The Dynamics of National Fleet Development

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Abstract.

In the past years many developing countries tried to establish or expand a national merchant fleet. However, there seems to exist a great discrepancy between the statement and the implementation of their shipping policies. This is mainly caused by the scarcety of their financial resources and the complexity of the maritime industry (e.g. shipping, shipbuilding, ports). Some of the sectors of the maritime industry have been subject of detailed research. However, the dynamics of the whole industry has never been studied. This paper presents a simple system dynamics model, that attempts to illustrate the dynamics of the maritime industry - in particular the national fleet sector - in a hypothetical developing country.

INTRODUCTION.

The problem of the development of a national fleet and its forward and backward linkages is very complex. There are many variables, which are mutually dependent, and often interact with long delays. As a result the policymakers of the different sectors of the maritime industry (e.g. shipping, shipbuilding, ports) have to cooperate intensively in order to coordinate the industry as a whole successfully. Practice shows that this cooperation and coordination is very difficult. Not only because of the complexity of the total system, but also as a result of human peculiarities. The latter is illustrated by the rather fruitless efforts given in the Netherlands, and within the Common Market, to create a unified port-policy. However, this problem needs not to be too serious in developing countries since they generally have a more or less centrally-planned economy. Although the recent outcry of UNCTAD concerning the alarming situation in most of the ports of developing countries, suggests differently. (the average waiting-time in ports increased from 2,2 days in 1971 to 19 days in June 1975)[1]

Bad planning in one sector of the maritime industry has direct consequences for the other sectors. Usually it implies high costs for the countries involved. (UNCTAD estimates the port-congestion costs in 1975 at 1 billion dollar, of which approx. 90 per cent is carried by the developing countries)

The first task of the policymakers in the maritime industry thus seems, to make the dynamic behaviour of the different sub-sectors and the subsequent overall-behaviour of the maritime industry in the country explicit.

Up till now only ports have been subject to more intensive research. An example is UNCTAD's publication "Development of ports".[2] Other sectors, such as shipbuilding, attract relatively little attention.[3] The maritime industry as a whole of one country has been studied in some cases. An example is UNCTAD's study "The development of the merchant marine of the Philipinnes".[4] This is, however, a description of the past development and at best a basis for planning.

What the policymakers actually need is a tool which is able to show in an instant

possible consequences of different policy-alternatives, or the influence of exogenous developments on the planning of the maritime industry. Such a tool is a simulation model.

In this article I present a simple simulation model of the development of a maritime industry. The purpose of the model is to illustrate the dynamic relationships between national objectives and national fleet development of a hypothetical country, and not to forecast the actual fleet development. Although the present model and parameters are hypothetical, the basic structure of the model may be applied in any developing country. However, some parts of the model may be removed and other added, depending on the specific national objectives and the country's characteristics.

Only a general outline of the model structure and -output are given. Those interested can obtain a more extensive description of this tentative model on request.[5]

THE MODELING PROCESS.

The function of a model is to reduce the seemingly chaotic reality to order. This ordering takes place among other things through selection, or abstraction of what seems irrelevant from a certain point of view, in order to gain overview and insight, and if possible to foresee and ultimately to influence the future. The process of ordering and selecting is called the conceptualization of a system. The resulting conceptual model has to be formalized according to existing (e.g. mathematical), methods. This formalizing is called the representation of the conceptual model.

Conceptualizing a system consists of the following steps:
1. outline of the general problem area
2. the problem-definition; what questions one likes to answer with the model
3. formulation of hypothesis of the variables of the system and their relations; this results in a rough conceptual model

Representing the conceptual model consists of the following steps:
4. refinement of the rough conceptual model to the level of a detailed flow-diagram, which enables one to write simple equations
5. choose parametrization
6. write equations
7. make computer runs
8. evaluate the output, and the model

In this article I shall treat - because of the limited space - only steps 1,2,3 and 7.

I. Outline of the general problem area.

Over the last two decades the developing countries have shown an increasing interest in the shipping sector. In spite of their individual efforts, the combined tonnage of their merchant fleets, expressed as a percentage of the world fleet, is still declining: from 7,3% in 1965 to 6,0% in 1973. For this reason, the United Nations Conference on Trade and Development, at its third session at Santiago in 1972, passed a resolution recognizing the aim of the developing countries to own at least 10 per cent of the total world tonnage in terms of deadweight by the end of the Second Development Decade in 1980.

If one does not refer this resolution to the level of polemics, but take it as a seriuos policy-statement, then the consequences for the developing countries are quite extensive in respect to the required investments in ships. Many western countries therefore strongly advice the developing countries to stay out of shipping, as the capital/output ratio and the capital/employment ratio are relatively high in comparisson with other industries. In spite of the persistent opposition, the developing countries try to establish or expand their fleets. The reasons for this development are many. Besides military considerations, they are mostly economic in nature. The economic reasons can be deducted from the so-called direct and indirect effects. The former being the effect on a country's income and industrializtion from the initial investment in ships (if any domestic resources are used), and the wages and profits which arise from the operation of the fleet. The latter being the effect from the prevention of disruptions of shipping services during hostilities in which the country concerned is not involved, reduction of economic dependence, the influence on conference decisions, economic integration within the country and with neighbouring countries, promotion of exports, diversification of employment, improvement of the balance of payments, realisation of comparative advantages, and finally the stiumulation of forward and backward linkages of the shipping industry.

Countries, trying to establish or expand a national fleet, have several methods of providing assistence to shipping and shipbuilding. These may be divided into the two broad categories of subsidies and cargo reservation. Under subsidies fall for instance: direct subsidies for the construction, purchase or improvements of ships; loans at low rates of interests, etc. Examples of cargo reservation are: legislation, regulations or other administrative measures for government-owned or sponsored cargo and commercial cargo, to be carried on national ships; use of terms of shipment - buying f.o.b. and selling c.i.f.; etc.

Many developing countries adopted the 40/40/20 cargo reservation formula, which means that every country claims 40% of the transport of seaborne goods to and from the country, while the remaining 20% of the transport is open to cross-traders. However, a great discrepancy often exists between the wish of a country to transport 40% of its seaborne im- and exports, and the implementation of such a policy. Indicative are the percentages of some countries (1971): Brazil 8%, Mexico 15%, Thailand 1%, Urugay 26%, United States 5%.

The fleet of the developing countries should expand enormerously before it is able to transport 40% of the im- and exports, since already 64% of all goods loaded in the world seaborne trade originate from these countries (1971).

It is therefore not unrealistic to assume that there will remain in the future a great discrepancy between the size of the national fleets of the developing countries as expressed in the shipping policy and the actual size of the fleets. It seems likely that in the long run this may even affect the shipping policy itself. This is just

one of the possible effects. Other effects depend on the national objectives of the individual country. If for example a country wants to man its ships with nationals, and it does not succeed in educating enough seamen, than this may have a negative feedback on the desired fleet development. The same may be true for a domestic ship-building and -repairing industry, and last but not least for the economic efficiency of the fleet. [6]

Now I have mentioned the reasons why developing countries may go into shipping, suffice it to say that I suppose a country A which intends to go into shipping. The direct cause being the increasing seaborne-export of a bulkcommodity (oil) that is abundantly available in A. Country A tries to expand its fleet till it can carry 50 per cent of this exportflow.

As part of the shipping-policy of the country, it wishes to man its ships entirely by nationals, and likewise to expand and repair its fleet through a national shipbuilding industry. Besides that it has to provide enough oil-terminals in its port to enable the ships to berth without delay.

Thus the desired expansion of the national fleet up to the level at which it carries 50 per cent of the exports, may be positively or negatively influenced (depending on the exact objectives of the country and its relative weights) by five factors. These are: the export of the bulkcommodity, the actual size of the national fleet, the

"reservoir" of national seamen, the actual shipbuilding capacity, and the actual number of oil-terminals in the port.

II. *The problem-definition*.

The purpose of the model can be defined as follows: "What will be the influence of the expansion of the bulkcommodity-export, the actual expansion of the national fleet, the education of seamen, the actual expansion of shipbuilding capacity, and the actual provision of oil-terminals on the desired expansion of the national fleet (the 50% of the seaborne export), and the subsequent final growth of the different sectors of the maritime industry, over a long period of time.

III. *A conceptual model*.

The conceptual model will be built up step by step, in order to make understanding by the reader as easy as possible.

a) the demand for shiptonnage and the earnings from export.

The demand for shiptonnage is determined by the export of the bulkcommodity (tonnage), its annual growth rate, and the productivity of the ships used in the trade. In the model the export of the bulkcommodity is exogenously determined and a function of time. The export of the bulkcommodity also determines, together with the market price of the bulkcommodity, the earnings from export by country A. The price of the commodity in the model is exogenously determined, and a random function of time.

These relationships are represented in figure 1.

-6-

figure 1
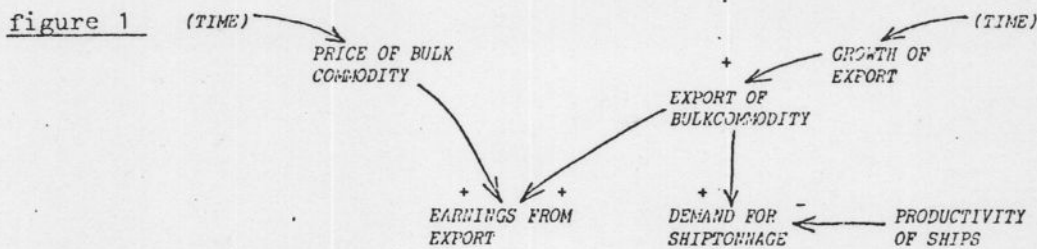
b) the national fleet.

The main determinant of the expansion of the national fleet is the discrepancy be-
tween the desired and actual share of the export carried by national ships of coun-
try A. The actual share is calculated by dividing the total tonnage of the national
fleet by the demand for shiptonnage (see a). The desired share is in the beginning a
fixed percentage of the total demand for shipping (50 per cent), but this percentage
may erode over time because of negative influences of: a persistently bad economic
efficiency of the national fleet, a persistently big discrepancy between desired and
actual share, and of course by influences of the other sectors, as will be seen fur-
ther on.

The economic efficiency of the national fleet is determined by the earnings from
shipping and the stock of capital invested in the fleet. The earnings from shipping
are determined by the share of the export carried by the national fleet and the
freight rate. In the model the freight rate is exogenously determined as a random
function of time. The earnings from export of the bulkcommodity and the earnings from
shipping make up the total earnings. The percentage of the total earnings allocated
to shipping, and the discrepancy between desired and actual share of the export car-
ried by the national fleet determine the investment in new ships. The investment in
new ships determines the growth of the national fleet. Figure 2 is a causal-loop
diagram of the national fleet.

figure 2
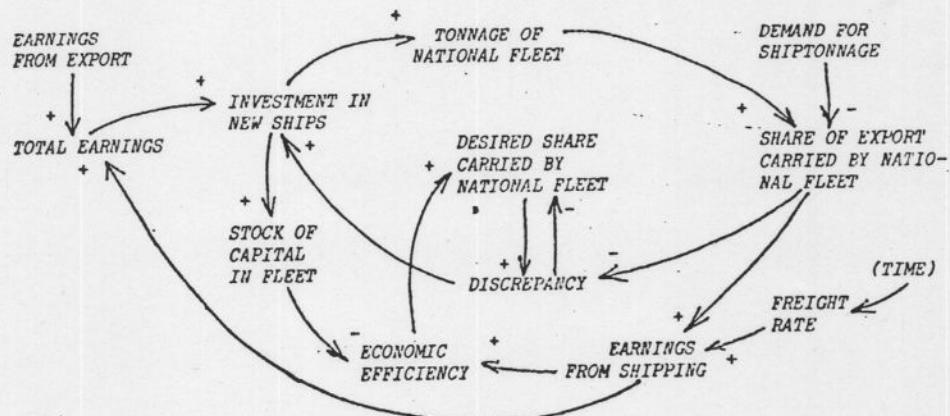
c) seamen.

Country A wants to man its ships entirely by nationals, which may serve different
objectives, such as national security (e.g. the case of the USA) or diversification
of employment.

Expansion of the fleet may take place at different speeds, and the demand for seamen with it. Thus the tuning of demand and supply is often difficult through delays, as for example it takes time to educate seamen. As a result, shortages or surpluses of seamen may arise. In the model it is assumed that a shortage of domestic seamen has a negative influence on the desired share of the cargo carried by the national fleet and a surplus a positive influence. Figure 3 illustrates the simple mechanism.
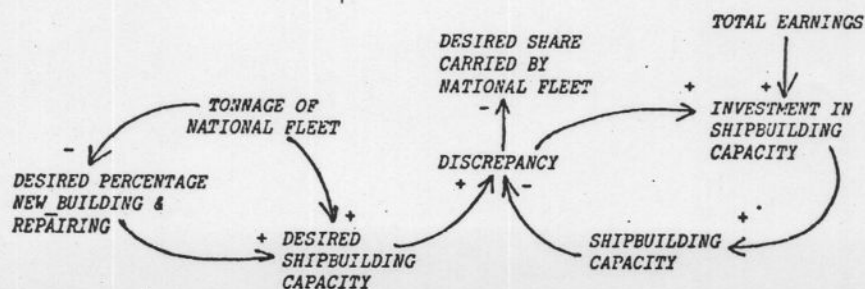
figure 3
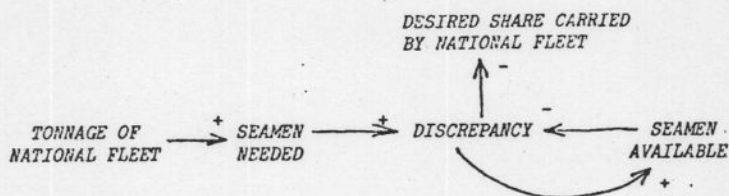
d) *shipbuilding*.

The establishment of a national fleet in country A is accompanied by the establish-ment of a shipbuilding industry. This industry supplies the country with ships for the expansion and replacement of the fleet, besides the normal repairs of the ships. The shipbuilding capacity is expressed in unit-ships per year, and is determined by the desired shipbuilding capacity, which in turn is dependent on the size of the national fleet. In the early stage of fleet development, the emphasis of the ship-building industry will be on the construction of new vessels, as there is little to repair. After the first growth-phase of the fleet, the emphasis will shift to repai-ring.

In the model the desired shipbuilding capacity is determined by the "desired percen-tage new-building and repairing", which is expressed in and in turn dependent on the size of the national fleet. In the model it is assumed that with a growing fleet the "percentage" diminishes, since repairing needs less shipbuilding capacity, than new-building.

The expansion of the fleet may take place at different speeds, and the desired ship-building capacity with it. As it takes time to expand the shipbuilding capacity, a discrepancy may arise between the desired shipbuilding capacity and the actual capa-city. The reverse may also be true. This discrepancy determines the investment in new shipbuilding capacity. In the model it is assumed that a shortage of shipbuilding capacity has a negative influence on the desired share carried by the national fleet; a surplus of capacity a positive influence. Figure 4 represents the shipbuilding sec-tor.

figure 4

e) seaport terminals.

The last major causal-loop diagram of the model (figure 5) shows the relation between the demand for shiptonnage and the seaport-terminals needed to berth the ships, used for the transportation of the bulkcommodity-export, and calling in the port of country A. The terminals needed are calculated from the demand for shiptonnage, the productivity of the ships used in the trade, and the terminal capacity.

The number of ships calling at the port may vary from time to time, and the terminals needed with it. This may cause a discrepancy between the terminals needed and the terminals available. In the model it is assumed that a shortage of terminal facilities increases the turn-around time of the ships and thus diminishes the productivity of the ships. A lower productivity consequently increases the demand for shiptonnage in order to carry the same amount of bulkcommodity over the seas.
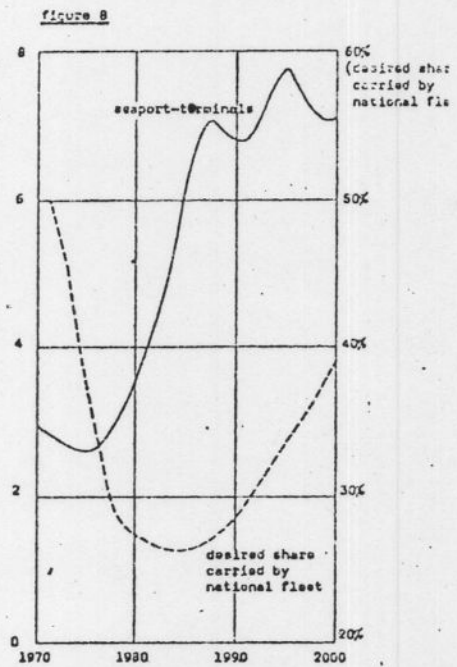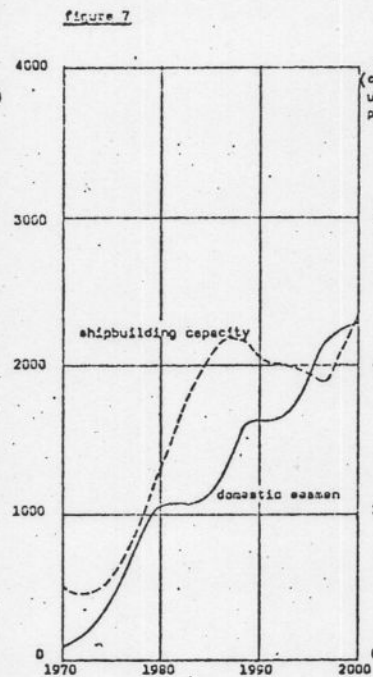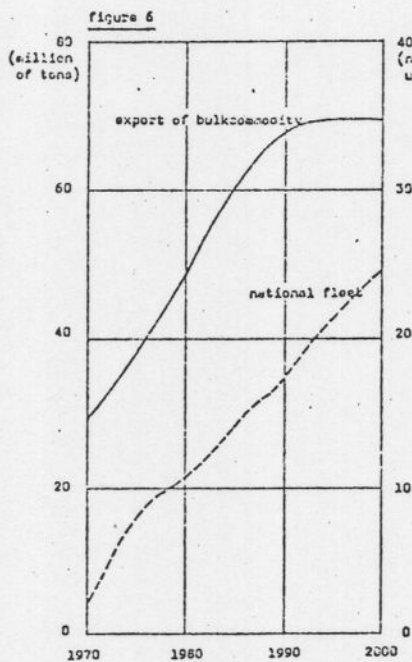
<u>figure 5</u>
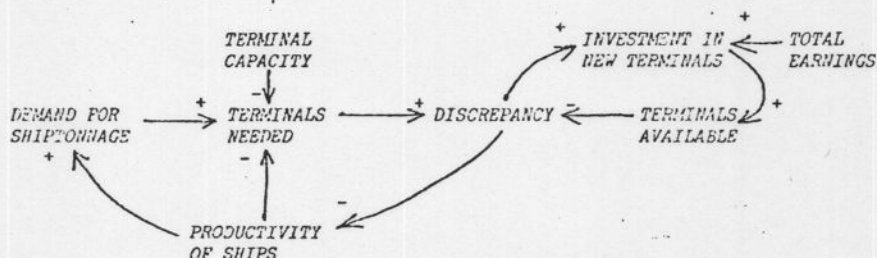
IV. <u>SOME OUTPUT</u>.

The model is written on approx. 140 punchcards in the computer-simulation language DYNAMO. This language makes it very simple to have every variable either plotted or printed as a function of time. I shall present only six of the main variables in such a way. In figure 6: the export of bulkcommodity, expresssed in million tons, and the national fleet, expressed in unit-ships of 150.000 dwt. In figure 7: the domestic seamen, and the shipbuilding capacity, expressed in unit-ships per year. In figure 8: the seaport terminals in numbers, and the desired share of the export carried by the national fleet, expressed in percentages of the total export of the bulkcommodity from country A.

In the modelrun it is assumed that only 20 per cent of the country's export earnings are allocated to the maritime industry.

Some of the curves show a rather oscillating pattern, especially seamen, shipbuilding and terminals. This is mainly caused by delays in the system, which make instantaneous adjustments of the variables impossible. The curve "desired share .." shows a different pattern. Its starts at 50 per cent, but is rapidly divided into halves in the first 15 years. The main reasons for this - in the model - are the slow expansion of the shipbuilding industry, due to lack of capital, and the persistently low return on investment in the shipping sector.

figure 6

80
(million
of tons)

40
(number of
unit-ships)

export of bulkcommodity

60

30

national fleet

40

20

20

10

0
1970   1980   1990   2000

0

figure 7

4000

8
(capacity in
unit-ships
per year)

3000

6

shipbuilding capacity

2000

4

domestic seamen

1000

2

0
1970   1980   1990   2000

0

figure 8

8

60%
(desired share
carried by
national fl)

seaport-terminals

6

50%

4

40%

2

30%

desired share
carried by
national fleet

0
1970   1980   1990   2000

20%

These are of course no conclusions which one may generalize. They merely illustrate
how the policymakers in developing countries may use such a simple model in order
to put certain national objectives and parameters to the test. Besides, they may sig-
nal in advance possible bottle-necks caused by exogenous or endogenous variables.
This first model of national fleet development is rather simple, but one will be sur-
prised, after playing around with it for some time, how one's intuition regarding th
dynamics of the maritime industry increases.

Since the development and execution of modelruns involve relatively little money and
time, I strongly recommend the policymakers in developing countries to consider the
initiation of this type of research seriously. The UNCTAD-Shipping Secretariat in
Geneva may possibly guide such efforts.

V. NOTES.

1. Slechte havens: strop 3de Wereld;NRC-Handelsblad,5.8.1975
2. UNCTAD;Development of ports - improvement of port operations and connected facil
   ties;United Nations,New York,1969,E.69.II.D.17
3. a rather recent effort in conceptualizing the shipbuilding industry and its envi-
   ronment is: H.P. Drewry;The rising costs of ship construction;London,1974,no.29
4. UNCTAD;The development of the merchant marine of the Philippines;Geneva,1.2.1971
   TD/B/C.4/84
5. Niko Wijnolst, Department of Civil Engineering, Stevinweg 1, Delft, Netherlands
6. a more extensive article on the subject of developing countries and shipping
   can be found in the magazine Norwegian SHIPPING News, no.17D,1975