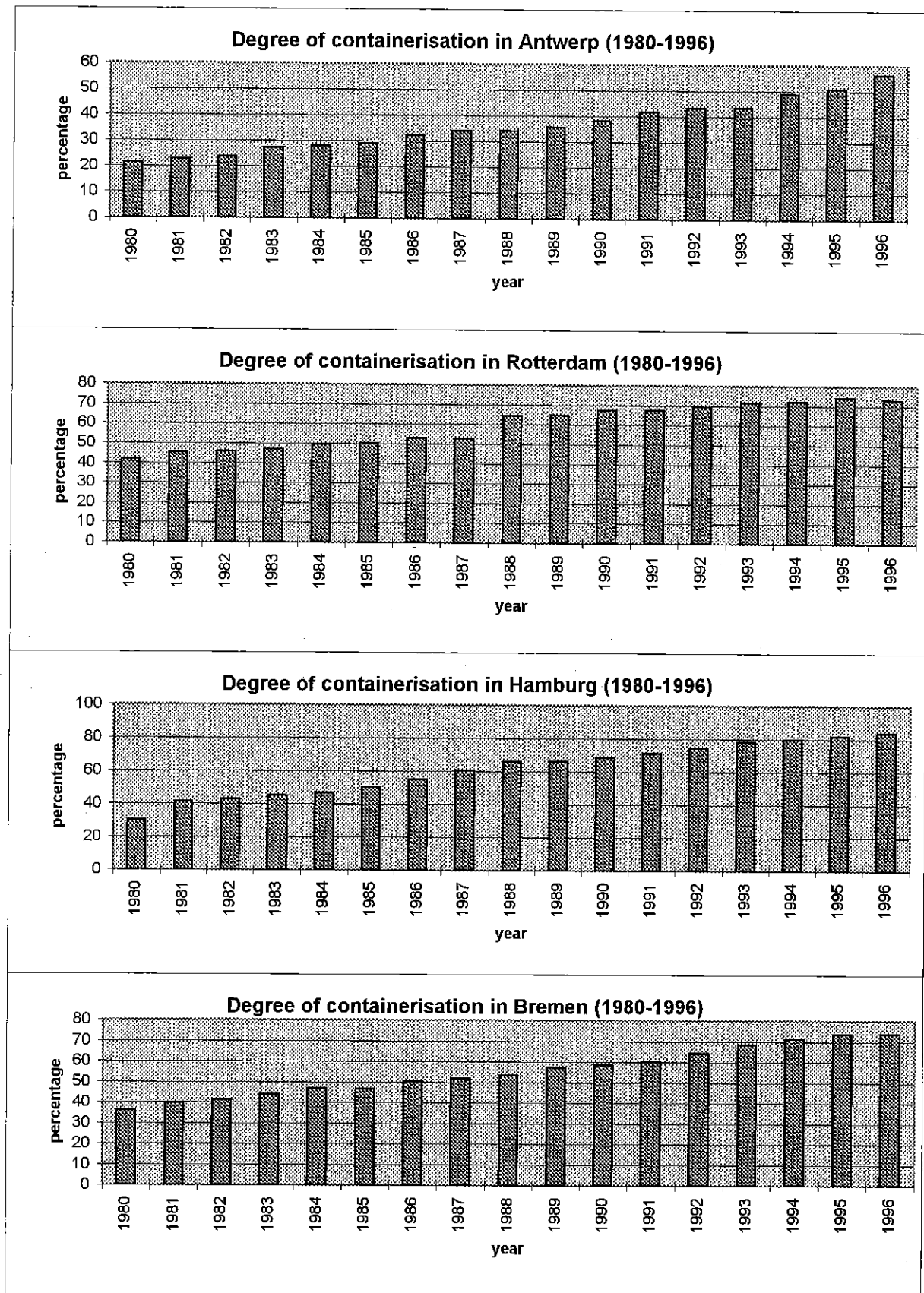
	1980	1987	1994	1996
Antwerp	21.5	34.1	48.9	56.4
Zeebruges	30.6	19.1	33.0	30.9
Rotterdam	41.9	52.7	72.1	73.2
Amsterdam	28.6	13.2	38.8	20.9
Hamburg	30.1	60.7	79.9	83.9
Bremen	36.0	51.9	71.4	73.6
Le Havre	58.9	70.4	63.2	69.9
Dunkirk	12.3	12.9	8.8	14.9
Average	32.5	39.4	52	52.9

Source: Calculations based on statistical data obtained from the Antwerp Port Authority

On the other hand, prudence is in order, as an increase in the containerisation rates does not necessarily signify a substitution of general cargo with container transport. It is, after all, also possible that general cargo has disappeared from the port in question. Moreover, it is not realistic to claim that a port such as Antwerp will eventually reach an equally high containerisation rate as competing ports. The share of non-containerisable cargo is, after all, much higher in Antwerp.

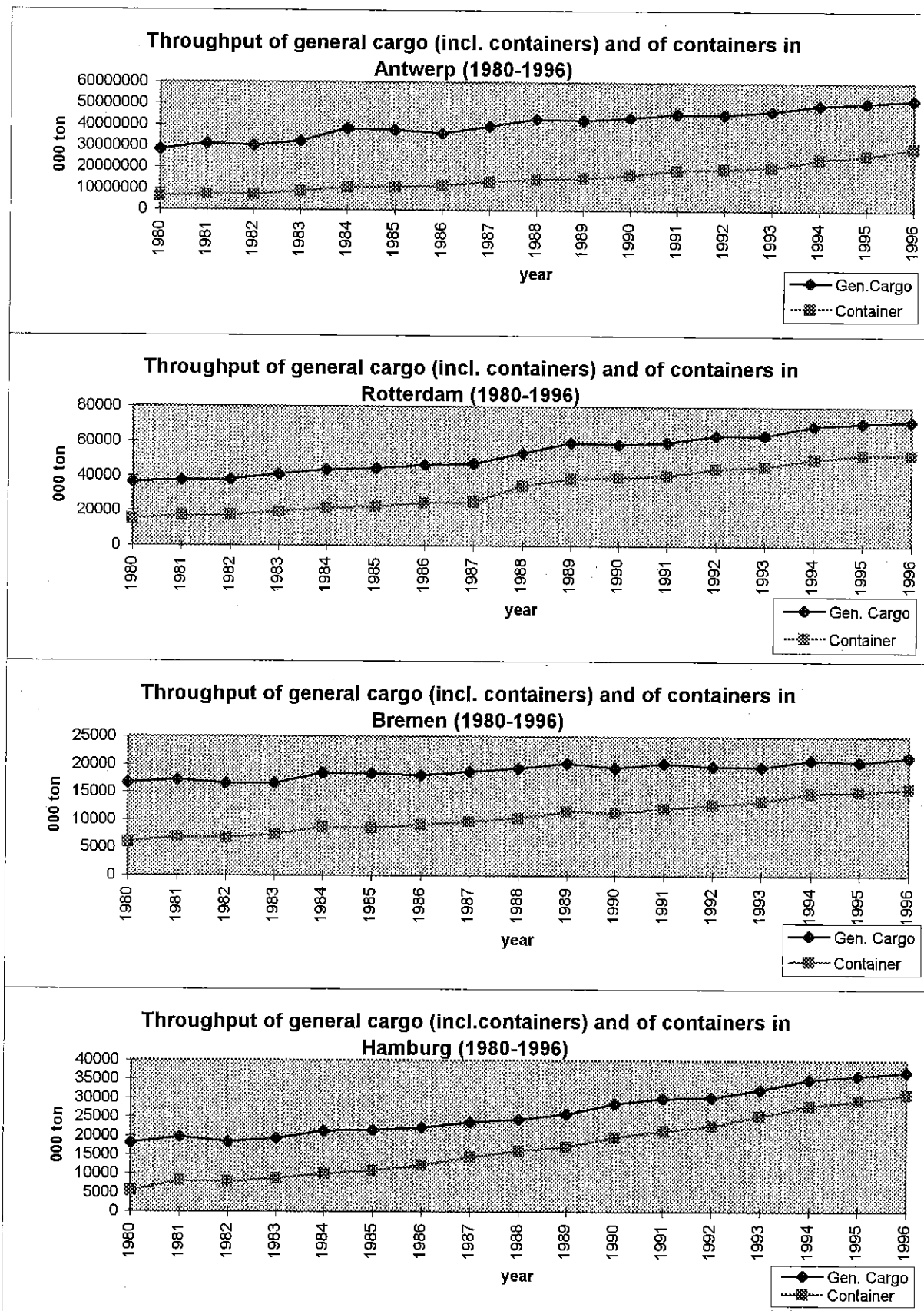
It must be clear by now that any forecast of future container throughput per port must also take due account of the actual containerisation rate and the additional growth percentage that might result from substitution. Forecasts of future container throughput should, however, not be detached from trends in throughput of general cargo.

Figure 5: Degrees of containerisation of the 4 most important ports in the Hamburg Le Havre range (1980-1996)



Source : "Antwerp Port Authority"

Figure 6 : Throughput of general cargo (incl. containers) and of containers in the 4 most important ports of the Hamburg-Le Havre range (1980-1996)



Source : " Antwerp Port Authority"

4. PORT COMPETITION, OR THE STRUGGLE FOR MARKET SHARE

If there is sufficient room for growth in container throughput, then the crucial question is: how will the port in question try and realise this, and which strategy will be adopted with regard to the positioning of the port and its market share?

This requires insight into the factors that determine the choice of port for a specific type of container traffic. Who is the most 'important' port user? Who decided on which port to call at and by which factors is this choice influenced?

The port users constitute quite a heterogeneous group: shipping agents, consignors, owners, handlers,... Moreover, port activity is a dynamic process, cf. the strategic alliances between shipping companies (e.g. Global Alliance, Grand Alliance,...), alliances between shipping agents and stevedores (CMB, Hessianatie), the alliances between stevedores and hinterland transport modes (e.g. Noordnatie and the Belgian railway company NMBS) (Meersman and Van de Voorde, 1997). This makes it much more difficult to acquire a genuine insight into why a certain port is chosen, via which companies established in that port the goods flows pass, and by means of which hinterland transport modes and routes. These questions are of central importance to the issue of port competition; a complicated, not always very transparent, matter.

In the past years, the traditional view on port competition, with a struggle at four levels (port industries, ports, port clusters, port ranges) has increasingly given way to the notion of a competitive struggle between logistics chains. Sea ports (and port industries) still constitute a link in the transport chain from origin to destination. One must pay due account to the total cost of the transport chain and all its costs centres: costs related to shipping (e.g. time factor, possible delays), port related costs (port dues, pilotage,...), cargo handling costs, cargo storage costs, feeder costs. Furthermore, industrial and commercial functions (including storage and distribution of goods) and hinterland transport are important besides throughput.

The goal in terms of port management is clear to see, i.e. to minimise costs due to handling and delays of sea ships. This clearly fits into the ultimate goal of minimising the global cost of the transport chain. This means that mutual trade-offs between links in the transport chain must be made, e.g. servicing of inland ports results in a higher cost per tonne transported by sea (because of longer distance to port, limited draught,...), but this is compensated for by reduced costs for hinterland transport.

The port which functions as a link in the cheapest transport chain will, in principle, stand the best chance of actually being called at. The ultimate decision process of the port user would, in other words, appear to make perfect sense. Does the port in question offer the same advantages as other ports serving the same hinterland? Does a port offer enough advantages as an additional port of call within an existing regular service or for the setting up of a new service or feeder service? In making a choice, the port user will take explicit account of market factors (e.g. the potential customers, competition from other shipping companies and consignors,...)

One thing is very clear from the overview above: what is important to the choice of port is not so much who makes this decision, but to what extent the above-mentioned battery of relevant variables is kept under control. Therefore, the question of which (cost) variables are most significant to the decision process is crucial. One must take into account in this respect that the cost structure is probably affected to a greater extent by exogenous factors (e.g. scale increases in world trade, or the rapid developments in the field of cargo handling equipment) than by factors related directly to the port.

In the next section, we shall deal with forecasting of container throughput in ports. To what extent did forecasters of the past take account of the multifarious influencing factors? Or did they restrict themselves to projections of observed trends, without any real theoretical basis?

5. FORECASTING

The competitive struggle between ports unfolds at different levels. From a long-term perspective, ports will be inclined to make sure that their available capacity does not impose an upper limit upon their growth potential. In order to assess whether or not this is the case, they require reliable forecasts regarding future volume of container traffic.

Clearly it does not suffice to have sufficient capacity; one also needs to find ways of using this capacity in the most economically sound manner. It is necessary in a competitive environment to continue to strive towards retaining or expanding the port's market share. Taking global traffic forecasts as a starting point, it is therefore equally important to have an adequate insight into the factors that determine this market share, so that one has some degree of control over demand for container throughput in the ports in question. Only if one has attained such an insight can one properly assess the possibility of capacity expansion.

We shall now first give a succinct overview of a number of (empirical) studies in which forecasts are made of the volume of future container traffic. Subsequently we shall work out a mental framework for prognoses to come.

5.1. Forecasting container throughput : a (selected) overview

One can subdivide past forecasting methods into two major categories, i.e. quantitative and qualitative methods.

Quantitative forecasting techniques are based upon historical data, in which one tries to discern a trend or a relationship. The estimated coefficients thus obtained are subsequently used to forecast future developments. The qualitative approach, on the other hand, is sooner based upon expert information and assessment than empirical evidence.

Within the category of quantitative models, one can distinguish between time series models and causal models. In time series models, the future value of the predicted variable is

obtained through extrapolation or mathematical and/or statistical deduction of the historical pattern of the variable concerned. Causal models, by contrast, start from the assumption that there is a causal relationship between the variable to be predicted and one or more other variables. In such a model, an attempt is made to formulate this relationship in mathematical terms. The formula thus obtained is used in the next phase to make predictions on the basis of scenarios.

The qualitative forecasting techniques include exploratory and normative techniques. In exploratory methods, future developments are assessed on the basis of empirical data regarding the past, enhanced by expert information about expectations concerning future volume of traffic. Normative methods start from proposed goals, and they try to determine whether these goals can be achieved, given existing capacity, structural restrictions and the state of technology.

Table 4 provides a non-exhaustive overview of past research and techniques that have been used to forecast port traffic, including for the ports of Antwerp and Rotterdam. Unfortunately, we do not know the model specifications and estimations for a number of important studies (e.g. OSC and Rotterdam). It appears from this overview that various methods are used to forecast future trends in goods flows. Some researchers put their trust in externally produced forecasts from international trade to which they apply shift-share methods - for broad categories of goods - in order to determine which trade flows from a given country will pass through which ports. Others restrict themselves to trend extrapolations or a mixture of trend analysis and the shift-share methodology.

Sun and Bunamo (1973) developed a model (nr.1 in table 4) to forecast the share of the port of New York in total US imports and exports. A distinction was made between a number of endogenous and exogenous factors. The exogenous factors included the size and the economic dynamism of the port's hinterland, the cyclic pattern of the national economy, the policy of the country, and the growth and maturity of the world economy. The endogenous factors concerned the capacity of the port for dealing with goods flows: terminals, frequency and geographic reach of the regular services, terminal tariffs, etc. The endogenous factors were not incorporated into the model because it was assumed that the supply of port services is extremely elastic in the long-term. Furthermore, there was a lack of relevant data.

The share of New York in the United States' goods imports and exports was subsequently explained in terms of three variables: the mix of goods handled in the port of New York, the maritime trade orientation, and the hinterland economy.

Table 4 : Overview of the most used forecasting methods

Authors/Institutions	Methodology	Function
1 Sun en Bunamo (1973)	Forecast of the share of the Port of New York in total US imports and exports	Share of the port of New York in US imports and exports as a linear function of different effects (commodity effect, domestic market effect, trading partner effect, dummy variable)
2 Studiecentrum voor de Expansie van Antwerpen (SEA) (tot 1985)	Development from a predominantly quantitative approach to a qualitative approach, in which strategic management options of the parties involved in port activities and historical data on transshipment are integrated	Linear and Loglinear regression analysis and trend extrapolation. Underlying variables were the evolution of import and export flows in proportion to the evolution of the index figure of Belgium's GNP and industrial production
Havenbedrijf Rotterdam (1976-1987) GoederenStroomModel (GSM1 t.e.m. GSM6)	Forecasts on the basis of linear equations in which GNP, population and production indexes are key-variables, by means of two macroeconomic scenarios combined with two possible developments in Rotterdam's market share	No functions specified
3 Dagenais en Martin (1987)	Long-term forecasts of container traffic for the port of Montreal, according to origin and destination for various goods categories	No functions specified
4 Blauwens, G. en Van Steelandt, G. (1992) "Voorspellingen van de containertrafik in de haven van Antwerpen"	Estimation of 4 relationships: 1. general cargo H-LH range & industrial output EEC, 2. Container & general cargo traffic range, 3. Container traffic Antwerp & general cargo traffic range, 4. Containers handled & container traffic in tonnes in Antwerp	1. Linear function industrial output EEC, 2. Loglinear function general cargo traffic within range, 3. Log share container traffic Antwerp as log general cargo range, 4. Log number of containers handled as log container traffic (in tonnes) Antwerp
5 Van Straelen, R. (1993) "Econometrische ramingen op lange termijn van het containerverkeer in de haven van Antwerpen"	Error correction models in which container traffic is forecast on the basis of total goods traffic (in turn predicted on the basis of index figures of industrial production in EU countries) and a lagged variable of the container traffic	Container throughput as a linear function of a lagged variable of container throughput as well as a lagged variable of total goods traffic in Antwerp
6 Vlaamse Havencommissie (1996) "Jaarlijks rapport over de perspectieven betreffende de havenontwikkeling"	General prognosis for Flemish ports: first a prognosis of future traffic for the H-LH range (linear equation on the basis of industrial production in the EU), followed by estimations of future market share Flemish ports	Linear equation in which container throughput in the H-LH range is explained by the evolution in the industrial production
7 Verbeke, A., Declercq, E., Teurlinckx, D. (1996) "The future growth of container traffic in the port of Antwerp"	Forecasts on the basis of different estimations (future general cargo-flows in H-LH range on the basis of GDP and past general cargo flows, loglinear estimations of the extent of containerisation)	General cargo in the H-LH range as a linear function of GDP-index, degree of containerisation is a loglinear function, estimation share of Antwerp through trend extrapolation
8 Masterplan Haven van Antwerpen (1996)	Quantitative prognosis: general cargo flows predicted on the basis of GNP of EU, USA and Japan. Competitive position of Antwerp integrated through forecast of expected market share in H-LH range	General cargo in the H-LH range as a linear function of GNP of EU, USA and Japan. Expected market share of Antwerp on the basis of trend extrapolation
9 Ocean Shipping Consultants (1997)	Qualitative prognosis: expert information and results of studies relating to specific sectors	No functions specified
10	Predictions on the basis of macro-economic variables	No functions specified

Dagenais and Martin (1987) proposed a method (nr.4 in table 4) of making disaggregated long-term forecasts concerning maritime container traffic for the port of Montreal, by origin and destination, and for different goods categories. Their article is a critique of the approach taken by Sun and Bunamo (1973), in the sense that they contest the hypothesis of a fixed hinterland. They argue that the market area of a port is dependent upon the physical distance between that area and the port on the one hand and the distance to rival ports on the other, expressed in transport costs per unit of distance. The different transport costs may change as a result of, for example, the introduction of new transport technology, variable fuel costs, exchange rate fluctuations, or institutional factors affecting price setting by shipping or railway companies. The 'fixed' relation between cost and distance is renounced.

The cited explanatory variables are similar to those produced by Sun and Bunamo (1973): international trade, the mix of goods, trade orientations of the port, the degree of containerisation, and the hinterland. Forecasts were made for imports and exports, per goods category and per origin-destination relation. Subsequently, different scenarios were worked out based on trend expectations regarding institutional factors and responses to these trends from shipping companies or conferences.

The traffic prognoses for the port of Antwerp produced by SEA (Studiecentrum voor de Expansie van Antwerpen) are primarily based on qualitative methods, in which strategic management options of the relevant players (port industry, transhippers, shipping companies, terminal operators,...) and historical trends in throughput data have been integrated.

The first model for Antwerp (nr.2 in table 4), which was published in 1980, includes a linear and a logarithmic regression analysis and trend extrapolation for total bulk cargo and a specific prognosis for each goods category. The exogenous variables taken into account were historic trends in import and export flows in relation to the index figure for Belgium's GNP and index figures for Belgium's industrial output. Two scenarios were used: an optimistic one, based on macro-economic estimations by the OECD, and a pessimistic one, in which much more modest economic expansion was assumed.

In the later models, the methodology tended more and more towards a qualitative technique. Twelve bulk categories were taken as a starting point. Each category was subjected to an economic and statistical analysis of loadings and unloadings, import and export figures for the economic union of Belgium and Luxembourg (BLEU), throughput and transit data, origin/destination relations, and the position of Antwerp in the Hamburg-Le Havre range (in terms of market share, growth,...). This information was complemented with an analysis of trends in the transport sector and the macro-economic environment. Finally, the estimated results were tested against expert information.

In the Master Plan for the port of Antwerp (1996) (nr. 9 in table 4), a combination is used of a quantitative and a qualitative approach. A quantitative distinction was made between general cargo and bulk cargo. In order to determine the course of general cargo flows, the index figure of GNP in the EU, the United States and Japan was used as an explanatory variable. For bulk cargo traffic, the index figure for industrial output in the European Union was used. The

competitive position of the port of Antwerp was integrated by means of incorporating a forecast of market share of the port in the Hamburg-Le Havre range.

In the qualitative component, expert information and results of specific disaggregated sector research was employed. Figures were further disaggregated by different goods categories (11 for general cargo; 7 for bulk cargo).

So far, the port authorities of Rotterdam have developed six cargo flows models (GSM) (nr. 3, table 4), with clearly discernible modifications. The most recent model (GSM6) distinguishes between twenty goods categories and three principal goods flows (loadings, unloadings and sea-sea transit). These principal flows are further subdivided into primary flows (of great significance to the port) and secondary flows (of lesser significance). It was assumed that the secondary flows would undergo an identical development to that of the primary flows. The forecasts of the future course of the various goods flows is based on a linear equation in which GNP is a central element. In recent years, the port authority of Rotterdam is increasingly making use of expert information.

GSM 6 describes two macro-economic long-term scenarios, based upon specific forecasts regarding macro-economic variables such as GNP, population and production index figures. In addition, the model distinguishes between a favourable variant with an increase in market share and a negative variant that assumes stagnation.

Blauwens and Van Steelandt (1992) (nr. 5 in table 4) forecasted the future container traffic in the port of Antwerp on the basis of four relationships. First, the general cargo traffic in the Hamburg-Le Havre range was estimated on the basis of the industrial output in the EEC. Subsequently, a relationship was estimated between the container traffic and the general cargo traffic in the range. Then the container traffic in Antwerp was related to the general cargo traffic in the range. Finally the number of containers handled in Antwerp were derived as a function of the container traffic in tonnes handled in Antwerp.

The Flemish Port Commission (Vlaamse Havencommissie, 1996) (nr. 7 in table 4) makes annual prognoses of traffic flows in Flemish ports. First, an estimation is made of future maritime traffic in the ports of the Hamburg-Le Havre range on the basis of a linear regression equation in which industrial output in the European Union is the principal explanatory variable. Subsequently, an estimation is made of the future market share of the Flemish ports, based upon two different scenarios: that of a status quo on the one hand, and a slight improvement on the other. This general prognosis is followed by a qualitative analysis of a number of important goods flows: dry bulk (ores, coal, grains and derivatives, and fertilisers), liquid bulk and general cargo (containers).

Verbeke et al. (1996) (nr. 8 in table 4) made a prognosis of container traffic in the port of Antwerp. First, the general cargo flows in the Hamburg-Le Havre range were estimated on the basis of GDP in the industrialised world. Subsequently, the future degree of containerisation in the range was estimated by means of a loglinear model in which restrictions had been incorporated. A combination of the two elements yielded a prognosis of future container

traffic in the range. It was assumed that the market share of the port of Antwerp would remain unchanged in the period 1996-2015.

A number of interesting observations can be made about this overview. The earliest studies that have been cited here are the most radical; More recent studies are often restricted to extrapolations of trends, e.g. with regard to throughput in a range with a constant market share. In some cases use is made of expert information.

5.2. Container throughput forecasting : a methodology

Up to now, it has often been the case that the reasoning behind container throughput forecasts, which are important for port investment decision-making, was rather mechanical in nature. After all, it appears that many so-called “models” are no more than simple trend extrapolations. The assumption behind these models is that trends from the past will manifest themselves in the future too. However, as a result of this approach one still lacks an instrument for analysis which is able to deal with effects due to changes to relevant factors.

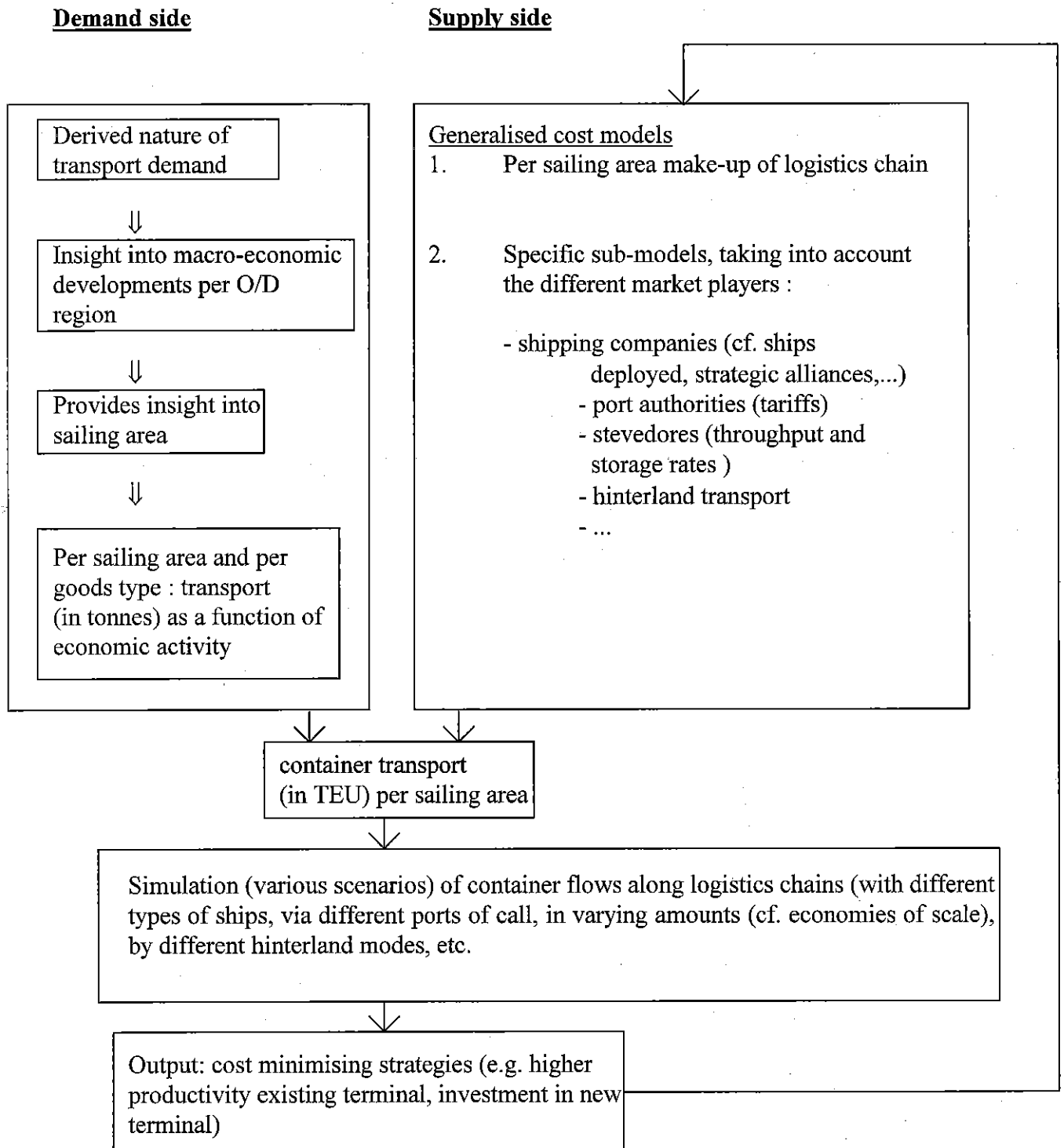
Typical for this kind of approach are a number of recent studies (including that by the Vlaamse Havencommissie (1996), Verbeke et al. (1996)) in which traffic in the Hamburg-Le Havre range are linked to one single economic parameter that is supposed to reflect the general economic trend. Subsequently, a correction is made for the varying degrees of containerisation of the ports concerned. And finally, by way of precaution, it is assumed that the market share of these ports will remain unchanged. The author themselves, by the way, are aware of the simplification of their approach. Verbeke et al. (1996, p. 67), for example, quite rightly point out that their “initial assumptions were quite simple”. Usually, however, the forecast are incorporated in an investment analysis by one single container terminal, while a broader approach is not feasible, if only for pressure of time.

If one wishes to attain a broader perspective on the economic aspects of container traffic, a different approach is required (figure 7). After all, reality is far more complex than any model that has been used up to now; models, by the way, which usually do not allow elaborate testing of strategic decisions.

An adequate model must, first and foremost, incorporate the notion of the ‘logistics chain’. This implies that a distinction needs to be made between ‘sailing areas’ (e.g. North Atlantic etc., on the basis of origin-destination matrices). Indeed, economic developments in each of these areas may vary, which in turn may have an effect on the types of vessels that are in operation, the type of cranes used, the time factor, etc. A thorough analysis of a number of partial indicators (cf. graphs above), for instance, does not allow one to just assume that ports will maintain an equal market share in the long-term.

There is a second indicator which points towards possible volatility, i.e. the varying degrees of containerisation of ports, which profoundly affects ports’ growth potential for container traffic on top of growth linked to economic development.

Figure 7 : Methodology for container throughput demand forecasts



Furthermore, there is the issue of port competition and the struggle for market share. This competition may be affected by multifarious variables. All things considered, the interaction between these elements may have a significant impact on profitability, which in turn may make or break an investment decision.

For this reason, we would like to propose a methodology that tries to take into account the above-mentioned considerations by incorporating as many decision variables and market players as possible. The approach is based upon a combination of disaggregated demand models on the one hand and a number of costs models on the other. It is our intention to arrive at a sequence of sub-models that encompasses the entire logistics chain, while also making a distinction between, among other things, sailing areas, ship size, crane type, hinterland transport mode, etc. In this manner, due account can also be given to the strategic behaviour of the market players. Furthermore, this modular make-up also has the advantage that, for each of the constituting elements, one can make use of the output of models developed elsewhere (e.g. for forecasts of demand for container traffic per sailing area).

Ultimately, two main groups may be distinguished in the initial phase. Firstly, there are the (spatially disaggregated) economic activities, which form the basis for the (derived) demand for transport. Therefore, insight is required into economic developments in large zones of origin and destination and a translation into maritime goods flows (in this case, containerised goods flows) per sailing area. A second group encompasses models relating to the generalised cost, with the make-up of the logistics chain per sailing area, and the specification (and, as the case may be, estimation) of a number of sub-models per type of activity (shipping companies, ports, stevedores, hinterland,...). With regard to hinterland transport, one will need to work with modal-split models.

The combination of the (partial) output of the two groups should allow one to work out different scenarios for container flows along logistics chains in which ports perform a pivotal function. In a subsequent phase, the output of these simulations will serve as the input for developing cost minimising strategies.

It speaks for itself that the impact of a new container terminal in a port, with a given capacity and cost structure, as well as its impact on capacity use at other terminals, fits into this methodological framework. In addition, however, it incorporates the interaction between changing strategic behaviour by the other market players. The 1997 discussion in Rotterdam between terminal operator ECT and shipping company Maersk about the 'dedicated terminal' is a striking example of the simultaneity of these kinds of decisions and effects.

This methodological overview explicitly addresses a number of shortcomings of the most commonly used models at the present moment. Extrapolation of trends clearly ignores the dynamism that is so typical of the transport industry. Moreover, the issue of container throughput forecasting is too complex to be considered from a purely econometric perspective, so that there is a need for strategic market share models and other simulation models that take into account, for example, the market behaviour of the various players.

The intentions of research efforts are often clear to see: to establish a theoretical framework that is broad enough to incorporate all relevant factors; and, in addition, to quantify the issue in order to allow the development of scenarios and strategies on the one hand and empirical testing on the other. Much can undoubtedly be learnt from assessments of decisions in the past.

CONCLUSION

The port industry has no doubts whatsoever: there is definitely a potential for growth in container transport and throughput associated with it, cf. recent 'traditional' forecasts. The question is whether there is sufficient capacity in the Hamburg-Le Havre range to deal with this growth. Clearly, the situation must be analysed separately for each port. There is no doubt that investments are required, but the question remains: how much and in which ports?

The force of attraction of a port must be seen as a link in the logistics chain. It is to a port's benefit to be part of a 'favourable' chain. A port that is a link in an 'unfavourable' chain, on the other hand, will need to make an extra effort to attract goods flows.

Insight into the complexity and interaction between the links in the transport chain is required. Because of this complexity, it is necessary to work out different scenarios, in which data from traditional forecasts is used as an input, but in which the role of the generalised cost and strategies are paramount.

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