THE CONTAINERISATION OF CHINA'S SEABORNE TRADE

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy by

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ABSTRACT

Containerisation was initiated in the United States during the mid-50's and entered on the deep-sea trades in the mid-60's. China started to carry containers in the late 1970's. China's state carrier, the China Ocean Shipping Co (Cosco) expanded its container fleet rapidly thereafter and is now one of the top carriers in the world. However, they still have many problems concerning the fleet structure, the ship size, the route deployment and the intermodal service, etc.

The major difficulty of China's containerisation comes from the port and inland transport. Lack of infrastructure and capital resources is the main obstacle. There are also many strategic issues relating to the development of container ports and the inland container distribution/consolidation systems.

The thesis starts with an investigation of the relationship between the trade development and economic growth in China. It is found that during a very long period China's trade and its economy grew hand in hand. A sophisticated forecasting technique is then employed to predict China's seaborne container traffic up to 1995, based on the comprehensive UN maritime trade data. The forecast result is used as a guideline towards the future development of China's container fleet, container ports and the inland container transport system.

It is found that the Sino-Mediterranean-Europe route is the most important market for China's container traffic and it is therefore suggested that Cosco should shift its priority of fleet expansion from the pacific accordingly. A comprehensive ship cost model is built to assess the various fleet options. In terms of container port development, it is suggested that in short and medium terms, China will be better-off by using Kobe and Hong Kong as relay centres. In the long run, while Hong Kong will continue to be a container hub port for southern China after it returns to Chinese rule in 1997, China could develop the port of Ningbo to replace Kobe as the transshipment centre for central and northern China. In the inland transport sector, it is suggested that by making the maximum use of the waterway resources, the immediate pressure on the congested roads and railways can be eased. China's roads and especially the railways should gradually involved in the business of container intermodal transport in a much longer term. This, it is considered, is the most cost-effective approach towards the development of China's intermodal transport system.

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CHAPTER 1 INTRODUCTION

1.1 PURPOSE AND OBJECTIVE

Containerisation was initiated in the United States during the mid-50's and entered on the deep-sea trades in the mid-60's. China did not start to carry containers until 1978 when Cosco[1] Shanghai set up the country's first containerised liner service: the China -- Australia route. The Cosco fleet experienced a continuous expansion thereafter and is now an important force which people cannot ignore. However, there are still many problems in Cosco's container service, concerning the fleet structure, the ship size, the route deployment and the intermodal service, etc.

China experienced and is facing more difficulties and hence more problems in the container port development and inland transport system, as compared to the development of its container fleet. Lack of capital is one of the major problems. If it is possible to shop around in the international market for cheap second hand container

1. The China Ocean Shipping Company.

tonnages, it is by no means possible to import some second hand motorways into China. There are also important problems with respect to port location, port development strategy and a development strategy for the inland container distribution/consolidation systems.

Although there exists plenty of literature concerning the theory of containerisation and the relationship between containerisation and the developing countries, little has been done in the particular case of China. It is the purpose of this thesis to fill in this gap in the field of containerisation in China. The objective of the thesis is to examine thoroughly all the fundamental issues in the development of containerisation in China, the fleet, the port and the inland transport infrastructures, to define the major problems and explore their possible solutions.

1.2 CONTAINERISATION AND THE DEVELOPING COUNTRIES

The early view on the relationship between containerisation and developing countries was rather negative. It was argued that containerisation was fundamentally unsuitable for developing countries. The main concern was that containerisation was essentially capital intensive, that it substituted capital for labour and thus would only be suitable for developed countries where capital resources were rich and labour was expensive. On the contrary, in most developing countries capital is a scarce resource and they have plenty of cheap labour. There are other problems including:

1. Lack of a tradition for the planned maintenance which is essential for the operation of complicated and high cost container handling equipment.

2. Physical and administrative difficulties in the integration with inland modes leading to problems in the operation of integrated system and maintenance of container control.

3. Problems in cargo balance and the movement of empty boxes.

4. Customs and other bureaucratic delays leading to potentially long inland container turnaround times and container dwell times in port (University of Liverpool Marine Transport Centre 1981).

Similarly, Graham and Hughes (1985) wrote in their book *Containerisation in the Eighties:*

> "Ten years ago, at the time the International Transport Convention was being proposed in Geneva, many doubts and fears were being expressed in developing countries about the problems of providing container services for them and the 'threat' posed by the multimodal transport operators. Containerisation was seen as a sophisticated, expensive invention of the industrial trading countries, foisted on the developing countries without thought for their needs, controlled by multinational operators many thousands of miles away and requiring expensive investments in port and inland transport facilities which the developing countries could not afford."

The view of containerisation in developing countries, however, has been modified in recent years. This change may be traced with reference to UNCTAD (1982) report *Multimodal Transport and Containerisation,* which claimed that "if the new systems are economically superior, developing countries should in the long run benefit from their introduction". Containerisation is no longer considered to be capital intensive. Contrarily, while it achieves savings in labour, it also achieves savings in capital in the long run. Graham and Hughes (1985) made the point fairly clear:

> "The lesson to be learned is that the high productivity of container services may actually reduce capital needs. One containership and accompanying containers will cost less than the four to six smaller, less complicated break-bulk vessels which would be required to do the same work without containerisation.

> The one container berth and back-up terminal facilities will certainly cost less to build than the seven to nine conventional berths which would otherwise be needed, especially if conversion of existing berths is involved".

They further pointed out that "today the situation is radically different. Containerisation of developing country trades is proceeding apace; by 1990 it is unlikely that any purely break-bulk liner services will remain". Their prediction five years ago has become the reality today.

By now international general cargo trade between developed countries may be considered fully containerised although there is still competition between containers and specialised systems. Part of the developing world has also largely completed its process of containerisation, especially in the Asian region where Taiwan has the world's largest container company, viz. Evergreen line and Hong Kong has the world's largest container port. Other developing countries are also involved in containerising their international seaborne trade although with varying degrees of success.

It is true that many developing countries face enormous difficulties in trying to containerise their trade. This difficulty becomes even greater when containers move to inland. This, however, does not preclude containerisation. If developing countries cannot enjoy the full advantage of containerisation, they can obtain part of the benefit. If containers would have to be stripped at port and distributed inland in break-bulk , then so be it. At least by doing so developing countries can benefit from the containerised shipping service because container ships provide more transport capacity per unit of capital than conventional ships. In fact, many of the problems that developing countries face are not immutable. As time goes by, developing countries will surely overcome these problems just as the developed countries did 20 years ago. Moreover, the world is going towards containerisation irrespective of any individual country's problems. It will simply be too costly for developing countries not to containerise.

Having dealt with this subject in general terms, this thesis will now concentrate on the problems of the actual implementation of containerisation in China. There will be no more such questions as whether or not China should containerise. Containerisation is in principle correct and China, like other developing countries, simply has no choice but to containerise.

1.3 METHODOLOGY AND THE LAYOUT OF THE THESIS

In order to achieve the objective set out in section 1.1, a first step is to determine the demand for container traffic in China. A sophisticated forecasting technique is employed to predict China's seaborne container traffic up to 1995. This starts with an analysis in Chapter 2 of trade development and economic growth in China during 1952-1986, especially the general cargo trade growth between 1975 and 1985. The analysis is based on the UN Maritime Transport Statistics (on magnetic tapes). The tapes are read into the IBM3081 mainframe at the University of Liverpool and the data was sorted out using Fortran 77 programs. China's container potential is then estimated in Chapter 3 based on the trade data and the U.K. experience of container penetration in various commodity groups. This is followed by a forecast of the container potential by means of correlating the container potential growth with macroeconomic growth. The real container traffic prediction is derived by applying an estimated container penetration rate to the forecast container potential figures. The advantage of deriving the real container traffic from forecast container potential instead of directly forecasting the real container traffic is that this avoids over-estimate of the container traffic, a mistake which is easily made by simple extrapolation. The real container traffic would never exceed the container potential which acts like a safety limit. Only when container penetration reaches 100% will the real traffic equal to the potential. The forecast demand is then used as a guideline towards the future development strategy of the supply sector, the container shipping fleet, container ports and the inland container transport system.

Chapter 4 reviews the development of China's container shipping against a background of the rapidly growing world container shipping fleet. A comparative study of the Cosco deepsea container fleet is carried out concerning the fleet structure and the container service network. Finally a ship's cost model is developed using the Lotus software Symphony on IBMPC.

Chapter 5 analyses issues in development strategy for Cosco. The present capacity of Cosco container fleet is compared with the forecast future demand in different scenarios (high, medium and low). A modified Ryder and Chappell model (University of Liverpool Marine

Transport Centre 1979) is used to examine the operating strategy of the Cosco container fleet, especially on the Sino-Europe and Sino-Mediterranean routes. Chapter 6 starts with a discussion of the economics of transport geography, followed by a survey of the current world container shipping service configurations on the mainstream routes Far East-Europe and Far East-North America. Finally a further study of the evolution of the Cosco's Far East-Europe service is carried out.

Chapter 7 tackles the other two important aspects of an integrated intermodal transportation system, viz. the container ports and the inland transport network. It starts with an investigation of the current situation of China's container ports and the inland container distribution/consolidation, followed by a analytical discussion of the future development strategies. Chapter 8 finally concludes the whole thesis, with a summary and some considerations of strategic issues.

REFERENCES

Graham, M. G. & Hughes, D. O. (1985), *Containerisation in the Eighties,* Lloyd's of London Press, London.

UNCTAD (1982), *Multimodal Transport and Containerisation,* United Nations, New York.

University of Liverpool Marine Transport Centre (1981), *Container Logistics and Terminal Design,* ed. S. Gilman, Liverpool.

__ (1979), *Optimal Speed and Ship Size for the Liner Trades,* by S. C. Ryder & D. Chappell, Liverpool.

CHAPTER 2 TRADE DEVELOPMENT AND ECONOMIC GROWTH IN CHINA

2.1 INTRODUCTION

International trade is both a function of economic growth and one of its main consequences. The reason for having international trade is not simply the result of the inability of a nation to produce every commodity that it needs. It is not unusual for countries to import certain commodities from others, though these commodities can be produced by themselves, possibly at a high cost. It is often beneficial to have international trade rather than to try to produce every commodity by oneself. Even if countries have absolute advantages in producing commodities, it is still beneficial for them to specialise in certain commodities which they can produce most efficiently while importing those in which they are relatively less efficient. The economic rationale behind international trade is explained by the law of comparative advantage. Comparative advantage is a qualitative theory of international trade, which is concerned with the pattern of trade, i.e. which country will export which good. The theory of comparative advantage is essentially very simple: If two countries engage in trade, each will have incentives to increase production, and reduce consumption, of goods in which it has the lower relative marginal cost prior to trade than the other (Dixit & Norman 1980).

China, with over one billion people, is the largest country in the world in terms of population. For a variety of historical, political and other reasons, foreign trade for a long time did not play a major role in the development of the Chinese national economy. Things have changed dramatically since 1978, when China decided to open its long closed door to the whole world. According to customs statistics, China's total import and export value in 1986 amounted to US $73.8 billion (National Statistics Bureau 1987a), 5 times the 1977 figure of US $14.7 billion (IMF 1985).

2.2 TRADE DEVELOPMENT AND ECONOMIC GROWTH 1952-1986

It is commonplace that economic growth and trade development go hand in hand. From the point of view of this study what is interesting is the nature of this relationship. Figure 2-1 indicates the general long term correlation between economic growth and trade development for a selection of major trading nations over the period 1720 to 1985. Trade and the economic development were positively correlated with each other and trade grew at the higher rate, with an exception during the period 1913 -- 1950 when the world experienced two world wars, frequent trade wars, and the severest economic depression in history (World Bank 1987).

As a centrally planned economy, China has for a long time a different statistical system to that of most of the world's market economies. Until recently official Chinese statistics provided no proper GNP or GDP data. Instead, Total Product of the Society (TPS)[1] and National Income (NI) have been the major macroeconomic indicators. According to the China Statistics Yearbook 1985 (National Statistics Bureau 1985), the major differences between TPS and GNP are:

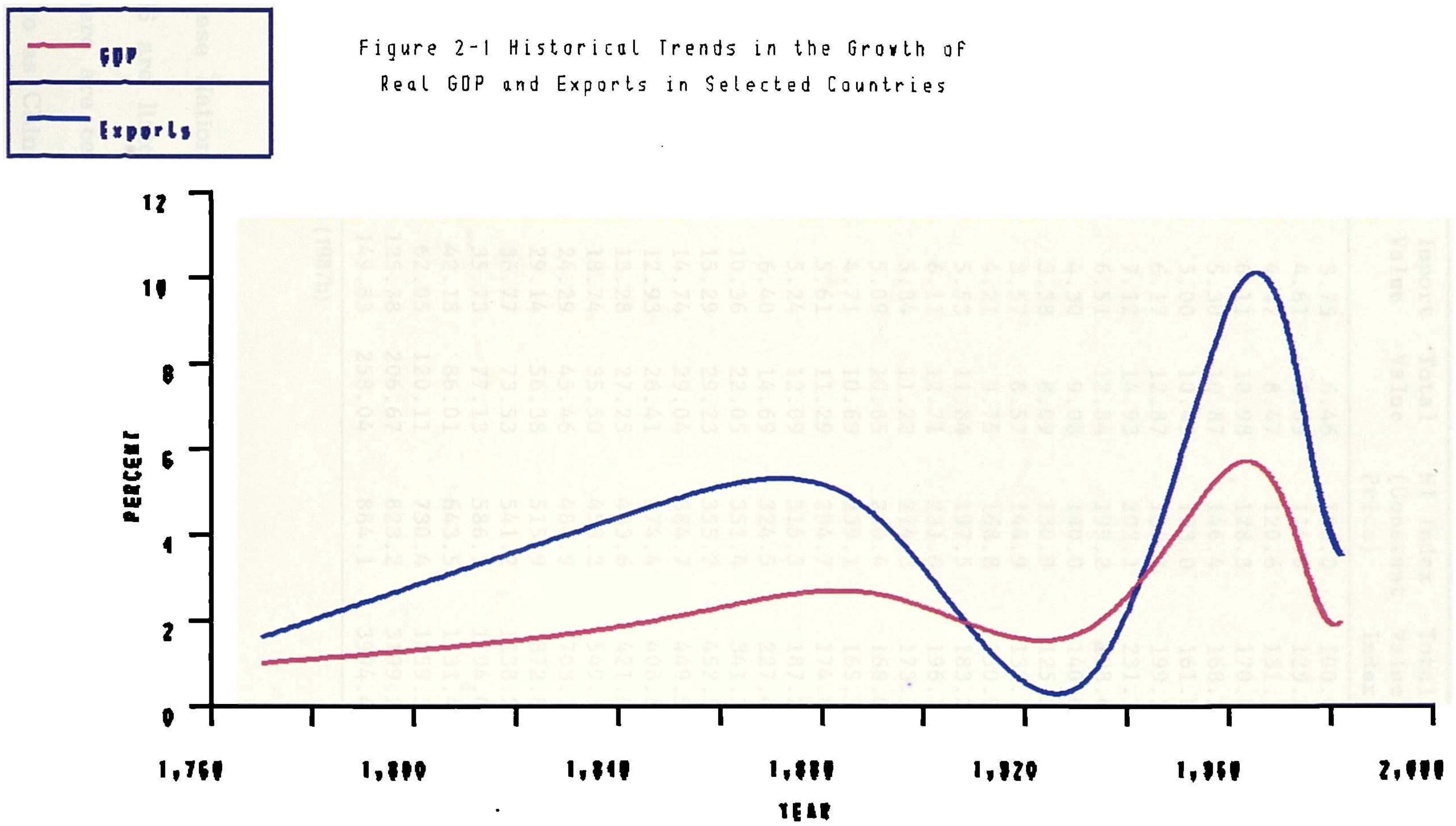
1. Outputs provided by non-material-produce departments (such as government, police, army, scientific research, education, culture, health, restaurant and other service departments) which are included in the GNP, are not included in TPS.

2. The value transferred from crude materials, such as fuel and power (which have been used by material-producing departments during production) which is included in GNP, is excluded from TPS.

There has recently been some development and in the 1987 version of the China Statistics Yearbook (National Statistic Bureau 1987b) GNP data are available for 1985 and 1986, amounting to 830.6 and

1. TPS is the sum of agriculture; industry; construction; transport, posts, telecommunication; and commerce (including supply and marketing of material and equipment and catering). NI is the sum of net output value of the above-mentioned five departments (National Statistics Bureau 1987a).

Figure 2-1 Historical Trends in the Growth of
Real GDP and Exports in Selected Countries



Source: Derived from the World Bank (1987).

938.6 billion yuan respectively. They are of course, too limited in their time span for the study being carried out in this thesis.

Table 2-1 Chinese NI and the Trade Data in Value (Billion Yuan)

Year	NI (Current Price)	Export Value	Import Value	Total Value	NI Index (Constant Price)	Total Value Index
1952	58.9	2.71	3.75	6.46	100.0	100.0
1953	70.9	3.48	4.61	8.09	114.0	125.2
1954	74.8	4.00	4.47	8.47	120.6	131.1
1955	78.8	4.87	6.11	10.98	128.3	170.0
1956	88.2	5.57	5.30	10.87	146.4	168.3
1957	90.8	5.45	5.00	10.45	153.0	161.8
1958	111.8	6.70	6.17	12.87	186.7	199.2
1959	122.2	7.81	7.12	14.93	202.1	231.1
1960	122.0	6.33	6.51	12.84	199.2	198.4
1961	99.6	4.78	4.30	9.08	140.0	140.6
1962	92.4	4.71	3.38	8.09	130.9	125.2
1963	100.0	5.00	3.57	8.57	144.9	132.7
1964	116.6	5.54	4.21	9.75	168.8	150.9
1965	138.7	6.31	5.53	11.84	197.5	183.3
1966	158.6	6.60	6.11	12.71	231.0	196.7
1967	148.7	5.88	5.34	11.22	214.3	173.7
1968	141.5	5.76	5.09	10.85	200.4	168.0
1969	161.7	5.98	4.71	10.69	239.1	165.5
1970	192.6	5.68	5.61	11.29	294.7	174.8
1971	207.7	6.85	5.24	12.09	315.3	187.2
1972	213.6	8.29	6.40	14.69	324.5	227.4
1973	231.8	11.69	10.36	22.05	351.4	341.3
1974	234.8	13.94	15.29	29.23	355.2	452.5
1975	250.3	14.30	14.74	29.04	384.7	449.5
1976	242.7	13.48	12.93	26.41	374.4	408.8
1977	264.4	13.97	13.28	27.25	403.6	421.8
1978	301.0	16.76	18.74	35.50	453.2	549.5
1979	335.0	21.17	24.29	45.46	484.9	703.7
1980	368.8	27.24	29.14	56.38	515.9	872.8
1981	394.0	36.76	36.77	73.53	541.2	1138.2
1982	426.1	41.38	35.73	77.13	586.1	1194.0
1983	473.0	43.83	42.18	86.01	643.5	1331.4
1984	565.0	58.06	62.05	120.11	730.4	1859.3
1985	700.7	80.89	125.78	206.67	823.2	3199.2
1986	779.0	108.21	149.83	258.04	884.1	3994.4

Source: National Statistic Bureau (1987b).

The Chinese National Income and trade data in value terms from 1952 to 1986 are listed in table 2-1. Besides the official Chinese sources, there are certain non-Chinese sources which provide what they refer to as Chinese GNP or GDP data. For example the World

Development Report (World Bank 1987) lists the average annual growth rate of Chinese GDP. From 1965 to 1980, this is shown as growing at a cumulative rate of 6.4 percent, while in the period 1980 -- 1985, it grew at 9.8 percent. These rates of growth are almost identical to those for the Chinese National Income listed in table 2-1, the average annual growth rate of the NI from 1965 to 1980 being 6.6 percent, and from 1980 to 1985, 9.8 percent.

The United Nations' National Accounts Statistics (UN 1986) distinguishes the market economies and the centrally planned economies by using two different systems, i.e. the System of National Accounts (SNA), in which GDP indicator applies, and the System of Material Product Balances (MPS) which applies Net Material Product (NMP) as the equivalent to GDP. Table 2-2 is compiled from the country tables of the National Accounts Statistics (UN 1986, 1985a & 1984b), which gives the Chinese GDP (NMP) data from 1970 to 1983.

Except for a slight difference in 1983, the GDP (NMP) data listed in table 2-2 is identical to the NI data in table 2-1. It may, therefore, be presumed that the Chinese GDP data used by both the World Bank and the United Nations is actually the National Income data presented in the China Statistics Yearbook. Thus in this particular case, the terms Chinese GDP or NMP and the NI may be treated as equivalents and are interchangeable, although in the real economic sense they should be distinguished from each other.

It can be seen from table 2-1 that during the period 1952-1959 both the Chinese economy and its foreign trade experienced continuous

Table 2-2 Chinese NMP at Current Market Prices (Billion Yuan)

YEAR	NMP
1970	192.6
1972	213.6
1973	231.8
1974	234.8
1975	250.3
1976	242.7
1977	264.4
1978	301.0
1979	335.0
1980	368.8
1981	394.0
1982	426.1
1983	467.3

Source: UN (1986, 1985a & 1984b).

growth. At that time the USSR was heavily involved in China's economic development, and the Communist bloc accounted for 65% of China's entire trade during the period (Lauriat 1983). Nineteen sixty saw a downward turn in the economy as well as in trade. This was due to a combination of factors, first the policies of the Great Leap Forward (1958-60), second a series of natural calamities and finally the Sino-Soviet split and the sudden withdrawal of Soviet advisers. Trade and the economy recovered between 1963 and 1966 which was the start of the Cultural Revolution. This was followed by two years of trade and economic recession until 1969. The economy then began to recover although the downward trend in foreign trade continued until 1970. Nineteen seventy was a transitional year in which the major dislocations caused by the Cultural Revolution abated (Kaplan, Sobin & Service 1982). The door of China's foreign trade widened in 1972 following President Nixon's historic visit to China, and this was reflected in an increase in trade value as shown in table 2-1. Nineteen seventy six saw a moderate economic recession attributed to the Tangshan earthquake, the deaths of several prominent figures in the country's leadership including former Chairman Mao Zedong and Premier Zhou Enlai, and the political turmoil thereafter. The national economy recovered quickly in the following year and the doors of trade burst open with the new leadership and the revival of the scheme for the Four Modernisations[1] (Lauriat 1983).

In an effort to modernise China as fast as possible, a large number of complete plants in key industries (such as petro-chemicals and iron and steel) were imported. This caused China to register a trade deficit of RMB1.98 billion yuan (US$1.14 billion) in 1978, followed by a RMB3.12 billion yuan deficit (US$2.01 billion) the next year.

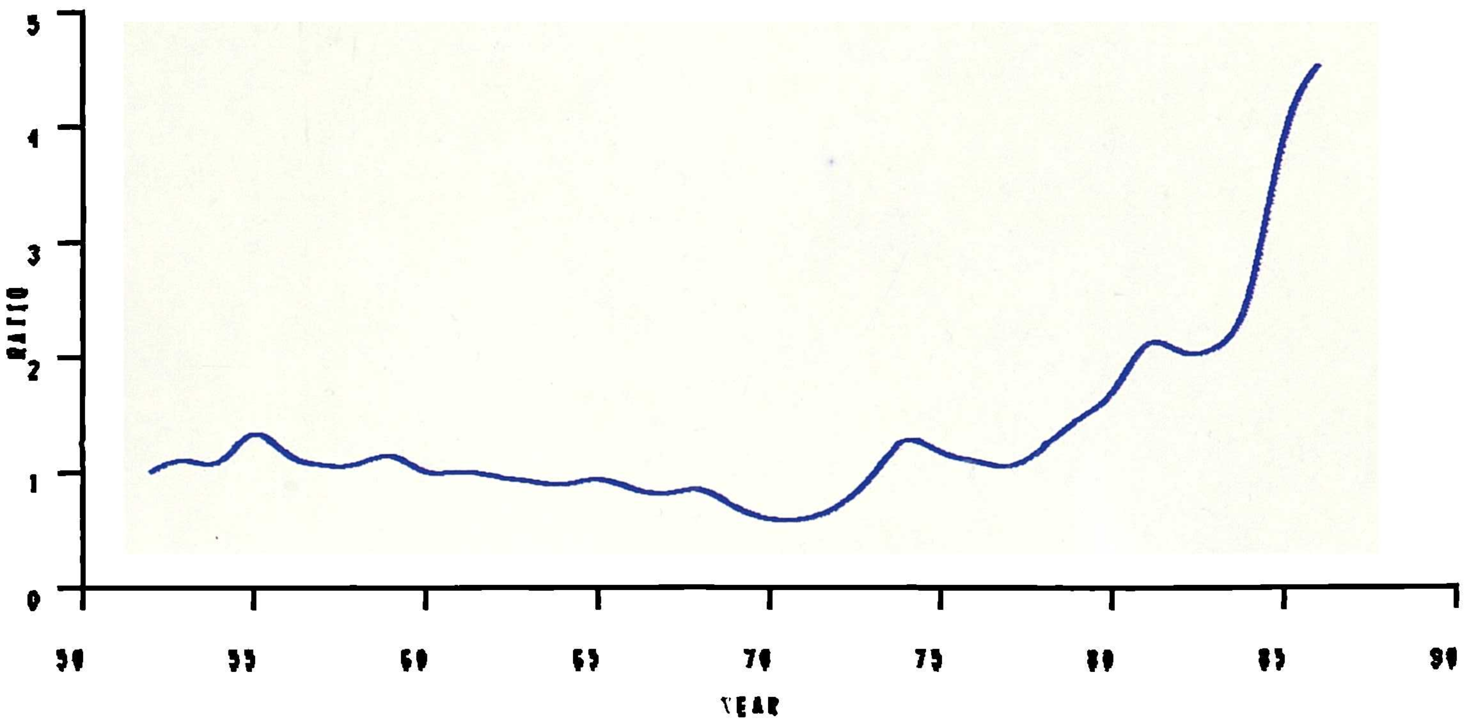
A new trade policy was formulated in 1980 in an effort to stem the growing trade deficits. On the import side this concentrated on importing technology (rather than whole plants) plus grains, iron ore and cotton. Meanwhile efforts were made to increase exports of textiles and oil. The immediate result of this policy was the trade balance in 1981 and the trade surplus in the following two years. Starting from 1984, however, the balance of payments fell into the red once again, as, stimulated by over-heating and the growth of

1. Initially announced by former Premier Zhou Enlai in 1975 which referred to the modernisation of China's Agriculture, Industry, National Defence and Science and Technology.

public consumption, imports rapidly boomed. Table 2-1 indicates that the import value in 1985 more than doubled compared with 1984 and the trade deficit reached an astonishing figure of RMB44.89 billion yuan (US$14.9 billion), falling slightly to RMB41.62 billion yuan (US$11.97 billion) in 1986. A readjustment policy was adopted in the same year which encouraged export expansion and restricted imports of consumer goods. The policy showed its effect in 1987 when China's trade deficit was reduced to RMB13.81 billion yuan (US$3.7 billion) (National Statistic Bureau 1988).

Table 2-1 shows that China's trade and its economy grew hand in hand during a very long period of 28 years (1952-1979) reflected in the ratio between trade value index and the NI index, the highest being 1.45 (1979) and the lowest being 0.59 (1970-1971) (See figure 2-2). In the 1980s, however, the situation changed. Trade in value terms grew far more rapidly than the economy. In 1980, the ratio between the two indexes was 1.69 and in the following three years it reached two. Nineteen eighty four saw the ratio at 2.55 and in the following two years it jumped to 3.89 and 4.52 respectively. It is considered that apart from the real trade volume growth (see 2.3), inflation was another important factor which caused the soaring trade value. However, it is an undoubted fact that international trade has been playing a more and more important part in the Chinese economy.

Figure 2-2 Ratio between Trade Value and NI Indexes



Source: Adapted from table 2-1.

2.3 STRUCTURE OF CHINA'S SEABORNE TRADE

2.3.1 SOURCE OF INFORMATION

Most countries in the world publish or at least collate trade statistics, but the figures are in a variety of different units of quantity, and are classified under a number of different systems. Global data on the movement of international seaborne trade used to be patchy and incomplete. As a developing country and centrally planned economy, the situation in China was even worse. It is very difficult to get access to international trade data and the statistical system differs tremendously from that of most of the market economies in the world. Thanks to the United Nations, who take the initiative of collating those international seaborne trade statistics that are available nationally in machine readable form, the situation now is much improved. The UN statistics provide data for a total of 128 commodity groups and 32 trading areas from 97 countries, and these are sufficiently detailed to be of real use in analysis. For those countries who do not supply export data in machine readable form, data are obtained from trading partners (Pearson 1987).

In carrying out this study, four years of China's seaborne trade data has been obtained from the above mentioned UN trade statistics. These are data for 1975, 1983, 1984 and 1985. The 1975 data provides a base year and the remaining three years' data provide the most up-to-date statistics currently available reflecting the recent trading situation in China.

The UN Maritime Transport Statistics (Sea-borne trade) study divides the world into 32 areas. For the purposes of this study these are grouped into 14 trading regions as follows:

(1) North America -- including the Great Lakes, Canada Atlantic, US North and South Atlantic, US Gulf, US Pacific and the North Pacific of North America.

(2) Central America and Caribbean -- the coasts between Mexico and Panama inclusive, plus all the Caribbean Islands and Bermuda, excluding Puerto Rico.

(3) South America -- including North Coast South America (from Caribbean Colombia to French Guiana, inclusive), East Coast South America (Coast of Brazil, Uruguay and Argentina and the nearby islands), and West Coast South America (from Pacific Colombia to Chile, inclusive).

(4) North and Atlantic Europe -- including the British Isles (UK, Ireland, Iceland and Faeroe Island), North Europe (Belgium, Netherlands, Germany F.R., Denmark, Norway), Centrally planned Europe, Baltic Sea (USSR, Poland and German Dem. Rep.) and Atlantic Europe (French Atlantic Coast, Spanish North Coast and Portugal).

(5) Mediterranean Asia, Europe and Africa -- referring to Mediterranean Europe (from the Spanish South Coast, including the Canary Islands, to that of Greece, inclusive, and Malta), Centrally planned Europe, Black Sea (Bulgaria, Romania and USSR), Mediterranean Asia (from coasts of Turkey to that of Israel, inclusive and Cyprus) and, Mediterranean Africa (from Egypt to Morocco, inclusive).

(6) Africa excluding Mediterranean -- consisting of Western Africa (from Western Sahara to Namibia, inclusive, and the nearby islands), Southern Africa (Republic of South Africa) and Eastern Africa (from Somalia to Mozambique, inclusive, and the nearby islands).

(7) Red Sea, Arabian Gulf -- including the Red Sea (Egypt, Sudan, Ethiopia, Djibouti, Israel, Jordan, Yemen, Dem. Yemen and Saudi Arabian West Coast) and the Persian Gulf (Iran, Iraq, Kuwait, Bahrain, Oman, Saudi Arabian East Coast, Qatar and United Arab Emirats).

(8) Southern Asia -- countries from Pakistan to Burma, inclusive.

(9) South East Asia -- including Malaysia, Singapore, Thailand, Democratic Kampuchea, Indonesia, East Timor, Philippines and Brunei.

(10) China Mainland.

(11) Centrally planned North Pacific excluding China -- consisting of Viet Nam, Democratic People's Republic of Korea and USSR.

(12) Japan.

(13) Far East Asia excluding Japan -- referring to Hong Kong, Macao, South Korea, Taiwan Province of the PRC, and Far East Asia NES.

(14) Oceania -- including Australia, New Zealand and other islands of Oceania.

In the original UN Statistics, the 128 commodity groups are classified into five broad categories, viz:

(1) Bulk, dry

(2) Bulk, liquid

(3) Refrigerated foods

(4) General cargo, dry

(5) Other dry cargo

The Marine Transport Centre has again re-classified the commodity groups more comprehensively according to the transport mode and commodity characteristics. This has been done using the Lotus software Symphony on IBMPC. The re-classification has been adopted by this study and is shown below.

(1) Major bulks

(2) Minor bulks

(3) Semi bulks

(4) Liquid bulks

(5) Oils and fats

(6) Cars and trucks

(7) Refrigerated cargoes

(8) Food, drink and tobacco

(9) Crude materials

(10) Chemicals

(11) Other general cargoes

2.3.2 GEOGRAPHICAL STRUCTURE

China virtually has trade relations with countries all over the world. Tables 2-3, 2-4, 2-5, 2-6 and 2-7 show China's seaborne trade with all the aforementioned regions in volume terms in the years 1975, 1983, 1984 and 1985.

Table 2-3 shows a tremendous growth in China's international seaborne trade during the period 1975-85. Total traffic flow increased from about 30 million tonnes (14 million tonnes of exports and 16 million tonnes of imports) in 1975 to 106 million tonnes (56 million tonnes of exports and 50 million tonnes of imports) in 1985, an average annual growth rate of 13.5%. Japan, North America, South East Asia, Oceania, North and Atlantic Europe, Far East Asia (excluding Japan), etc. are the most important trading partners. By 1985, Japan remained as China's largest trading partner, accounting for 43.2% of China's total exports and 27.4% of the total imports. However a continuous downward trend of the Japanese share was experienced during the period, especially in terms of Chinese exports which were as high as 70.8% in 1975. South East Asia became China's second largest export market in 1985, with a market share of 21%, followed by Far East Asia excluding Japan (13.4%) and North America (10.5%). In terms of Chinese imports, North America was the second most important partner after Japan, accounting for 23.6% of China's total imports in 1985, followed by the Oceania (21.4%) and North and Atlantic Europe (11.6%). It is noticed, however, that North America was China's largest import supplier in 1983 and 1984 (see tables 2-4, 2-5, 2-6 and 2-7).

Theoretically, there should be reasonable volumes of seaborne trade between China and other centrally planned North Pacific countries. Only 85 tonnes of Chinese exports in 1985 and 12 tonnes of Chinese imports in 1984 were shown in the UN seaborne trade statistics. But this may be because the United Nation might not have access to the trade data.

Table 2-3 Traffic Flow (Export + Import) by Region (Tonne)

Region	1975	1983	1984	1985
N. America	2757581	18151028	20225799	17706810
C. America Caribb	244594	820153	707783	865696
S. America	305036	7428334	2578100	3563902
N. & Atlantic Europe, UK	2172443	6337795	5768154	7980211
Med. Asia, Europe, Africa	861103	2623960	3436408	4563985
Africa ex Med.	228798	184935	103534	260920
Red Sea, Arabian Gulf	298228	438528	273983	194847
S. Asia	559779	841612	832514	632325
S.E. Asia	2028555	4514817	8333073	13508219
CP N. Pacific ex China	0	0	12	85
Japan	16195336	28383634	32321509	37816392
Far E. Asia ex Japan	656172	5064644	6876662	7839680
Oceania	3461978	4448933	8117411	10984918
TOTAL	**29769603**	**79238373**	**89574942**	**105917990**

Source: UN (1985b, 1984a, 1983 & 1975)

Table 2-4 Pattern of China's Seaborne Trade in 1975 (Tonne)

Region	Export	%	Import	%
N. America	55887	0.4	2701694	17.3
C. America Caribb	11695	0.1	232899	1.5
S. America	9068	0.1	295968	1.9
N. & Atlantic Europe, UK	745621	5.3	1426822	9.2
Med. Asia, Europe, Africa	299753	2.1	561350	3.6
Africa ex Med.	153037	1.1	75761	0.5
Red Sea, Arabian Gulf	151849	1.1	146379	0.9
S. Asia	385912	2.7	173867	1.1
S.E. Asia	1606074	11.3	422481	2.7
CP N. Pacific ex China	0	0.0	0	0.0
Japan	10038360	70.8	6156976	39.5
Far E. Asia ex Japan	656172	4.6	0	0.0
Oceania	64191	0.5	3397787	21.8
TOTAL	14177619	100.0	15591984	100.0

Source: UN (1975).

Table 2-5 Pattern of China's Seaborne Trade in 1983 (Tonne)

Region	Export	%	Import	%
N. America	2808304	7.8	15342724	35.5
C. America Caribb	12264	0.0	807889	1.9
S. America	2727354	7.6	4700980	10.9
N. & Atlantic Europe, UK	1945097	5.4	4392698	10.2
Med. Asia, Europe, Africa	686518	1.9	1937442	4.5
Africa ex Med.	93010	0.3	91925	0.2
Red Sea, Arabian Gulf	304870	0.8	133658	0.3
S. Asia	454984	1.3	386628	0.9
S.E. Asia	3112324	8.7	1402493	3.2
CP N. Pacific ex China	0	0.0	0	0.0
Japan	18717004	52.0	9666630	22.4
Far E. Asia ex Japan	4977674	13.8	86970	0.2
Oceania	141376	0.4	4307557	10.0
TOTAL	35980779	100.0	43257594	100.0

Source: UN (1983).

Table 2-6 Pattern of China's Seaborne Trade in 1984 (Tonne)

Region	Export	%	Import	%
N. America	4108557	9.2	16117242	36.0
C. America Caribb	1229	0.0	706554	1.6
S. America	2011162	4.5	566938	1.3
N. & Atlantic Europe, UK	1935160	4.3	3832994	8.6
Med. Asia, Europe, Africa	969576	2.2	2466832	5.5
Africa ex Med.	72720	0.2	30814	0.1
Red Sea, Arabian Gulf	60017	0.1	213966	0.5
S. Asia	555943	1.2	276571	0.6
S.E. Asia	6898565	15.4	1434508	3.2
CP N. Pacific ex China	0	0.0	12	0.0
Japan	21527212	48.0	10794297	24.1
Far E. Asia ex Japan	6540147	14.6	336515	0.8
Oceania	136244	0.3	7981167	17.8
TOTAL	44816532	100.0	44758410	100.0

Source: UN (1984).

Table 2-7 Pattern of China's Seaborne Trade in 1985 (Tonne)

Region	Export	%	Import	%
N. America	5852637	10.5	11854173	23.6
C. America Caribb	178766	0.3	686930	1.4
S. America	1967273	3.5	1596629	3.2
N. & Atlantic Europe, UK	2162935	3.9	5817276	11.6
Med. Asia, Europe, Africa	1525851	2.7	3038134	6.1
Africa ex Med.	213082	0.4	47838	0.1
Red Sea, Arabian Gulf	106688	0.2	88159	0.2
S. Asia	287232	0.5	345093	0.7
S.E. Asia	11692897	21.0	1815322	3.6
CP N. Pacific ex China	85	0.0	0	0.0
Japan	24075792	43.2	13740600	27.4
Far E. Asia ex Japan	7467036	13.4	372644	0.7
Oceania	249303	0.4	10735615	21.4
TOTAL	55779577	100.0	50138413	100.0

Source: UN (1985).

2.3.3 COMMODITY STRUCTURE

Tables 2-8 to 2-12 show the commodity structure of China's seaborne trade in 1975, 1983, 1984 and 1985 respectively. It can be seen from the tables that Chinese trade was scattered around all the eleven commodity groups. Liquid bulk was the largest trading commodity with more than nine million tonnes, accounting for over 30% of Chinese seaborne trade in 1975. This was followed by semi-bulks (24%), major bulks (22.5%), general cargoes (13%, including food, drink and tobacco, crude materials, chemicals and other general cargoes) and minor bulks (8%). The situation was similar in 1985. Liquid bulks, semi-bulks and major bulks still took the lead. However, the share of the minor bulks had risen to 12% and that of the general cargoes fallen to 10%.

In 1985, liquid bulks dominated Chinese exports, accounting for 73% of the total volume, followed by minor bulks (20%), major bulks (18%) and general cargoes (10%). Turning to the import sector, more than half of the total volume were semi bulks. Other major imports were major bulks (28%) and general cargoes (12%).

Comparing table 2-12 with 2-11, it can be seen that total Chinese seaborne export volume experienced an increase of over 24% during 1984-85. Although the total import volume only increased 12% during the same period, it is noticed that the volume of general cargo imports increased by over 28%. General cargoes are small in volume compared with bulk goods, but are much higher in value. The comparison of the two years' data thus partly explains the rapid growth in China's trade value during 1984-85. What is more, seaborne trade does not represent the entire trade volume, although it is the dominant mode. An increase of trade volume carried by other transport modes, land or air, which are quite possibly of high value goods, can greatly contribute to the total trade value.

Table 2-8 Traffic Flow (Export + Import) by Commodity (Tonne)

Commodity	1975	1983	1984	1985
Major bulks	6692770	21786192	20911103	22082882
Minor bulks	2470306	8633567	10497267	12351965
Semi bulks	7092622	21382385	23528836	26976142
Liquid bulks	9095436	18158713	24490342	32754657
Oils & fats	131443	210389	157764	274488
Cars & trucks	67957	67672	201139	568563
Refrigerated cargoes	228337	376759	348953	285832
Food drink & tobacco	673250	1652205	1317029	1401479
Crude materials	701258	1021675	1302734	1475501
Chemicals	1346269	3016599	3357983	3422277
Other general cargo	1269955	2932217	3461792	4324174
TOTAL	29769603	79238373	89574942	105917990

Source: UN (1985b, 1984a, 1983 & 1975).

Table 2-9 Commodity Structure of China's Seaborne Trade in 1975 (Tonne)

Commodity	Export	%	Import	%
Major bulks	1641758	11.6	5051012	32.4
Minor bulks	1638794	11.6	831512	5.3
Semi bulks	145552	1.0	6947070	44.6
Liquid bulks	8980556	63.3	114880	0.7
Oils & fats	26541	0.2	104902	0.7
Cars & trucks	757	0.0	67200	0.4
Refrigerated cargoes	227891	1.6	446	0.0
Food drink & tobacco	636019	4.5	37231	0.2
Crude materials	138019	1.0	563239	3.6
Chemicals	242633	1.7	1103636	7.1
Other general cargo	499099	3.5	770856	4.9
TOTAL	14177619	100.0	15591984	100.0

Source: UN (1975).

Table 2-10 Commodity Structure of China's Seaborne Trade in 1983 (Tonne)

Commodity	Export	%	Import	%
Major bulks	5003451	13.9	16782741	38.8
Minor bulks	6667202	18.5	1966365	4.5
Semi bulks	1375817	3.8	20006568	46.2
Liquid bulks	18117019	50.4	41694	0.1
Oils & fats	118703	0.3	91686	0.2
Cars & trucks	1985	0.0	65687	0.2
Refrigerated cargoes	370001	1.0	6758	0.0
Food drink & tobacco	1086894	3.0	565311	1.3
Crude materials	324420	0.9	697255	1.6
Chemicals	1086956	3.0	1929643	4.5
Other general cargo	1828331	5.1	1103886	2.6
TOTAL	35980779	100.0	43257594	100.0

Source: UN (1983).

Table 2-11 Commodity Structure of China's Seaborne Trade in 1984 (Tonne)

Commodity	Export	%	Import	%
Major Bulks	5003451	13.9	15001955	33.5
Minor Bulks	5909148	13.2	2297496	5.1
Semi bulks	1094514	2.4	22434322	50.1
Liquid Bulks	24347419	54.3	142923	0.3
Oils & fats	82860	0.2	74904	0.2
Cars & trucks	2889	0.0	198250	0.4
Refrigerated cargoes	343489	0.8	5464	0.0
Food drink & tobacco	1011751	2.3	305278	0.7
Crude materials	598733	1.3	704001	1.6
Chemicals	1081360	2.4	2276623	5.1
Other general cargo	2144598	4.8	1317194	2.9
TOTAL	44,816,532	100.0	44,758,410	100.0

Source: UN (1984).

Table 2-12 Commodity Structure of China's Seaborne Trade in 1985 (Tonne)

Commodity	Export	%	Import	%
Major Bulks	8200510	18.3	13882372	27.7
Minor Bulks	9080274	20.3	3271691	6.5
Semi bulks	675509	1.5	26300633	52.5
Liquid bulks	32730618	73.0	24039	0.0
Oils & fats	99340	0.2	175148	0.3
Cars & trucks	2770	0.0	565793	1.1
Refrigerated cargoes	278970	0.6	6862	0.0
Food drink & tobacco	1147722	2.6	253757	0.5
Crude materials	608600	1.4	866901	1.7
Chemicals	890428	2.0	2531849	5.0
Other general cargo	2064836	4.6	2259368	4.5
TOTAL	55779577	100.0	50138413	100.0

Source: UN (1985).

2.4 THE GENERAL CARGO TRADES

Following the general review of all China's trade, the thesis now focuses on the general cargo groups which provide most of the containerised cargo. These are food, drink and tobacco; crude materials; chemicals and other general cargoes.

2.4.1 FOOD, DRINK AND TOBACCO

Tables 2-13, 2-14, 2-15 and 2-16 show details of China's exports and imports of food, drink and tobacco in 1975, 1983, 1984 and 1985. The major Chinese exports are vegetable products, dried vegetables and prepared vegetables NES. In 1985 they accounted for 58% by weight of the total Chinese exports of food, drink and tobacco. Tea and mate were the other major items accounting for 10%. Around 42% of the Chinese imports in 1985 were cereals, flour, and meal. Other major import commodities in the same year were refined sugar (17%) and non-fresh milk etc (10%).

In 1985, around 53% of the Chinese exports of food, drink and tobacco went to North and Atlantic Europe and the Mediterranean area. Other major markets were Japan (19%), South East Asia (15%) and Far East Asia (excluding Japan, 6%). About 58% of Chinese imports of food, drink and tobacco came from South East Asia and Japan. North America and North and Atlantic Europe were the other two big suppliers accounting for 35% in aggregate.

Table 2-13 Breakdown of Food, Drink and Tobacco by Commodity (Export Tonne)

Commodity	1975	1983	1984	1985
Refined sugar	73483	4327	2052	10369
Coffee	1741	9990	3688	2327
Tea and mate	35605	85736	102134	101947
Meat,dried etc	9734	34647	24497	11200
Non-fresh milk etc	954	650	521	472
Fish,dried etc	2268	1413	763	840
Fish NES, tinned	10885	14832	13538	10806
Meal, cereal flour	937	12228	3644	832
Prepared grains	16321	29115	51293	50107
Edible nuts	40734	42209	46540	52764
Dry fruits etc	53360	81573	68460	55413
Dried vegetables	54655	72070	90930	89374
Prepared vegetables NES	112985	245318	237841	234179
Confectionery etc	21400	69458	45931	46608
Cocoa and chocolate	1773	7603	7999	8137
Spices	27023	68376	66660	48902
Margarine etc	309	11	84	0
Food preparations	10517	37087	38850	34162
Vegetable products	124669	222388	149822	342223
Non-alcoholic beverage	3803	3822	3213	4214
Alcoholic bev.	7844	23465	31917	29268
Tobacco, unmanufactured	24921	20111	20871	12950
Tobacco, manufactured	98	438	503	628
TOTAL	636019	1086894	1011751	1147722

Source: UN (1985b, 1984a, 1983 & 1975).

Table 2-14 Breakdown of Food, Drink and Tobacco by Commodity (Import Tonne)

Commodity	1975	1983	1984	1985
Refined sugar	0	382776	46210	42177
Coffee	3281	24448	6473	3107
Tea and mate	2000	226	263	2966
Meat,dried etc	0	360	315	148
Non-fresh milk etc	0	5447	4284	25691
Fish,dried etc	4	0	0	9
Fish NES, tinned	0	39	20	20
Meal, cereal flour	0	107709	176586	106048
Prepared grains	9	224	1923	1069
Edible nuts	20012	1441	1103	835
Dry fruits etc	30	674	4054	4031
Dried vegetables	992	30874	48557	39334
Prepared vegetables NES	8	690	945	9185
Confectionery etc	20	3360	5375	2603
Cocoa and chocolate	9874	2448	1856	7421
Spices	725	360	439	433
Margarine etc	217	885	923	2033
Food preparations	11	205	253	778
Vegetable products	2	0	13	9
Non-alcoholic beverage	3	398	280	150
Alcoholic bev.	41	2156	999	2159
Tobacco, unmanufactured	0	200	4394	2,794
Tobacco, manufactured	2	99	31	757
TOTAL	37231	565311	305278	253757

Source: UN (1985b, 1984a, 1983 & 1975).

Table 2-15 Breakdown of Food, Drink and Tobacco by Region (Export Tonne)

Region	1975	1983	1984	1985
N. America	3741	27397	38082	47805
C. America Caribb	81	178	90	110
S. America	182	207	192	319
N. & Atlantic Europe, UK	255985	342155	214134	361090
Med. Asia, Europe, Africa	43767	116094	174034	244591
Africa ex Med.	7507	3778	1178	952
Red Sea, Arabian Gulf	43519	46443	7262	7072
S. Asia	11069	30315	16087	9734
S.E. Asia	162782	221135	227981	176195
CP N. Pacific ex China	0	0	0	0
Japan	100120	220210	244836	214667
Far E. Asia ex Japan	75	65313	72933	70201
Oceania	7191	13669	14942	14986
TOTAL	636019	1086894	1011751	1147722

Source: UN (1985b, 1984a, 1983 & 1975)

Table 2-16 Breakdown of Food, Drink and Tobacco by Region (Import Tonne)

Region	1975	1983	1984	1985
N. America	0	21041	71058	59469
C. America Caribb	2231	0	0	0
S. America	2	1740	505	15
N. & Atlantic Europe, UK	54	375568	33056	28349
Med. Asia, Europe, Africa	47	4010	14474	6253
Africa ex Med.	29741	557	290	3706
Red Sea, Arabian Gulf	1232	0	43	0
S. Asia	2024	12219	28	2751
S.E. Asia	1675	60666	83870	89492
CP N. Pacific ex China	0	0	0	0
Japan	0	80698	99616	57533
Far E. Asia ex Japan	0	573	577	644
Oceania	225	8239	1761	5545
TOTAL	37231	565311	305278	253757

Source: UN (1985b, 1984a, 1983 & 1975)

2.4.2 CRUDE MATERIALS

Crude materials include crude rubber, wool, animal hair, cotton and crude organics, etc (tables 2-17 and 2-18). In 1985, cotton had a share of 45% out of 0.6 million tonnes of the Chinese exports of crude materials. Another major item was crude organic NES which accounted for 37%. Major Chinese imports in the same year were crude rubber (36%), wool, animal hair (15%) and other fibres NES (44%).

Nearly 70% of the Chinese exports of crude materials went to Far East Asia including Japan in 1985. North and Atlantic Europe and the Mediterranean together made up for 21%. On the other hand, 48% of the Chinese imports in the same year came from South East Asia and Japan. Other major suppliers were Mediterranean Asia, Europe and Africa (15%), Oceania (12%) and North America (7%) (see tables 2-19 and 2-20).

Table 2-17 Breakdown of Crude Materials by Commodity (Export Tonne)

Commodity	1975	1983	1984	1985
Crude rubber	177	3444	4842	2653
Wool, animal hair	15196	15496	20634	18488
Cotton	18469	46843	225323	274323
Jute	674	31118	21220	32521
Hard fibres	2357	5505	3253	2579
Other fibres NES	32052	42541	68622	50647
Undressed Fur skins	250	343	938	1284
Cork, raw and waste	0	5	0	1
Crude organic NES	68844	179125	253901	226104
TOTAL	138019	324420	598733	608600

Source: UN (1985b, 1984a, 1983 & 1975).

Table 2-18 Breakdown of Crude Materials by Commodity (Import Tonne)

Commodity	1975	1983	1984	1985
Crude rubber	273840	159781	298327	314221
Wool, animal hair	4820	81106	70759	132152
Cotton	183945	229668	34872	25647
Jute	0	66798	20893	10434
Hard fibres	10500	0	1	0
Other fibres NES	89180	156833	273934	376777
Undressed fur skins	0	126	87	304
Cork, raw and waste	67	274	615	608
Crude organic NES	887	2669	4513	6758
TOTAL	563239	697255	704001	866901

Source: UN (1985b, 1984a, 1983 & 1975).

Table 2-19 Breakdown of Crude Materials by Region (Export Tonne)

Region	1975	1983	1984	1985
N. America	2839	10840	12327	6851
C. America Caribb	128	9	0	1
S. America	61	388	159	103
N. & Atlantic Europe, UK	55129	71642	80406	91573
Med. Asia, Europe, Africa	8340	24000	30690	45014
Africa ex Med.	301	41	63	179
Red Sea, Arabian Gulf	778	2020	4864	637
S. Asia	9	5262	11860	16327
S.E. Asia	2327	52302	71717	29887
CP N. Pacific ex China	0	0	0	0
Japan	66542	150218	179447	202596
Far E. Asia ex Japan	15	6311	203377	214192
Oceania	1550	1387	3823	1240
TOTAL	138019	324420	598733	608600

Source: UN (1985b, 1984a, 1983 & 1975)

Table 2-20 Breakdown of Crude Materials by Region (Import Tonne)

Region	1975	1983	1984	1985
N. America	60706	28735	79612	63893
C. America Caribb	25079	31500	1500	1500
S. America	8885	50388	21398	23354
N. & Atlantic Europe, UK	18035	24694	21915	44538
Med. Asia, Europe, Africa	32849	75363	110527	128957
Africa ex Med.	18367	5662	0	0
Red Sea, Arabian Gulf	60763	20000	20890	20604
S. Asia	100006	187072	31349	25345
S.E. Asia	160122	125938	245002	225252
CP N. Pacific ex China	0	0	0	0
Japan	73603	72841	115103	189993
Far E. Asia ex Japan	0	1931	5073	36153
Oceania	4824	73131	51632	107312
TOTAL	563239	697255	704001	866901

Source: UN (1985b, 1984a, 1983 & 1975)

2.4.3 CHEMICALS

Chemicals form an important part of China's general cargo trade. The detailed breakdown of chemicals by commodity and region are presented in tables 2-21, 2-22, 2-23 and 2-24. In 1985, the most important Chinese export of chemical products were the inorganic chemicals which represented a share of 45% out of the total of 0.9 million tonnes. Other major items were organic chemicals (16%) and chemicals NES (23%). Among the total of 2.5 million tonnes of imported chemical products were plastic materials (50%), organic chemicals (23%) and inorganic chemicals (21%).

Fifty eight percent of China's chemical product exports went to Far East Asia including Japan. Exports to North and Atlantic Europe, Southern Asia, the Mediterranean, South East Asia and the Oceania aggregately made up for about 39%. Turning to China's imports of chemicals, North and Atlantic Europe provided 36%, followed by Japan (26%), North America (18%) and the Mediterranean (10%).

Table 2-21 Breakdown of Chemicals by Commodity (Export Tonne)

Commodity	1975	1983	1984	1985
Chemicals NES	242633	242432	248899	204791
Organic chemicals	0	220931	184693	145320
Inorganic chemicals	0	467517	436744	401259
Radioactive mater.	0	936	0	0
Dyeing,tanning mater.	0	50354	104318	43018
Medicinal products	0	19164	18026	21230
Perfume, ess. oils	0	36767	48956	33182
Plastic mater.	0	48855	39724	41628
TOTAL	242633	1086894	1081360	890428

Source: UN (1985b, 1984a, 1983 & 1975).

Table 2-22 Breakdown of Chemicals by Commodity (Import Tonne)

Commodity	1975	1983	1984	1985
Chemicals NES	1103636	75115	90657	77409
Organic chemicals	0	404914	488062	574123
Inorganic chemicals	0	704209	588490	541507
Radioactive mater.	0	2	8	2
Dyeing,tanning mater.	0	15215	15231	16406
Medicinal products	0	1052	1929	2668
Perfume, ess. oils	0	33026	35925	48993
Plastic mater.	0	696110	1056321	1270741
TOTAL	1103636	1929643	2276623	2531849

Source: UN (1985b, 1984a, 1983 & 1975).

Table 2-23 Breakdown of Chemicals by Region (Export Tonne)

Region	1975	1983	1984	1985
N. America	2870	30144	41068	21212
C. America Caribb	544	279	67	15
S. America	2579	5011	2249	972
N. & Atlantic Europe, UK	68610	167883	162790	136975
Med. Asia, Europe, Africa	18517	74880	61004	49763
Africa ex Med.	6163	3351	749	895
Red Sea, Arabian Gulf	27503	2643	2030	1489
S. Asia	1859	77714	127598	68594
S.E. Asia	42324	167541	140147	48043
CP N. Pacific ex China	0	0	0	0
Japan	62082	270536	269961	255399
Far E. Asia ex Japan	20	249049	231195	260718
Oceania	9526	37925	42502	46353
TOTAL	242,633	1,086,956	1,001,360	890,428

Source: UN (1985b, 1984a, 1983 & 1975)

Table 2-24 Breakdown of Chemicals by Region (Import Tonne)

Region	1975	1983	1984	1985
N. America	129784	229934	402564	446486
C. America Caribb	520	0	0	576
S. America	199	100089	2300	5103
N. & Atlantic Europe, UK	152973	746491	928167	900708
Med. Asia, Europe, Africa	82398	199690	223109	241736
Africa ex Med.	5	1315	0	83
Red Sea, Arabian Gulf	12	0	0	0
S. Asia	83	51	28	1
S.E. Asia	53	33057	58823	136813
CP N. Pacific ex China	0	0	0	0
Japan	735920	610168	548429	653414
Far E. Asia ex Japan	0	7372	108821	143764
Oceania	1689	1476	4382	3165
TOTAL	1103636	1929643	2276623	2531849

Source: UN (1985b, 1984a, 1983 & 1975)

2.4.4 OTHER GENERAL CARGOES

The remaining general cargoes fall into the category of Others. They consist of textiles, electrical machinery and other machinery NES, metallic products, miscellaneous manufactures, and non-ferrous metal, etc. Tables 2-25 and 2-26 show the detail. In 1985 the major Chinese export goods were textiles (0.6 million tonnes), miscellaneous manufactures (0.5 million tonnes), miscellaneous metallic products (0.3 million tonnes) and mineral manufactures NES (0.3 million tonnes). On the other hand, electrical machinery and other machinery NES (0.6 million tonnes), aluminium (0.3 million tonnes), metal working machines (0.2 million tonnes) and textiles (0.2 million tonnes) were the major imports in the same year.

In 1985, 60% of China's exports of the other general cargoes went to Far East including Japan. North and Atlantic Europe and the Mediterranean together made for 22% and the North America accounted for 8%. In terms of China's imports, Japan was the largest supplier with a share of 47%. Other large partners were North and Atlantic Europe (16%), North America (15%), the Mediterranean (10%) and the Oceania (6%) (see tables 2-27 and 2-28).

Table 2-25 Breakdown of Other General Cargoes by Commodity (Export Tonne)

Commodity	1975	1983	1984	1985
Articles of paper	4373	43854	44880	38514
Textiles	161134	392726	654081	642257
Electrical machinery	14484	43658	62272	64775
Other machinery NES	12578	41679	36560	28026
Leather and rubber	32995	54340	45077	45273
Veneer sheets plyw.	3982	7964	3393	3942
Wood and cork, NES	3705	33608	30914	36791
Mineral manuf. NES	76381	225744	307331	262572
Misc. metallic products	27886	335400	290497	251204
Misc. manuf.	116893	458883	496615	500868
Crude minerals NES	961	12648	13547	12943
Copper	357	11325	9444	6042
Aluminium	328	24242	7304	6181
Tin	4773	3243	2890	15020
Non-ferr. met. NES	7905	15200	17208	15982
Finished structure	1729	4294	3723	2787
Wire, metal container	4482	21393	17526	10087
Agricultural machin.	816	3435	3932	4062
Metal working machin.	3957	11920	13075	13269
Motorcycles & parts	954	10	23	106
Railway vehic.	3997	19199	18665	13860
Aircraft,boats	24	30	44	406
Live animals	4	212	89	66
Hides & skins	2716	21271	13836	24805
Explosives	9018	37492	45900	49056
Commodities NES	2665	4561	5772	15942
TOTAL	499099	1828331	2144598	2064836

Source: UN (1985b, 1984a, 1983 & 1975).

Table 2-26 Breakdown of Other General Cargoes by Commodity (Import Tonne)

Commodity	1975	1983	1984	1985
Articles of paper	308	1645	1712	2396
Textiles	30492	73644	105022	187944
Electrical machinery	17276	34457	94036	282124
Other machinery NES	108767	105839	154459	346826
Leather and rubber	1111	43486	28253	54771
Veneer sheets plyw.	408	22998	11836	14662
Wood and cork, NES	84	5499	1839	1475
Mineral manuf. NES	7980	39289	53860	123167
Misc. metallic products	6611	7944	17885	26647
Misc. manuf.	3682	20060	28108	56415
Crude minerals NES	7	105	85	1136
Copper	24595	223856	98736	121926
Aluminium	344679	165551	125103	252190
Tin	4	50	20	137
Non-ferr. met. NES	30655	151433	223135	171768
Finished structure	23543	33427	15667	52331
Wire, metal container	44465	39952	67883	122120
Agricultural machin.	6843	1984	8077	23630
Metal working machin.	57790	51820	110503	230720
Motorcycles & parts	1087	109	10242	30522
Railway vehic.	23077	13351	64244	35394
Aircraft,boats	26390	1042	205	4573
Live animals	2	174	939	2876
Hides & skins	9999	4670	15107	22393
Explosives	1	3	98	136
Commodities NES	1000	61532	80131	91062
TOTAL	770856	1103886	1317194	2259368

Source: UN (1985b, 1984a, 1983 & 1975).

Table 2-27 Breakdown of Other General Cargoes by Region (Export Tonne)

Region	1975	1983	1984	1985
N. America	22122	165723	185854	166590
C. America Caribb	3308	9870	907	306
S. America	5183	6915	5480	504
N. & Atlantic Europe, UK	85100	308953	319377	319189
Med. Asia, Europe, Africa	65080	181087	148282	137767
Africa ex Med.	63352	15288	7037	6345
Red Sea, Arabian Gulf	54102	127400	27515	24238
S. Asia	12677	44551	43685	41320
S.E. Asia	115193	371140	224445	100592
CP N. Pacific ex China	0	0	0	85
Japan	57183	236978	290656	315416
Far E. Asia ex Japan	0	330213	852346	923874
Oceania	15799	30213	39014	28610
TOTAL	499099	1828331	2144598	2064836

Source: UN (1985b, 1984a, 1983 & 1975)

Table 2-28 Breakdown of Other General Cargoes by Region (Import Tonne)

Region	1975	1983	1984	1985
N. America	154043	328668	251960	333490
C. America Caribb	4992	0	0	3
S. America	49	30708	5607	28567
N. & Atlantic Europe, UK	247049	215053	275796	371287
Med. Asia, Europe, Africa	79466	63425	114721	213943
Africa ex Med.	1453	274	318	204
Red Sea, Arabian Gulf	19528	121	0	55
S. Asia	3656	3553	2298	2637
S.E. Asia	324	34318	43429	70793
CP N. Pacific ex China	0	0	12	0
Japan	244977	363450	527372	1065204
Far E. Asia ex Japan	0	4275	9286	37057
Oceania	15319	59591	86395	136128
TOTAL	770856	1103886	1317194	2259368

Source: UN (1985b, 1984a, 1983 & 1975)

REFERENCES

Dixit, A. & Norman, V. (1980), *Theory of International Trade,* Jamese Nisbet and Company Limited, Welwyn, Herts. & the Cambridge University Press.

Goss, R. O. (1983), *Economics and the International Regime for Shipping,* A paper for the Ucl-Soiuzmorniiproekt Law of the Sea Colloquium, Moscow.

IMF (1985), *International Financial Statistics,* vol. 38, n.p.

Kaplan, F. M., Sobin, J. M. & Service, J. S. (1982), *Encyclopaedia of China Today,* 3rd edn, Macmillan Publishers, London.

Lauriat, G. (1983), *China Shipping, the Great Leap Forward,* Lloyd's of London Press, Colchester, England.

National Statistic Bureau (1988), Communique on the Statistics of 1987 Economic and Social Development, *Beijing Review,* 31: no. 9, 20-26.

__ (1987a), Communique on the Statistics of 1986 Economic and Social Development, *Beijing Review,* 30: no. 9, 20-26.

__ (1987b), *China Statistics Yearbook 1987* (in Chinese), China Statistics Press, Beijing.

__ (1985), *China Statistics Yearbook 1985* (in Chinese), China Statistics Press, Beijing.

Pearson, R. (1987), *Container Ships and Shipping,* Fairplay, London.

UN (1986), *National Accounts Statistics: Main Aggregates and Detailed Tables, 1984,* United Nations, New York.

__ (1985a), *National Accounts Statistics: Main Aggregates and Detailed Tables, 1983,* United Nations, New York.

__ (1985b, 1984a, 1983 & 1975), *Maritime Transport Statistics (Seaborne Trade),* New York.

__ (1984b), *National Accounts Statistics: Main Aggregates and Detailed Tables, 1982,* United Nations, New York.

World Bank (1987), *World Development Report 1987,* Oxford University Press, New York.

CHAPTER 3 CONTAINER TRAFFIC FORECASTS TO 1995

3.1 INTRODUCTION

China's seaborne container traffic increased rapidly since 1978 when Cosco Shanghai set up the country's first containerised liner service. In 1986 Cosco shipped some 315,000 TEUs and the total container throughput for major Chinese container ports amounted to 533,007 TEUs (CI 1988). Shanghai, China's largest container port, ranking 59 in the world, handled 250,000 TEUs in 1986 (CI 1988) and Cosco Shanghai, the major container carrier in China, ranked 12 in the world with an annual deployment of 438,037 TEUs (Transmodal Industries Research 1986). These are quite remarkable figures when it is taken into account that they have been achieved in the short period of 8 years.

It is clearly likely that container traffic in China will grow in response to increasing container penetration (see 3.5) and the growth of the economy. However, precisely, how big will the demand of container traffic be in the next few years, and therefore, how is the supply, i.e. shipping, inland and port sectors going to meet such demand? This remains a question. A reliable estimate of container traffic is fundamental for China's container shipping industry and it is the purpose of this chapter to provide a long range forecast of China's container traffic up to the year 1995. The forecast is based on China's seaborne trade data introduced in Chapter 2, Chinese statistics of National Income and trade, and Containerisation International Yearbook statistics of container movements through Chinese ports.

3.2 CONTAINER POTENTIAL

The overall structure of China's seaborne trade is analysed in Chapter 2, which contains all groups of cargo, i.e. major bulks, minor bulks, semi-bulks, liquid bulks, refrigerated foods, specialised goods and general cargoes. Clearly not all these goods can be containerised, e.g. liquid bulks. Even in the general cargo sector, which is considered to be highly containerisable, there are still cargoes which are not suitable for container transport. However, technological progress continues to bring cargoes into the container sector as in the case of coffee, where ventilation, lining and other techniques have solved the problem of condensation.

From the start of the container revolution to the late 1970's container technology or capability has been increasing continuously. Since the turn of this decade (the 1980's), it is considered that world containerisation has moved into its full maturity, particularly between developed nations. The development of container traffic follows the classic 'S' curve (Gilman 1983). Container traffic grows slowly when the system is initially introduced, as this is an initial learning period. This is followed by a period of very rapid growth as the system takes over general cargo traffics. Eventually a break point is reached at which the transfer of cargo from the conventional system to the new container system is complete. After that the rate of growth falls back to that generated by the natural increase of trade. Although it can be assumed that the level and degree of containerisation on the major developed routes has reached its maximum, there is still some growth to come from increasing container penetration in some developing countries. China, because of its late start and lack of development of container infrastructure, is a case in point. All countries differ in their trade patterns but it is safe to assume that the level and degree of containerisation in China will not exceed what has already been achieved by developed countries. Thus China's container potential may be defined by applying the level and degree of containerisation which has already been achieved in developed countries on a commodity by commodity basis to China's traffic pattern.

In carrying out this analysis both cargo volume and commodity type determine the extent of containerisation, as the propensity to containerise a cargo is not only based on a commodity's physical characteristics, but also on the volume of trade (World Bank 1984). In some cases trade growth can lead to a reduction in the proportion of traffic available to container services. For example, a small volume of bulk cargo might well be carried in containers whereas a large volume would justify the use of a specialised bulk carrier.

Table 3-1 gives the container potential factors (CPF) for the 128 commodity groups of the UN data base, penetration rates being derived in the Liverpool University Marine Transport Centre from the UK Customs statistics. This distinguishes three categories of trade volume, viz. those under 10,000 tonnes, those between 10,000 and 100,000 tonnes and those over 100,000 tonnes. The table also shows the container stowage rates (CSR) in TEUs per tonne.

This is a broad analysis based on U.K. experience. It is used when it is not possible to make a case to case study to produce precise results. The results are estimates which produce a reasonably accurate analysis of the container potential of China's seaborne trade. The following example illustrates how the container potential is calculated using CPF, CSR and the trade data in tonne.

> In 1984, China exported 2,052 tonnes of refined sugar (table 2-13). According to table 3-1, the CPF for refined sugar under 10,000 tonnes of trade volume is 1 and the CSR is 0.08. Therefore the export container potential of refined sugar would be 2050 $\times$ 1 $\times$ 0.08 = 164 TEUs. In the same year, China imported 46,210 tonnes of refined sugar. In this case the CPF is 0.5 and thus the import container potential of refined sugar would be 46210 $\times$ 0.5 $\times$ 0.08 = 1848 TEUs.

Based on this methodology and data presented in Chapter 2 and table 3-1, tables 3-2, 3-3, 3-4 and 3-5 show the container potential of Chinese seaborne trade in 1975, 1983, 1984 and 1985; table 3-6 then gives the summary. It is shown that container potential grew substantially between 1975 and 1985. Export volume increased from 149,263 TEUs in 1975 to 425,343 TEUs in 1985 while the import volume increased just in line from 187,445 TEUs in 1975 to 532,970 TEUs in 1985. Both export and import potential experienced an average annual growth rate of 11 percent.

Table 3-1 Container Potential Factors and Stowage Rates

Commodity	CPF			CSR
	<10000	10000-100000	>100000	
Wheat,unmilled	0.00	0.00	0.00	0.12
Rice	0.80	0.10	0.00	0.12
Cereals nes unm.	0.00	0.00	0.00	0.12
Iron ores	0.25	0.00	0.00	0.06
Bauxite	0.25	0.00	0.00	0.07
Coal	0.00	0.00	0.00	0.06
Coke	0.00	0.00	0.00	0.05
Other solid fuels	0.00	0.00	0.00	0.06
Natural phosphates	0.00	0.00	0.00	0.06
Raw sugar	0.50	0.20	0.02	0.08
Groundnuts,green	0.80	0.50	0.25	0.09
Soya beans	0.50	0.00	0.00	0.09
Oil seeds nes	0.80	0.50	0.25	0.09
Copper ores	0.25	0.00	0.00	0.07
Manganese ores	0.25	0.00	0.00	0.07
Non-ferrous ores nes	0.25	0.00	0.00	0.07
Iron & steel scrap	0.95	0.00	0.00	0.06
Non-ferrous scrap	0.95	0.00	0.00	0.06
Natural fertilisers	0.00	0.00	0.00	0.06
Animal feeding stuff	0.60	0.10	0.00	0.12
Gypsum,plasters	0.20	0.10	0.00	0.06
Mineral sands	0.50	0.25	0.00	0.06
Sulphur	0.00	0.00	0.00	0.06
Iron pyrites	0.00	0.00	0.00	0.06
Salt	0.50	0.10	0.00	0.08
Asbestos,crude	1.00	1.00	1.00	0.10
Other crude min. nes	1.00	0.50	0.00	0.06
Non-energy pet.-prod	0.00	0.00	0.00	0.08
Pulpwood	0.25	0.10	0.02	0.09
Logs,conifer	0.10	0.05	0.02	0.09
Logs,non-conifer	0.10	0.05	0.02	0.08
Lumber,shaped	0.50	0.12	0.02	0.09
Other wood nes	0.50	0.12	0.02	0.09
Manufactured fert.	0.50	0.00	0.00	0.06
Pig iron	0.50	0.00	0.00	0.09
Other ferro-alloys	0.50	0.00	0.00	0.06
Products,f.b.metals	0.90	0.10	0.05	0.07
Paper & paperboard	0.20	0.10	0.00	0.11
Cement	0.00	0.00	0.00	0.08
Woodpulp,paper waste	0.50	0.50	0.10	0.10
Crude petroleum etc	0.00	0.00	0.00	0.06
Gasolines	0.00	0.00	0.00	0.08
Kerosene,jet fuels	0.00	0.00	0.00	0.08

(To be continued)

Table 3-1 Container Potential Factors and Stowage Rates (Continued)

Commodity	CPF			CSR
	<10000	10000-100000	>100000	
Distillate fuels	0.00	0.00	0.00	0.08
Residual fuel oil	0.00	0.00	0.00	0.07
Fuel,gases,liquefied	0.00	0.00	0.00	0.08
Molasses	0.00	0.00	0.00	0.08
Mineral tar oils	0.00	0.00	0.00	0.08
Olive oil	0.00	0.00	0.00	0.13
Palm oil	0.20	0.02	0.02	0.13
Other oils & fats	0.20	0.02	0.02	0.13
Passenger cars	0.10	0.00	0.00	0.70
Other vehicles nes	0.50	0.00	0.00	0.70
Fresh meat	0.50	0.50	0.50	0.10
Fresh milk & cream	0.00	0.00	0.00	0.08
Butter & cheese	0.40	0.40	0.40	0.08
Fresh eggs	0.00	0.00	0.00	0.08
Fresh fish	0.10	0.10	0.10	0.09
Oranges etc	0.20	0.20	0.20	0.08
Bananas	0.10	0.10	0.10	0.08
Potatoes	0.10	0.10	0.10	0.08
Other fruit & veget.	0.35	0.35	0.35	0.08
Refined sugar	1.00	0.50	0.35	0.08
Coffee	0.90	0.90	0.90	0.06
Tea & mate	0.97	0.97	0.97	0.15
Meat,dried etc	0.97	0.97	0.97	0.10
Non-fresh milk etc	0.55	0.55	0.55	0.08
Fish,dried etc	0.97	0.97	0.97	0.09
Fish nes,tinned	0.97	0.97	0.97	0.10
Meal,cereal flour	0.90	0.75	0.75	0.12
Prepared grains	0.97	0.97	0.97	0.12
Edible nuts	0.70	0.70	0.70	0.08
Dry fruits etc	0.97	0.97	0.97	0.11
Dried vegetables	0.97	0.97	0.97	0.08
Preserved veget.nes	0.50	0.50	0.50	0.08
Confectionary etc	0.97	0.97	0.97	0.08
Cocoa & chocolate	0.12	0.12	0.12	0.07
Spices	0.74	0.74	0.74	0.11
Margarine etc	0.97	0.97	0.97	0.08
Food preparations	0.97	0.97	0.97	0.08
Vegetable prods	0.90	0.90	0.90	0.08
Non-alcoholic bev.	0.80	0.80	0.80	0.12
Alcoholic bev.	0.90	0.90	0.90	0.10
Tobacco,unmanuf.	0.90	0.90	0.90	0.14
Tobacco,manuf.	0.97	0.97	0.97	0.14
Crude rubber	0.90	0.90	0.90	0.08

(To be continued)

Table 3-1 Container Potential Factors and Stowage Rates (Continued)

Commodity	CPF			CSR
	<10000	10000-100000	>100000	
Wool,animal hair	0.90	0.90	0.90	0.10
Cotton	0.70	0.70	0.70	0.07
Jute	0.70	0.70	0.70	0.12
Hard fibres	0.70	0.70	0.70	0.12
Other fibres nes	0.70	0.70	0.70	0.12
Undressed fur skin	0.95	0.95	0.95	0.09
Cork,raw & waste	0.95	0.95	0.95	0.09
Crude organic nes	0.95	0.95	0.95	0.09
Chemicals nes	0.52	0.52	0.52	0.08
Organic chemicals	0.50	0.30	0.20	0.08
Inorganic chemicals	0.70	0.60	0.40	0.08
Radioactive mater.	0.90	0.00	0.00	0.08
Dyeing,tanning mat.	0.80	0.80	0.80	0.08
Medicinal prods	0.80	0.80	0.80	0.19
Perfume,ess.oils	0.80	0.80	0.80	0.12
Plastic materials	0.90	0.90	0.90	0.10
Articles of paper	0.95	0.95	0.95	0.18
Textiles	0.80	0.80	0.80	0.16
Electrical machine.	0.85	0.85	0.85	0.12
Other machinery nes	0.85	0.85	0.85	0.08
Leather & rubber	0.90	0.90	0.90	0.25
Veneer sheets,plyw.	0.40	0.30	0.15	0.10
Wood & cork nes	0.70	0.50	0.20	0.10
Non-metal miner.manuf	0.65	0.65	0.65	0.10
Misc. metallic prods	0.80	0.80	0.80	0.10
Misc. manufactures	0.95	0.95	0.95	0.10
Crude minerals nes	0.90	0.50	0.00	0.08
Copper	0.50	0.50	0.50	0.07
Aluminium	0.80	0.80	0.80	0.09
Tin	0.80	0.80	0.80	0.07
Non-ferr.met.nes	0.80	0.80	0.80	0.07
Finished structures	0.50	0.50	0.50	0.10
Wire,metal container	0.50	0.50	0.50	0.10
Agricultural machin.	0.80	0.80	0.80	0.14
Metal working machin.	0.70	0.70	0.70	0.11
Motorcycles & parts	0.70	0.70	0.70	0.12
Railway vehicles	0.80	0.80	0.80	0.70
Aircraft,boats	0.10	0.10	0.10	0.20
Live animals	0.10	0.00	0.00	0.08
Hides & skins	0.95	0.95	0.95	0.08
Explosives	0.80	0.80	0.80	0.10
Commodities nes	0.90	0.90	0.90	0.13

Source: Derived in the Liverpool University Marine Transport Centre from the UK Customs data.

Table 3-2 China Seaborne Container Potential 1975 (TEUs)

	North America	Central America Carrib.	South America	N & At. Europe UK Balt	Med Asia Europe & Africa	Africa Ex Med	Red Sea Arabian Gulf	South Asia	South East Asia	Japan	Far East Asia ex Japan	Oceania	World
EXPORT													
Major bulks	0	0	0	307	580	395	0	0	22	150	0	73	1528
Minor bulks	310	112	23	5872	1572	119	675	19	2259	1787	0	449	13196
Semi bulks	0	81	42	61	73	337	344	290	517	197	0	12	1955
Liquid bulks	0	0	0	0	0	0	0	0	0	0	0	0	0
Oils & fats	104	0	0	36	35	4	33	2	50	134	0	14	411
Cars etc.	0	8	1	140	6	80	9	0	13	0	0	0	257
Refrigerated cargoes	38	0	0	1075	1922	7	103	0	2225	1268	0	7	6644
Food drink & tobacco	357	7	12	17865	4149	646	2856	487	12379	7721	5	625	47110
Crude materials	239	11	5	4510	700	24	68	1	175	5274	1	131	11139
Chemicals	156	43	152	3250	1172	465	1596	143	2154	2452	1	508	12092
Other general cargoes	2349	326	474	8579	6563	6941	6530	1651	13621	6040	0	1855	54929
Total	3553	588	708	41695	16772	9020	12213	2593	33415	25025	8	3673	149263
IMPORT													
Major bulks	0	0	0	2	0	0	0	602	364	0	0	0	968
Minor bulks	5	297	1508	5	105	457	1503	0	171	0	0	1318	5369
Semi bulks	1597	0	63	3658	517	67	0	7	297	10919	0	920	18045
Liquid bulks	0	0	0	0	0	0	0	0	0	0	0	0	0
Oils & fats	70	0	27	72	0	27	0	46	257	0	0	114	614
Cars etc.	269	0	0	1344	190	0	0	0	0	8	0	0	1811
Refrigerated cargoes	0	0	0	10	0	0	0	1	0	0	0	4	15
Food drink & tobacco	0	111	0	4	4	1206	67	293	133	0	0	18	1836
Crude materials	3061	1229	437	1514	1931	1279	3001	7201	11520	6012	0	434	37618
Chemicals	8986	46	17	8595	4849	0	0	4	3	33376	0	77	55953
Other general cargoes	10592	280	11	16340	5796	106	1403	324	13	29118	0	1226	65215
Total	24579	1964	2063	31543	13393	3143	5980	8478	12757	79433	0	4112	187445

Table 3-3 China Seaborne Container Potential 1983 (TEUs)

	North America	Central America Carrib	South America	N & At. Europe UK Balt	Med Asia Europe & Africa	Africa Ex Med	Red Sea Arabian Gulf	South Asia	South East Asia	Japan	Far East Aisa ex Japan	Oceania	World
EXPORT													
Major bulks	3	0	0	471	485	749	215	131	348	12	0	10	2425
Minor bulks	408	55	81	4076	2631	122	205	1505	5943	4658	1500	845	22028
Semi bulks	380	38	1	318	188	54	789	458	1586	1031	1973	57	6873
Liquid bulks	0	0	0	0	0	0	0	0	0	0	0	0	0
Oils & fats	6	0	0	191	68	1	0	31	195	29	0	25	546
Cars etc.	64	1	0	63	12	21	6	172	131	8	203	0	682
Refrigerated cargoes	10	5	1	2448	1410	4	72	1	2763	3892	35	22	10664
Food drink & tobacco	2088	13	20	26036	10651	352	2438	3238	17896	16044	4217	1266	84262
Crude materials	907	1	31	5874	2039	4	170	435	3837	11976	540	120	25933
Chemicals	1555	21	293	5513	3620	221	165	4359	7676	7515	11197	1801	43936
Other general cargoes	15589	754	581	32068	18509	1620	11783	5542	36295	23359	37555	3385	187039
TOTAL	21012	888	1010	77059	39612	3148	15844	15871	76672	68523	57220	7530	384388
IMPORT													
Major bulks	2	0	0	0	0	0	0	0	348	0	0	0	350
Minor bulks	668	1242	946	79	9	1347	0	3	1878	244	788	517	7721
Semi bulks	10154	0	3865	7866	1408	116	0	130	1732	24195	567	2620	52653
Liquid bulks	0	0	0	0	0	0	0	0	0	0	0	0	0
Oils & fats	35	0	0	31	0	0	0	0	315	84	0	84	550
Cars etc.	1055	0	439	3163	2752	0	2	0	31	167	14	2	7626
Refrigerated cargoes	37	0	4	12	0	0	0	0	0	1	0	39	94
Food drink & tobacco	1893	0	15	10786	405	6	0	515	4099	7256	41	779	25795
Crude materials	2284	1544	3315	2026	5277	277	980	11886	9094	5996	135	6291	49105
Chemicals	15907	0	8840	35221	11744	84	0	2	1581	26887	582	67	100914
Other general cargoes	25027	0	1416	17359	4997	21	10	568	1715	31754	391	4305	87563
TOTAL	57061	2786	18839	76544	26591	1852	992	13105	20794	96585	2518	14703	332371

Table 3-4 China Seaborne Container Potential 1984 (TEUs)

	North America	Central America Carrib	South America	N & At. Europe UK Balt	Med Asia Europe & Africa	Africa Ex Med	Red Sea Arabian Gulf	South Asia	South East Asia	Japan	Far East Asia ex Japan	Oceania	World
<u>EXPORT</u>													
Major bulks	0	0	0	506	597	8	369	138	385	21	0	102	2126
Minor bulks	163	1	221	4295	2334	9	458	14	4600	5414	3130	732	21371
Semi bulks	194	0	4	305	130	14	87	626	959	988	1739	73	21371
Liquid bulks	0	0	0	0	0	0	0	0	0	0	0	0	0
Oils & fats	20	0	0	115	53	0	0	28	74	38	2	6	336
Cars etc.	37	9	0	67	25	98	14	58	124	20	544	0	996
Refrigerated cargoes	28	6	3	1661	1088	3	20	0	2446	4300	20	20	9595
Food drink & tobacco	2575	6	15	16772	15293	109	457	1965	19452	17834	4848	1271	80597
Crude materials	1002	0	13	6506	2286	3	409	526	4827	13600	13312	268	42852
Chemicals	1895	5	157	7246	3433	48	127	7438	7227	9117	12933	2023	51649
Other general cargoes	17672	93	515	33015	16345	727	2300	4982	24018	30473	89683	4308	224131
TOTAL	23586	120	928	70408	41584	1019	4241	15875	64112	81805	126211	8803	438772
<u>IMPORT</u>													
Major bulks	0	0	0	1	0	0	0	0	0	0	0	0	1
Minor bulks	264	1128	1249	38	43	906	0	48	942	304	850	489	6261
Semi bulks	11851	0	2016	7809	2234	0	0	258	917	29757	169	3188	58199
Liquid bulks	0	0	0	0	0	0	0	0	0	0	0	0	0
Oils & fats	33	0	0	25	0	0	1	0	114	74	1	105	353
Cars etc.	2350	0	1988	3499	32	0	0	0	427	0	3	1	8300
Refrigerated cargoes	7	0	3	73	0	0	0	0	1	7	1	42	134
Food drink & tobacco	6396	0	4	1570	1506	16	2	3	5635	8956	59	92	24239
Crude materials	6471	73	1926	1796	8894	0	1056	2402	17808	9340	390	4612	54768
Chemicals	29665	0	147	46301	13879	0	0	4	4995	32717	5717	214	133639
Other general cargoes	33003	0	523	18966	10560	30	0	455	2963	60763	725	6228	134216
TOTAL	90040	1201	7856	80078	37148	952	1059	3170	33802	141918	7915	14971	420110

Table 3.5 China Seaborne Container Potential 1985 (TEUs)

	North America	Central America Carrib	South America	N & At. Europe UK Balt	Med Asia Europe & Africa	Africa Ex Med	Red Sea Arabian Gulf	South Asia	South East Asia	Japan	Far East Asia ex Japan	Oceania	World
EXPORT													
Major bulks	0	0	0	605	604	1107	476	261	215	12	0	44	3324
Minor bulks	384	1	81	4009	3602	12	1037	253	2139	5125	3960	710	21313
Semi bulks	459	0	0	221	425	74	79	1067	263	424	1331	44	4387
Liquid bulks	0	0	0	0	0	0	0	0	0	0	0	0	0
Oils & fats	7	0	0	85	99	0	42	25	146	50	10	12	476
Cars etc.	50	2	0	37	16	23	4	31	91	7	654	1	916
Refrigerated cargoes	34	7	1	2129	920	1	18	0	1095	3600	56	24	7885
Food drink & tobacco	2978	7	32	26914	20503	104	528	1181	14789	15809	4849	1125	88819
Crude materials	581	0	9	6682	3303	14	54	1332	1824	13934	14112	97	41942
Chemicals	1170	2	41	6110	2995	57	96	4005	2599	9023	12580	2177	40855
Other general cargoes	15230	31	55	33497	14363	651	2027	4521	12273	32237	97341	3200	215426
TOTAL	20893	50	219	80289	46830	2043	4361	12676	35434	80221	134893	7434	425343
IMPORT													
Major bulks	2	0	0	0	0	0	0	0	885	151	0	0	1038
Minor bulks	235	1096	0	186	2145	900	0	147	1749	441	923	885	8707
Semi bulks	13640	0	4792	16079	6282	3	0	10	608	34504	281	2756	78955
Liquid bulks	0	0	0	0	0	0	0	0	0	0	0	0	0
Oils & fats	118	0	79	45	46	0	0	0	92	101	0	211	692
Cars etc.	42	0	0	0	87	0	0	3	143	0	67	22	364
Refrigerated cargoes	23	0	0	83	0	0	0	0	1	0	0	66	173
Food drink & tobacco	4959	0	2	1429	586	40	0	400	5281	5161	56	270	18184
Crude materials	5252	73	2099	3627	10728	0	1032	1949	16344	15232	2970	9649	68955
Chemicals	35063	43	456	40450	15924	4	0	0	11638	43624	7200	173	154575
Other general cargoes	32241	0	2324	27668	17640	19	5	468	5010	100627	4450	10875	201327
TOTAL	91575	1212	9752	89567	53438	966	1037	2977	41751	199841	15947	24907	532970

Table 3-6 Summary of China's Seaborne Container Potential (TEUs)

	1975	1983	1984	1985	Growth p.a.
Export	149263	384388	438772	425343	11.0%
Import	187445	332371	420110	532970	11.0%
Total	336708	716759	858882	958313	11.0%

3.3 THE FORECASTING OF CONTAINER POTENTIAL

As shown in table 3-6, the average annual rate of growth of the container potential of China's seaborne trade was 11% during the period 1975 -- 1985. Although detailed container potential data for the years 1976 -- 1982 were not available, Chinese trade in value terms increased steadily supporting the 11% cumulative growth rate of seaborne container potential for the whole period of 1975 -- 1985.

During the same period, the Chinese National Income index (1952=100, constant price) increased from 384.7 in 1975 to 823.2 in 1985 (table 2-1), representing an average annual growth rate of 7.9%. When compared with the 11% of container potential growth rate, a ratio of 1.4 has resulted, which agrees with Gilman (BTE 1986). In fact Gilman found that over the period 1971-1981 the growth in the world's general cargo trades was about 1.4 times that of the world economy, i.e. 1% of world GDP growth may cause a growth of 1.4% in the world's general cargo trades. There may be an element of coincidence in the figure 1.4 itself, of course. Using this ratio Gilman projected the total of 191.6 million tonnes of world deepsea container cargo in 1990. It is hence assumed that during the period 1986-95, 1% of China's real NI (i.e. GDP in this case) growth will cause a growth of 1.4% in China's seaborne container potential.

Having established the relationship between China's international trade development and its economic growth, we can proceed to develop forecasts of seaborne container potential. The first requirement is an estimate of the Chinese economic growth in the next few years up to 1995. It would be beyond the scope of this thesis to carry out a macroeconomic forecasting exercise but, fortunately, the World Bank has provided some general forecasts from which figures for China may be derived.

In the World Development Report (World Bank 1987), data on the economic performance of developing countries are given in terms of the average annual percentage change of real GDP for a period of 30 years from 1965 to 1995 (see table 3-7). The world is divided into two broad groups: the developing countries and the industrial countries. Developing countries are further divided into Low-income countries, Middle-income countries, Oil exporters, Exporters of manufactures, Highly indebted countries and sub-Saharan Africa etc. As a country with the GNP per capita of US $310 in 1985, China falls into the category of Low-income developing countries[1].

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1. Low-income countries are those with 1985 GNP per person of US $400 or less (World Bank 1987).

According to the World Bank estimation, in these countries GDP in real terms will grow at an average annual rate of 6.7% (high case) or 4.6% (low case). The high case is based on the following assumptions:

1. Fiscal and international payment imbalances are reduced in a way that maintains growth in the industrial countries.
2. Unemployment in the industrial countries is reduced substantially by 1995.
3. Governments halt the protectionism in the industrial countries and thereby increase international trade flows and improve the efficiency of their economies.
4. The developing countries themselves adopt adjustment programs to restructure their economies and spur employment and income growth.

In case of failure of the above mentioned assumptions, the low case, according to the World Bank, would apply. What's more, if the developing countries themselves undertake no reforms at all, and if the international environment deteriorates further, their growth rate could be even lower.

Table 3-7 Average Annual Percentage Change of Real GDP in Developing Countries 1965-1995

				1986-95	
	1965-73	1973-80	1980-86	High	Low
Developing countries	6.5	5.4	3.6	5.9	3.9
Low-income countries	5.5	4.6	7.4	6.7	4.6
Middle-income countries	7.0	5.7	2.0	5.4	3.6
Oil exporters	6.9	6.0	0.8	4.4	3.6
Exporters of manufactures	7.4	6.0	6.0	6.9	4.3
Highly indebted countries	6.9	5.4	0.6	5.4	3.5
Sub-Saharan Africa[1]	6.4	3.2	-0.4	4.0	3.2

1. Excluding South Africa.
Source: World Bank (1987).

It is understood that the World Bank data of GDP growth for developing countries is based on a sample of ninety countries. But the historic data does not fit the development of the Chinese economy. Table 3-7 shows that during the periods of 1965-73, 1973-80 and 1980-86, the average annual growth rates of real GDP for low-income developing countries were 5.5%, 4.6% and 7.4% respectively. But the Chinese GDP grew at the rates of 7.5%, 5.6% and 9.4% during the same periods, this being 1-2 percent higher than the average for low-income developing countries.

Since the late 1970's, the Chinese government has firmly adopted the open-door policy and promoted reform both economically and politically. As a result the national economy has been developed rapidly with little fluctuation. The Chinese Premier Li Peng (1988) predicted at the Seventh National People's Congress:

> "In the next five years, by accelerating and deepening the reform we shall promote the development of the productive forces, fulfil the Seventh Five-Year Plan and draw up and begin to implement the Eighth Five-Year Plan. On condition that economic performance steadily improved, it is expected that the gross national product will increase at an average annual rate of 7.5%."

Hence it is conceivable that the Chinese economy will continue to grow at a rate higher than the average of other low-income developing countries. Based on the World Bank studies and the analysis of the general economic situation in China, three different scenarios are assumed for the growth of Chinese real GDP up to 1995 for the purposes of this project:

(1). High case -- Supported by the historic and recent rates of economic growth and an optimistic view of the future sustained by the open door policy. A rate of growth of 8.0% per annum is assumed.

(2). Medium case -- The World Bank high case for low-income developing countries, i.e. an annual average rate of 6.7% is adopted as the medium scenario for China.

(3). Low case -- The World Bank low case for low-income developing countries, i.e. an annual average rate of 4.6% is adopted as the pessimistic scenario for the growth of the Chinese economy.

On this basis and with the ratio 1.4:1, the Chinese seaborne container potential would grow at an annual rate of 11.2% (High case), or 9.4% (Medium case), or 6.4% (Low case). Thus China's container potential can be projected as shown in tables 3-8, 3-9 and 3-10.

3.4 EXPECTED TRADE PATTERNS IN 1995

China's total seaborne potential volume by 1995 has been estimated in the last section as 1,229,666 TEUs of exports and 1,540,815 TEUs of imports in the high case, 1,044,510 TEUs of exports and 1,308,808 TEUs of imports in the medium case and 790,962 TEUs of exports and 991,104 TEUs of imports in the low case. But what will actually

Table 3-8 Projected Chinese Container Potential (TEUs) 1986-1995 (High Case)

Year	Exports	Imports	Total
1986	472981	592663	1065644
1987	525955	659041	1184996
1988	584862	732853	1317716
1989	650366	814933	1465300
1990	723208	906206	1629414
1991	804207	1007701	1811908
1992	894279	1120563	2014842
1993	994438	1246066	2240504
1994	1105815	1385625	2491440
1995	1229666	1540815	2770481

Table 3-9 Projected Chinese Container Potential (TEUs) 1986-1995 (Medium case)

Year	Exports	Imports	Total
1986	465325	583069	1048394
1987	509066	637878	1146943
1988	556918	697838	1254756
1989	609268	763435	1372703
1990	666549	835198	1501737
1991	729194	913709	1642901
1992	797738	999595	1797333
1993	872726	1093557	1966283
1994	954762	1196351	2151113
1995	1044510	1308808	2353318

Table 3-10 Projected Chinese Container Potential (TEUs) 1986-1995 (Low case)

Year	Exports	Imports	Total
1986	452565	567080	1019645
1987	481529	603373	1084902
1988	512347	641989	1154336
1989	545137	683076	1228214
1990	580026	726793	1306819
1991	617148	773308	1390456
1992	656645	822800	1479445
1993	698670	875459	1574129
1994	743385	931488	1674874
1995	790962	991104	1782065

happen on each individual trading route remains an important question, with respect to development of the fleet and Chinese ports.

Tables 3-11 and 3-12, derived from tables 3-2 to 3-5, investigate developments in trading pattern. Between 1975 and 1985 the export pattern showed a structural change in favour of Far East Asia, while the import pattern was fairly stable. Far East Asia (excluding Japan) had become the largest export market for China's containerised and potentially containerisable goods by 1985, accounting for 31.7% of total exports. Only ten years ago there was virtually no seaborne trade between the two. The other major markets were Japan, North and Atlantic Europe, the Mediterranean and South East Asia. Turning to China's imports, Japan was the largest partner with a market share of 37.5% in 1985. North America, North and Atlantic Europe, Mediterranean and South East Asia were the other major partners.

However it is difficult to predict what will happen by 1995. Trade volumes on each individual route are a matter related to not only the Chinese national economy but also the economies of the trading partners. Besides there are also many non-economic factors which can significantly influence the trade pattern. For example, as mentioned before, during the early years of the People's Republic, China's foreign trade was limited to the Soviet Union and other Eastern Bloc countries due to the economic blockade policy adopted by the USA against China. Far East Asia, Japan, Western Europe and North America gradually became China's major trading partners only after the Sino-Soviet split during the 1960's and the thaw of the Sino-American relationship in the early 1970's. It would be beyond the scope of this thesis to thoroughly discuss and predict all these economic and political factors affecting shares. Estimates of the market share of China's export and import container potential are given in tables 3-11 and 3-12 based on data available for the years of 1975, 1983, 1984 and 1985, with an element of extrapolation of major trends.

It is anticipated that Far East Asia (excluding Japan) will remain as China's largest export market for container goods, accounting for 31.5% of the total export. Chinese imports from this region are expected to rise to around 10% of the total. This region has the advantage of being very near to China. As the relationship continues to improve between China mainland and the NICs especially Taiwan and South Korea, the future trading prospects appears promising.

Table 3-11 Market Share of China's Export Container Potential (%)

Region	1975	1983	1984	1985	1995 (est.)
N. America	2.4	5.5	5.4	4.9	8.0
C. America Caribb	0.4	0.2	0.0	0.0	0.0
S. America	0.5	0.3	0.2	0.1	0.0
N. & Atlantic Europe, UK	27.9	20.0	16.1	18.9	19.0
Med. Asia, Europe, Africa	11.2	10.3	9.5	11.0	10.5
Africa ex Med.	6.0	0.8	0.2	0.5	0.0
Red Sea, Arabian Gulf	8.2	4.1	1.0	1.0	0.5
S. Asia	1.7	4.1	3.6	3.0	2.0
S.E. Asia	22.4	19.9	14.6	8.3	7.0
Japan	16.8	17.8	18.6	18.9	20.0
Far E. Asia ex Japan	0.0	14.9	28.8	31.7	31.5
Oceania	2.5	2.0	2.0	1.7	1.5
TOTAL	100.0	100.0	100.0	100.0	100.0

With a share of 35%, Japan will still be the most important import market for China. Meanwhile, Japan will also be China's second largest export market after the other Far East Asian region, with a market share of 20%.

Europe and Mediterranean has for decades been the important market for China's containerisable cargoes. It is estimated that by 1995 North and Atlantic Europe will have a share of 19% out of the total Chinese exports and the Mediterranean will take about 10.5%.

Table 3-12 Market Share of China's Import Container Potential (%)

Region	1975	1983	1984	1985	1995 (est.)
N. America	13.1	17.2	21.4	17.2	15.0
C. America Caribb	1.0	0.8	0.3	0.2	0.0
S. America	1.1	5.7	1.9	1.8	1.5
N. & Atlantic Europe, UK	16.8	23.0	19.1	16.8	15.0
Med. Asia, Europe, Africa	7.1	8.0	8.8	10.0	11.0
Africa ex Med.	1.7	0.6	0.2	0.2	0.0
Red Sea, Arabian Gulf	3.2	0.3	0.3	0.2	0.0
S. Asia	4.5	3.9	0.8	0.6	0.0
S.E. Asia	6.8	6.3	8.0	7.8	8.0
Japan	42.4	29.1	33.8	37.5	35.0
Far E. Asia ex Japan	0.0	0.8	1.9	3.0	10.0
Oceania	2.2	4.4	3.6	4.7	4.5
TOTAL	100.0	100.0	100.0	100.0	100.0

In the import sector, the two regions are estimated to account for 15% and 11% respectively.

Prospects for China's North America trade present a problem. For the region as a whole, in terms of container trade, there are more goods flowing east-bound than west-bound on the Pacific. In the case of China, it is just the opposite. The cargo flow is heavily imbalance in favour of the North America. It is considered that this phenomenon is going to change a bit by the year 1995. As indicated in table 3-11 and 3-12, the share of China's exports to North America is going to rise to around 8% and that of China's imports from the region will fall to 15%. The Asian NICs are now entering the transitional phase from developing to developed countries. Accompanying this transition is the growing labour cost and the appreciation of their currencies against the US dollar. This may provide an excellent chance for China mainland to march on towards the US market by developing those labour-intensive, export-oriented industries.

Southern Asia is also an important market for China's exports, though it showed a continuous downward trend. It is estimated that this region will still have a market share of 7% in 1995. The share of China's imports from the Oceania remained steady around 4% in recent years and it is predicted that this will stand at around 4.5% in 1995. The remaining markets are very small and relatively unimportant.

Based on estimations in tables 3-11 and 3-12, tables 3-13 and 3-14 show China's container potential in 1995 by individual region.

Table 3-13 Estimated Chinese Export Container Potential in 1995 by Regions (TEUs)

Region	High	Medium	Low
N. America	98373	83561	63255
C. America Caribb	0	0	0
S. America	0	0	0
N. & Atlantic Europe, UK	233637	198457	150231
Med. Asia, Europe, Africa	129115	109674	83023
Africa ex Med.	0	0	0
Red Sea, Arabian Gulf	6148	5223	3953
S. Asia	24593	20890	15814
S.E. Asia	86077	73116	55348
Japan	245933	208902	158138
Far E. Asia ex Japan	387345	329021	249068
Oceania	18445	15668	11860
TOTAL	1229666	1044510	790692

Table 3-14 Estimated Chinese Import Container Potential in 1995 by Regions (TEUs)

Region	High	Medium	Low
N. America	231122	196321	148666
C. America Caribb	0	0	0
S. America	23112	19632	14867
N. & Atlantic Europe, UK	231122	196321	148666
Med. Asia, Europe, Africa	169490	143969	109021
Africa ex Med.	0	0	0
Red Sea, Arabian Gulf	0	0	0
S. Asia	0	0	0
S.E. Asia	123265	104705	79288
Japan	539285	458083	346886
Far E. Asia ex Japan	154082	130881	99110
Oceania	69337	58896	44600
TOTAL	1540815	1308808	991104

3.5 CONTAINER PENETRATION

Container penetration is defined as the ratio of actually containerised cargo to the total containerisable cargo, as defined by the container potential.

The forecasting results presented in the last two sections are the container potential figures which differ from the actual container traffic in that it is not necessary that all these cargoes are actually carried in containers. However, assuming an overnight containerisation i.e. one hundred percent container penetration, these projected figures could equal to the real container traffic (loaded TEUs). The question is: will China achieve complete containerisation by 1995? If not, what will be the container penetration rate?

The Containerisation International Yearbook provides a good source on information for the measurement of the degree of containerisation. Container traffic data in the major Chinese container ports have been available since 1979. Those major container ports include Shanghai, Xingang, Huangpu, Dalian, Qingdao, Xiamen and Fuzhou. Table 3-15 presents China's total container port traffic, i.e. the aggregated container traffic of the above mentioned ports in terms of loaded TEUs during the period of 1979-1985. Until now, China's container ports have attracted little or no foreign transshipment cargo. Therefore, these container port traffic data (loaded TEUs) can be treated as the actual Chinese containerised cargo with reasonable accuracy. On the other hand, table 3-16 lists China's potential container traffic data during the same period. Dividing the real container traffic data in table 3-15 by the corresponding container potential data in table 3-16, table 3-17 shows the container penetration rate from 1979 to 1985. Initially in 1979 when China just started to carry containers, the container penetration was as low as 5.2 percent. Then it increased steadily and in a short period of six years it has reached 34.6 percent. The average annual growth rate of the container penetration was as high as 37 percent. Thus rather conservatively, it is assumed that China will achieve 80 percent as the container penetration by 1995. For simplicity, a further assumption is made that this container penetration rate is applied to each individual route, i.e. each individual route is treated as the same in terms of container penetration.

Table 3-15 China Container Port Traffic 1979-1985 (Loaded TEUs)

Year	Export	Import	Total
1979	13253	12212	25465
1980	20952	20741	41693
1981	35246	35250	70496
1982	63749	45304	109053
1983	83182	58319	141501
1984	107187	99046	206233
1985	117618	213734	331352

Source: Derived from CI (1987, 1986, 1985, 1984, 1983 & 1982).

Based on the data presented in tables 3-13 and 3-14, tables 3-18, 3-19 and 3-20 show the projected Chinese seaborne container traffic in three different scenarios. In these tables, the individual routes are classified into three categories: deep sea (over 1500 nautical

Table 3-16 China Container Potential Traffic 1979-1985 (Loaded TEUs)

Year	Export	Import	Total
1979	239943	249397	489340
1980	270174	267852	538026
1981	304216	287673	591889
1982	342548	308961	651509
1983	384388	332371	716759
1984	438772	420110	858882
1985	425343	532970	958313

NB. Data for 1979-1982 are estimated by the author.

Table 3-17 China Container Penetration 1979-1985 (%)

Year	Export	Import	Total
1979	5.5	4.9	5.2
1980	7.8	7.7	7.7
1981	11.6	12.2	11.9
1982	18.6	14.7	16.7
1983	21.6	17.5	19.7
1984	24.4	23.6	24.0
1985	27.7	40.1	34.6

miles), medium sea (over 500 nautical miles) and short sea (under 500 nautical miles). The export and import data represent real loaded TEUs while the round trip traffic data are derived from doubling the heavy leg of a round trip, either export or import. It can be see from the tables that in the optimistic scenario, the total China seaborne container traffic will reach 2.9 million TEUs in 1995; while on the other hand, in the pessimistic scenario it will only be 1.9 million TEUs and, in the medium case, 2.5 million TEUs. In all cases, the share of the deepsea traffic is about 42% with the short sea traffic accounting for 50% and the medium sea traffic, 8%. This result is consistent with China's general cargo trade pattern analysed in Chapter 2.

Table 3-18 Estimated China Seaborne Container Traffic in 1995 (High Case)

Region	Export (Loaded TEUs)	Import (Loaded TEUs)	Round Trip Traffic (TEUs)
N. America	78698	184898	369796
C. America Caribb	0	0	0
S. America	0	18490	36980
N. & Atlantic Europe, UK	186910	184898	373820
Med. Asia, Europe, Africa	103292	135592	271184
Africa ex Med.	0	0	0
Red Sea, Arabian Gulf	4918	0	9836
Oceania	14756	47117	94234
Deep-sea total	388574	570995	1155850
S. Asia	19674	0	39348
S.E. Asia	68862	98612	197224
Medium-sea total	88536	98612	236572
Japan	196746	431428	862856
Far E. Asia ex Japan	309876	123266	619752
Short-sea total	497769	499224	1482608
TOTAL	983733	1232652	2875030

Table 3-19 Estimated China Seaborne Container Traffic in 1995 (Medium Case)

Region	Export (Loaded TEUs)	Import (Loaded TEUs)	Round Trip Traffic (TEUs)
N. America	66849	157057	314114
C. America Caribb	0	0	0
S. America	0	15706	31412
N. & Atlantic Europe, UK	158766	157057	317532
Med. Asia, Europe, Africa	87739	115175	230350
Africa ex Med.	0	0	0
Red Sea, Arabian Gulf	4178	0	8356
Oceania	12534	47117	94234
Deep-sea total	330066	492112	995998
S. Asia	16712	0	33424
S.E. Asia	58493	83764	167528
Medium-sea total	75205	83764	200952
Japan	167122	366466	732932
Far E. Asia ex Japan	263217	104705	526434
Short-sea total	430339	471171	1259366
TOTAL	835609	1047046	2456316

Table 3-20 Estimated China Seaborne Container Traffic in 1995 (Low Case)

	Export (Loaded TEUs)	Import (Loaded TEUs)	Round Trip Traffic (TEUs)
N. America	50604	118932	237964
C. America Caribb	0	0	0
S. America	0	11894	23788
N. & Atlantic Europe, UK	120184	118932	240368
Med. Asia, Europe, Africa	66418	87217	174434
Africa ex Med.	0	0	0
Red Sea, Arabian Gulf	3162	0	6324
Oceania	9488	35680	71360
Deep-sea total	249857	372655	754238
S. Asia	12651	0	25302
S.E. Asia	44278	63430	126860
Medium-sea total	56929	63430	152161
Japan	126510	277509	555018
Far E. Asia ex Japan	199254	79288	398508
Short-sea total	325764	356797	953526
TOTAL	632554	792884	1859925

REFERENCES

BTE (1986), *Container Shipping in Transition*,Occasional paper 77, by S. Gilman, AGPS, Canberra.

CI (1988), *Containerisation International Yearbook 1988*, ed. M. R. Lambert, National Magazines, London.

__ (1987), *Containerisation International Yearbook 1987*, ed. M. R. Lambert, National Magazines, London.

__ (1986), *Containerisation International Yearbook 1986*, ed. M. R. Lambert, National Magazines, London.

__ (1985), *Containerisation International Yearbook 1985*, ed. M. R. Lambert, National Magazines, London.

__ (1984), *Containerisation International Yearbook 1984*, ed. M. R. Lambert, National Magazines, London.

__ (1983), *Containerisation International Yearbook 1983*, ed. M. R. Lambert, National Magazines, London.

__ (1982), *Containerisation International Yearbook 1982*, ed. M. R. Lambert, National Magazines, London.

Gilman, S. (1983), *The Competitive Dynamics of Container Shipping,* Gower Publishing, Hants, England.

Li, P. (1988), Report on the Work of the Government, delivered at the First Session of the Seventh National People's Congress on March 25, 1988, *Beijing Review*, 31: no. 17, 18-43.

World Bank (1984), *Technological and Operational Developments in Liner Shipping in West Africa*, vol. 1, *Traffic*, by Gilman & Associates, Washington DC.

__ (1987), *World Development Report 1987*, Oxford University Press, New York.

CHAPTER 4 THE DEVELOPMENT OF CHINESE CONTAINER SHIPPING

4.1 INTRODUCTION

The role of international transport is to bridge the spatial separation of trading countries in the world. Among all kinds of transport services between nations, shipping is by far the most important mode. The basic function of shipping is the creation of utilities of place, i.e. the carriage of goods from places where their utility is low to places where it is high (Branch 1981). For any of a wide range of commodities, it may generally be found that the tonne/km cost of transport by sea lies somewhere between 5% and 10% of the equivalent for the relevant land mode -- be it rail, road or pipeline (Goss 1984). This is largely because ships can exploit their economies of scale more easily. In terms of weight something like 90% of all international trade moves by sea, and so far as long-distance trade is concerned virtually all is seaborne (Jansson & Shneerson 1987).

Considered from the standpoint of types of services provided, modern international shipping may be divided into dry bulk carriers, oil tankers, containerships, ro-ro vessels, specialised carriers and conventional general cargo vessels. This on the one hand has been the result of the continual technological evolution in the shipping industry which began in the last century and, on the other hand, has been the response of the shipping industry towards the ever increasing international trade.

In the days when ships were powered by wind and sail, operators were not able to provide services to fixed time schedules. It was only with the invention of steamships in the mid nineteenth century that the vagaries of weather could largely be ignored for services to be operated on specific routes under pre-arranged time tables. However, the major disadvantage of the traditional method of shipping general cargo in break-bulk form is that it entailed a high degree of handling during the entire journey over land and sea from the consignor to the cargo's final destination. This disadvantage was not acute during the entire period from mid nineteenth century until mid twentieth when labour costs were low. However, starting from 1950s shipping costs began to increase rapidly especially in the developed countries and labour costs, including stevedoring, were rapidly taking up a larger share of the total. On the other hand, significant advances were made in vessel design after the second world war. The aim of these advances was to improve vessel productivity and utilisation. Unfortunately, these advances were virtually neutralised by increases in port delays and congestion. As a result, vessels could spend some 60% of their time in port and only a fraction of that time was spent actually working cargo (The University of Liverpool 1980). The economic consequence of the long turnaround times and slow handling rates was that cargo handling expenses usually amounted to between 40% and 60% of the gross freight income.

Meanwhile, world trade experienced a steady increase after the Second World War. These combined forces stimulated efforts to increase handling rates and made it possible to construct and deploy purpose built, specialised ships. This led to a series innovations in the shipping of cargo: the discovery of the advantage of bulk shipping, e.g. ULCC, VLCC and large-scale dry bulk carriers; the development of the concept of unitisation of smaller-scale cargoes of heterogeneous nature and the emergence of the semi-bulk trades for cargoes like forest products, steel products and cement. Among these innovations, the development of unitisation has now advanced to the point where its most successful form of unitisation, containerisation, is universally accepted and dominates the deep-sea general cargo market.

Seaborne container transport began with the containerised coastal services around the US from 1955 onwards by Sea-Land and Matson Navigation. However, the most significant step in the advance of world deepsea container shipping was taken in 1965 when Sea-Land announced its intention to bring containerships into the transatlantic trade, which was quickly followed by United States Lines' plans for a container service on the North Atlantic in 1966 (Drewry 1986).

Container service were soon inaugurated on all of the world's major trade routes.

4.2 THE WORLD CONTAINERSHIP FLEET

Since the mid-1960's several types of container-carrying ships have evolved, viz. fully cellular containerships, ro-ros, conbulkers and semi-containerships. However, the predominant ship type is the fully cellular containership. Tables 4-1 and 4-2 show the structure of the world containership fleet at November 1, 1983 and 1987 respectively. It can be seen from the tables that the cellular sector (including ships converted to cellular) had a share of 50% out of the total world container fleet of 1,753,802 TEUs in 1983 and that this increased slightly to 52% in 1987. However, if the slots on order are considered the cellular system had 161,420 out of 198,271 TEUs, which would further increase its share. If account is taken of the facts that many of the vessels in the large sector of ships under 500 TEUs capacity work in short sea trades, that ships outside the cellular sector do not spend such a high proportion of their time carrying general cargo (and are at times considerably less productive), clearly the cellular system has achieved a position of dominance in the world deepsea trade (Gilman 1988).

Table 4-1 World Containership Fleet and Orderbook by Size and Type at November 1, 1983

	Under 500	500-999	1000-1499	1500-1999	2000-2499	2500+	Total TEUs
FULLY CELLULAR							
Present slots	70586	101454	175297	228829	96747	83589	756502
No of ships	253	137	141	132	43	30	736
Slots on order	7886	18227	25465	31744	6670	115404	205396
No of ships	20	26	19	18	3	36	122
CONVERTED TO CELLULAR							
Present slots	8204	50372	59818	7840	0	0	126234
No of ships	30	72	53	4	0	0	159
RO-RO/CONTAINER							
Present slots	17264	18170	26919	0	0	0	62353
No of ships	57	27	22	0	0	0	106
Slots on order	780	2078	0	3600	10500	0	16958
No of ships	3	3	0	2	5	0	13
RO-RO							
Present slots	69022	47005	60335	22423	8100	0	206885
No of ships	256	70	48	13	4	0	391
Slots on order	10246	4960	6504	0	7320	0	29030
No of ships	34	8	5	0	3	0	50
SEMI-CONTAINER							
Present slots	310066	128185	11167	0	0	0	449418
No of ships	1167	195	10	0	0	0	1372
Slots on order	22750	17553	6291	0	0	0	46594
No of ships	63	26	5	0	0	0	95
BULK/CONTAINER							
Present slots	16962	61016	44592	17000	0	0	139570
No of ships	49	84	34	11	0	0	178
Slots on order	504	6186	11427	13002	0	0	31164
No of ships	4	9	9	8	0	0	30
BARGE CARRIERS							
Present slots	2301	7435	0	3104	0	0	12840
No of ships	7	10	0	2	0	0	19
Slots on order	0	1026	1480	0	0	0	2506
No of ships	0	2	1	0	0	0	3
TOTAL							
Present slots	494405	413637	378128	279196	104847	83589	1753802
No of ships	1819	595	308	162	47	30	2961
Slots on order	42166	50030	51212	48346	24490	115404	331648
No of ships	124	74	40	28	11	36	313

Source: Philips & Fossey (1984).

Table 4-2 World Containership Fleet and Orderbook by Size and Type at November 1, 1987

	Under 500	500-999	1000-1499	1500-1999	2000-2499	2500+	Total TEUs
FULLY CELLULAR							
Present slots	106940	150030	206279	250858	172915	409463	1296485
No of ships	371	206	168	145	76	137	1130
Slots on order	2527	4460	12252	16777	16424	108980	161420
No of ships	7	6	10	10	8	35	76
CONVERTED TO CELLULAR							
Present slots	8875	38844	59184	4722	8000	0	119625
No of ships	38	56	50	3	4	0	151
RO-RO/CONTAINER							
Present slots	110587	86546	75198	39671	19873	14559	346434
No of ships	430	137	60	23	9	5	664
Slots on order	3910	7565	0	0	0	0	11475
No of ships	12	10	0	0	0	0	22
SEMI-CONTAINER							
Present slots	426398	193868	16825	0	0	0	637091
No of ships	1703	301	15	0	0	0	2019
Slots on order	7934	9166	0	0	0	0	17100
No of ships	29	15	0	0	0	0	44
BULK/CONTAINER							
Present slots	21470	82060	106341	82030	12545	0	304446
No of ships	62	113	86	50	6	0	317
Slots on order	0	0	0	0	8276	0	8276
No of ships	0	0	0	0	4	0	4
BARGE CARRIERS							
Present slots	2458	10648	2947	3104	0	0	19157
No of ships	7	17	2	2	0	0	28
TOTAL							
Present slots	676728	561996	466774	380385	213333	424022	2723238
No of ships	2611	830	381	223	95	142	4282
Slots on order	14371	21291	12252	16777	24700	108980	198271
No of ships	48	31	10	10	12	35	146

Note:

1. Ro-Ro/Container includes pure ro-ro ships.
2. Source: Fossey (1988).

The other point to note is the tremendous growth in the number of large capacity vessels. Table 4-3 shows the development of the deepsea container fleet during 1975-1984. It is clear from the table that large capacity ships grew much faster than small ones during the period. Table 4-2 suggests that by November 1987, ships with a capacity of over 2000 TEUs had a total slots of 637,355 TEUs or 23% of the entire world container fleet slots. A more important point is 55% of the slots on order are placed on ships with a capacity of 2500 TEUs or over, which will further increase the share of the large capacity containerships in the near future.

Table 4-3 Development of the World Deepsea Containership Fleet 1975-1984

	400-699	700-999	1000-1499	1500-1999	2000+	Total TEUs
1975						
Slots '000 TEUs	61.9	60.0	145.4	75.7	67.7	410.7
No of ships	112	73	121	44	25	375
1979						
Slots '000 TEUs	129.1	140.9	272.2	148.5	120.9	811.6
No of ships	240	170	224	91	47	772
1984						
Slots '000 TEUs	194.5	171.2	389.1	292.2	285.5	1332.5
No of ships	375	210	316	169	113	1183
SLOTS GROWTH %						
1975-1979	109	135	87	96	79	98
1979-1984	51	22	43	97	136	64

Note:

1. Ships includes fully cellular containerships, ro-ros, ro-ro/containerships and container/bulk carriers.
2. Source: Drewry (1986).

4.3 THE CHINA OCEAN SHIPPING COMPANY

The China Ocean Shipping Company (Cosco) is China's state carrier for its foreign trade. On 4th April 1986 Cosco celebrated its 25th anniversary. Since its founding in 1961, the Cosco fleet has grown to over 600 vessels with a combined tonnage capacity of 15 million DWT, of which, the share of container fleet (including ro-ro ships) is 6.3% (Fig. 4-1 & 4-2) (JAMRI 1987).

The main corporate objective of Cosco were described by Wan (1988) as:

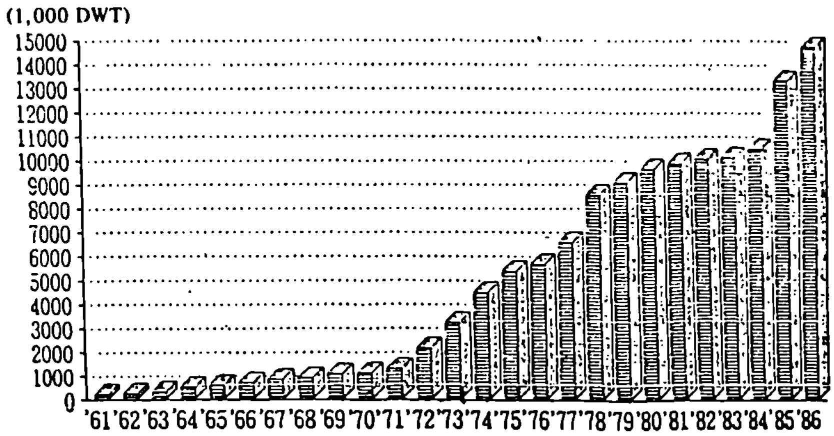
1. to fulfil the state plan
2. to satisfy the needs of shippers
3. to educate employees

Although profit was one of the targets included in the state plan, it was not a separate objective. Before the economic reform, when the state plan could be achieved by secured freights, little attention was paid to service quality or shippers' complaints, although one of the major corporate objectives was to satisfy the needs of shippers. The objective of "educating employees" does not mean technical training but rather ideological and moral education. Since the reform and the introduction of competition, as Wan (1988) pointed out, the accomplishment of the state plan has to some degree been affected by less secured freights. Accordingly, Cosco has had to make greater efforts with respect to service quality in order to compete. Nevertheless, the Cosco management continues to act according to the achievement of largely operational-oriented planned targets. While the reform aims to make companies fully responsible for their profits and losses, the situation at the present stage is far from achieving this objective.

Cosco's container fleet is mainly operated by three of its five branches, viz. Cosco Shanghai, Cosco Guangzhou and Cosco Tianjin. Cosco's Beijing headquarters is responsible for coordinating and directing the operating branches in addition to determining general maritime policy. By 1986, Cosco operated 46 full container vessels with an aggregate capacity of 38,000 TEUs between all major Chinese ports and Europe, the Mediterranean, Asia and North America (CI 1987a).

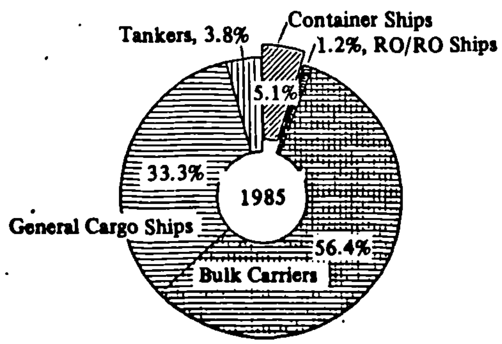
Cosco Shanghai is the largest container carrier in China. With an annual TEU deployment of 438,037, it ranked No. 12 in the world in 1986 (Transmodal Industries Research 1986). It owns 23 fully cellular container ships and many ro-ro and semi-container ships. Container services are operated on the following routes (CI 1987a):

1. Transpacific routes;
2. PRC / Far East -- North Europe;
3. PRC -- Australia;
4. Asian Coastal routes.



Source: JAMRI (1987).

Figure 4-1 Tonnage of Cosco's Ocean Going Ships



Source: JAMRI (1987).

Figure 4-2 Cosco Fleet by Ship Types, 1985.

Cosco Guangzhou owned 16 fully cellular containerships and some ro-ro and semi-containerships, with an annual deployment of 66,237 TEUs in 1986 (Transmodal Industries Research 1986).. Container services are operated on the following routes (CI 1987a):

1. PRC -- North Europe
2. PRC -- Mid-East
3. Asian Coastal routes

Cosco Tianjin owned 2 fully cellular containerships and a few semi-containerships, with an annual deployment of 137,106 TEUs in 1986 (Transmodal Industries Research 1986). Container services are concentrated in Sino-West African and Sino-Japanese routes.

4.4 MAJOR CONTAINER SERVICES OF THE COSCO FLEET

4.4.1 TRANSPACIFIC ROUTES

(1). PRC/Japan -- USEC/GC

There are two sailings per month on this service provided by Cosco Shanghai, starting from Shanghai/Xingang alternatively, calling at Kobe, Long Beach, New York, Charleston and Houston, then back to Kobe, Shanghai/Xingang. There are five fully cellular containerships engaged in the service, each of a capacity of about 1,700 TEUs and with a speed of 16 knots. They were newly built in West Germany in 1985 and 1986. The service was USEC/GC only before September 1986. After that, Cosco decided to call on the way at Long Beach on the west coast.

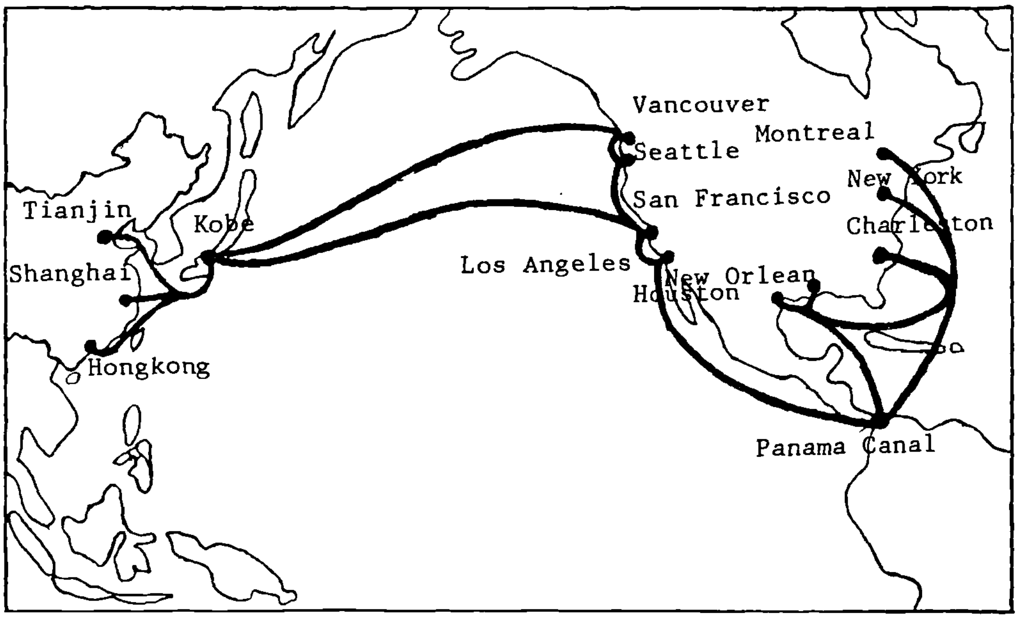


Figure 4-3 Transpacific Routes

(2). Far East -- WCNA

Cosco Shanghai provided three sailings per month on this service, made by three ro-ro ships, each of an average capacity of 737 TEUs, and two fully cellular ships of a capacity of 724 and 1322 TEUs. The service starts from Hong Kong on 5, 15 and 25 each month, calling at Kobe, Long Beach, San Francisco, Seattle and Vancouver, then back to Kobe and Hong Kong. Cargo from the China mainland is carried by feeder vessels to Kobe. This arrangement obviously reflects the fact that Cosco gives its priority to punctual service, since ships are easily delayed at the ports of the China mainland. This also makes it possible for Cosco to provide the fixed-day service (FDS).

As mentioned above, there are also two calls per month at Long Beach on the west coast made by Cosco's east coast-bound fleet. Therefore, there are altogether five calls per month as far as the west coast is concerned.

4.4.2 PRC/FAR EAST -- EUROPE

Jointly operated by Cosco Shanghai and Cosco Guangzhou, there are four sailings of fixed-day service (FDS) each month. The service starts from Shanghai (two sailings), Xingang (one sailing) and Guangzhou (one sailing) alternatively, calling at Hong Kong, Singapore, London, Hamburg, Rotterdam, Antwerp and Dunkirk (two calls per month) on the way to Europe, then back to Singapore, Hong Kong, Shanghai, Xingang and Guangzhou. Ten fully cellular containerships are engaged in the service, each with an average capacity of 1,246 TEUs. These ships were built during 1982-1985.

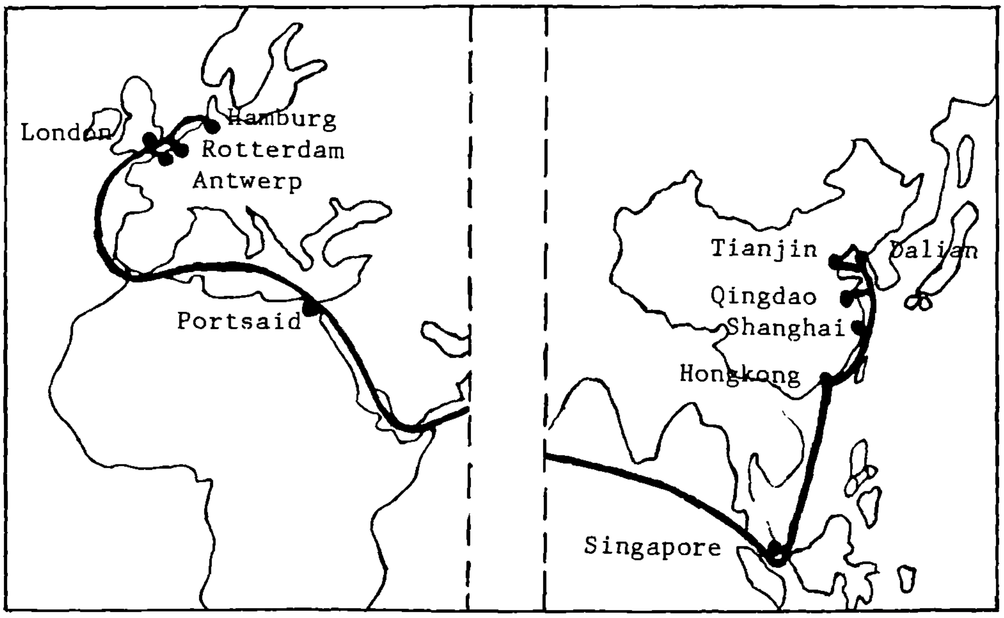


Figure 4-4 PRC/Far East -- Europe Route

4.4.3 PRC – AUSTRALIA

This service is provided by Cosco Shanghai, with three sailings per month. It starts from Shanghai, calling at Hong Kong, Melbourne, Sydney on the way to Australia, then back to Hong Kong and calling at Xingang before returning to Shanghai[1]. Five ro-ro ships, each of 430 TEUs of capacity, are involved in the service.

1. Only two calls per month at Hong Kong and Xingang on the return journey.

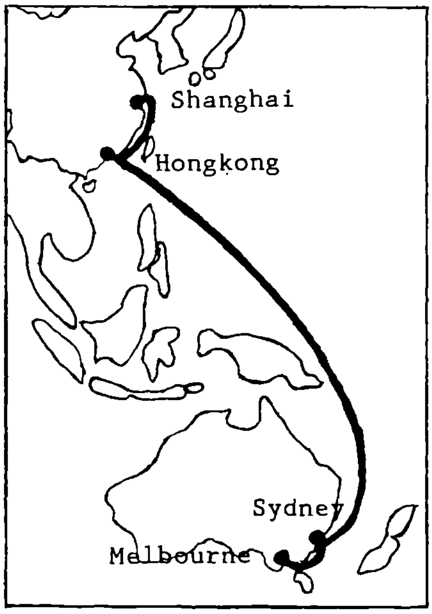


Figure 4-5 PRC -- Australia Route

4.4.4 PRC -- MIDDLE EAST

This service is operated by Cosco Guangzhou, with two sailings per month. It starts from Shanghai and Xingang alternatively, calling at Hong Kong, Bangkok, Singapore, Karachi, Dubai, Dammam and Kuwait, then back to Karachi, Bangkok, Hong Kong and Shanghai or Xingang. Four fully cellular containerships serve this line, with a total capacity of 2,844 TEUs (724 × 3 + 672).

4.4.5 PRC -- WEST AFRICA

This service is maintained by Cosco Tianjin with 14 semi-containerships of 3,080 TEUs in total. They call at Shanghai, Hong Kong, Singapore, Dakar, Freetown, Tema, Abidjan, Lome, Cotonou, Lagos, Douala and Matadi.

4.4.6 ASIAN COASTAL ROUTES

Cosco provides various Asian coastal container links. The major services are as follows:

(1). PRC -- Southeast Asia

Cosco Shanghai maintains two sailings per month from Qingdao and Shanghai alternatively, calling at Penang, Port Kelang, Singapore and Hong Kong. Two fully cellular containerships serve this line, with a capacity of 682 TEUs and 724 TEUs respectively.

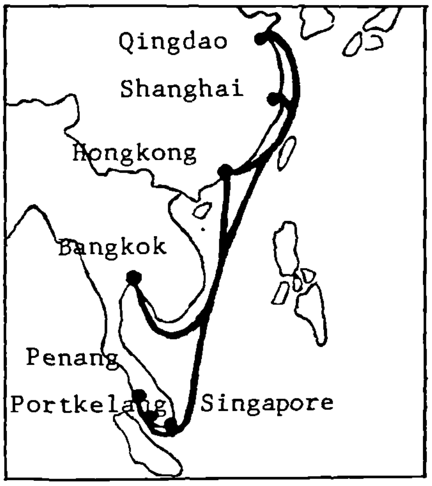


Figure 4-6 PRC -- Southeast Asia Route

(2). China mainland -- Hong Kong feeders

The following routes are served by Cosco Shanghai: Dalian -- Hong Kong (monthly); Qingdao -- Hong Kong (monthly); Shanghai -- Hong Kong (fortnightly); Zhang Jia Gang -- Hong Kong (fortnightly).

Figure 4-7 Shanghai -- Hong Kong Route

(3). Sino -- Japan/Hong Kong

Container services are provided on several routes by Cosco linking the major Chinese container ports with Hong Kong and the main Japanese Ports. Follows are the major routes:

- Shanghai -- Yokohama, Nagoya, Osaka, Kobe (six sailings per month);
- Dalian -- Yokohama, Kobe (every 15 days);
- Qingdao -- Yokohama, Osaka, Kobe (every 15 days);
- Guangzhou (Huangpu) -- Nagoya, Yokohama, Kobe, Hong Kong (every 10 days);
- Haikou -- Yokohama, Kobe, Hong Kong, Haikou (monthly);
- Xiamen -- Hong Kong (four sailings per month);
- Tianjin -- Nagoya, Yokohama;

- Tianjin -- Osaka, Kobe;
- Tianjin -- Yokohama, Kobe.

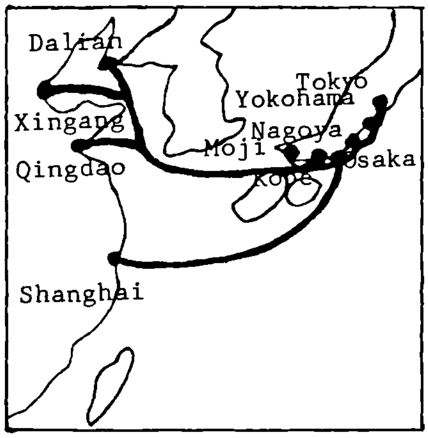


Figure 4-8 Sino-Japan Route

4.5 RECENT DEVELOPMENT OF THE COSCO CONTAINER SHIP FLEET

In October 1987, Cosco bought five 1,200 TEU 'C' class vessels from the Danish shipowner A. P. Møller. The vessels were built in 1968/69 and were converted from general cargo to full container vessels in 1980. They have been renamed as Tao He, Hui He, Yi He, Shun He and Jian He respectively. The five will be deployed in the Far East/WCNA schedule maintained by Cosco Shanghai (CI 1987b). This will enable the service to move up from three sailings a month to a weekly frequency in January 1988. According to CI, these ships will replace the existing tonnage with capacities of between 724 TEUs and 1,234 TEUs, thus further enhancing Cosco's presence in competitive transpacific markets. Furthermore, the retired tonnage from the Far East/WCNA service is likely to be redeployed into Cosco's Australian service, replacing yet smaller 400 TEU Ships.

Cosco Shanghai has launched a third transpacific service since September 1987. According to the Containerisation International (1987c), three 1,140 TEU conbulkers offer monthly sailings between Hong Kong, Kobe, Long Beach, New York, Houston, Long Beach, Kobe and Hong Kong. Chinese cargoes are transhipped to southern Chinese ports over Hong Kong and northern points via Kobe. If the West Coast, East Coast and Gulf Coast services are taken together, Cosco has an overall transpacific annual two way capacity of some 195,000 TEUs (CI 1987b).

Cosco is continuing to upgrade its container services and expand slot capacity on the major container routes. Besides the transpacific services, two additional vessels has been deployed on to its Europe service, enabling Cosco to provide a six-to-seven day frequency. Cosco has also revised its European port rotation which now consists of Rotterdam, Hamburg, London and Antwerp. Switching London from first call to penultimate call has knocked six days off eastbound transit times from the U.K. (ibid). Meanwhile, Cosco Tianjin is also boosting its Mediterranean service from a conventional link to a fully containerised service (CI 1988a & 1988b). Starting from the end of

January 1988, the service will operate at a frequency of two sailings per month, calling at Barcelona, Marseilles and Genoa in the Mediterranean and the Chinese ports of Xingang and Shanghai. Eight semi-container vessels averaging 520 TEUs capacity are deployed in this schedule. By the second half of 1988, Cosco hopes to be able to add a second monthly sailing and deploy larger, fully cellular vessels.

In 1987, Cosco ordered two 2,700 TEU containerships from British Shipbuilders, with an option for a third. It is understood that Cosco is looking for a full series of five vessels. The first two ships, currently under construction in Govan Shipbuilders, are due to be handed over during December 1988 and May 1989. They are expected to be placed on the Far East -- US East Coast route (CI 1987b). This, in turn, may lead to a further strengthening of Sino-Europe trade with a possibility of extension of the schedule from Hong Kong to Kobe.

4.6 COMPARATIVE STUDIES OF THE COSCO DEEPSEA CONTAINER FLEET

4.6.1 THE LEADING CONTAINER OPERATORS AND THEIR SLOTS DISTRIBUTION

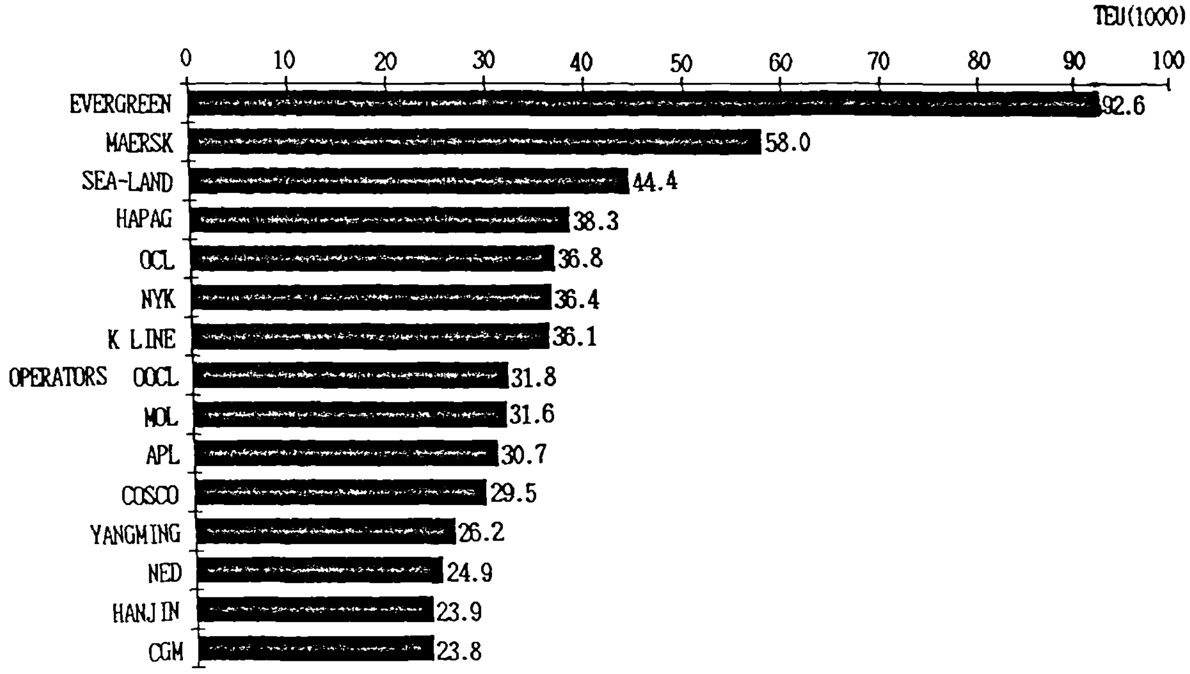
According to NYK (1987), by the end of 1986 a total of 1,053 full-containerships aggregating 27.37 million DWT with a total capacity of 1.54 million TEUs were in operation on the world major deepsea routes. Table 4-4 shows the detail. It can be seen from table 4-4 that the Middle East-related route is an artery which outstrips the transatlantic route. This is because many routes linking all areas in the world with the Middle East are put together for convenience in classification and also the volume of ships calling at Middle East en route to other main destinations are included.

Table 4-4 Full-Containership Fleets Classified by Routes

ROUTE	VSL	GT	DWT	TEU	TEU(%)
FE/US	211	6391831	6961077	414607	26.9
FE/E,MED	167	4899642	5237225	298350	19.4
US/E,MED	165	3599552	4038631	236625	15.4
WORLD/AUNZ	130	2456411	2813714	145088	9.4
WORLD/ME	193	3107591	4527817	291024	18.9
WORLD/SAM	79	1663578	1697411	91386	5.9
WORLD/AF	82	1426975	1609708	79906	5.2
WORLD/I	40	539234	652510	35873	2.3

Source: NYK (1987).

By 1986, Evergreen of Taiwan was the world's largest containership operator controlling a fleet of 44 vessels with an aggregate capacity of 92,580 TEUs (NYK 1987). Table 4-5 shows the world's top 20 full-containership operators by 1986 (see also fig. 4-9)[1].



Source: NYK (1987).

Figure 4-9 Top 15 Full-Containership Operators

1. Ships refer to full-containerships of 3,000 GT or over and 150 TEUs or over, including fully cellular type, ro-ro type and ro-ro/cellular type which are engaged in international deep sea trade, exclusive of intra-regional trade.

Table 4-5 TOP 20 FULL-CONTAINER OPERATORS AND THEIR SLOTS DISTRIBUTION (TEUs)

Operator	Area	No.	Flag	VSL	Slots	Slots Distribution								
						FE/NA	FE/E.MED	NA/E MED	W/AUNZ	W/ME	W/C SAM	W/AF	W/I	TOTAL
EVERGREEN	F.EAST	1	TWN	44	92580	82012	67020	63476	0	7056	0	0	0	219564
NYK	F EAST	6	JPN	22	36365	20662	11105	0	2788	11244	0	0	0	45799
K LINE	F EAST	7	JPN	20	36118	24670	4326	0	2032	1930	0	1700	0	34658
OOCL	F EAST	8	HKG	16	31790	20986	6964	0	1892	1948	0	0	0	31790
MOL	F EAST	9	JPN	17	31605	18997	5606	0	3018	6414	0	1770	0	35805
COSCO	F EAST	11	CHR	28	29482	12691	12464	0	2155	2172	0	0	0	29482
YANGMING	F EAST	12	TWN	14	26170	15314	10124	0	732	10124	0	0	0	36294
HANJIN	F.EAST	14	KRS	13	23878	23878	0	0	0	0	0	0	0	23878
NOL	SE AS.	18	SNG	11	19203	14218	2050	0	1217	0	0	0	1718	19203
ZIM	M EAST	16	ISR	18	21858	15352	21858	15352	6506	0	15352	0	0	74420
UASC	M.EAST	17	KUW	13	20970	0	0	6448	0	20970	0	0	0	27418
MAERSK	EUROPE	2	DEN	28	57969	33684	8488	10575	0	15797	0	0	368	68912
HAPAG	EUROPE	4	GFR	18	38250	0	14978	15113	1589	16975	4585	0	0	53240
OCL	EUROPE	5	GBI	19	36812	0	17519	0	14697	22955	0	708	708	56587
NED	EUROPE	13	NTH	15	24946	0	10884	6555	0	4332	2662	5493	0	29926
CGM	EUROPE	15	FRA	18	23756	0	2960	2455	6528	1711	8446	3367	0	25467
ACT	EROPE	19	GBI	13	18194	0	0	0	18194	0	0	0	0	18194
BSC	EUROPE	20	USR	21	17737	0	8736	242	4747	8736	4012	0	0	26473
SEA-LAND	USA	3	USA	23	44417	26140	0	17227	0	0	1050	0	0	44417
APL	USA	10	USA	17	30652	26894	0	0	0	3758	0	0	3758	34410
TOTAL				388	662752	335498	205082	137443	66095	136322	36107	13038	6552	936137
PERCENTAGE (%)						36	22	15	7	15	4	1	1	100

Source. NYK Research Chamber (1987)

It can be seen from table 4-5 that Maersk of Denmark ranked No.2 with 28 ships of a capacity of 57,969 TEUs, followed by Sea-Land (USA), Hapag-Lloyd (West Germany), OCL (Britain), NYK (Japan), K line (Japan), OOCL (Hong Kong), MOL (Japan) and APL (USA). Cosco ranked No.11 with 28 deepsea containerships of a capacity of 29,482 TEUs.

Also shown in table 4-5 is the slot distribution of the top 20 full containership operators. The transpacific route is obviously the busiest one with a slots capacity of 335,498 TEUs or 36% out of a total capacity of 936,137 TEUs, followed by the Far East/Europe & Mediterranean route (22%), the transatlantic route (15%) and the Middle East related routes (15%). For reasons stated before, the Middle East related routes have a high slots share. The table shows that both the Africa and the India related routes have very small shares of the total slots capacity.

4.6.2 CONTAINERSHIP FLEET STRUCTURE ANALYSIS

Table 4-6 lists the 28 deepsea containerships owned by Cosco in 1986. They comprise 20 fully cellular ships and 8 ro-ro ships. Ro-ro ships account for 29% of the total Cosco deepsea container fleet. This is a very high ratio compared with other top container fleets which mainly consist of pure cellular ships. Table 4-7 shows the deepsea container fleet of the Maersk Line. They are all full containerships except one. This reflects the simple fact that fully cellular containership is the most efficient system for deepsea container transport.

Table 4-6 Cosco Deepsea Container Fleet

NAME	TP	YEAR	GT	DWT	TEU	SP'D	ROUTE
BAI HE KOU	RR	1980	5986	7374	435	17.2	FE/AUNZ
BIN CHENG	FC	1985	9683	12739	724	15.0	FE,J/WCNA
BIN HE	FC	1985	23542	33389	1696	17.7	FE/USWC/USEC
CHAO HE	FC	1985	19835	25955	1322	17.0	FE,J/WCNA
CHUN HE	FC	1984	19835	26100	1322	17.0	FE/E
FEN HE	FC	1982	16208	20828	1152	18.7	FE/E
GAO CHENG	FC	1984	9683	12739	724	17.0	FE/ME
GU BEI KOU	RR	1980	12321	13996	753	18.0	FE,J/WCNA
GU CHENG	FC	1985	9683	12739	724	15.5	FE/ME
HUA YUAN KOU	RR	1979	5986	7374	430	19.0	FE/AUNZ
LIAO HE	FC	1983	19915	26025	1234	17.7	FE/E
LUO HE	FC	1983	19915	26025	1234	17.7	FE/E
MING CHENG	FC	1985	9683	12739	724	17.0	FE/ME
QING HE	FC	1982	16100	20828	1152	18.7	FE/E
QIU HE	FC	1984	19732	25808	1318	17.5	FE/E
SHA HE	FC	1983	19915	26025	1234	17.7	FE/E
SONG HE	FC	1986	24438	33265	1700	16.0	FE/USWC/USGEC
TAI PING KOU	RR	1980	5986	7374	430	19.0	FE/AUNZ
TANG HE	FC	1983	16100	20828	1152	18.7	FE/E
XI FENG KOU	RR	1980	12321	13976	729	21.0	FE,J/WCNA
XIANG HE	FC	1985	24043	30939	1684	16.7	FE/USWC/USGEC
XIAO SHI KOU	RR	1980	5986	7374	430	17.2	FE/AUNZ
XING HE	FC	1985	19237	25925	1328	17.0	FE/E
YIN HE	FC	1984	19237	25925	1328	17.0	FE/E
YU HE	FC	1986	24043	30940	1686	17.5	FE/USWC/USGEC
ZHANG JIA KOU	RR	1980	12321	13996	729	15.5	FE,J/WCNA
ZHI JIANG KOU	RR	1979	5986	7374	430	19.0	FE/AUNZ
ZHUANG HE	FC	1985	24438	33240	1668	17.0	FE/USWC/USGEC
Total 28 ships			432158 GT	561839 DWT	29482 TEUs		

Source: NYK (1987).

It is noticed that the ship size of the Cosco container fleet is small as compared with others. With 28 ships, it has a slot capacity of only 29,482 TEUs, while the same number of Maersk ships have a total capacity of 57,969 TEUs, twice as large as the Cosco ships. It is also shown in table 4-6 that the Cosco ships are slow in speed. Most of them are around 17 knots whereas the Maersk ships average 22 knots. It is obvious that the trend among major carriers is towards very large and fast cellular ships.

Table 4-7 Maersk Deepsea Container Fleet

NAME	TP	YEAR	GT	DWT	TEU	SP'D	ROUTE
ADRIAN MAERSK	FC	1975	29901	30760	1818	24.7	FE,J/ME
ALBERT MAERSK	FC	1975	29901	30461	1818	24.7	FE,J/ME
ALVA MAERSK	FC	1976	34382	31560	2092	22.0	USGEC/MED/ME
ANDERS MAERSK	FC	1976	33401	30460	1984	24.7	USGEC/MED/ME
ANNA MAERSK	FC	1976	33401	35108	1984	24.7	FE,J/E
ARILD MAERSK	FC	1976	34382	36482	2092	22.0	USGEC/MED/ME
ARNOLD MAERSK	RC	1975	40549	30662	1779	21.0	USGEC/MED/ME
ARTHUR MAERSK	FC	1983	33401	30460	1984	24.7	FE,J/E
AXEL MAERSK	FC	1975	33401	35108	1984	24.7	FE,J/E
CECILIE MAERSK	FC	1967	21609	24617	1218	21.0	FE,J/PNW
CHARLOTTE MAERSK	FC	1968	21609	24937	1218	21.2	FE,J/ME
CHASTINE MAERSK	FC	1968	21551	25007	1218	21.2	FE,J/PNW
CHRISTIAN MAERSK	FC	1968	21349	24937	1218	21.2	FE,J/PNW
CLARA MAERSK	FC	1968	21609	25078	1218	21.2	FE,J/PNW
CLIFFORD MAERSK	FC	1969	21349	25130	1218	21.2	FE,J/PNW
CORNELIA MAERSK	FC	1967	21562	24617	1218	21.2	FE,J/PNW
DRAGOR MAERSK	FC	1974	40390	32821	2628	20.0	USGEC/MED/ME
LARS MAERSK	FC	1984	43431	53400	3016	23.0	FE/USWC/USEC
LAURA MAERSK	FC	1980	43233	53763	3000	24.0	FE/USWC/USEC
LAUST MAERSK	FC	1984	40366	48600	2776	23.0	FE/USWC/USEC
LEDA MAERSK	FC	1982	30694	31600	3000	24.0	FE/USWC/USEC
LEISE MAERSK	FC	1980	43233	53623	3016	24.0	FE/USWC/USEC
LEXA MAERSK	FC	1981	43233	53615	3000	24.0	FE/USWC/USEC
LOUIS MAERSK	FC	1984	43431	42800	3016	23.0	FE/USWC/USEC
LUNA MAERSK	FC	1982	37124	41100	2536	23.0	FE,J/E
MAERSK CLEMENTINE	FC	1978	7588	11007	368	16.2	I/ME
MC-KINNEY MAERSK	FC	1985	43431	53400	3016	24.5	FE/USWC/USEC
REGINA MAERSK	FC	1983	37057	43600	2536	23.0	FE/USWC/USEC
Total 28 ships			906568 GT	984713 DWT	57969 TEUs		

Source: NYK (1987).
NB: The five 'C' class vessels: Charlotte Maersk, Chastine Maersk, Christian Maersk, Clara Maersk and Clifford Maersk were sold to Cosco in October 1987 (see section 4.5).

Cosco maintains five fully containerised routes, viz. PRC/Japan -- USEC/GC, Far East -- WCNA, PRC/Far East -- Europe, PRC -- Australia and PRC -- Mid East. Tables 4-8 and 4-9 compare the Cosco cellular fleet with other selected operators on the transpacific and the Far East/Europe routes.

It is apparent from tables 4-8 and 4-9 that the Cosco box ships are comparatively smaller in size and slower in speed than those of

Table 4-8 Comparisons of the Selected Containership Fleets on the Transpacific Route

	Fleet Nos	Fleet TEUs	Average Size	Average Speed	Frequency	Annual TEUs
Far East -- WCNA						
Cosco	5	4257	851	18	10 Days	30636
Evergreen	6	17192	2865	21	Weekly	148980
Maersk	6	7308	1218	21	Weekly	63336
APL 1	4	5804	1451	23	Weekly	75452
APL 2	5	8546	1709	21	Weekly	88868
APL 3	5	12544	2509	23	Weekly	130468
K Line	6	14050	2342	21	Weekly	121784
Hanjin	5	5774	1154	19	Weekly	60008
Far East -- ECNA						
Cosco	5	8434	1687	17	15 Days	40488
Evergreen 1	11	26336	2394	21	Weekly	124488
Evergreen 2	13	33628	2587	21	Weekly	134524
Maersk	9	26376	2931	24	Weekly	152412
KL/NOL/OOCL	8	18932	2367	22	9 Days	95995
Hanjin	8	18104	2263	22	Weekly	117676
Yangming	7	15314	2188	21	9 Days	88736

Source: NYK (1987).

other carriers. Service frequency is also lower on all these major routes. As a result a lower annual slot capacity is provided. For instance, Cosco serves the Far East -- WCNA route with five ships averaging 851 TEUs in capacity and 18 knots in speed at a 10-day frequency, producing 30,636 TEUs of annual slot capacity. This compares with Hanjin, which has five ships but averaging 1,154 TEUs in capacity and 19 knots in speed at a weekly frequency, producing

Table 4-9 Comparisons of the Selected Containership Fleets on the Far East -- Europe Route

	Fleet Nos	Fleet TEUs	Average Size	Average Speed	Frequency	Annual TEUs
Cosco	10	12464	1246	18	4/Month	59808
Evergreen 1	11	26336	2394	21	Weekly	124488
Evergreen 2	13	33628	2587	21	Weekly	134524
Maersk	4	8488	2122	24	14 Days	55172
Ace	11	25550	2323	23	Weekly	120796
Trio 1	9	25345	2816	23	Weekly	146432
Trio 2	11	28429	2584	24	Weekly	134386
Yangming	6	10124	1687	23	9/10 Days	64816

Source: NYK (1987).

60,008 TEUs of slot capacity annually. On the Far East -- Europe route, Cosco produces 59,808 TEUs of annual slot capacity with ten ships averaging 1,246 TEUs in size and 18 knots in speed at a frequency of four sailings per month; whereas Yangming, with only six ships averaging 1,687 TEUs in size and 23 knots in speed at a frequency of 9/10 days, produces 64,816 TEUs of slot capacity annually. Clearly, the Cosco box ships are comparatively less efficient and, therefore, less competitive as far as scale economies are concerned.

4.6.3 CONTAINER SERVICE NETWORK ANALYSIS

Containerisation has made possible efficient intermodal through transport via integral linking of different modes of transport.

Intermodal through transport, also known as international multimodal transport, refers to the conveyance of goods from one country to another in more than one mode of transport under a single contract or a combined transport bill of lading, which is issued by the individual or corporation who organises such a service, or the multimodal transport operator who is responsible for the fulfilment of the terms of the contract (JAMRI 1983).

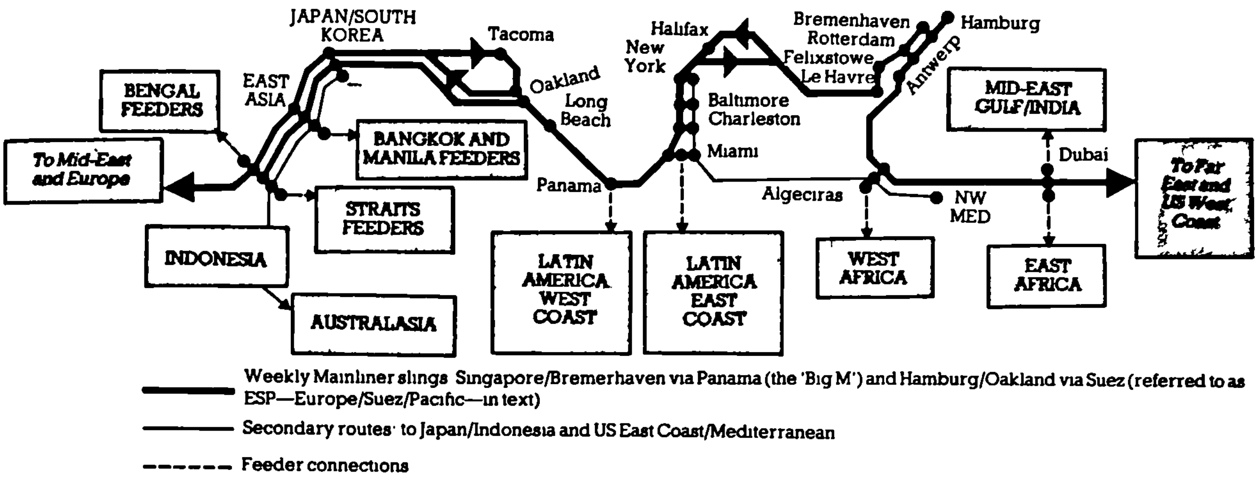
Containerisation has also changed the shippers' concept of traditional liner shipping. Shippers have become much more service conscious. Therefore, shipping lines have the strongest motivation to establish the efficient intermodal through transport networks and provide the shipper with high quality service. As a matter of fact, most containership operators today are making great efforts to design multi-route integrated service networks, so as to achieve the best possible competitive positions.

Two Examples of Integrated Networks

(1). Maersk Line

Maersk Line operates a fleet of modern containerships in a world wide network of services. Figure 4-10 shows the schematic diagram of the way the Maersk Line global network looked in 1988.

According to Phillips (1988), Maersk is planning to extend its existing weekly all-water Far East -- North America (West and East Coast) service (table 4-7) on through to Europe by April 1988. The



Source: Phillips (1988).

Figure 4-10 Schematic diagram of the way the Maersk Line global network looks

service route is shaped rather like a big 'M' (ie Singapore, East Asia, Japan, North and South California, through Panama to Miami, New York, and then to Europe). Maersk Line also provides a wide range of intermodal services as follows (CI 1988b):

1. USEC/GC -- Far East/Japan (weekly): a full range of east and Gulf coast ports are served via Long Beach and Tacoma using double-stack train services.

2. Far East/Japan -- East Coast Canada: Calgary, Winnipeg, Edmonton, Toronto and Montreal are served via Tacoma.

3. Mediterranean -- WCNA (fortnightly): Mediterranean ports to San Francisco, Oakland, Los Angeles/Long Beach and San Diego via Houston; and to Seattle, Portland, Tacoma and Vancouver via Baltimore.

4. WCNA -- Mid-East (fortnightly): WCNA ports to a full range of Middle East ports via Baltimore and Houston.

5. WCNA -- West Africa (fortnightly): WCNA ports to a full range of west Africa ports via Houston and Baltimore.

(2). Evergreen Line

Evergreen of Taiwan is well known for its round-the-world (RTW) services. The services started in July 1984 on a ten-day frequency both east and west bound. They were upgraded to once per week in mid-April 1985, using 22 'G' class vessels, each of a capacity of 2728 TEUs. The ports of call made by Evergreen's two RTW services are as follows (Drewry 1986):

> Charleston, Norfolk (westbound only), Baltimore (eastbound only), New York, Le Havre, Antwerp, Rotterdam, Felixstowe, Hamburg, Port Kelung, Busan, Osaka, Tokyo and Cristobal.

Besides the RTW service, Evergreen provides a wide range of end-to-end services as well as landbridge/minibridge services and operates a double-stack train service between Los Angeles and Chicago (CI 1988b).

In contrast to these major carriers, Cosco has been slow in designing world wide integrated container service network necessary if it is to be successful in catching up with containerisation in the world shipping industry. Intermodalism is still in its embryonic stage. According to CI (1987a), mini/microbridge services are available to East Coast/Mid-West via Long Beach and San Francisco on Cosco's WCNA -- Far East service. On the PRC mainland sector, it was reported that Cosco was initiating interior point intermodal (IPI) service to a range of points following the conclusion of an intermodal agreement with the Chinese ministry of railways (CI 1987d). At present, Cosco extensively uses the ports of Hong Kong and Kobe as its transhipment hubs. However, due to the limitations of the inland container consolidation/distribution systems and irrational pricing policies, there exists a situation to which due attention should be paid. Chinese export cargoes to North America or Europe are often carried to these hubs in break bulk form and then stuffed into containers before being carried to their final destinations. On the other hand, Chinese import cargoes are often stripped in these hubs before being transhipped to Chinese ports. Such is also the case in the major Chinese ports which are served directly by Cosco's main stream box ships. The ratio of containers being carried door-to-door is quite low. Shippers have not yet enjoyed the full advantages of containerisation simply because they are still charged for their containers according to the conventional methods, which quite often cost them even more while the transit time of the goods is not necessary shortened. Therefore the conventional methods of liner shipping may still be preferred by Chinese shippers. Things, however, are starting to change as Gao (ibid.) explained that a through tariff would be offered by Cosco to a range of destinations in China.

4.7 ECONOMICS OF CONTAINER SHIP CHOICE

Only a few years ago, whether or not China should containerise its seaborne trade was still a controversial issue. People were still arguing whether containerisation would benefit China or not. This, however, is not the question today. The fundamental issue today is the right choice of container ships and service strategies on each already containerised route to enhance the performance of the container fleets and their competitive status.

In section 4.2 the general trend of the world container fleet was analysed and in section 4.6 a comparative study was carried out which indicated that Cosco ships were small in size, slow in speed and offered less frequent service as compared with the world's leading containership operators. In the present section the economics of container ship choice will be studied using the technique of ship cost modelling.

4.7.1 METHODS OF CALCULATING SHIP COSTS

There are four methods which are commonly used in comparing ship costs (Pearson 1987):

1. Daily costs at sea or in port;
2. Cost per tonne-mile or TEU-mile;
3. Voyage costs or round trip costs;
4. Through, or door-to-door, transport costs.

Major items of ship's daily costs at sea include ship's capital costs, fuel costs, insurance costs, maintenance and crew costs. Ship's daily costs in port refer to the cost to the shipowner of the ship's time in port (ibid). The main difference between ship's daily costs at sea and in port is the fuel cost. Thus, ship's daily costs in port can be defined as the ship's daily costs at sea minus bunker cost plus additional fuel consumption of the auxiliaries. Most of these cost items are annually incurred, and should be spread over the number of days per year as ship is in operation (15 days unavailable per year being a common figure) (University of Liverpool Marine Transport Centre 1979).

Calculating ship's daily costs at sea takes into account the differences in fuel/capital costs of different speed/size, but not the difference in transport capacity achieved. For example, although a 2,000 TEU, 25 knots container ship is more expensive to construct and operate than a 1,500 TEU, 20 knots ship, the former would generate 1.2 million TEU-miles in the space of 24 hours at sea, which is 67 percent more than the 0.72 million TEU-miles generated by the slower and smaller ship. Fast/bigger ships are generally more expensive, however they are undoubtedly more productive at sea. Thus the costs per TEU-mile indicator reflects more accurately the transport efficiency at sea of different ship size/speed combinations.

However, it is not safe to conclude that the larger the ship, the lower will be its transportation costs. Diseconomies of scale could easily happen if bigger ships were to spend a longer time in port. The cost per-TEU-mile formulation is concerned solely with the ship cost of actually moving the cargo, i.e. the sea transport cost, while ignoring the cost of ship's time in port. A more realistic approach is to minimise the overall voyage costs, or round trip costs of the ships concerned.

The through, or door-to-door transport cost measure, on the other hand, is usually confined to evaluating different configurations of the itinerary assuming the ship size/speed and inland origin/destination pattern of the containers remain constant (Pearson 1987). The purpose of the present section is to compare different ships operating over given itineraries. Therefore, the voyage or round trip cost method is the most suitable approach.

4.7.2 SELECTION OF SAMPLE SHIPS

The cost modelling study will be carried out on four major container routes of Cosco, i.e. Far East -- Europe, Far East -- WCNA, Far East -- ECNA and Far East -- Oceania. Eight ships are selected for the purpose of this study, as shown in table 4-10.

Table 4-10 List of the Sampling Ships

	Size(TEU)	Speed(kn)	Type
Ship A (GX)	3428	20.7	FC
Ship B (C-10)	4300	24.2	FC
Ship C (New Oasis)	2214	19.0	FC
Ship D (Yu He)	1686	17.5	FC
Ship E (Tai He)	2700	19.0	FC
Ship F (Qiu He)	1318	17.5	FC
Ship G (Bin Cheng)	724	15.0	FC
Ship H (C class)	1218	21.2	FC

Source: NYK (1987).

Ship A represents the 'GX' class vessels of Evergreen Line. With a capacity of 4300 TEUs, ship B is a typical example of APL's newly built C-10s. Ship C on the other hand, represents the 'New Oasis' of MOL. Ship D, with a capacity of 1686 TEUs, is typical of Cosco's 'He' class ships, 'Yu He' for example. Ship E is one of the future ships for Cosco, 'Tai He', which is currently under construction in Govan Shipbuilders in Scotland. Ships F and G represent Cosco's 'Qiu He' and 'Bin Cheng' respectively. Ship H is one of the former Maersk C class vessels which Cosco acquired in 1987. It is assumed that all the eight ships can enter every port on the routes defined below:

- ***Far East -- Europe***: Shanghai, Hong Kong, Singapore, London, Hamburg, Rotterdam, Antwerp, Singapore, Hong Kong, Shanghai.
- ***Far East -- WCNA***: Hong Kong, Kobe, Long Beach, San Francisco, Seattle, Vancouver, Kobe, Hong Kong.
- ***Far East -- ECNA***: Shanghai, Kobe, Long Beach, New York, Charleston, Houston, Kobe, Shanghai.
- ***Far East -- Oceania***: Shanghai, Hong Kong, Melbourne, Sydney, Hong Kong, Shanghai.

4.7.3 CALCULATION OF CAPITAL COSTS

Strictly speaking, here the term 'capital cost' refers specifically to a ship's initial building cost. Gilman (1980) pointed out that if ship price could be taken to represent costs of construction including the reasonable rate of return on capital, then it would be possible to directly use delivered prices in parametric comparisons. Unfortunately, he found that ships were often being offered at anything up to 40% below cost price and in some cases on very favourable credit terms. He then concluded that it was clearly impossible to use market prices alone in any parametric comparison.

It is considered, however, that under certain circumstances ship's delivery price could still be valuable in such cost analysis. For example, if one restricts the selection of sample ships to those which were built in the same ship yard or in shipyards of the same country, then the problem may not be that acute.

Certain methods for estimating costs based on design studies have been developed as the alternative for cost estimating. Jansson and Shneerson (1987) developed the well-known geometric principle with a bearing to shipbuilding cost, the 'two-thirds power rule'. They explained that there were more or less marked economies of ship size in the costs of machinery, hull engineering, outfit, steelwork etc., and as a whole it seemed that the ship capital cost is proportional to the two-thirds power of the ship size. Symbolically, they got the following formula:

$$Log(building\ cost) = -4.236 + 0.655Log(DWT)$$

$$(R^2 = 0.34)$$

Unfortunately their sample consisted of fifty observations of the contracted prices of ***bulk carriers***. The difference between the structure of a bulk carrier and a fully cellular containership is very distinctive. The latter obviously needs more advanced technology and equipment as well as more steelwork, thus more expensive to construct. To improve the matter, Liu (1989) carried out an independent research in the Liverpool University Marine Transport

Centre, using a sample of 57 observations of the building prices for fully cellular containerships taken from FISYS (1987). All the ships selected were built in shipyards in Japan. He derived the following formula:

$$Ln(capital\ cost)(\$m) = -2.44 + 0.761Ln(TEU)$$

$$(R^2 = 0.69,\ S.D. = 0.187)$$

The above formula is used to estimate ships' capital cost in this study except that for Ship H. Among the eight sample ships selected (table 4-10), ships A and C were built in Japanese yards. Although ships B, D, E, F and G were not built in Japan, their capital costs are measured by the same 'Japanese Criteria'. It is anticipated that this should not produce inconsistent result as compared with ships A and C. As for Ship H, the cost is estimated at US$5 million (Macalister 1987).

The estimated ships' capital cost can be annulised by using the annuity factor. A discount rate of 5% in ***real*** terms is chosen to calculate the annuity factor. It is assumed that the average vessel life is 18 years (except Ship H) with negligible scrappage value. Each vessel is assumed to service 350 days per annum. Thus ships' daily capital costs can be derived.

Ship H was originally built in 1968 as a general cargo ship and converted into fully cellular in 1980. Three different scenarios have been assumed for the possible remaining life of the vessel, i.e. 10 years (Ship H_1), 8 years (Ship H_2) and 5 years (Ship H_3). The result is shown in table 4-11.

Table 4-11 Ship's Daily Capital Costs

	Size (TEU)	Total capital (m$)	Discount rate	Annuity factor	Annual cost (m$)	Daily cost ($)
Ship A (GX)	3428	42.7	5%	11.6896	3.65	10437
Ship B (C-10)	4300	50.7	5%	11.6896	4.34	12392
Ship C (New Oasis)	2214	30.6	5%	11.6896	2.62	7486
Ship D (Yu He)	1686	24.9	5%	11.6896	2.13	6086
Ship E (Tai He)	2700	35.6	5%	11.6896	3.05	8714
Ship F (Qiu He)	1318	20.6	5%	11.6896	1.76	5036
Ship G (Bin Cheng)	724	13.1	5%	11.6896	1.12	3203
Ship H_1 (C class)	1218	5.0	5%	7.7271	0.65	1850
Ship H_2 (C class)	1218	5.0	5%	6.4632	0.77	2210
Ship H_3 (C class)	1218	5.0	5%	4.3295	1.15	3330

Source: Appendices (1), (2), (3) and (4).

4.7.4 CALCULATION OF SHIP'S FUEL COST

Fuel costs form an important part in ship's total cost structure. For a ship equipped with diesel engines, fuel consumption mainly consists of three portions: those consumed by the main engine known as marine fuel oil (MFO); those consumed by the auxiliary engines known as marine diesel oil (MDO); and certain amount of lubricating oil which is necessary for the running of the engines.

Fuel costs are determined by a number of factors. Speed is the most important determinants of fuel costs. Other factors which affect fuel costs include type of the engine, horsepower, type of fuel used and its price, ship size and the shape of the hull (Chrzanowski 1984).

Given bunker price, ship's daily fuel cost will be determined by its daily fuel consumption, which, in turn will be determined by the scale of horsepower used to generate the ship's service speed. It is normally assumed that 80% of the powerplant's installed BHP is actually utilised in obtaining the service speed.

In order to calculate the fuel costs of the five sample ships, following assumptions are made based on Gilman (1980) and Pearson (1987):

1. The main engine consumes 130 grammes of fuel oil per hour for each BHP being generated. The price of MFO is taken as $120/tonne.
2. The main engine needs one gramme of lubricating oil per hour for each BHP. The price of lubricating oil is $220/tonne.
3. For ships up to 1500 TEUs the auxiliary engines consume 2 tonnes of MDO per day at sea and 4 tonnes in port and for ships over 1500 TEUs they consume 3 tonnes at sea and 5 tonnes in port. The price of MDO is taken as $170/tonne.

The result of the calculation of ship's daily fuel costs at sea are shown in table 4-12. When a ship is in port, its main engine will normally be closed down and consume no fuel oil. However additional demands will be placed on the auxiliaries. At 4 or 5 tonnes of MDO per day, this represents a cost of $680 or $850 respectively.

Table 4-12 Ship's Daily Fuel Costs at Sea

	Installed BHP	Service BHP	Daily MFO ($)	Daily Lub. ($)	Daily MDO ($)	Total cost ($)
Ship A (GX)	23180	18544	6943	98	510	7551
Ship B (C-10)	57000	45600	17073	241	510	17823
Ship C (New Oasis)	16000	12800	4792	68	510	5370
Ship D (Yu He)	14700	11760	4403	62	510	4975
Ship E (Tai He)	22770	18216	6820	96	510	7426
Ship F (Qiu He)	13500	10800	4044	57	340	4441
Ship G (Bin Cheng)	8086	6469	2422	34	340	2796
Ship H (C class)	21614	17291	6474	91	340	6905

Source:

1. *Lloyd's Register of Shipping* (1987).
2. *Fairplay International Shipping Weekly* (1988).
3. *Lloyd's List* (1987).
4. Appendices (1), (2), (3) and (4).

4.7.5 ESTIMATE OF INSURANCE & MAINTENANCE AND CREW COST

"Shipping, in a sense, is a highly dangerous business. In order to provide protection against a physical loss or damage to the ship, liability to third parties or against the loss earnings, shipowners need to subscribe to a number of insurance policies" (Chrzanowski 1984). To keep the ships seaworthy the owners have also to bear costs of repair and maintenance. Normally, the costs of insurance and maintenance are assumed to amount to some fixed percentage of the ship's initial capital cost. A percentage of 2.7 was suggested by Gilman (1980) and this ratio will be used in this study for all sample ships except Ship H. It is considered that for a second-hand vessel of over 20 years age, the percentage rate should be much higher. In this study a percentage of 10% is assumed. Thus ship's insurance and maintenance costs are taken to be a total of 2.7%, or for Ship H, 10% of initial capital costs per annum and converted to a daily basis on the same assumption of 350 working days (see table 4-13).

Ship's manning level and crew costs vary tremendously according to flag. Over the past decade, technological development has made it possible for shipowners to greatly lower ship's manning level thus reduce cost. For example, the following crew numbers were taken by Gilman (1980) in *Ship Choice in the Container Age.*

Ship size	*Manning*
100 TEUs	11
200 TEUs	14
300 TEUs	18
400 TEUs	22
500 TEUs	28
600 TEUs and upwards	31

Today a panamax vessel with a capacity of more than 3000 TEUs (Evergreen's GX class vessel for example) will only need 16 crew members. However, for vessels under the PRC flag, manning level is a different story. Ships normally employ more than 30 crew members. In the present study, manning level for ships A, B and C are taken as 16 and that for ships D, E, F, G and H 34 crew members are considered to be reasonable (see table 4-13).

Crew costs differ from country to country. It is assumed that for ships A, B and C the annual cost for each crew member is $45000. While the wage level in China is substantially lower, annual cost for each crew member on ships D, E, F, G and H is taken to be $10000. Table 4-13 shows the daily crew cost of each of the five sample ships.

Table 4-13 Ship's Daily Insurance & Maintenance and Crew Cost

	Initial Capital (m$)	Annual I & M ($)	Daily I & M ($)	Manning	Annual cost per head ($)	Daily crew cost ($)
Ship A (GX)	42.7	1152900	3294	16	45000	2057
Ship B (C-10)	50.7	1368900	3911	16	45000	2057
Ship C (New Oasis)	30.6	826200	2361	16	45000	2057
Ship D (Yu He)	24.9	672300	1921	34	10000	971
Ship E (Tai He)	35.6	961200	2746	34	10000	971
Ship F (Qiu He)	20.6	556200	1589	34	10000	971
Ship G (Bin Cheng)	13.1	353700	1011	34	10000	971
Ship H (C class)	5.0	500000	1429	34	10000	971

Source: Appendices (1), (2), (3) and (4).

4.7.6 CALCULATION OF SHIP'S TIME AT SEA AND IN PORT

Ship's round trip time is comprised of two parts: time at sea and in port. Ship's time at sea is determined by route length and ship speed. Given service speed, route length becomes the sole determinant. The round trip distance of each of the four itineraries in this study is derived from the *Admiralty Distance Tables* (Hydrographic Department 1984, 1978 & 1976). Time at sea can thus be calculated, plus a two-day allowance on each itinerary (see table 4-14).

Total numbers of containers carried on ship and container handling rate are the main determinants of ship's time in port. It is assumed that each of the eight sample ships has a load factor of 90% and of the total containers carried, the ratio between 40ft and 20ft containers are 50:50. Each ship is assumed to be worked by two cranes simultaneously and the average box handling rate is set to be 20 moves per hour per crane. Taking into account the fact that these five ships are operating on multi-port itineraries, it is anticipated that there would be certain amount of re-stow boxes, which is assumed to be equal to 15% of the containers carried on board. Thus ship's time in port can be calculated, plus two days' allowance for port access time, waiting for berth and waiting to commence cargo handling etc. (see table 4-15).

Table 4-14 Ship's Time at Sea

	Speed	Time (Days)			
	(knots)	FE-Europe (21715')	FE-WCNA (13761')	FE-ECNA (23179')	FE-Oceania (11796')
Ship A (GX)	20.7	45.7	29.7	48.7	25.7
Ship B (C-10)	24.2	39.4	25.7	41.9	22.3
Ship C (New Oasis)	19.0	49.6	32.2	52.9	27.9
Ship D (Yu He)	17.5	53.7	34.8	57.2	30.1
Ship E (Tai He)	19.0	49.6	32.2	52.9	27.9
Ship F (Qiu He)	17.5	53.7	34.8	57.2	30.1
Ship G (Bin Cheng)	15.0	62.3	40.2	66.4	38.7
Ship H (C class)	21.2	44.7	29.0	47.6	25.2

Source: Appendices (1), (2), (3) and (4).

Table 4-15 Ship's Time in Port

	Capacity (TEUs)	No. of boxes	Movements	Re-stow	Total movements	Time (days)
Ship A (GX)	3428	2056	8224	308	8532	10.9
Ship B (C-10)	4300	2580	10320	387	10707	13.2
Ship C (New Oasis)	2214	1328	5312	199	5511	7.7
Ship D (Yu He)	1686	1012	4048	152	4200	6.4
Ship E (Tai He)	2700	1620	6480	243	6723	9.0
Ship F (Qiu He)	1318	791	3163	119	3282	5.4
Ship G (Bin Cheng)	724	435	1739	65	1804	3.9
Ship H (C class)	1218	731	2923	110	3033	5.2

Source: Appendices (1), (2), (3) and (4).

4.7.7 COMPARISON OF SHIP'S TOTAL ROUND TRIP COST

With ship's daily costs and ship's time at sea and in port available, the calculation of ship's total round trip cost is quite straight forward. Dividing the total round trip cost by total TEUs carried, cost per TEU can be derived as shown in tables 4-16 to 4-19.

If a ship which can carry containers cheaply from one place to another is a good ship and a ship which has to carry containers more costly from the same place to the same destination is a bad ship, then

Table 4-16 Ship's Total Round Trip Cost -- Far East/Europe

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	590815	354409	186472	116454	1248151	202
Ship B (C-10)	651670	713250	205680	108181	1678780	217
Ship C (New Oasis)	428711	273003	135309	117917	954940	240
Ship D (Yu He)	365783	272611	115448	58385	812227	268
Ship E (Tai He)	510073	376145	160989	56946	1104153	227
Ship F (Qiu He)	297649	242140	93922	57414	691125	291
Ship G (Bin Cheng)	212075	176902	66919	64327	520224	399
Ship H_1 (C class)	92279	312046	71256	48454	524034	247
Ship H_2 (C class)	110248	312046	71256	48454	542003	239
Ship H_3 (C class)	164582	312046	71256	48454	596337	272

Source: Appendices (1).

the fact that Evergreen's GX and APL's C-10 vessels are the best is crystal clear (see tables 4-16, 4-17, 4-18, and 4-19). On the other hand, it can also be seen from the tables that most of the Cosco ships do not have the ability to compete with GX or C-10 in terms of unit transport cost per TEU. Cosco's future ships, represented by ship E (Tai He), will give the best performance among its container fleet. In fact the unit transport cost of Tai He will be fairly close as compared with C-10 vessels, especially on the relatively shorter routes, for example the Far East-WCNA route. The former Maersk

Table 4-17 Ship's Total Round Trip Cost -- Far East/WCNA

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	423720	233518	133734	83519	874490	142
Ship B (C-10)	481963	469160	152117	80009	1183249	153
Ship C (New Oasis)	298252	179336	94134	82034	653756	164
Ship D (Yu He)	250526	178394	79071	39988	547978	181
Ship E (Tai He)	358297	246609	113086	40001	757993	156
Ship F (Qiu He)	202274	158044	63827	39017	463162	195
Ship G (Bin Cheng)	141315	115124	44591	42864	343895	264
Ship H_1 (C class)	63357	204100	48923	33268	349648	159
Ship H_2 (C class)	75694	204110	48923	33268	361985	165
Ship H_3 (C class)	112999	204110	48923	33268	399290	182

Source: Appendices (2).

C-class vessels would be able to provide a similar performance if their remaining life could be as long as ten years (represented by Ship H_1). The remaining three Cosco ships, i.e. Ship D (Yu He), Ship F (Qiu He) and Ship G (Bin Cheng) are clearly too small and thus too expensive to operate on deep-sea routes. In fact the longer the route is, the worse the situation will be. This is because the larger ships can exploit their scale economies more comfortably on longer route.

Table 4-18 Ship's Total Round Trip Cost -- Far East/ECNA

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	621948	376934	196299	122591	1317772	214
Ship B (C-10)	683290	758729	215659	113430	1771109	229
Ship C (New Oasis)	453018	290455	142981	124602	1011057	254
Ship D (Yu He)	387258	290166	122226	61813	861463	284
Ship E (Tai He)	538352	400280	169914	60103	1168650	240
Ship F (Qiu He)	315420	257809	99530	60841	733599	309
Ship G (Bin Cheng)	225259	188412	71080	68327	553078	424
Ship H_1 (C class)	97668	332158	75417	51283	556526	254
Ship H_2 (C class)	116686	332158	75417	51283	575544	263
Ship H_3 (C class)	174193	332158	75417	51283	633051	289

Source: Appendices (3).

In this study, only the costs of ship's time is included. Other costs, the capital cost of the containers and cargo's inventory cost for instance, have been completely ignored. Should these costs be included, the larger and faster ships like GX and especially C-10 would become more favourable. The assumed price of MFO ($120/tonne) is actually much higher than the prevailing market price (around $80-90 per tonne). This has distorted the actual performance of the fast ships, C-10 in particular. Should the oil price become lower, the Cosco ships would be even less competitive.

Table 4-19 Ship's Total Round Trip Cost -- Far East/Oceania

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	382439	203652	120705	75382	782179	127
Ship B (C-10)	440038	408859	138884	73049	1060830	137
Ship C (New Oasis)	266022	156196	83962	73169	579349	145
Ship D (Yu He)	222052	155118	70084	35443	482697	159
Ship E (Tai He)	320802	214608	101251	35815	672476	138
Ship F (Qiu He)	178712	137269	56392	34472	406845	171
Ship G (Bin Cheng)	123834	99862	39075	37562	300334	230
Ship H_1 (C class)	56212	177432	43406	29516	306566	140
Ship H_2 (C class)	67158	177432	43406	29516	317512	145
Ship H_3 (C class)	100256	177432	43406	29516	350610	160

Source: Appendices (4).

4.7.8 EFFECTS OF SHADOW PRICING AND HIGHER CAPITAL COST

So far in this study, all the cost items are assessed using market prices. However, market prices do not always reflect the true costs to the economy of the resources. The true economic cost of a resource is its opportunity cost defined as the benefit obtained in the most productive alternative use. If a resource is scarce (e.g. foreign currency), the shadow price representing the opportunity cost may be greater than the market price; whereas if it is plentiful (e.g. labour) the shadow price will be less than the market price.

For the purpose of this study we will investigate the implications of a low shadow wage rate for Chinese ships. Since wages are a small part of total costs we will in fact set hem to zero as an extreme case. Tables 4-20 to 4-23 evaluate the effects of the zero wage costs on ship's total round trip cost.

It can be seen from the tables that the zero crew cost enhances the performances of the Cosco ships. Ship E (Tai He) actually produces very slightly lower cost/TEU figures than the C-10. It is also noticed that the second-hand Ship H_1 is very competitive. However, the remaining three Cosco ships, i.e. Ship D (Yu He), Ship F (Qiu He) and especially Ship G (Bin Cheng) are still too small to compete with the GX or C-10.

The initial capital costs of ships used in this study were derived at a time when the world shipping industry enjoyed an era of very low newbuilding costs. However, it is inconceivable that this is going to last for ever and there are already clear signs that the era is about to end, with a doubling of prices which does not still not leave shipbuilders with excessive profits. Before we enter the next chapter which will discuss Cosco's development strategies, tables 4-24 to 4-27 test the effects of doubling newbuilding prices.

The tables show that although generally the voyage costs/TEU all increase dramatically, it is the small ships that will be hardest hit.

Table 4-20 Ship's Total Round Trip Cost -- Far East/Europe (With Chinese Crew Cost = 0)

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	590815	354409	186472	116454	1248151	202
Ship B (C-10)	651670	713250	205680	108181	1678780	217
Ship C (New Oasis)	428711	273003	135309	117917	954940	240
Ship D (Yu He)	365783	272611	115448	0	753842	248
Ship E (Tai He)	510073	376145	160989	0	1047207	215
Ship F (Qiu He)	297649	242140	93922	0	633711	267
Ship G (Bin Cheng)	212075	176902	66919	0	455896	350
Ship H_1 (C class)	92279	312046	71256	0	475580	217
Ship H_2 (C class)	110248	312046	71256	0	493549	225
Ship H_3 (C class)	164582	312046	71256	0	547883	250

It can clearly be seen from the tables that the higher capital costs increase the advantages of large ships. This is because they provide greater TEU capacity per unit of capital. This result applies to newbuildings. However, if the second-hand market does not immediately reflect newbuilding costs, smaller second-hand vessels may for a time compete more effectively with large and new vessels. The implication of the result is that in the short and medium terms those container carriers who opt for the newbuilding strategy will

Table 4-21 Ship's Total Round Trip Cost -- Far East/WCNA (With Chinese Crew Cost = 0)

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	423720	233518	133734	83519	874490	142
Ship B (C-10)	481963	469160	152117	80009	1183249	153
Ship C (New Oasis)	298252	179336	94134	82034	653756	164
Ship D (Yu He)	250526	178394	79071	0	507990	167
Ship E (Tai He)	358297	246609	113086	0	717992	148
Ship F (Qiu He)	202274	158044	63827	0	424145	179
Ship G (Bin Cheng)	141315	115124	44591	0	301031	231
Ship H_1 (C class)	63357	204100	48923	0	316380	144
Ship H_2 (C class)	75694	204110	48923	0	328717	150
Ship H_3 (C class)	112999	204110	48923	0	366022	167

have to go for the largest ships they can afford. Alternatively, they can keep a low profile by continuing with existing fleets or using such second-hand vessels as may become cheaply available. In the long run, however, the world deep-sea container shipping industry will be even more dominated by large vessels, whether newbuildings or second-hand.

Table 4-22 Ship's Total Round Trip Cost -- Far East/ECNA (With Chinese Crew Cost = 0)

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	621948	376934	196299	122591	1317772	214
Ship B (C-10)	683290	758729	215659	113430	1771109	229
Ship C (New Oasis)	453018	290455	142981	124602	1011057	254
Ship D (Yu He)	387258	290166	122226	0	799650	263
Ship E (Tai He)	538352	400280	169914	0	1108547	228
Ship F (Qiu He)	315420	257809	99530	0	672758	284
Ship G (Bin Cheng)	225259	188412	71080	0	484751	372
Ship H_1 (C class)	97668	332158	75417	0	505243	230
Ship H_2 (C class)	116686	332158	75417	0	524261	239
Ship H_3 (C class)	174193	332158	75417	0	581768	265

Table 4-23 Ship's Total Round Trip Cost -- Far East/Oceania (With Chinese Crew Cost = 0)

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	382439	203652	120705	75382	782179	127
Ship B (C-10)	440038	408859	138884	73049	1060830	137
Ship C (New Oasis)	266022	156196	83962	73169	579349	145
Ship D (Yu He)	222052	155118	70084	0	447253	147
Ship E (Tai He)	320802	214608	101251	0	636661	131
Ship F (Qiu He)	178712	137269	56392	0	372373	157
Ship G (Bin Cheng)	123834	99862	39075	0	262772	202
Ship H_1 (C class)	56212	177432	43406	0	277050	126
Ship H_2 (C class)	67158	177432	43406	0	287996	131
Ship H_3 (C class)	100256	177432	43406	0	321094	146

Table 4-24 Ship's Total Round Trip Cost -- Far East/Europe (With Double Capital Cost)

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	1181630	354409	186472	116454	2025438	328
Ship B (C-10)	1303340	713250	205680	108181	2536130	328
Ship C (New Oasis)	857422	273003	135309	117917	1518960	381
Ship D (Yu He)	731566	272611	115448	58385	1293458	426
Ship E (Tai He)	1020147	376145	160989	56946	1775216	365
Ship F (Qiu He)	595299	242140	93922	57414	1082696	456
Ship G (Bin Cheng)	424150	176902	66919	64327	799218	613

Table 4-25 Ship's Total Round Trip Cost -- Far East/WCNA (With Double Capital Cost)

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	847439	233518	133734	83519	1431943	232
Ship B (C-10)	963926	469160	152117	80009	1817329	235
Ship C (New Oasis)	596504	179336	94134	82034	1046141	263
Ship D (Yu He)	501051	178394	79071	39988	877575	289
Ship E (Tai He)	716595	246609	113086	40001	1229376	253
Ship F (Qiu He)	404548	158044	63827	39017	729262	307
Ship G (Bin Cheng)	282630	115124	44591	42864	529802	407

Table 4-26 Ship's Total Round Trip Cost -- Far East/ECNA (With Double Capital Cost)

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	1243896	376934	196299	122591	2136019	346
Ship B (C-10)	1366580	758729	215659	113430	2670058	345
Ship C (New Oasis)	906037	290455	142981	124602	1607057	403
Ship D (Yu He)	774515	290166	122226	61813	1370946	452
Ship E (Tai He)	1076705	400280	169914	60103	1876917	386
Ship F (Qiu He)	630839	257809	99530	60841	1148549	484
Ship G (Bin Cheng)	450518	188412	71080	68327	849416	652

Table 4-27 Ship's Total Round Trip Cost -- Far East/Oceania (With Double Capital Cost

	Capital cost ($)	Fuel cost ($)	I & M cost ($)	Crew cost ($)	Total cost ($)	Cost per TEU ($)
Ship A (GX)	764879	203652	120705	75382	1285323	208
Ship B (C-10)	880075	408859	138884	73049	1639752	212
Ship C (New Oasis)	532045	156196	83962	73169	929334	233
Ship D (Yu He)	444104	155118	70084	35443	774832	255
Ship E (Tai He)	641604	214608	101251	35815	1094529	225
Ship F (Qiu He)	357424	137269	56392	34472	641948	271
Ship G (Bin Cheng)	247668	99862	39075	37562	463243	355

REFERENCES

Branch, A. E. (1981), *Elements of Shipping*, Chapman and Hall, London.

CI (1988a), Cosco Box Boost, *Containerisation International*, 22: no. 2, 12.

__ (1988b), *Containerisation International Yearbook 1988*, ed. M. R. Lambert etc, National Magazine, London.

__ (1987a), *Containerisation International Yearbook 1987*, ed. M. R. Lambert etc, National Magazine, London.

__ (1987b), Cosco Marches On, *Containerisation International*, 21: no. 12, 7.

__ (1987c), New Cosco Link, *Containerisation International*, 21: no. 10, 7.

__ (1987d), Cosco goes IPI in PRC, *Containerisation International*, 21: no. 3, 13.

Couper, A. D. (1972), *The Geography of Sea Transport*, Hutchinson & Co. (Publications), London.

Drewry (1986), *Traffic and Competition on Round-the-World Container Routes*, Drewry Shipping Consultants, London.

Fairplay International Shipping Weekly, (1988), APC Takes Delivery of Its Wide Boxship, 306: no. 5457.

FISYS (1987), *Newbuilding Ship Price*, Fairplay, London.

Fossey, J. (1988), Slots Count Slows as Scrappage Grows, *Containerisation International*,22: no.1, 40.

Gilman, S. (1988), *Deep Sea Container Shipping: A Further Evolution*, unpublished paper.

__ (1980), *Ship Choice in the Container Age*, University of Liverpool Marine Transport Centre, Liverpool.

Goss, R. O. (1984), *Policies for Canadian Seaports*, UWIST, Cardiff.

Hydrographic Department (1984), *Admiralty Distance Tables Pacific Ocean*, Hydrographer of Navy, Taunton, Somerset.

__ (1978), *Admiralty Distance Tables Indian Ocean*, Hydrographer of Navy, Taunton, Somerset.

__ (1976), *Admiralty Distance Tables Atlantic Ocean*, Hydrographer of Navy, Taunton, Somerset.

JAMRI (1987), *Far East -- European Liner Trade*, JAMRI Report No. 20, by Yamada, H., Tokyo.

__ (1983), *World Containerisation 1983: Analysis and Future Outlook on Containerisation Developments*, Shipping & Trade News, Tokyo.

Jansson, J. O. & Shneerson, D. (1987), *Liner Shipping Economics*, Chapman and Hall, London.

Liu, S. J. (1989), The Pacific Container Freight Market: An Analysis of Demand, Supply and Costs, M.Phil thesis, University of Liverpool.

Lloyd's List, (1987), Cosco Box Ship Design Reflects New Chinese Emphasis on Port Planning, 30 November.

Lloyd's Register of Shipping (1987), *Register of Ships 1987-88,* London.

Macalister, T. (1987), Cosco Acquires Five A. P. Møller Vessels, *Lloyd's List,* 29 October.

NYK Research Chamber (1987), *World's Containership Fleet and its Operations,* Tokyo News service, distributed by Fairplay Publications, London.

Pearson, R. (1987), *Container Ships and Shipping,* Fairplay, London.

Phillips, F. E. (1988), Maersk: How Many Master-strokes Still to Come?, *Containerisation International,* 22: no.3, 25.

Phillips, F. E. & Fossey, J. (1984), And Still They Come... but New Ship Orders Are Dropping Back, *Containerisation International,* 18: no.1, 39.

Transmodal Industries Research (1986), *Supply Pressure in Container Shipping 1986 -- 1988,* vol. 2, *Carriers,* London.

University of Liverpool Marine Transport Çentre (1979), *Optimal Speed and Ship Size for the Liner Trades,* by S. C. Ryder & D. Chappell, Liverpool.

Wan, H. (1988), British and Chinese Shipping Companies: A Comparative Study of Organisation and Management, PhD thesis, University of Wales, Cardiff.

CHAPTER 5 ISSUES IN DEVELOPMENT STRATEGY FOR COSCO

5.1 INTRODUCTION

In the last two chapters China's seaborne container traffic up to 1995 has been forecast, the present world and Cosco containership fleet been analysed and the economics of ship choice been studied. The question now is how should the shipping sector, in the term mainly of Cosco, act to meet the demand in 1995. This question actually contains several elements relating to ship choice, fleet size, route deployment, service frequency and the shipping policy to be adopted. It is the purpose of this chapter to thoroughly examine the important issues in these areas.

5.2 SHIPPING POLICY AND MARKET SHARE

Shipping policy is such a big and important subject that one can devote an entire thesis to it. The prime concern in this study is the issue of cargo reservation and the Cosco share of China's future container traffic and particularly, the implication of market share with respect to the development of the Cosco container fleet.

As a centrally planned economy, China could be considered to have a natural predisposition towards the adoption of a policy of one hundred percent cargo reservation for its national fleet. For example, in 1987 China was accused of selling CIF and buying FOB so that the seaborne freight revenue generated in its trade can be earned by Chinese ships (OECD 1987). Such a policy, however, is difficult to sustain, because trading partners sooner or later will rebel against such trade terms. Goss (1987) made the point fairly clear in his editorial article How to Make Money in Shipping for the journal *Maritime Policy & Management:*

> "World shipping is, however, a largely free market; despite much noise about it, there is in practice little national protectionism if only because it would be so expensive for those who applied it."

Admittedly, some sort of coordination did exist between Cosco, the largest ship owner under the Ministry of Communications (MOC) and Sinotrans, the largest shipper or cargo owner under the Ministry of Foreign Economic Relations & Trade (Mofert) of the PRC. The prime function of the MOC is to control China's transport system with shipping being its predominant task, whilst that of Mofert is to secure the cargoes and shipping space for the import and export of foreign trade. Notwithstanding a degree of coordination, the theme of the relationship between the two is largely one of competition and rivalry. Sinotrans could book space on Cosco ships. Alternatively, the company could also choose any other carriers, or it could run its own chartered vessels through its sister company Sinochart.

With the deepening of China's economic reform, the system of foreign trade has also changed, and the dominant positions of Mofert and Sinotrans have been eroded to some extent. Nowadays, local provinces and municipalities and even some large scale companies have control over their foreign trade policies. China's highest government body, the State Council, has raised the total number of local bodies authorised to participate in foreign trade to 288 cities and counties (Fletcher 1988). More often than not, local foreign trade bureaus or Sinotrans branches negotiate for them and hand their cargo directly to foreign shipping lines. Alternatively, they may choose to run their own feeder fleets shipping their goods to/from Hong Kong or Japan, while foreign shipping lines control the deep-sea leg.

The trend to decentralisation of the Chinese economy is thus quite pronounced. The Chinese shipping market is not now a totally protected one and a mechanism of free competition is emerging. No guarantee is granted to Cosco, the national line that it will be favoured for carrying Chinese goods, and any carriers who appear more competitive can win a share of the Chinese shipping market. For example, a contract has been signed by Lloyd Triestino and Sinotrans, under which the Italian carrier is authorised to carry containers between the Mediterranean and China, covering a full range of Chinese ports including Dalian, Huangpu, Qingdao, Shanghai and Xingang, via Hong Kong (Mayer 1988). On the transpacific route, according to the bilateral liner shipping agreement between China and the United States, US flag ships are allowed at least one-third of all bilateral shipping and trade and can enter 40 specified Chinese ports (Williams 1988).

In these circumstances the market share of Cosco becomes difficult to estimate. It could be 70% or more if Cosco becomes very competitive and efficient. It could be 40% according to the 40:40:20 formula of the United Nations Liner Code, or less. In this study, however, it is assumed for simplicity that Cosco will take 50% out of the total traffic volume based on the consideration that China and its trading partners should have the equal shares. It must be stressed that this is a pure hypothesis for the sake of this study. It provides the basis for a scenario in which to consider the nature of the options which may be open to Cosco, in terms of scale and frequency of operation.

Cosco has so far adopted a non-conference strategy. It believes that its status as an independent outsider will enable it to pick up more cargoes from both Chinese and foreign-based shippers than it would by being subject to conference restrictions and cargo allocation. Ever since the establishment of the world's first liner shipping conference (the UK-Calcutta conference) in 1875, debate has raged over their virtues and vices. Even today as the world shipping industry has moved into the era of intermodalism, there is still no universal agreement as to whether conferences bring good or bad for shippers or carriers and economic efficiency. The reality today is that both conference carriers and non-conference outsiders play an important role in providing shippers with high quality container shipping services. Take the Far East-Europe route for example. This is a route traditionally dominated by the Far Eastern Freight Conference (FEFC). Nowadays, container services provided by non-conference outsiders on the route have grown to a very substantial level. By 1989 conference carriers accounted for around 57% of total capacity and the conference share of actual liftings is estimated to be approximately 55% of the trade (Matthews 1989) (see tables 5-1 and 5-2).

Table 5-1 North Europe/Far East Conference Container Services

Operator	Frequency	No of Ships	TEU Capacity	Two-way Capacity (TEUs)
Ace	weekly	8	3200-3500	340000
DSR/POL(Eacon)	weekly	10	946-1633	115000
Maersk	weekly	8	2040-3000	240000
Rickmers	monthly	4	420-1022	12000
ScanDutch/Misc	weekly	9	2600-2900	280000
Trio	5-6/month	26	2700-3600	840000

Source: Matthews (1989).

One of the main advantages for Cosco if it was to become a conference carrier would be that it would enjoy a guaranteed conference tariff rate which is normally some 5-10% higher than the outsider rate. However, as Cosco believes, the main disadvantage is that it would have to subject itself to conference rules and might not be able to secure the loading rights that it wishes to have.

Table 5-2 North Europe/Far East Non-Conference Container Services

Operator	Frequency	No of Ships	TEU Capacity	Two-way Capacity (TEUs)
Balt Orient	9 days	8	824-1254	80000
Cosco	7/8 days	10	1152-1984	145000
CMA	10 days	8	1597-1797	120000
Evergreen	weekly	25	2728-3428	300000
Hanjin/Cho Yang	weekly	9	1500-2700	250000
Norasia/Sea-Land	weekly	13	1980	150000
Senator	fortnightly	12	956-1706	65000
TFH	3 weeks	4	1000	30000
Unithai	21 days	4	120- 462	7000
Yangming	weekly	11	1940-3090	280000

Source: Matthews (1989).

Therefore, the benefits that the higher tariff rate brings could easily be offset by the loss of loading rights and freedom of action. In this respect, the defection of the two original conference carriers Hanjin Shipping and Cho Yang Shipping, both from South Korea, can serve as an example. According to Matthews (1989), they "had lost patience with their continued failure to secure greater carrying rights". Therefore, they simply left FEFC in early 1989 and set up their independent weekly service between Far East and Europe. They now have around 3.5 times their previous slot capacity on the route. This incident must have some influence on Cosco. If Cosco were in the FEFC, its situation might be no better than that of the Korean carriers when they were members and it might be asked to give up some of its slot capacity on the route. However, this also tells Cosco that a conference carrier does not have to stay in the conference camp for ever. It can leave whenever it wants. Therefore Cosco can for the moment leave its options open and can consider conference membership on a case by case basis as circumstances arise.

5.3 FUTURE DEMAND AND PRESENT CAPACITY

Based on the 50% assumption made in last section, the comparison between Cosco's present container carrying capacity and demand in 1995 is presented in tables 5-3, 5-4 and 5-5. Present capacity is estimated around 0.71 million TEUs (two-way annually), including 0.41 million TEUs of deep-sea capacity and 0.3 million TEUs of medium and short sea capacity. In the optimistic scenario, total Chinese container traffic would reach 2.86 million TEUs in 1995, with 40% being deep-sea and 60% medium and short sea traffic. Thus total demand for the Cosco fleet would reach 1.43 million (0.57 million of deep-sea traffic and 0.86 million of medium and short sea). In the intermediate and pessimistic scenarios, total Chinese container traffic would be 2.46 and 1.86 million TEUs, representing a total demand of 1.23 million (0.49 million of deep-sea and 0.74 million of medium and short sea) and 0.93 million (0.37 million of deep-sea and 0.56 million of medium and short sea) respectively for the Cosco container fleet. The general situation, thus, is that demand on the medium and short sea is much greater than the deep-sea. Take the intermediate case for example (table 5-4). The difference between deep-sea capacity and demand is only 0.08 million TEUs; whereas that between medium and short sea capacity and demand is 0.44 million TEUs.

Table 5-3 Demand in 1995 and Cosco's Present Capacity (High Case, TEUs)

	Present two-way capacity	Demand in 1995	Difference
DEEP-SEA			
N. America	195000	184898	+10102
C. America Caribb	0	0	0
S. America	0	18490	-18490
N. & Atlantic Europe, UK	119616	186910	-67294
Med. Asia, Europe, Africa	24912	135592	-110680
Africa ex Med.	5280	0	+5280
Red Sea, Arabian Gulf	34128	4918	+29210
Oceania	30960	47117	-16157
SUB-TOTAL	409896	577925	-168029
MEDIUM & SHORT SEA			
SUB-TOTAL	300000	859590	-559590
TOTAL	709896	1437515	-727619

Note:

1. '+' indicates over-capacity.
2. Present capacity estimated from CI (1988) & NYK (1987).

Table 5-4 Demand in 1995 and Cosco's Present Capacity (Intermediate Case, TEUs)

	Present two-way capacity	Demand in 1995	Difference
DEEP SEA			
N. America	195000	157057	+37943
C. America Caribb	0	0	0
S. America	0	15706	-15706
N. & Atlantic Europe, UK	119616	158766	-39150
Med. Asia, Europe, Africa	24912	115175	-90263
Africa ex Med.	5280	0	+5280
Red Sea, Arabian Gulf	34128	4178	+29950
Oceania	30960	47117	-16157
SUB-TOTAL	409896	497999	-88103
MEDIUM & SHORT SEA			
SUB-TOTAL	300000	730159	-430159
TOTAL	709896	1228158	-518262

Note:

1. '+' indicates over-capacity.
2. Present capacity estimated from CI (1988) & NYK (1987).

Table 5-5 Demand in 1995 and Cosco's Present Capacity (Low Case, TEUs)

	Present two-way capacity	Demand in 1995	Difference
DEEP SEA			
N. America	195000	118932	+76068
C. America Caribb	0	0	0
S. America	0	11894	-11894
N. & Atlantic Europe, UK	119616	120184	-568
Med. Asia, Europe, Africa	24912	87217	-62305
Africa ex Med.	5280	0	+5280
Red Sea, Arabian Gulf	34128	3162	+30966
Oceania	30960	35680	-4720
SUB-TOTAL	409896	377119	+32777
MEDIUM & SHORT SEA			
SUB-TOTAL	300000	552844	-252844
TOTAL	709896	929963	-220067

Note:

1. '+' indicates over-capacity.
2. Present capacity estimated from CI (1988) & NYK (1987).

5.3.1 DEEP-SEA ROUTES

Although generally the difference between deep-sea traffic demand in 1995 (based on the 50% assumption) and Cosco's present deep-sea fleet capacity is relatively small compared with the medium and short sea, the situation varies tremendously according to route. For example, extra demand for Cosco's deep-sea container carrying capacity will mainly come from North and Atlantic Europe and the Mediterranean area. In contrast to this container traffic on the Sino-Africa and Sino-Middle East routes is expected to contract dramatically and by 1995 even the present limited container carrying capacity would become largely, if not totally, surplus.

(1). The High Case

In the optimistic scenario, Cosco will require a total annual two way capacity of 0.58 million TEUs. This means that it will need a 41% increase of its present capacity by 1995.

The demand for capacity is expected mainly from the Sino-Europe and Sino-Mediterranean routes, reaching 67,294 TEUs and 110,680 TEUs respectively, as shown in table 5-3. It is these two trading routes that Cosco should pay special attention to. On the Sino-Europe route, a total of 186,910 TEUs' two way traffic would require a weekly service using ships of 1,800 TEUs in size; while on the Sino-Mediterranean route a weekly service using ships of 1,300 TEUs will meet the traffic demand of 135,592 TEUs. Alternatively, there is a possibility for Cosco to merge these two routes, since the Mediterranean is en route from the Far East to North Europe. In such a case a weekly service using ships of 3,100 TEUs would meet the total demand of the two sub-routes. This unique single service by ships of 3,100 TEUs is deemed to be more economical and efficient than the two separate service using smaller ships.

On the transpacific route, present capacity is already 10,000 TEUs surplus in relation to the demand in 1995. With the deployment of five 1200 TEUs former Maersk vessels and the delivery of another five new buildings of 2700 TEUs in the near future, it seems that Cosco is going into a position of over-supply. It would therefore have either to acquire a more than 50% of Chinese traffic or get involved in international cross-trading.

Round trip traffic demand between China and the Oceania will reach 47,117 TEUs in 1995. To meet this demand the present Sino-Australia service operated by Cosco needs to be enhanced and fortnightly service with ships of 1000 TEUs capacity will be justified. At present, there is no container liner service between China and South America. There would be a traffic volume of 18,490 TEUs on the route in 1995. This could justify a monthly service using ships of 800 TEUs capacity. However the traffic will be heavily unbalanced on the route with virtually no east-bound cargo. This may suggest that the best ship choice would be a flexible type, such as a conbulker.

While on some deep-sea routes traffic is growing continuously, traffic on the Sino-Africa and Sino-Middle East the trend has been decreasing. There could be over-supply on these routes by 1995 as indicated in table 5-3.

(2). The Intermediate Case

In the intermediate case, Cosco will have to acquire an extra annual two way capacity of just 88,103 TEUs, equivalent to a 21% increase on the present capacity, to carry 50% of the estimated Chinese deep-sea container trade in 1995 (see table 5-4). On the Sino-Europe route, an additional capacity of 39,150 TEUs would be required to meet the total demand of 158,766 TEUs. This would justify a weekly service of ships of 1,500-1,600 TEUs in capacity. On the Sino-Mediterranean route, the difference between the demand and the present supply would reach 90,263 TEUs in 1995. A weekly service using ships of 1,100 TEUs capacity would be necessary to meet the demand of 115,175 TEUs. Once again, the merging of the two routes would enable Cosco to launch a weekly service using ships up to 2,700 TEUs. On the Oceania route, a demand of 47,117 would suggest a fortnightly service with ships of 900 TEUs. It may be worthwhile for Cosco to launch a monthly Sino-South America service using ships around 650 TEUs in 1995 as the demand is increasing, though heavily unbalanced.

As indicated in table 5-4, in the intermediate case, the present capacity of Cosco's transpacific service will surpass the demand in 1995 by the amount of 39,150 TEUs. The same situation applies to the Sino-Africa and Sino-Middle East routes, with a surplus of capacity of 5,280 TEUs on the former and an over-capacity of 29,950 TEUs on the latter.

(3). The Low Case

If the low case should turn out to be true, then the present capacity of Cosco's deep-sea container fleet would surpass the demand in 1995 with an over-capacity of 32,777 TEUs. This, however, is not to say that the present capacity will necessarily meet the future demand. While on some trading routes there is over-capacity, on others there are still shortages and, different routes have different ship choices. Table 5-5 shows the detail.

5.3.2 THE MEDIUM AND SHORT SEA ROUTES

Medium and short sea routes are estimated to account for 58% of China's seaborne container traffic in 1995, totalling 1.72 million TEUs in the high case, 1.46 million TEUs in the intermediate case and 1.11 million TEUs in the low case. However, the present capacity on medium and short sea routes is only about 300,000 TEUs, or 42% of the total fleet capacity. It is again assumed that Cosco will carry 50% of the total traffic.

Under the optimistic scenario, there is a huge gap of 0.56 million TEUs between Cosco's present capacity and future demand. Cosco would need to treble the present annual two way capacity of the medium and short sea container fleet to meet an estimated total demand of 0.86 million TEUs in 1995 (see table 5-3). This gap is reduced to 0.43 million TEUs under the intermediate scenario, which means that Cosco needs to increase its medium and short sea container fleet capacity by 143% to meet the total demand of 0.76 million TEUs in 1995. The gap will further drop to 0.25 million TEUs under the pessimistic scenario but Cosco would still have to nearly double its present capacity to meet the demand of 0.55 million TEUs.

It is thus clear that for Cosco the expansion of the medium and short sea container fleet appears to be a more urgent task than that of the deep-sea fleet. This general situation is deemed to have some significant impact on the development strategy of China's container ports and the inland transport system, which will be analysed in the later chapters.

5.4 FLEET OPERATION STRATEGIES

Containership fleet operation generally belongs to the category of liner shipping service, which bears the characteristics of a fixed set of ports of call and a fixed service frequency. A container fleet usually consists of a number of similar ships. Ports of call, service frequency, ship size, service speed and fleet size are the main elements in-so-far as the strategy of container fleet operation is concerned.

5.4.1 THE PORTS

The ports of call for a particular service are chosen by the fleet operator based on the considerations such as the inland origin/destination of cargo, transit time, port resources, port access, links with inland transport and the potential to attract traffic in the future. For container liner service, the condition of the port itself is a decisive factor which influences ship operators' choice. Those ports with efficient container handling systems, adequate container stowage yard and excellent geographic location are in a superior competitive position. In the intermodal age, the largest container hub port does not necessarily have to be the largest cargo origin/destination. Japan is undoubtedly the largest economic and international trade centre in the Far East. It is Hong Kong, however, with a relatively small economy that has the largest single container port in the region and in the world.

In the early stages of containerisation it was widely believed that container service would become highly concentrated with very large ships plying between a very limited number of super-ports, wider distribution being achieved by feeder service or inland transport. Theoretically, it is possible for shipping lines to absorb some inland costs from the sea freight so that shippers can deliver their container goods to such super-ports with no extra inland haulage cost as if they are delivering the goods to the nearest traditional ports. In practice however, this kind of concentrated service has never materialised and the idea of super-ports itself has been strongly criticised. The main reasons are that the substitution of inland transport or feeder service for diversion of the deep-sea ships is not necessarily a cheap option, scale economies in the ship are not quite as powerful as expected and they are not totally lost by multi-port calling (Gilman 1980; Pearson & Fossey 1983).

5.4.2 SERVICE FREQUENCY

Service frequency is an important factor which influences the choice of ship size, ship speed and fleet size. Services of a weekly interval have been the norm in modern container shipping, along with some 10-day or 15 day services for carriers with lower cargo capture. In the recent years, however, the concept of "Fixed Day of the Week Service" (FDWS) has become popular in the world's main stream container routes (JAMRI 1987). The advantage of an FDWS is that it enables shippers to match their logistic needs to the scheduled calls of the vessel and it also gives the carriers in return a guarantee of cargo.

5.4.3 SHIP SIZE, SHIP SPEED AND FLEET SIZE

Ship size, ship speed and fleet size are three interrelated factors which form the major part of the fleet operation strategy. A deterministic model developed by Ryder and Chappell (University of Liverpool Marine Transport Centre 1979) explains the interrelationship between the three. This is illustrated below, although one small change is made from the original model.

Assumptions

1. A shipping line operates a fleet of M identical ships on an N port itinerary at a regular frequency.
2. The ports are classified into two sets: $P_1 = (p_1, \ldots, p_k)$ represents ports of origin and $P_2 = (p_{k+1}, \ldots, p_n)$ represents ports of destination.
3. Container freight rate R_{ij} between any $P_i \varepsilon P_1$ and any $P_j \varepsilon P_2$ is a constant R. No containers are carried between ports belonging to the same set.
4. There is a particular annual (or daily) demand for container ship space to/from each port on the route.
5. The line's objective is profit maximisation.

The ship's round trip time (t) is the sum of ship's time at sea, cargo handling time and port access time which is given by the following formula:

$$t = \frac{X}{V} + \frac{4lQ}{H} + NK = \frac{HX + 4lQ + HNKV}{VH} \quad \ldots\ldots\ldots\ldots(1)$$

Where

- X = total round trip distance in nautical miles.
- V = common ship speed in nautical miles per day (24 hours).
- l = common load factor for each ship on the route, $0<l\leq1$.
- Q = common ship size in TEUs.
- H = common container handling rate at each port in TEUs per day.
- K = access time (days).

At any time, there are αM ships in service on the line, where $\alpha = \frac{365 - Z}{365}$ (Z = Annual number of days each ship spends off hire). Therefore each $\frac{t}{\alpha M}$ days a ship arrives at each port on the route and at each set of ports loads and discharges lQ containers. Thus the average daily demand (q) in TEUs for transport capacity in each direction between P_1 and P_2 can be expressed as:

$$q = \frac{\alpha MlQ}{t} = \frac{H\alpha lMVQ}{HX + 4lVQ + HNKV} \dots\dots\dots\dots(2)$$

As discussed in sub-section 5.4.2, it is common practice for shipping lines to operate on a particular regular frequency, FDWS for example. Therefore service frequency (T) can be another determinant for ship size Q, ship speed V and fleet size αM.

$$T = \frac{t}{\alpha M} = \frac{HX + 4lVQ + HNKV}{\alpha HVM} \dots\dots\dots\dots(3)$$

Given t, q and T, assuming a load factor of 100%, i.e. let l=1, Ship size Q, ship speed V and fleet size M can be obtained by solving equations (1), (2) and (3):

$$Q = qT \dots\dots\dots\dots(4)$$

$$V = \frac{HX}{Ht - 4qT - HNK} \dots\dots\dots\dots(5)$$

$$M = \frac{t}{\alpha T} \dots\dots\dots\dots(6)$$

However, this model cannot satisfy the requirement of container shipping. In formula (6), T is the service frequency while t represents ship's round trip time. As indicated in the last sub-section, in modern container shipping, FDWS is a common practice. An FDWS means that T equals to seven while t must be multiples of seven. Thus, according to formula (6), fleet size M must be a non-integer, which is unacceptable. It is only when α is an integer that M can also be an integer. The only possible integer for

α is 1, which requires the annual number of days each ship spends off hire (Z) to be zero. This in practice implies that the shipping company has to either charter in an extra vessel or simply drop one voyage when a certain ship in the fleet is off hire. In this study we will let α equal one and ignore the extra cost thus caused. Thus formula (6) will be modified as:

$$M = \frac{t}{T}$$

The effect of changes of the relevant factors on M, Q and V are shown in table 5-6. For example, other things being equal, an increase in service frequency (reduction of the service interval) would require an increase of the fleet size with smaller individual ship size and slower service speed; whilst a decrease of the turnaround time would require less ships but steaming at a higher speed with no change on the ship size.

Table 5-6 Effect of Changes of the Relevant Factors on M, Q and V.

	∂T	∂t	∂q	∂H	∂X	∂N	∂K
∂M	-	+	0	0	0	0	0
∂Q	+	0	+	0	0	0	0
∂V	+	-	+	-	+	+	+

Note:

- "+" indicates a direct ratio.
- "-" indicates an inverse ratio.
- "0" indicates that the factors are irrelevant.

Source: University of Liverpool Marine Transport Centre (1979).

5.4.4 CASE STUDIES

(1). The Sino-Europe Route

Seaborne container traffic between China and North and Atlantic Europe in 1995 would reach 317,532 TEUs in 1995 (intermediate case, see table 3-19). Thus total demand for Cosco containership fleet on the Sino-Europe route would approximately be 160,000 TEUs. This represents an average daily demand (q) of 220 TEUs in each direction between China and Europe. Assuming Cosco would get a cross-trading share of 80 TEUs per day via Hong Kong and Singapore, this put the total daily demand at 300 TEUs.

If Cosco maintains the same service itinerary as specified in sub-section 4.7.2, the ports of call would be Shanghai, Hong Kong and Singapore in the Far East end and London, Hamburg, Rotterdam and Antwerp at the European end. The total number of port calls (N) would be nine (Hong Kong and Singapore would be double calls). The service is set to be weekly (T=7) and total round trip distance X=21,715 nautical miles (see table 4-14). Assuming a required round-trip time (t) of 70 days, a common container handling rate (H) of 1440 TEUs per day (the ratio between 40ft and 20ft containers are 50:50; each ship worked by two cranes simultaneously and the average box handling rate set to be 20 moves per hour per crane) and an average port access time of 0.5 day, ship size Q, ship speed V and fleet size M can be obtained by formulae (4), (5) and (6):

$$Q = 2100 \text{ TEUs}; \; V = 15.2 \text{ knots}; \; M = 10$$

Therefore on this particular service route, Cosco would need a fleet of 10 containerships, each with a capacity of 2100 TEUs and a service speed of 15.2 knots.

In the above case, if the daily traffic demand and service frequency is fixed, then ship size is a constant. However, there does exist a trade-off between fleet size and ship speed. If the round trip time is required to be reduced to 63 days, then Cosco would only need 9 ships, but at a higher speed of 17.2 knots. If the round-trip time is further reduced to 56 days, only eight ships with a service speed of 19.8 knots would be required. Tautologically, a fleet can be operated either with more ships steaming at a lower speed or with less ships (saving capital cost) steaming at higher speed (thus higher fuel cost) and achieving fast turnaround. The annual costs of the fleet with different service speed and fleet size options can be calculated using the ship's round-trip cost model established in Chapter 4, as shown in table 5-7. It should be noted that when calculating ship's fuel consumption, it is essential to have an accurate estimate of installed BHP. In this respect, the following formula suggested by Pearson (1987) is adopted:

$$\textit{Installed BHP} = 0.065 \times \sqrt{(\textit{TEU Capacity})} \times (\textit{Service speed})^3$$

Table 5-7 Fleet Options on the Sino-Europe Route

Round trip (days)	Service frequency (days)	Ship size (TEUs)	Fleet size	Service speed (knots)	Annual ship cost (m$)	Annual fleet cost (m$)
70	7	2100	10	15.2	4.8	47.7
63	7	2100	9	17.2	5.2	46.5
56	7	2100	8	19.8	5.8	46.6
49	7	2100	7	23.4	7.0	49.2

Source: Appendices (5).

It can be seen from table 5-7 that if the fleet operates 10 ships at a service speed of 15.2 knots, the annual fleet cost will be US$47.7 million. If the fleet size is reduced to 9 ships and the service speed raised to 17.2 knots, the annual fleet cost is slightly reduced, while on the other hand ship's turnaround time is reduced from 70 days to 63 days. Thus the second option is clearly superior to the first one. In the third option, with 8 ships at a service speed of 19.8 knots the annual fleet cost virtually remains unchanged, and a further 7-day turnaround time has been knocked off. In the final option with only 7 ships steaming at a speed of 23.4 knots, the turnaround time is further shortened to 49 days. On the other hand, however, the penalty of high fuel consumption begins to bite. The annual fleet cost rises to US$49.2 million. It is thus clear that the third option is the best.

It must be pointed out that the above result is largely subject to the assumptions, especially the assumption of fuel price made in Chapter 4. It is a well known fact the world oil market is one of the most changeable. It should also be noted that the possible savings of inventory costs for both the cargo and the containers as a result of the faster turnaround is not considered in the study. In making the decision which fleet size/ship speed combination Cosco is opt for, it largely depends on how is Cosco going to evaluate ship's turnaround time. Bearing in mind the situation of fierce competition in the world container shipping industry, rapid ship turnaround can be vital. Thus even the final option could prove to be worthwhile.

(2). The Sino-Mediterranean Route

The Sino-Mediterranean service is currently maintained by Cosco Tianjin with eight semi-container vessels at a twice monthly frequency. This service clearly needs to be enhanced because by 1995 the estimated container traffic on the route would reach 0.23 million TEUs (intermediate case, see table 3-19). This represents a total annual two-way demand of 0.12 million, or an average daily demand (q) of 160 TEUs for the Cosco fleet. Ports of call on the itinerary are assumed to be Xingang and Shanghai at the Chinese end and Genoa, Marseilles and Barcelona at the Mediterranean end. The total number of port calls for a round trip (N) would be five. A weekly service frequency is assumed and the total round-trip distance X=19,700 nautical miles. Based on the same assumptions and methodology as in the study of the Sino-Europe route, ship size Q, ship speed V, fleet size M and the annual fleet cost can be obtained as shown in table 5-8. It can be clearly seen from the table that on the Sino-Mediterranean route, the fleet of seven ships, each with a capacity of 1120 TEUs, servicing at a speed of 18.9 knots and a turnaround time of 49 days is the best choice.

Table 5-8 Fleet Options on the Sino-Mediterranean Route

Round trip (days)	Service frequency (days)	Ship size (TEUs)	Fleet size	Service speed (knots)	Annual ship cost (m$)	Annual fleet cost (m$)
56	7	1120	8	16.3	3.4	27.4
49	7	1120	7	18.9	3.9	27.3
42	7	1120	6	22.6	4.8	29.0
35	7	1120	5	27.9	6.8	33.8

Source: Appendices (6).

(3). Feasibility of Combining the Sino-Europe and Sino-Mediterranean Routes

The Sino-Europe and Sino-Mediterranean routes are currently served by Cosco Shanghai and Cosco Tianjin separately. Since the Mediterranean area is en route between Far East and Europe, there exists a possibility for Cosco to combine these two separate routes, as mentioned in 5.3. Case studies (1) and (2) indicate that the most economic fleet serving the Sino-Europe route would cost US$46.5 million annually and that serving the Sino-Mediterranean route, US$27.3 million. This represents a total annual cost of US$73.8 million.

If the two routes are to be combined, the total daily demand (q) would reach 460 TEUs in 1995. The itinerary is assumed to be: Xingang, Shanghai, Hong Kong, Singapore, Genoa, Marseilles, Barcelona, London, Hamburg, Rotterdam, Antwerp, Barcelona, Marseilles, Genoa, Singapore, Hong Kong and Xingang. Thus the total numbers of port calls would be 16. A weekly service frequency is also assumed and the total round-trip distance would be 24,490 nautical miles. Hence the fleet size, ship size, service speed and the annual fleet cost can be calculated according to different round-trip time requirement, as shown in table 5-9.

It can be seen from table 5-9 that the annual fleet costs of the first two options are lower than US$73.8 million. With the ship size being a constant of 3220 TEUs, a fleet of 11 ships with a service speed of 17.0 knots would cost US$72.9 million; this being reduced to US$72.4

Table 5-9 Fleet Options for the Combined Sino-Mediterranean-Europe Route

Round trip (days)	Service frequency (days)	Ship size (TEUs)	Fleet size	Service speed (knots)	Annual ship cost (m$)	Annual fleet cost (m$)
77	7	3220	11	17.0	6.6	72.9
70	7	3220	10	19.2	7.2	72.4
63	7	3220	9	22.2	8.3	74.4
56	7	3220	8	26.1	10.0	80.0

Source: Appendices (7).

when the fleet size is reduced to 10 and the service speed is increased to 19.2 knots. Clearly the latter is a better option which will produce a saving of about one million dollars over the two separate fleets which are required if the Sino-Europe and the Sino-Mediterranean routes are to be separately served. When making the decision, it must also be considered that the transit time of cargo to/from Europe would be at least three to four days longer under the one-fleet option compared with the two-fleet option; whilst the savings thus achieved is not very significant. On the other hand, considering the general situation of the world container shipping industry, it may turn out that the market will eventually be dominated by a few large scale companies using new big ships. Thus small shipping lines with small ships may find it hard to survive in the long run.

5.4.5 THE MEDIUM AND SHORT SEA FLEET

So far the discussion and analysis of fleet operation strategies has been concentrated on the deep-sea sector. However, as indicated in 5.3, by 1995 China's seaborne container traffic on the medium and short sea routes will account for 58% of the total. This is mainly due to the rapid regional economic and trade development in Asia, Japan, the NICs and China itself. Thus intra-regional trade will be of great importance in China's foreign trade.

China's intra-regional trade routes can be classified into two categories: those linking China mainland with Japan, Hong Kong, Taiwan, Korea and other Far East areas, i.e. the short sea routes and those linking China with the Southern and Southeast Asia, i.e. the medium sea routes. The question of ship choice on the short sea route is basically a matter of ro-ro versus lo-lo. Ro-ro ships can be categorised into ro-ro container ships, ro-ro conventional ships, pure car carriers, ro-ro forest product ships, passenger car ferries and ro-ro bulk carriers, etc. (Grey 1985). Ro-ro ships are generally faster than lo-lo ships of a similar capacity. However, they are much more expensive to build than the lift-on containerships. The major advantages of the ro-ro system lie in cargo handling. Instead of a container gantry crane in the lo-lo system, a ramp or link span is used in the ro-ro operation which is less expensive. The process of roll-on, roll-off via the ramp is clearly much faster than that of lift-on, lift-off. Trailers used in the ro-ro operation generally have a greater cubic capacity than containers, this being a particular advantage for low density goods. However, a trailer terminal normally requires a larger area of parking space than its lo-lo counterpart, because trailers cannot be stacked (Garratt 1980).

On the short sea route, the ship size is substantially smaller and the numbers of port calls are normally much less as compared with those on the deep-sea route. There are fewer constraints on port accessibility and cargoes are usually shipped via the nearest port. Take the Sino-Japan route for example. This route can be divided into various sub-routes between the Chinese ports Shanghai, Dalian, Qingdao, Guangzhou (Huangpu), Haikou, Xiamen and Tianjin (Xingang) and the Japanese ports Yokohama, Nagoya, Osaka and Kobe. Total monthly sailings on the Sino-Japan route exceed 15 (see 4.4.6). By 1995, the estimated annual two-way container traffic between China and Japan would reach 0.73 million TEUs (see table 3-19). If Cosco is to carry 50% of the total, a daily two-way capacity of at least 1000 TEUs is necessary to meet the demand.

On the medium sea sector, Southeast Asia is China's major trading partner. The estimated annual two-way container traffic by 1995 would be 0.17 million TEUs (see table 3-19). This requires a weekly service with ships of 820 TEUs capacity if Cosco is to take half of the stake.

5.5 SUMMARY

To sum up, an efficient Cosco fleet with a reasonable market share of Chinese traffic and some cross-trading traffic could have enough cargo for efficient deep-sea services on reasonably optimistic assumptions about traffic, especially on the Far East-Mediterranean-Europe route. Cosco could run a single weekly service to Europe with Panamax sized vessels or alternatively it can split services to Mediterranean and North Europe with smaller vessels. However, Cosco must realise that it would be competing with other giant carriers in a sophisticated market. It seems that there is more limited opportunity for Cosco in the highly competitive pacific market. On the medium and short sea routes, there are fair prospects for traffic growth and they are certainly less risky for Cosco.

REFERENCES

CI (1988), *Containerisation International Yearbook 1988*, ed. M. R. Lambert etc, National Magazine, London.

Fletcher, N. (1988), Doors Opening Wider, special report, China: Expanding Horizons for Trade, *Journal of Commerce*, 4 October.

Garratt, M. G. (1980), Ro-Ro Versus Lo-Lo: A Matter of Scale, *Maritime Policy & Management*, 7: 223-232.

Gilman (1980), A Critique of the Super-Port Idea, Editorial, *Maritime Policy and Management*, 7: 77-78.

Goss, R. O. (1987), How to Make Money in Shipping, Editorial, *Maritime Policy and Management*, 14: 1-3.

Grey, M. (1985), *Ro-Ro Ships and Shipping*, Fairplay, London.

JAMRI (1987), *Far East -- European Liner Trade*, JAMRI Report No. 20, by H. Yamada, Tokyo.

Mayer, C. (1988), Big Chinese Box Deal Won by Triestino, *Lloyd's List*, 19 December.

Matthews, S. J. (1989), FEFC: The Shape Of Things To Come, *Containerisation International*, 23: no.3, 31.

NYK Research Chamber (1987), *World's Containership Fleet and Its Operations*, Tokyo News Service, distributed by Fairplay Publications, London.

OECD (1987), *Maritime Transport 1986*, Paris.

Pearson, R. (1987), *Container Ships and Shipping*, Fairplay, London.

Pearson, R. & Fossey, J. (1983), *World Deep-Sea Container Shipping*, Gower Publishing, Aldershot, England.

University of Liverpool Marine Transport Centre (1979), *Optimal Speed and Ship Size for the Liner Trades*, by S. C. Ryder & D. Chappell, Liverpool.

Williams, H. (1988), Sea-Land to Open Office in China, *Lloyd's List*, 16 December.

CHAPTER 6 CONTAINER TRANSPORT GEOGRAPHY AND EVOLUTION OF COSCO'S EUROPE SERVICE

6.1 INTRODUCTION

The last two chapters touched briefly on the issues of container fleet service networks (4.6.3) and container port choice (5.4.1). The present chapter is to examine in detail the question of container transport geography from the point of view of the container fleets.

The containerisation of world seaborne trades has brought about great changes in liner shipping itineraries and service patterns. Under the conventional break-bulk system, ship size was severely constrained by the slow cargo handling rates. Ships had to make multi-port calls to gain extra cargoes and turnaround time were rather long. With the advent of the container revolution, cargo handling rates were dramatically increased and restraints on ship size all but vanished. A first generation containership was twice the deadweight capacity of the largest conventional ship and, because of its faster service speed and less time spent in port, was eight to ten times more productive (Pearson & Fossey 1983). As a result of this more productive system, a series of changes in liner shipping service pattern took place, e.g. less port calls, fast turnaround, amalgamation of services and line mergers, etc. One of the most important effects of containerisation was the selective elimination of port calls. Many of the traditional general cargo ports thus lost their business and become obsolete, Liverpool, for example, in many of its trades. However, concentration did not go as far as the super-port idea as was widely expected in the early stages of containerisation (see 5.4.1). Most container shipping lines adopted an intermediate strategy, i.e. retaining a multi-port calling pattern, but with tighter itineraries, an increased use of feeder strategies and much larger minimum volumes of cargo for each individual port call.

6.2 ECONOMICS OF TRANSPORT GEOGRAPHY

One of the most important task of liner shipping is the wide distribution of cargo. In order to achieve this, shipping lines can adopt various strategies, e.g. direct calls, transhipment, feeder links and inland mini/micro bridge, etc.

Depending on the relative magnitude of the costs involved, it could still be beneficial even with main line containerships to divert and hence multiport, rather than adopt a concentrated service strategy plus feeder network. There are a number of parameters which control the economics of route itineraries.

6.2.1 LOW SEA TRANSPORT COSTS

Sea transport is much cheaper than the land modes, rail or road. Table 6-1 shows the costs of moving cargo (per 100 TEU miles) by containerships of various sizes and speed at full load.

Table 6-1 Sea Transport Costs per 100 TEU-miles

Ship Size	Speed		
(TEUs)	19k	21k	23k
600	$11.12	$11.88	-
1,000	$ 8.40	$ 8.58	$ 9.46
1,500	$ 6.16	$ 7.05	$ 7.57
2,000	$ 6.10	$ 6.48	$ 7.20
3,000	$ 4.08	$ 4.34	$ 4.80

Source: University of Liverpool Marine Transport Centre (1981).

On the other hand, land mode transport costs are about $128 per 100 TEU miles by road, and $230 by rail. Thus sea transport costs are some 10-20 times lower than the cheapest land based mode (University of Liverpool Marine Transport Centre 1981).

6.2.2 TRANSPORT CONVEXITY RATIO

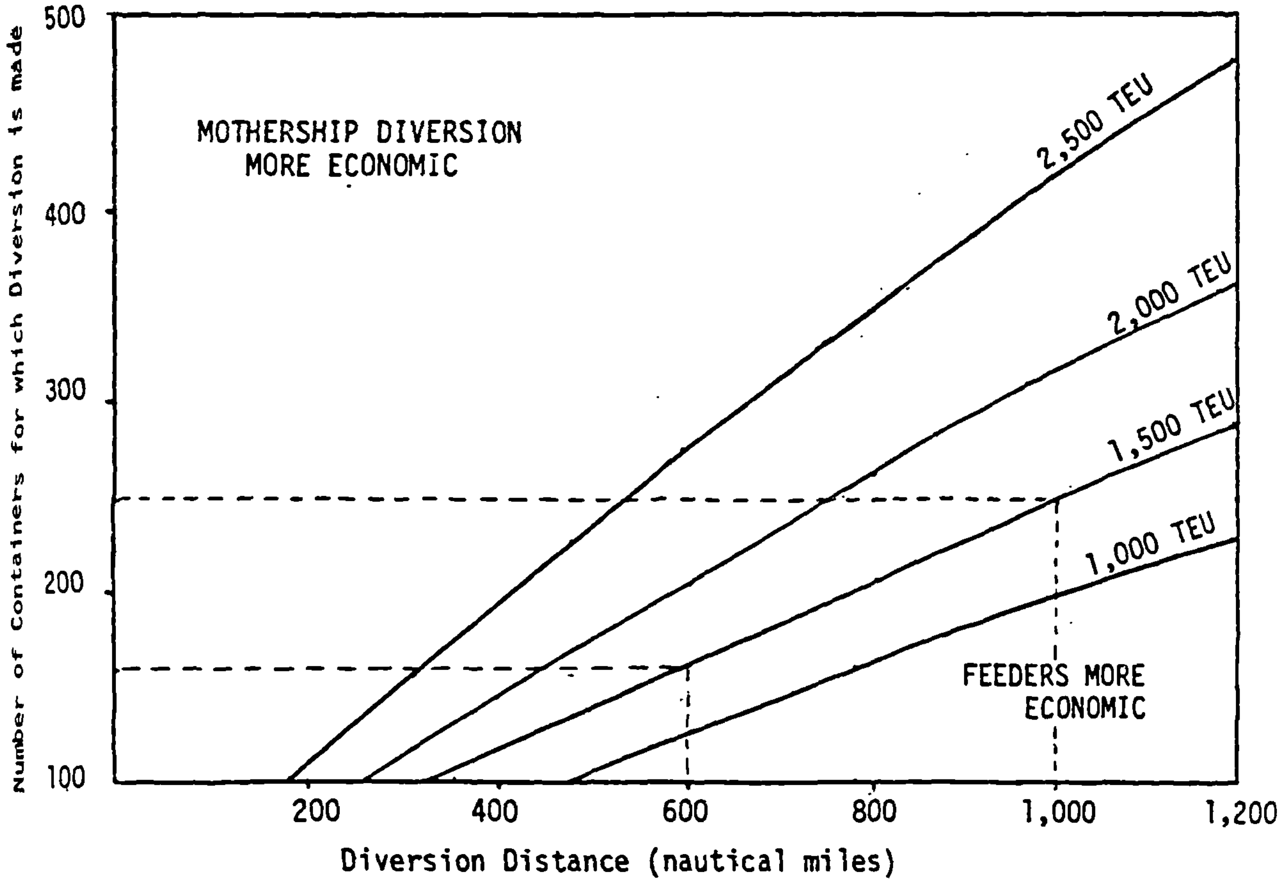
Convexity ratio is defined as the ratio between marine and land miles. The ratio varies tremendously in each particular case depending on the exact shape of land masses, and the alignment of the sea route in relation to the land mass (University of Liverpool Marine Transport Centre 1981). It is an important factor which determines whether a ship should divert to made a direct call at a particular port or it should use the inland transport mode to distribute the cargo. On the one hand, if little additional distance could save significant inland transport distances, the ship could be justified to divert and make direct calls. On the other hand, if the additional sailing distance required to serve a port is far in excess of inland distance, then the inland distribution/consolidation system should perhaps be used instead of direct calls. In practice, however, due to the huge difference in the marine and inland transport costs, a convexity ratio in excess of at least 10 would be necessary to justify a land based feed in competition with large container vessels. Any ratio less than 10 might imply a preference for a marine diversion or using the feeder ships (University of Liverpool Marine Transport Centre 1981).

6.2.3 CONSIGNMENT SIZE

Another important factor, which decides whether or not the main line vessel will be diverted, or a feeder vessel deployed, is the consignment size of cargo at the proposed port of call. Figure 6-1 and 6-2 show the optimum distances between main ports and feeder ports and the economics of mothership size in relation to consignment size. Firstly, it can be seen from the figures that given consignment size, the smaller the main line ship the more economic it becomes to divert the ship itself. For a vessel of 2,500 TEUs, a diversion of under 300 miles could be considered economic for a consignment size of 160 TEUs whereas for a smaller vessel of 1,500 TEUs, the economic diversion distance is doubled for the same consignment size. Secondly, for any given diversion distance, the greater the consignment size the more economic diversion becomes. For a 1,000-mile diversion distance, a consignment size of 250 TEUs could have a vessel of 1,500 TEUs to divert while a consignment size of just 320 TEUs could be enough to attract direct calls by a vessel of 2,000 TEUs. Finally, given vessel size, the greater the consignment size, the farther a ship can divert. For a 1,500 TEUs vessel, a 160 TEUs consignment size would attract it to make direct calls only if the diversion distance is under 600 miles whereas a 250 TEUs consignment size could make it divert for a distance up to 1,000 miles.

6.3 CONTAINER SHIPPING SERVICE CONFIGURATIONS

Despite the fact that most container shipping lines adopt a multi-port calling strategy, operating patterns vary tremendously from line to line. Two major service patterns can be identified, viz. the round-the-world (RTW) strategy and the end-to-end strategy.

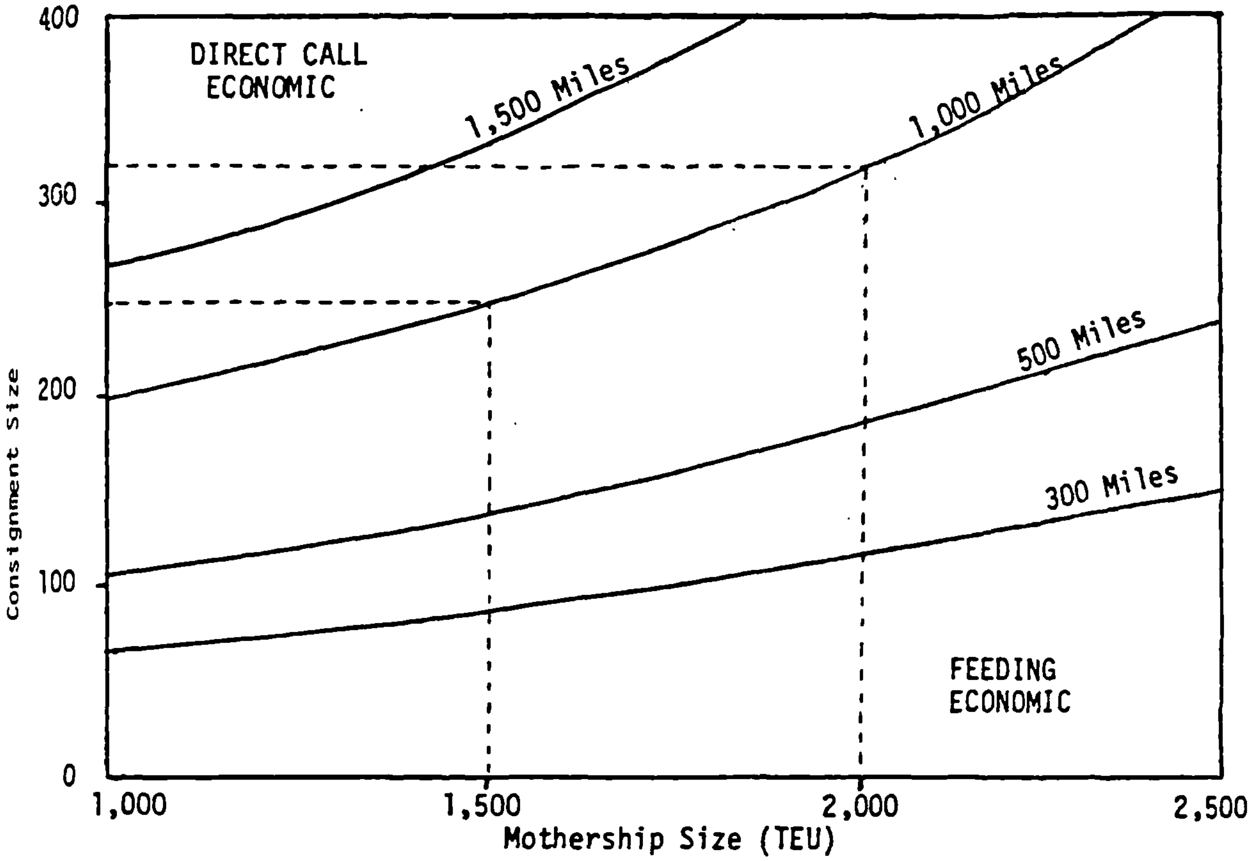


Source: University of Liverpool Marine Transport Centre (1981)

Figure 6-1 Optimum Distances between Main Ports and Feeder Ports (for variously sized mainline vessels)

While the RTW service is typified by Evergreen of Taiwan, most of the other major container lines are involved in end-to-end service.

Figure 6-3 shows the itineraries of Evergreen's RTW service. On the East bound service there are 21 port calls including Colombo, Port Kelang, Singapore, Hong Kong, Kaohsiung, Keelung, Busan, Hakata, Osaka, Nagoya, Shimizu and Tokyo in the Far East; Los Angeles, Charleston, Baltimore and New York in the North America and Le Havre, Antwerp, Rotterdam, Felixstowe and Hamburg in the Europe. On the West bound service, there are 20 port calls including Tokyo,

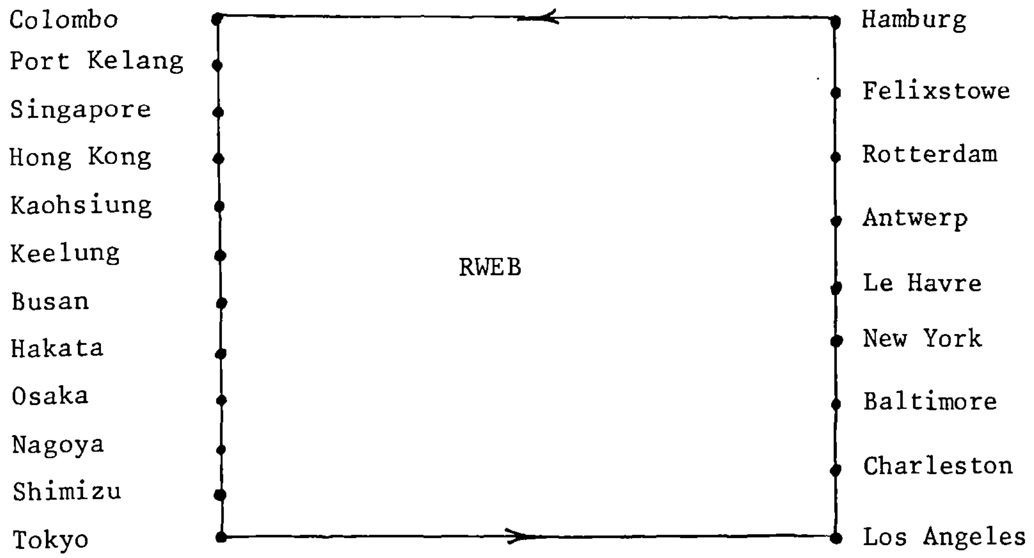


Source: University of Liverpool Marine Transport Centre (1981)

Figure 6-2 The Economics of Mothership Size in Relation to Consignment Size (for various diversion distances)

Nagoya, Osaka, Busan, Keelung, Kaohsiung, Hong Kong, Singapore and Colombo in the Far East; Hamburg, Felixstowe, Rotterdam, Antwerp and Le Havre in the Europe; New York, Norfolk, Charleston and Los Angeles in the North America and Kingston and Panama in the Central America. Despite the fact of RTW service, this is essentially a multi-port strategy supported by feeder services.

Figures 6-4, 6-5, 6-6 and 6-7 show itineraries of some leading container lines on the Europe-Far East route. Virtually all are



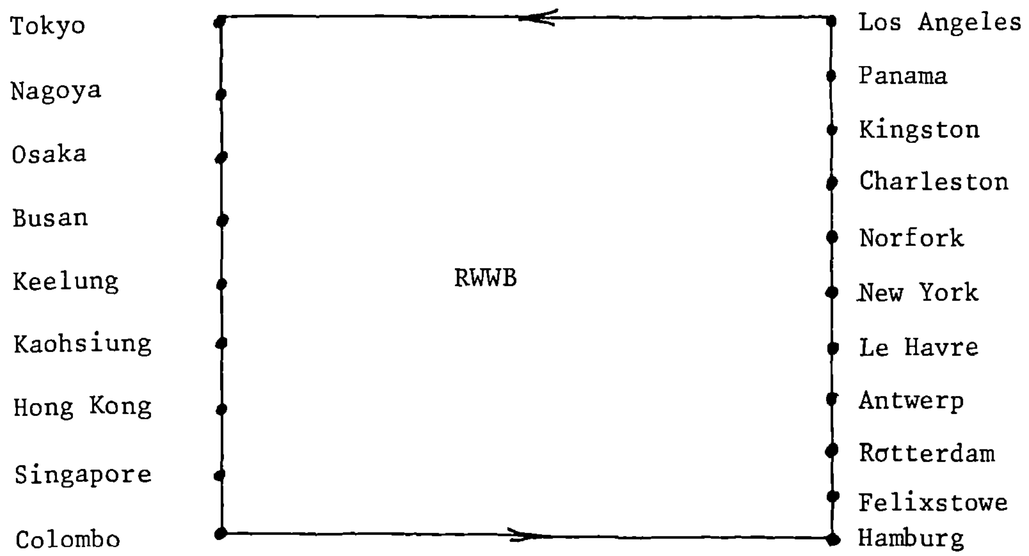


Figure 6-3 Evergreen's RTW Service

multi-port services with feeder networks. The Ace Group calls at five European ports (Le Havre, Felixstowe, Hamburg, Bremerhaven and Rotterdam) and goes straight through to the Far East with no stop at the Mediterranean or the Middle East. It calls at Singapore, Hong Kong, Kaohsiung, Busan, Tokyo and Osaka in the Far East end. Wider spread of cargo is achieved by a series of feeder networks. Hong Kong feeds PRC ports while Kaohsiung feeds Keelung and the Philippines. The Southeastern Asian ports of Kelang, Jakarta and Bangkok are fed via Singapore.

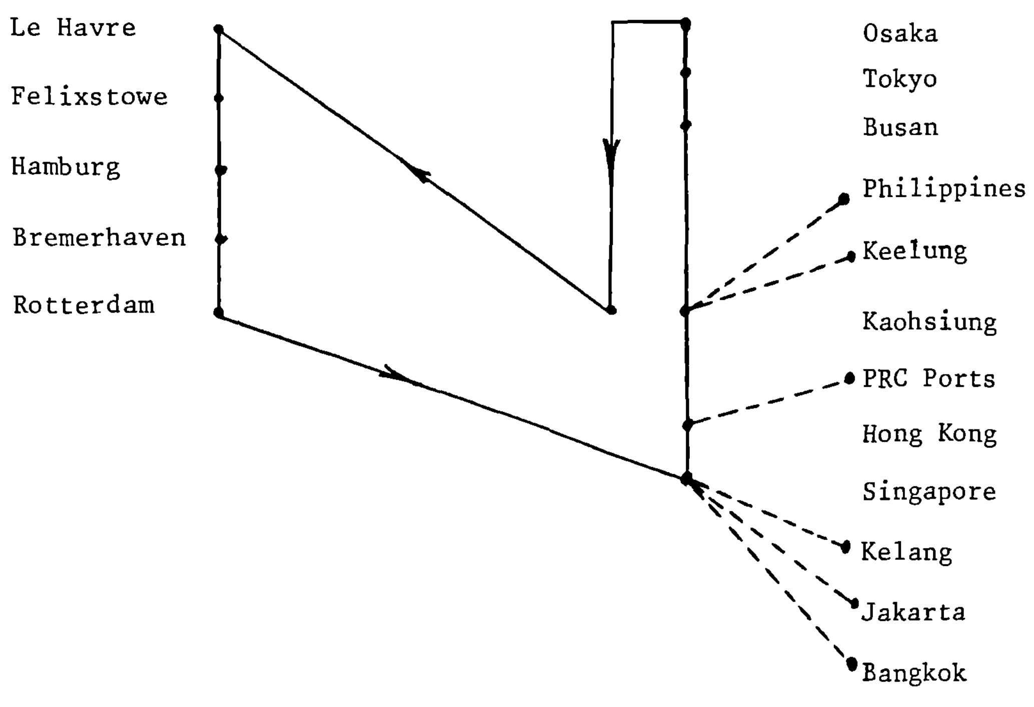


Figure 6-4 Ace Group: Far East, Japan/Europe

The Maersk line calls only four European continental ports, viz. Antwerp, Rotterdam, Bremerhaven and Hamburg. UK ports are fed via Rotterdam. Before going through to the Far East, it chooses to stop at Algeciras, through which other west Mediterranean ports are fed. It then calls at Singapore (which relays cargo to/from Indonesia, Malaysia and Thailand), Hong Kong, Keelung (which feeds Kaohsiung, the Philippines and the PRC), Busan, Kobe and Tokyo.

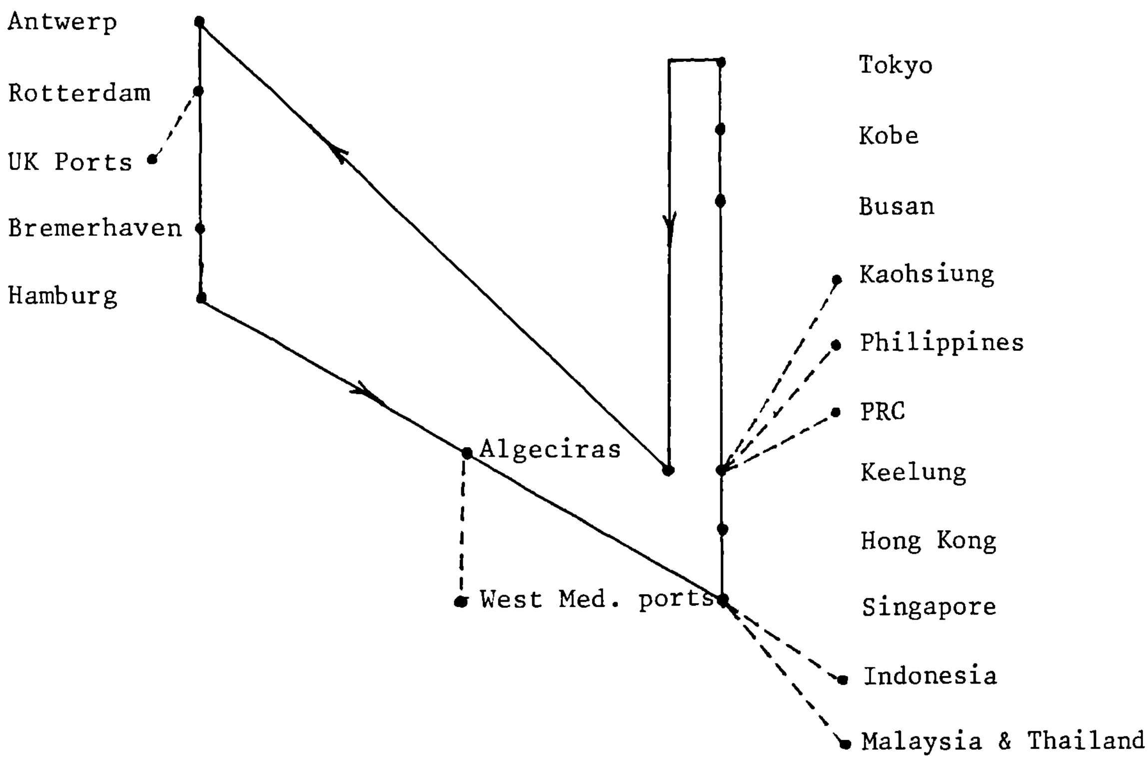
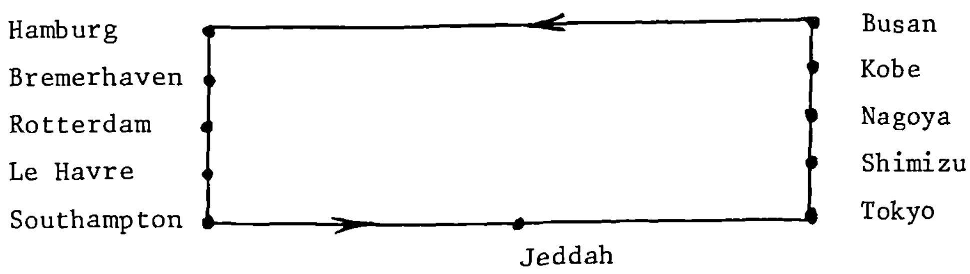


Figure 6-5 Maersk: Far East, Japan/Europe

The Trio group adopts a geographically specialised strategy on its Europe/Far East service. Two separate services are provided with one specialising at Europe/Japan and another at Europe/SE Asia. Both services adopt the same itinerary at the European end, viz. Hamburg, Bremerhaven, Rotterdam, Le Havre and Southampton. Both make calls at the Middle East port Jeddah en route. The Japan service calls at Tokyo, Shmizu, Nagaya, Kobe and Busan while the SE Asia service calls at Kelang (which feeds Penang), Singapore (which feeds Bangkok), and Hong Kong and Kaohsiung (both of which feed Manila).

Trio 1: Far East, Japan/Europe



Trio 2: Far East/Europe

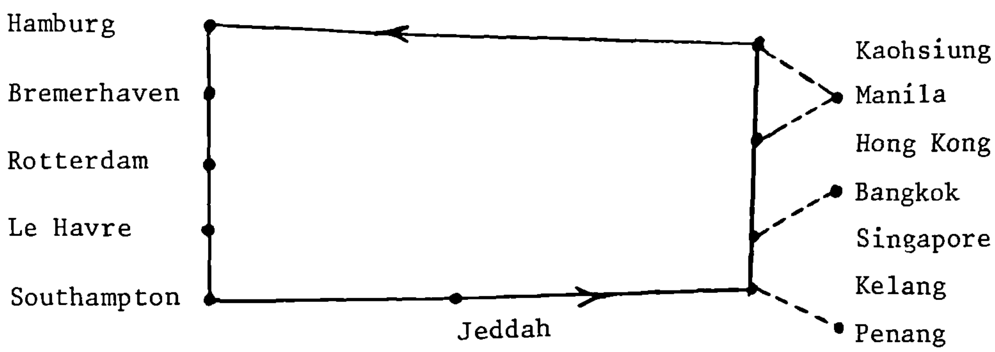


Figure 6-6 Trio's Far East/Europe Service

Finally, Yangming line also provides an extensive service network on the Far East/Europe route. It calls at the European ports of Hamburg, Rotterdam, Felixstowe, Antwerp, Le Havre and the Middle East port of Jeddah en route. It then goes on to make calls at Hong Kong, Singapore, Kaohsiung, Yokohama, Kobe and Keelung. On the way back to Europe, it calls at Hong Kong, Singapore and Jeddah once again, plus the Mediterranean port Genoa. The port of Keelung provides feeder service for Manila and Singapore acts as a transshipment centre for the Southeast Asian ports of Kelang, Penang, Jakarta, Surabaya, Bombay, Cochin, Madras and Calcutta.

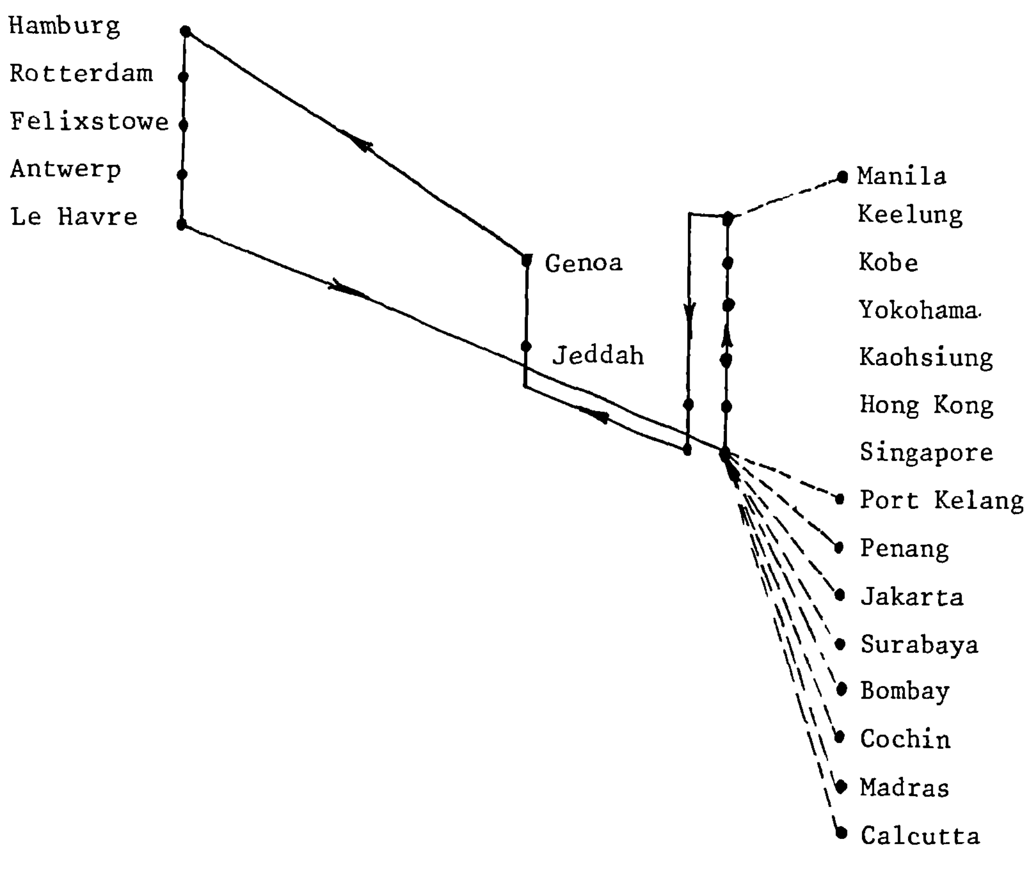


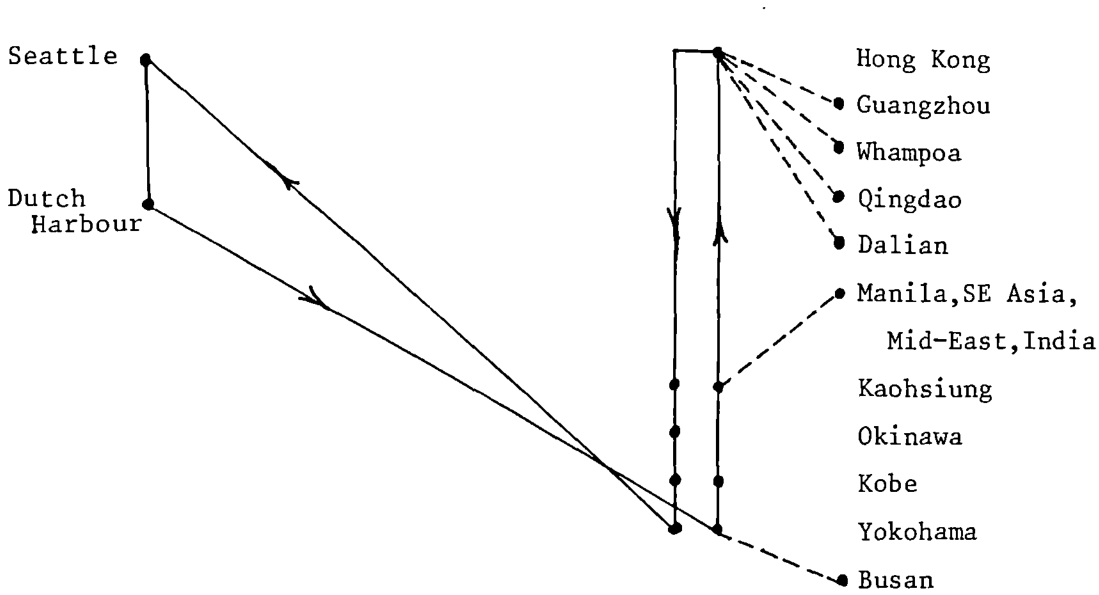
Figure 6-7 Yangming: Far East/Europe

Figures 6-8, 6-9, 6-10, 6-11 and 6-12 illustrate some selected itineraries on the transpacific route. The American President lines provide two separate services: one specialise at PNW-Japan/Far East and the other, PSW-Japan/Far East. Both itineraries are relatively concentrated, especially at the American end. On the PNW-Japan/Far East service, it calls at Seattle, Dutch Harbour, Yokohama, Kobe, Kaohsiung, Hong Kong and Okinawa; whereas on the PSW-Japan/Far East service, the port of calls are San Pedro, Oakland, Yokohama, Kobe, Hong Kong, Kaohsiung and Nagaya. US East/Gulf coast and the Mid-West are served via Seattle and Oakland using mini/microbridge. On both services, Hong Kong acts as a transshipment centre for cargoes to/from China mainland.

Sea-Land provides similar services to those of APL. On the PNW-Japan/Far East service, it calls at Tacoma, Yokohama, Kobe/Osaka, Busan, Kaohsiung and Hong Kong; whereas on the PSW-Japan/FE service the ports of calls at Long Beach, Oakland, Yokohama/Tokyo, Kobe/Osaka, Busan, Kaohsiung and Hong Kong. Tacoma and Long Beach serve the US East/Gulf Coast and the Mid-West via mini/microbridge. China mainland is served by feeder links from Kobe/Osaka (for Northern China) and Hong Kong (for Shanghai).

The South Korean container lines Hanjin offers two services, viz. Far East/Japan-PSW/USEC and Far East-PNW. It differs from APC and Sea-Land in that it choose to serve the East Coast by making direct calls (Far East/Japan-PSW/USEC) as well as by intermodal services via Seattle. Maersk lines provide two similar services with more extensive direct coverage as compared with Hanjin. On the USEC/WC-FE/Japan service, it calls at New York, Baltimore, Philadelphia, Charleston, Miami, Long Beach, Oakland, Yokohama, Tokyo, Kobe/Osaka, Hong Kong. Singapore and Keelung. All major PRC ports are served via feeder connections to/from Hong Kong. On the USWC-Japan/Far East service, it calls at Tacoma/Seattle (cargo

PNW/Japan, Far East



PSW/Japan, Far East

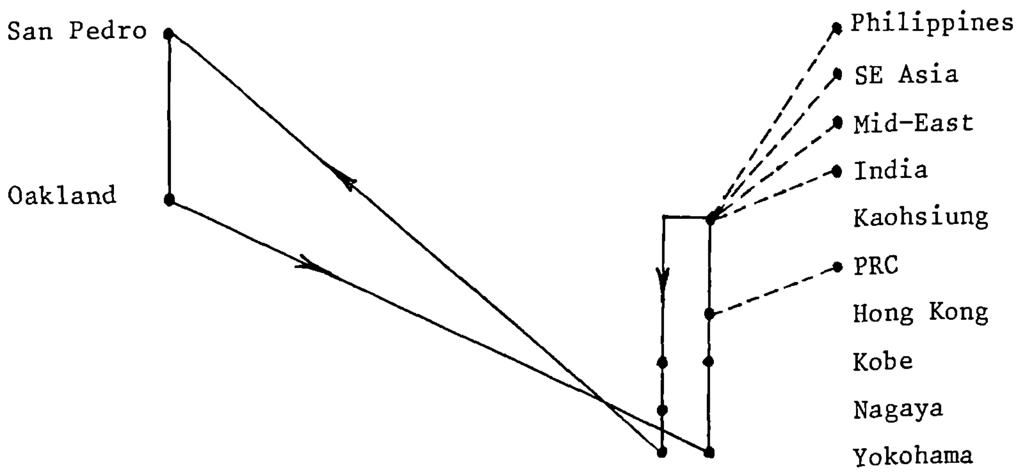


Figure 6-8 APL: Transpacific Services

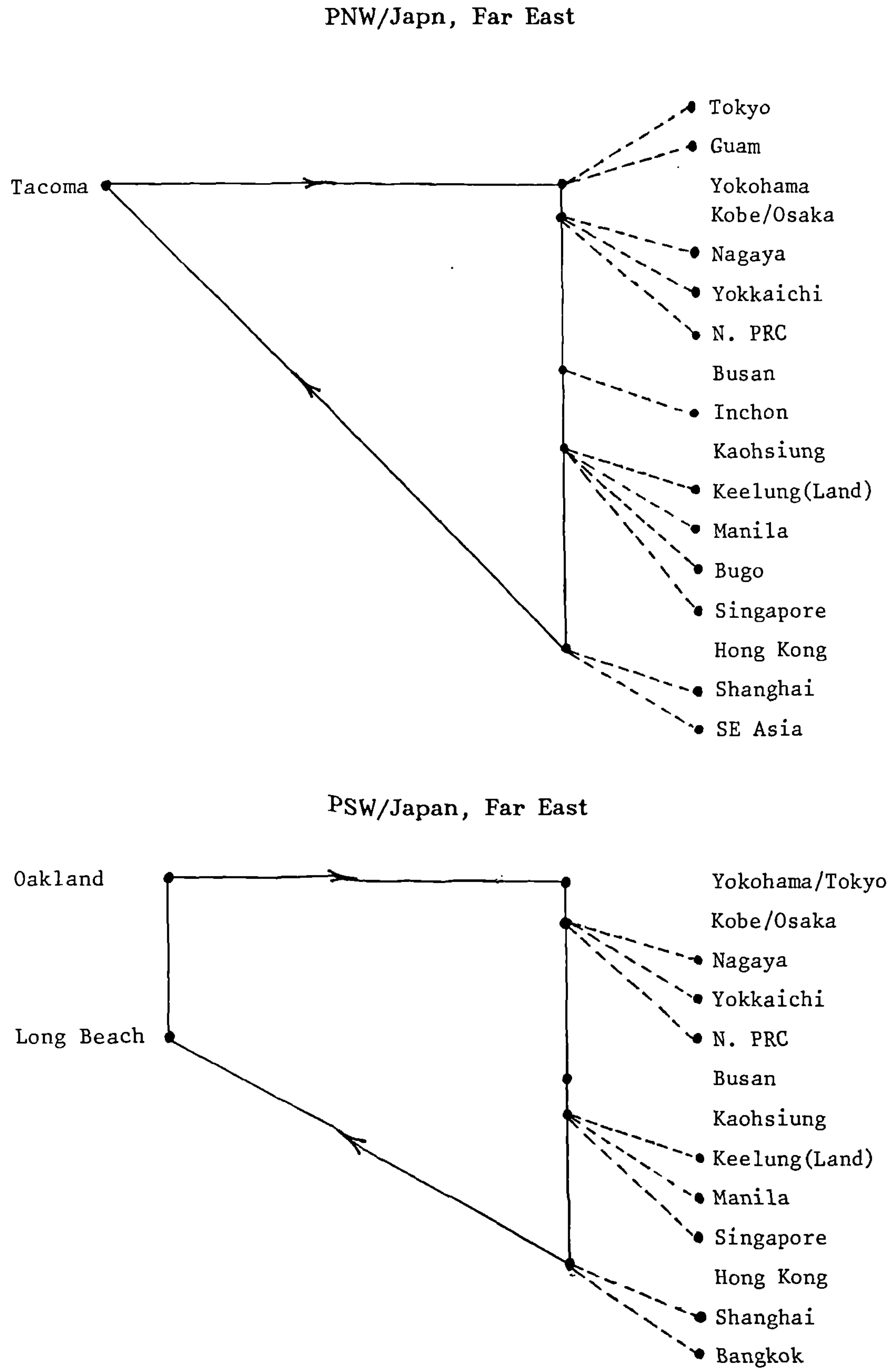
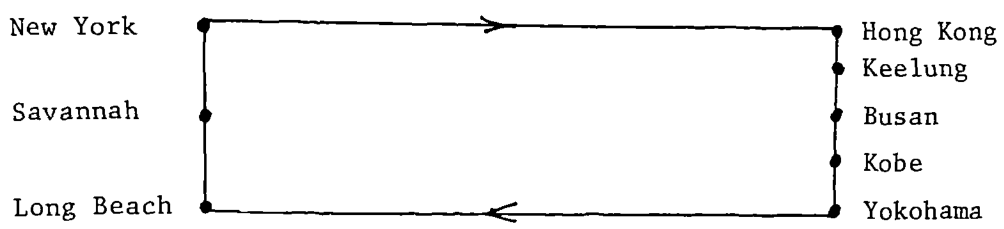


Figure 6-9 Sea-Land: Transpacific Services

to/from Vancouver, Minibridge/IPI service to New York, Mid-West), Oakland and Hong Kong. An extensive feeder network connects Singapore, Jakarta, Surabaya, Semarang, Bangkok, Port Kelang, Penang, Belawan, Colombo, Manila, Kaohsiung, Taichung, Busan India, Pakistan, Bangledesh and the Mid-East.

Far East, Japan/PSW, USEC



Far East/PNW

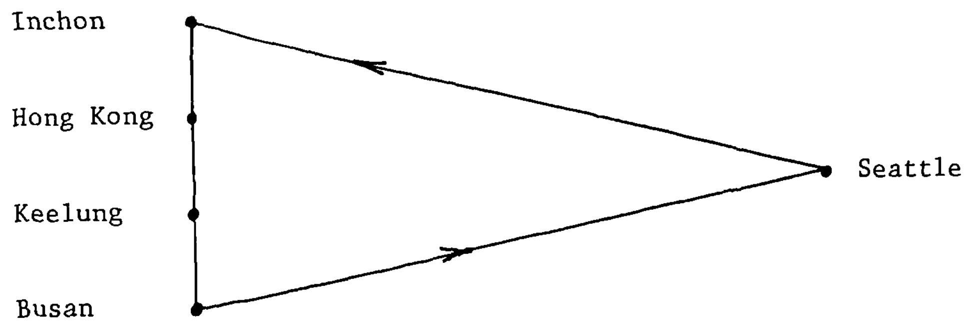
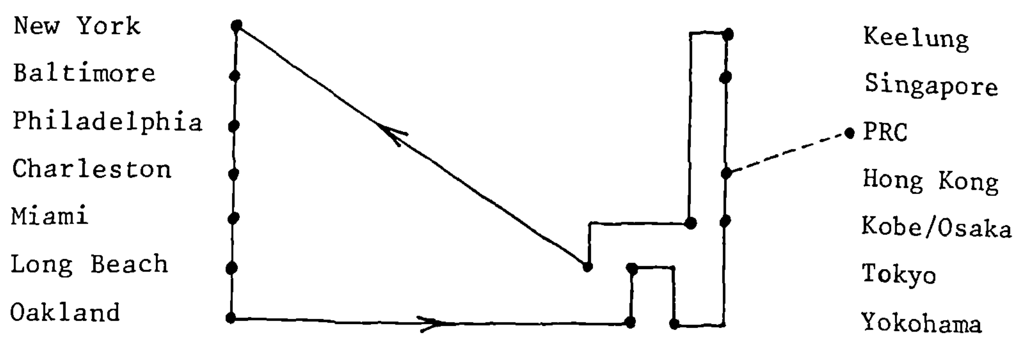


Figure 6-10 Hanjin: Transpacific Services

USEC, WC/Far East, Japan



USWC/Japan, Far East

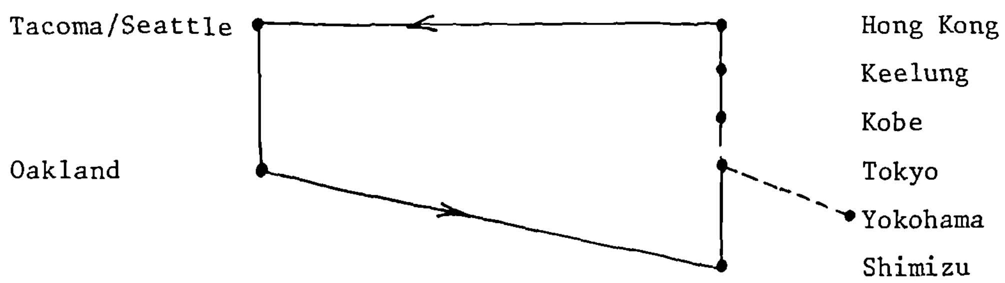


Figure 6-11 Maersk: Transpacific Services

Finally, the Taiwanese line Yanming provides a single transpacific service, viz. Far East/Japan-USWC/EC. It calls at Kaohsiung, Hong Kong, Keelung, Kobe, Yokohama, Los Angeles, Saramah, New York, Baltimore, Wilmington, Houston. The East coast ports Miami, Tampa, Jacksonville, Norfolk, Charleston, Philadelphia, Providence, Boston and the West coast ports San Francisco, Oakland and Sandiego are served via feeder links.

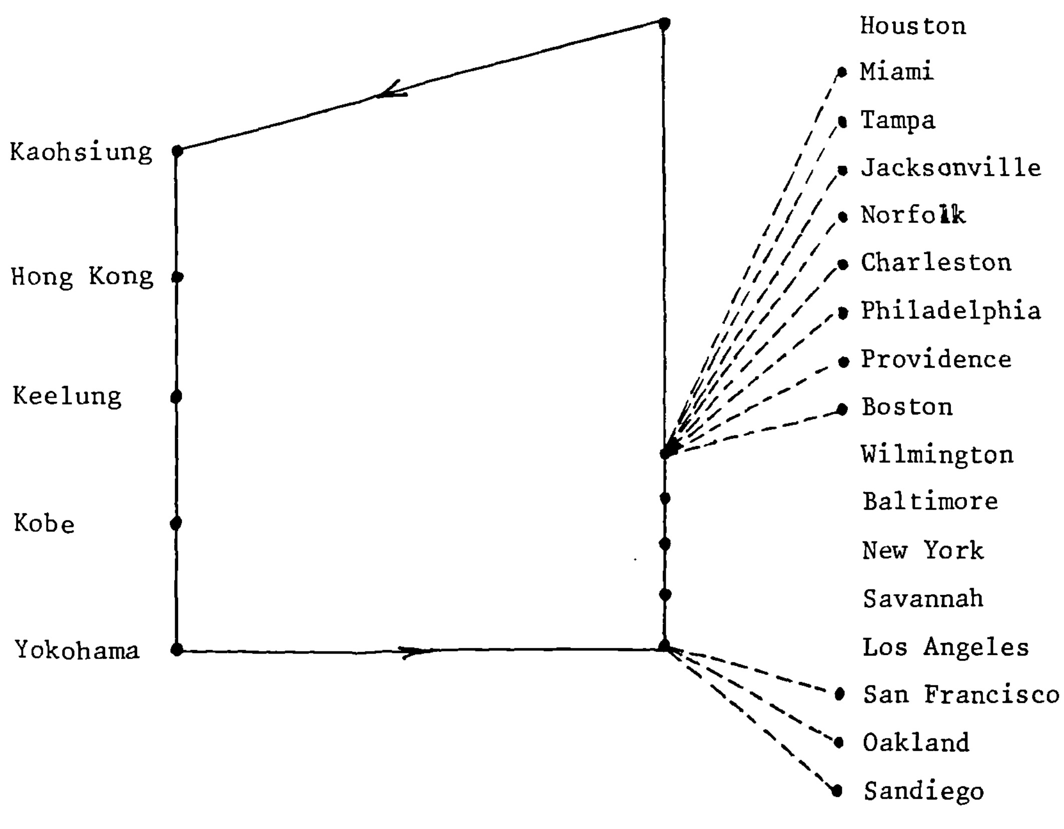


Figure 6-12 Yangming: Far East, Japan/USWC, EC

6.4 TRANSPORT GEOGRAPHY OF THE COSCO SINO-MEDITERRANEAN-EUROPE SERVICE

In Chapter 5, the feasibility of combining the Sino-Europe and Sino-Mediterranean routes by 1995 was analysed. The conclusion was that the transit time of cargo to/from Europe would be at least three to four days longer under the one-fleet option compared with the two-fleet option whilst the savings thus achieved were not very significant. This is mainly due to the assumed double calls at the three Mediterranean ports, viz. Genoa, Marseilles and Barcelona. From the last section it can be seen that this is a very rare practice. It is also noticed from the last section that among all the major lines serving Europe and Far East, there is no line which calls at the Chinese mainland ports. Most of them serve China mainland by feeder connections via Hong Kong. It is considered that this is mainly due to the general backward condition of the mainland ports and the inland container transport networks. It is almost impossible for Chinese ports to accommodate a third generation containership over 3,000 TEUs and ship delays may easily occur due to port congestion. It is not anticipated that there would be any fundamental improvements in the situation by 1995. Therefore, it could be beneficial for Cosco to consider the option of dropping direct calls at China mainland and using feeder strategy instead. Matthews (1989) in his recent article commented like this:

> "....the most effective choice will be for the (Cosco) vessels not to call directly at the PRC at all, but to use Cosco's extensive feeder services to consolidate cargo in Hong Kong or Japan where it can be transshipped efficiently.
>
> "A similar arrangement may eventually be necessary on the Europe service. Most of Cosco's deepsea services already

> incorporate a call at Hong Kong, which is used to some extent to consolidate cargo from various PRC and South East Asian ports. This type of arrangement will be necessary until the PRC develops efficient inland transportation of containers, a situation which is still some way off."

Furthermore, Hong Kong itself will become the "Special Administrative Region" of China in 1997. Therefore it will be sensible for Cosco to make better use of Hong Kong.

Based on the above considerations, it is suggested that Cosco should adopt the following itinerary for its Sino-Mediterranean-Europe service:

Hong Kong -- Singapore -- Barcelona -- Felixetowe -- Hamburg -- Rotterdam -- Antwerp -- Barcelona -- Singapore -- Hong Kong

This service should be supported by feeder networks linking Shanghai, Xingang with Hong Kong and linking Marseilles and Genoa with Barcelona.

6.4.1 MOTHER SHIP FLEET OPTIONS AND COSTS

Thus on the Sino-Mediterranean-Europe service route, there would be nine port calls with a total round-trip distance of 21,000 nautical miles. Based on the fixed day weekly service and a daily demand of 460 TEUs (see Chapter 5), the fleet size, service speed and the annual fleet cost can be calculated according to different round-trip time requirement, as shown in table 6-2. It is clearly shown in the table that the 9-ship option and the 8-ship option have virtually the same low annual fleet cost figure. With a turnaround time of only 56 days, however, the latter is obviously a better option.

Table 6-2 Fleet Options for the Concentrated Sino-Mediterranean-Europe Route

Round trip (days)	Service frequency (days)	Ship size (TEUs)	Fleet size	Service speed (knots)	Annual ship cost (m$)	Annual fleet cost (m$)
70	7	3220	10	15.6	6.3	63.2
63	7	3220	9	17.7	6.8	61.5
56	7	3220	8	20.6	7.7	61.8
49	7	3220	7	24.6	9.4	65.0

Source: Appendices (8).

6.4.2 FEEDER SHIP OPTION AND COSTS

The main line Sino-Mediterranean-Europe service needs the support of two separate feeder services, one connecting Marseilles and Genoa with Barcelona and the other connecting Shanghai and Xingang with Hong Kong.

(1). Mediterranean Feeder

It is assumed that the Mediterranean feeder would have the route itinerary of Barcelona -- Marseilles -- Genoa -- Barcelona. The following data are used in deciding fleet options.

- Total round-trip distance X = 870 miles
- Total number of port calls N = 3
- Common container handling rate H = 1440 TEUs

- Average daily demand q = 107 TEUs

Assuming a service frequency of 6 days and a round-trip time of 6 days, and using formulae (4), (5) and (6) described in Chapter 5, the following result can be obtained:

- Ship size Q = 642 TEUs
- Ship number M = 1
- Ship speed V = 13.3k

If, however, assuming a service frequency of 5 days and a round-trip time of 5 days, the following result would be obtained:

- Ship size Q = 535 TEUs
- Ship number M = 1
- Ship speed V = 18.0k

Using the methodology developed in Chapter 5, table 6-3 compares these two options and it can be clearly seen that they have the same annual cost figure.

Table 6-3 Fleet Options for the Mediterranean Feeder

Round trip (days)	Service frequency (days)	Ship size (TEUs)	Fleet size	Service speed (knots)	Annual ship cost (m$)	Annual fleet cost (m$)
6	6	642	1	13.3	2.1	2.1
5	5	535	1	18.0	2.1	2.1

Source: Appendices (9).

(2). Hong Kong Feeder

It is assumed that the Hong Kong feeder would have the route itinerary of Hong Kong -- Shanghai -- Xingang -- Hong Kong. The following data are used in deciding fleet options.

- Total round-trip distance X = 3,200 miles
- Total number of port calls N = 3
- Common container handling rate H = 1440 TEUs
- Average daily demand q = 150 TEUs

Assuming a service frequency of 7 days and a round-trip time of 14 days, and using formulae (4), (5) and (6) described in Chapter 5, the following result can be obtained:

- Ship size Q = 1,050TEUs
- Ship number M = 2
- Ship speed V = 13.9k

If, however, assuming a service frequency of 6 days and a round-trip time of 12 days, the following result would be obtained:

- Ship size Q = 900 TEUs
- Ship number M = 2
- Ship speed V = 16.7k

Using the methodology developed in Chapter 5, table 6-4 compares these two options and it can be clearly seen that the former option has a slightly better annual cost figure.

Table 6-4 Fleet Options for the Hong Kong -- China Feeder

Round trip (days)	Service frequency (days)	Ship size (TEUs)	Fleet size	Service speed (knots)	Annual ship cost (m$)	Annual fleet cost (m$)
14	7	1050	2	13.9	2.9	5.7
12	6	900	2	16.7	3.0	6.0

Source: Appendices (10).

6.4.3 COMPARISON AND CONCLUSION

The total annual fleet cost for the concentrated Sino-Mediterranean-Europe service which comprise the mothership service plus two separate feeder links would be less than $70 million. With a mothership turnaround time of 56 days, this compares with the 10-ship option with a round-trip time of 70 days and an annual fleet cost of $72.4 million under the multi-port Sino-Mediterranean-Europe service (see Chapter 5). The concentrated service with feeder links has the lowest cost, although the margin is not enormous. However, it would have better transit times and greater reliability between major centres. It would also keep the fleet at eight vessels of economic size in current terms.

Overall the analysis shows a fair range of options. Actual decisions will depend on opportunities in the market place with respect to price of vessels. There are indications that prices are firming up, and if this trend continues it may make newbuilding strategy difficult to follow, particularly as competitive fleets have been built up in a low cost era.

REFERENCES

Mathews, S. J. (1989), Linking up the Cosco Chain, *Containerisation International*, 23: no.2, 37.

Pearson, R. & Fossey, J. (1983), *World Deep-Sea Container Shipping*, Gower Publishing, Aldershot, England.

University of Liverpool Marine Transport Centre (1981), *Container Logistics and Terminal Design*, ed. S. Gilman, Liverpool.

CHAPTER 7 PORT AND INLAND TRANSPORT

7.1 CONTAINER PORTS IN CHINA

Seaports have often played an important role in China's history, although there were times when the questions relating to their development were ignored. Those ports along the Southeastern coast such as Quanzhou and Ningbo were famous trading ports in the world five centuries ago. From the mid-nineteenth century to the middle of the twentieth China lagged far behind western countries in foreign trade and marine transportation. This was the result of the close-door policy implemented by the Qing Dynasty and the political instability and economic stagnation during the first half of this century. At the founding of the People's Republic in 1949 there were only 60 berths with a capacity to handle vessels of over 10,000 tonnes in the whole country (Shen 1987). The development of seaports has undergone three stages since then.

The first stage in the post revolution era (1949-1972) saw little progress in the development of ports. This stage was marked mainly by economic recovery and by full utilisation and technical transformation of existing port facilities. In the second stage (1973-1980) there was a rapid expansion of foreign trade especially after 1978, causing the main seaports to be congested. To solve this problem, harbour construction was accelerated and fifty deep water berths were built during the period. In the third stage (after 1981) foreign trade and sea transportation flourished greatly, which has made the handling capacity of ports still more insufficient. The Sixth Five-Year Plan (1981-1985) laid great stress on port construction. In the five years construction commenced for 132 deep water berths (for ships of 10,000 dwt and over). Of these 54 berths were completed, with an increased handling capacity of more than 100 million tonnes. Table 7-1 shows the throughput and berthing capacity of the main seaports in China.

China's first full-container berth was put into operation in 1981 at Tianjin (Xingang), followed successively by Huangpu and Shanghai. Table 7-2 lists the major container ports in China.

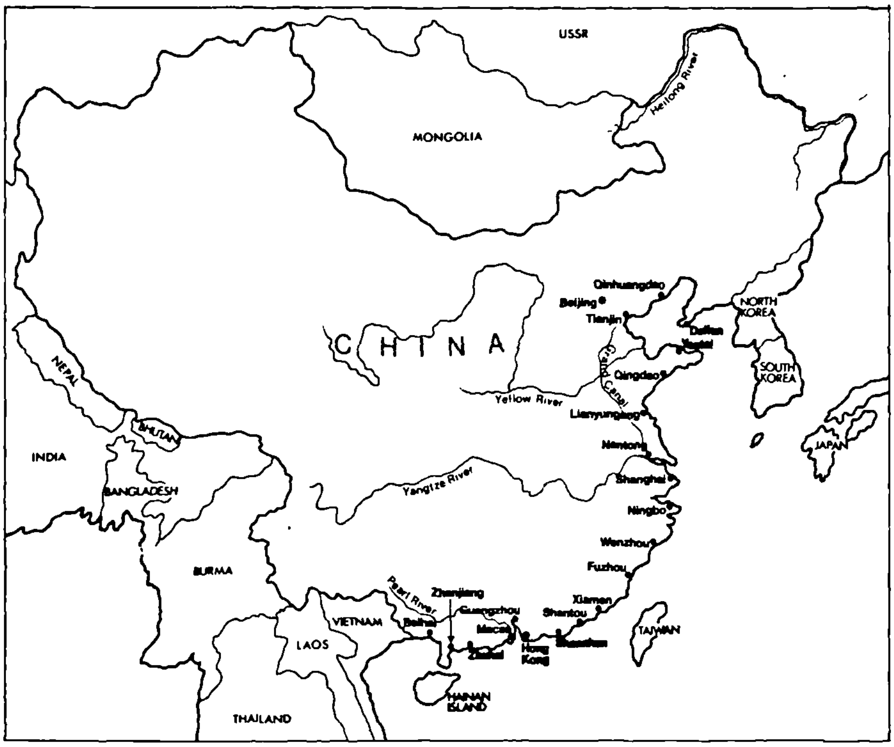


Figure 7-1 China's Seaports

It can be seen from tables 7-1 and 7-2 that Shanghai is China's largest port in terms of both the total cargo throughput and the container throughput. Shanghai is located at the mouth of the Yangtze river which connects it to a valley whose economy is highly developed. It has always been China's main centre for foreign trade. There are two main container terminals, each comprising two berths. The larger terminal has a berth length of 424m and a minimal water depth of 10.5m. It is served by two Shanghai Port Machinery Plant (SPMP) and two Sumitomo 30.5t Container gantry cranes. The

Table 7-1 Throughput and Berthing Capacity of Main Seaports in China 1986

Ports	Throughput ('000 tonnes)	Length of berths(m)	No. of berths	Deep water berths
Dalian	44290	15033	100	25
Yingkou	1130	1013	13	1
Qinhuangdao	48730	4063	22	14
Tianjin	18180	7419	40	24
Yantai	6910	2052	17	3
Qingdao	28010	8328	44	16
Shijiusuo	2630	1141	5	3
Lianyungang	9490	1416	11	5
Shanghai	126040	16217	165	45
Ningbo	17950	3586	40	7
Shantou	2310	753	9	0
Huangpu	19170	5143	45	19
Zhanjiang	12960	2942	20	13
Haikou	1740	1270	13	0
Basuo	3910	842	5	3
Sanya	640	715	7	0
Total	344090	71924	556	170

Source: National Statistic Bureau (1987).

terminal has a total area of 23.6ha (container parking 12.4ha, storage 11,500TEUs) served by nine 30.5t rubber-tyred yard gantries plus front-end loaders, yard tractors and chassis.

Tianjin is the second largest container port in China in terms of throughput. However, in terms of the design capacity, Tianjin is by far the largest container port in China. Serving the capital

Table 7-2 Capacity and Throughput of Major Container Ports in China (TEUs)

Port	Capacity	Throughput		
		1986	1987	1988
Dalian	--	--	54035	74945
Huangpu	200000	52061	57479	84448
Qingdao	--	50220	60116	85008
Shanghai	320000	204000	224000	310000
Tianjin	400000	166692	162106	218000
Xiamen	--	14243	14276	16000
Total	920000	487216	572012	788401

Source: Matthews (1989a).

Beijing, Tianjin is a major centre for foreign trade in Northern China. The port has four container berths totalling 1,300m, equipped with 3 Japanese and 5 SPMP 40.5t gantry cranes. Minimum water depth is 12m. The container terminal has a total area of 57.5ha, including 43ha of stacking area which is capable of storing 22,100 TEUs. The container yard is served by sixteen 40.5t rubber-tyred yard gantries, one 40t, two 25t and three 16t mobile cranes plus one 60t, three 36.5t, eleven 25t and four 16t front-end loaders and, yard tractors and chassis.

Located close to Hong Kong, Huangpu is the largest port serving southern China. The port has two lo-lo/ro-ro container berths totalling 471m, served by two SPMP and one Sumitomo 30.5t container gantry cranes. Minimal water depth is 12m. It has a total area of 22.5ha, including a container yard of 9.2ha capable of stacking 6,000

TEUs. The yard is equipped with one 50t, two 40t, one 36.5t and two 25t mobile cranes, plus yard tractors and yard chassis.

Dalian is the largest port serving Northeastern China. It has a ro-ro/lo-lo container berth of 270m long, equipped with two 27.5t portal cranes. The minimum water depth is 9m. Terminal facilities including a total area of 3.5ha served by 6 front-end loaders plus yard tractors and chassis.

Currently the world's largest container port, the port of Hong Kong will become a Chinese port after 1997 when the British colony is due to return to Chinese rule. Container handling in Hong Kong is concentrated at the Kwai Chung facility which comprises a total of six terminals. Terminals 1 & 5 are operated by the Modern Terminals Ltd. They have three berths totaling 777m, served by seven Hitachi 35t and one Davy Morris 40t container gantry cranes. Minimum water depth is 12.2m. Terminal facilities include a total area of 28.1ha (storage 16,000 TEUs) served by 5 rail-mounted Hitachi (35t) and 3 rubber-tyred Davy Morris (40t) yard gantries, 1 Grove TM2700 (18t) and 1 Coles Agneas (7t) truck cranes, plus 58 straddle carriers and 18 front-end loaders. Terminals 2, 4 and 6 are operated by Hongkong International Terminals Ltd. They have a total quay length of 1,491m, equipped with 4 IHI (40t), 2 Hitachi (35t) and 4 Mitsui-Paceco (30t, two 35t, 40t) container gantry cranes. Minimum water depth is 12.2m. Terminal facilities include a total area of 42ha (storage 25,584 TEUs), served by 33 rubber-tyred Mitsui-Paceco yard gantry cranes, plus 8 front-end loaders and yard tractors and chassis. Terminal 3 is a single user terminal operated by Sea-Land Orient Ltd.

It has one berth of 305m long, equipped with three Mitsui-Paceco 30t container gantry cranes. Minimum water depth is 12.2m. The terminal has a total area of 17.1ha (storage 4648 TEUs) served by 9 rubber-tyred Mitsui-Paceco (40t) yard gantries plus yard tractors and chassis.

Purpose-built container terminals are not elsewhere available in Chinese ports. Containers are handled by multi-purpose or conventional berths with self-sustaining container vessels in the ports of Qingdao, Xiamen, etc.

However, development of container terminals is planned at various ports. It once seemed as if virtually every port of any size in China had grandiose plans for developing large scale container facilities, commented Matthews (1989a). In his report "Chinese Play Patience With Port Development", he claimed that there had been at least 20 separate schemes under consideration at various times. This is an unrealistic approach towards container port development and could lead to severe consequences (see later discussions in section 7.4).

According to Matthews (1989a), there is a total of over 20 ports in the PRC regularly handling containers, although the vast majority of container traffic passes through eight. These are the six major container ports listed in Table 7-2 plus Fuzhou and the Yangtze river port of Nanjing. In an effort to coordinate port development more closely, the ministry of communications has set up a special study to examine container transportation. One of its tasks is to investigate the development of a national port information network and thus improve overall management of port development. This initiative is intended to rationalise development plans for container facilities and avoid each port producing independent and unrealistic plans in isolation. At present, some facilities, such as those at Shanghai, are already close to optimum throughput and there is a risk of some congestion. Under the current five-year plan, which extends until end-1990, it had been planned to build a total of 10 new container terminals, including facilities to handle third generation vessels at Dalian and Ningbo. These facilities are under construction and are expected to be operational some time in 1991. Smaller terminals, taking second generation and short-sea ships, are planned at Shanghai and Fuzhou. Shallow water depth prevents these ports from handling larger ships.

7.2 THE INLAND CONTAINER TRANSPORT SYSTEM

Inland transport is an important link in the chain of intermodal container transport. The inland container transport system mainly consists of the railway, the road and the inland waterways. Containerisation makes the idea of intermodal door-to-door transport of general cargoes possible, as Macdiarmid and Chambers (1983) indicated:

> "The change in method of general cargo conveyance which follows the introduction of container shipping into a trade lies primarily in the availability of a unit which can be moved by land and sea. When the trunk haul was limited to the sea passage general cargo was assembled in dock sheds for loading to ships and discharged at receiving ports for sorting prior to movement inland. With the use of container the trunk haul can be projected beyond the ports to inland centres where traffic is generated, and the

grouping of exports or dispersal of imports is no longer limited to port areas."

China's economy and population is concentrated along the eastern coast line and the Yangtze river basin. Table 7-3 shows the National Income and population data for the major provinces and cities in the eastern coastal area and the Yangtze river basin. It can be seen from the table that they comprise nearly 80% of China's total National Income and 70% of the total population. It is, therefore, reasonable to assume that 80% or more of China's total container traffic are generated in these provinces and cities. Certainly the first destination of imports will be in these areas as will be the origin of manufactured and semi manufactured exports.

In China the inland transport network has experienced continuous development over the last 30 years as shown in table 7-4. However, the density of the network is still very low. For example, in 1986 China had a total population of 1.06 billion, thus the density of the railways was only 0.05km/'000 inhabitants and that of the roads 0.91km/'000 inhabitants. In terms of territory areas (China has a total area of 9.6 million km^2), the density of the railways was 5.5km/'000km^2 and that of the roads 100.3km/'000km^2.

In 1986, 2.75 billion tonnes of goods were transported on inland journeys in China and the freight turnover reached 1223.5 billion tonne-km (see table 7-5). It is clearly shown in table 7-5 that China's inland freight transport is heavily reliant on the railways. By tonnage, railways accounted for half of the total traffic, and 71.6% of the tonne-km traffic, while for road traffic these figures were 28.7%

Table 7-3 Regional National Income (1985) and Population (1986)

Region	National Income (Billion Yuan)	Population (million)
Liaoning	42.57	37.26
Beijing	19.45	9.75
Tianjin	15.09	8.19
Hebei	34.09	56.17
Shandong	55.23	77.76
Jiangsu	57.85	62.70
Shanghai	40.97	12.32
Zhejinag	36.58	40.70
Fujian	16.48	27.49
Guangdong	50.30	63.46
Guangxi	15.41	39.46
Anhui	27.18	52.17
Jiangxi	17.30	35.09
Hubei	35.85	49.89
Hunan	30.08	56.96
Sichuan	49.14	103.20
Total	543.57	732.57
National total	700.70	1057.21

Source: National Statistic Bureau (1987)

and 3.0% respectively. These differences in shares are accounted for by the different average lengths of haul of a freight tonne by the two modes of transport. Of the remaining two modes, domestic water transport dominated, accounting for 20.3% of all tonne-km -- a share much greater than that of road.

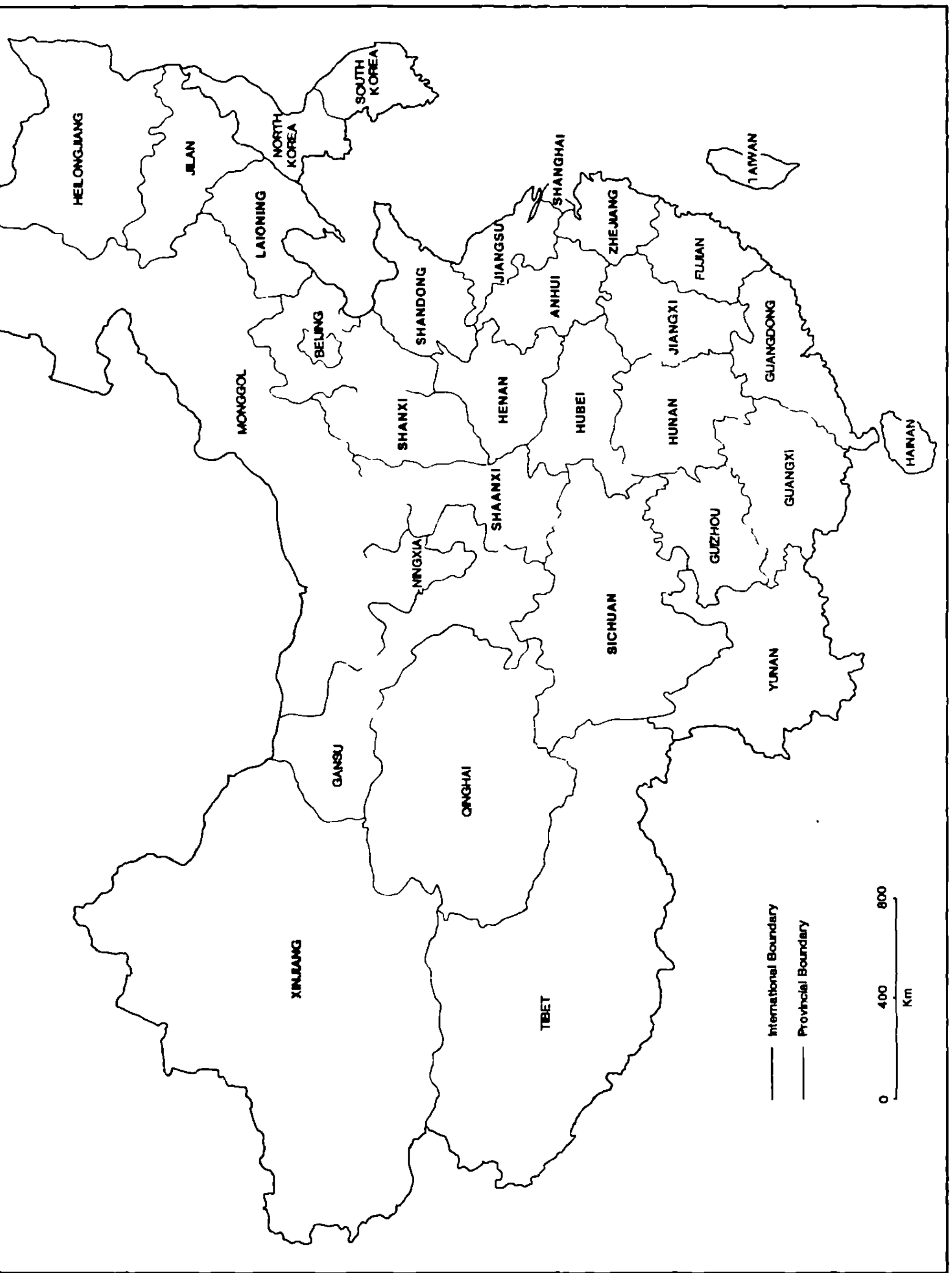


Figure 7-2 China's Provinces

Table 7-4 China Transport Network 1952-1986 ('000km)

Year	Railways	Roads	Inland Waterways	Pipelines
1952	22.9	126.7	95.0	--
1957	26.7	254.6	144.0	--
1962	34.6	463.5	161.9	0.1
1965	36.4	514.5	158.0	0.4
1970	41.0	636.7	148.4	1.2
1975	46.0	783.6	135.6	5.3
1976	46.3	823.4	137.4	6.3
1977	47.4	855.6	137.4	6.7
1978	48.6	890.2	136.0	8.3
1979	49.8	875.8	107.8	9.1
1980	49.9	888.3	108.5	8.7
1981	50.2	897.5	108.7	9.7
1982	50.5	907.0	108.6	10.4
1983	51.6	915.1	108.9	10.9
1984	51.7	826.7	109.3	11.1
1985	52.1	942.4	109.1	11.8
1986	52.5	962.8	109.4	13.0

Source: National Statistic Bureau (1987)

Table 7-5 Inland Freight Transport in 1986

	Tonnes (Billion)	Tonne-km (Billion)	Average length of haul
Road	0.79 (28.7%)	36.9 (3.0%)	46.7
Rail	1.36 (49.5%)	876.5 (71.6%)	644.5
Domestic water	0.45 (16.4%)	248.9 (20.3%)	553.1
Pipelines	0.15 (5.4%)	61.2 (5.0%)	408.0
Total	2.75 (100%)	1223.5 (100%)	502.7

Source: National Statistic Bureau (1987)

China's inland freight transport experienced a 17-fold increase during the period 1952-1986, railway traffic increasing 15 times, road 26 times and domestic water 21 times (see table 7-6). China's passenger traffic increased 18 times including an increase of 13 times on railways and 74 times on roads (National Statistic bureau 1987). During the same period, the total length of China's railways and roads increased by some 2.3 and 7.6 times respectively (table 7-4). The consequence is severe congestion particularly on the railways. It is estimated that the current capacity of China's total inland transport system is not enough for passenger transportation alone (He 1985). In the total network of 52,487km railways, only 8.4% is electrified and 23.7% operated by diesel. The remaining 67.9% is operated with steam locomotives. Furthermore, about 80% of the total railway consists of single line track, which is a major limitation on carrying capacity. The condition of the road network is no better than that of the railway. Most roads in China are of simple, two-lane construction and the movement of motorised transport is often restricted by pedal-powered vehicles and hand or horse drawn carts. Until recently, the construction of motorway system was given very little consideration in China.

As a result, the volume of containers being handled at ports in China has run ahead of the ability of inland transport systems in China to cope. Consequently, comparatively few containers move beyond the immediate hinterlands of container ports. For example, the port of Shanghai handled a total of 84,040 TEUs of import containers in 1986. Only 30% were transported door-to-door, of these 91% were carried by lorries, 4% by train and 5% by barges. Some

85% of this door-to-door transport took place in Shanghai itself[1]. Most of the imported containers were stripped inside the port and then transported in break-bulk form. But, even break-bulk cargoes need some kind of inland transport to reach their final destination, be it rail, road or water. It therefore appears that massive expansion and development of the inland transport infrastructure should be on the top agenda, as Matthews (1989b) indicated:

> "Having devoted considerable resources to building up an extensive array of deep-sea and short-sea container services, and gradually improving the ability of PRC ports to handle boxes and containerships, the need to develop matching inland connections has become increasingly urgent. Although the marine box terminals themselves are performing reasonably well in turning ships around, inadequacy of intermodal links is causing congestion in and around the port areas.
>
> "State-owned China Ocean Shipping Co (Cosco) is keen to develop a truly door-door container service network, in contrast to its present container services which are mainly port-port. A Cosco spokesman commented that developing inland container transport facilities in PRC must now become a top priority. He was pleased that some roads were being improved, but he regarded rail developments as the main need, in view of the huge size of the country and the long distances over which boxes will need to move.
>
> "Foreign lines carrying boxes to the PRC are in a particularly good position to see the shortcomings of inland transport in the country, comparing it with highly developed intermodal networks in Europe and North America. A spokesman for one major foreign carrier pointed out that inland inadequacies are beginning seriously to hamper container operations, and new investment is vital if the PRC is to continue its switch from break-bulk to containers."

---

1. Data collected form Shanghai Harbour Authority.

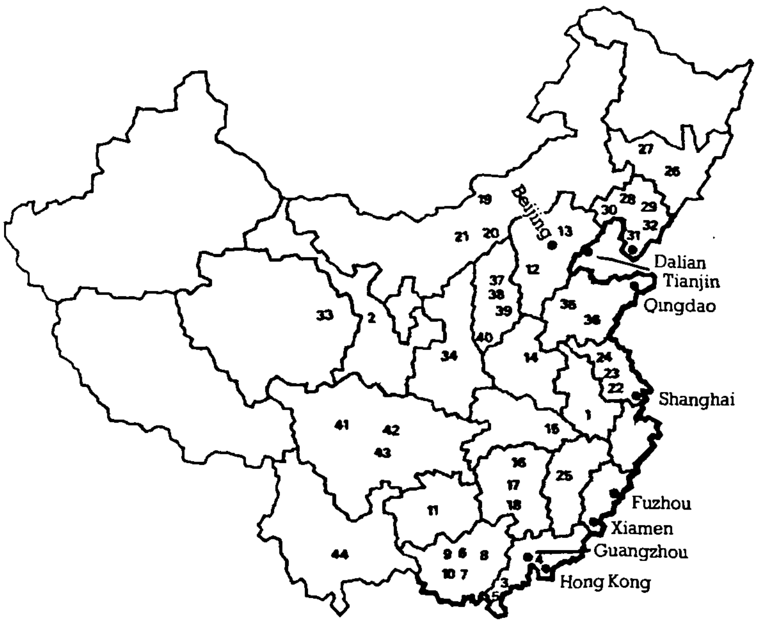
Table 7-6 Inland Freight Transport 1952-1986 (Billion Tonne-km)

Year	Railways	Roads	Domestic Water	Pipelines	Total
1952	60.2	1.4	11.8	--	73.4
1957	134.6	4.8	33.9	--	173.3
1962	172.1	6.2	34.0	--	212.3
1965	269.8	9.5	43.3	--	322.6
1970	349.6	13.8	51.2	--	414.6
1975	425.6	20.3	81.8	26.2	553.9
1976	386.9	21.0	85.5	35.7	529.1
1977	456.8	25.1	102.1	38.7	622.7
1978	534.5	27.4	129.2	43.0	734.1
1979	559.8	26.8	139.3	47.6	773.5
1980	571.7	25.5	152.1	49.1	798.4
1981	571.2	25.3	150.7	49.9	797.1
1982	612.0	30.3	170.8	50.1	863.2
1983	664.6	33.5	181.1	52.4	931.6
1984	724.8	35.4	196.1	57.2	1013.5
1985	812.6	35.4	225.5	60.3	1133.8
1986	876.5	36.9	248.9	61.2	1223.5

Source: National Statistic Bureau (1987)

Matthews (1989b) also noticed that "a relatively small number of marine boxes move by rail, although there are significant movements of domestic cargo, using non-ISO mini-containers". He said:" In the longer term, in view of the immense size of the country, the railways are probably the key to expanding intermodalism in the PRC, even though there is still a very long way to go. Development of a truly comprehensive rail container network in the PRC has possibly to be viewed over a timescale of decades."

According to Matthews (1989b), approximately 30,000 TEUs were moved inland to/from Chinese ports by rail during 1988. This only accounted for less than 3% of total boxes handled at Chinese ports. At present there are just over 40 inland railyards capable of handling ISO containers, among which many can only handle 20ft units (see figure 7-3).



Province	Locations (map reference)
Anhui	Wuhu(1)
Gansu	Lanzou(2)
Guangdong	Maoming(3), Shenzhen(4), Zhangjiang(5)
Guangxi	Guilin(6), Guixia(7), Hechi(8), Liuzhou(9), Nanning(10)
Guizhou	Guiyang(11)
Hebei	Shijiazhuang(12), Guanganmen(13)
Henan	Zhengzhou(14)
Hubei	Wuhan(15)
Hunan	Changsha(16), Zhuzhou(17), Hengyang(18)
Inner Mongolia	Eren(19), Huhot(20), Jining(21)
Jiangsu	Nanjing(22), Wuxi(23), Zhenjiang(24)
Jiangxi	Nanchang(25)
Jilin	Huangqitan(26), Mengjiatun(27)
Liaoning	Liaoyang(28), Shenyang(29), Yinkou(30), Dandong(31), Manzhouli(32)
Qinghai	Xining(33)
Shaanxi	Xian(34)
Shandong	Jinan(35), Yantai(36)
Shanxi	Datong(37), Linfen(38), Taiyuan(39), Yuncheng(40)
Sichuan	Chengdu(41), Chongqing(42), Jinhungpo(43)
Yunnan	Kunming(44)

Figure 7-3 Inland Rail Depots in the PRC Which Are Able to Handle ISO Containers

In the road sector, Matthews (1989b) pointed out that generally roads in China are often unsuitable for container vehicles and there is very little appropriate lifting equipment. In addition to the inadequacy of many road surfaces, limitations imposed by bridges, sharp bends and tunnels mean that access is often restricted. For example, the maximum load of most bridges in China is only five tonnes whereas a container lorry plus the container itself could easily weigh 30 tonnes.

Availability of container trucks and chassis is reckoned by Matthews (1989b) not to be a major problem, because a number of joint venture container trucking companies have been set up at major ports. One of the pioneering joint ventures in inland container operation is Land-Ocean Inchcape in Shanghai, comprising Inchcape, Sinotrans, Shanghai port and local trucking interests. It operates a fleet of 46 Scania container trucks and runs two container depots in Shanghai, one specialising in handling dangerous goods. This is the first operation of its kind in China.

Matthews (1989b) further indicated that documentation procedures will have to be reformed if inland movements in the PRC are to increase significantly. Because shipping lines are not in direct control of inland movements, usually only port-port bills of lading are issued. Trucking is normally arranged by merchants' haulage, using Sinotrans or one of the joint venture operators, while boxes moved by rail are consigned to the custody of local rail bureaux. Ocean carriers would like to have more direct control over their boxes and regard this as necessary before intermodal transport of containers can develop fully. For example, Maersk line, one of the largest foreign lines moving containers in China, commented that its containers are mainly trucked from ports using its own subsidiaries or joint venture firms, with most movements limited to a radius of around 50 miles. This is mainly due to the difficulty of controlling and monitoring movements of containers which have gone inland, apart from the lack of suitable equipment and facilities. Once the control and monitoring of the container breaks down, it is almost certain that the container will never come back again.

7.3 STRATEGY FOR PORT GEOGRAPHICAL LOCATIONS

It was pointed out in Chapter 6 that no major lines on the Far East-Europe and Far East-North America routes make direct calls at China mainland ports. Carriers like Ace Group, Maersk, APL and Sea-Land serve Chinese ports by feeder connections via Hong Kong, Kobe and Keelung (see figures 6-4, 6-5, 6-8, 6-9 and 6-11). Only Cosco provides direct callings at Shanghai, Tianjin (Xingang) and Guangzhou (Huangpu) (see figures 4-3 and 4-4). However, as Cosco speeds up the upgrading of its mainstream service by introducing large third generation vessels, it can be predicted that sooner or later it will have to consider dropping its direct calls at Chinese ports. In the short-sea sector, however, it is a different story. Most of China's container ports are extensively covered mainly by Chinese and Japanese carriers, e.g. Cosco, NYK, and K-Line, etc.

The reason that mainstream lines tend to avoid China mainland varies. Apart from the poor inland connections discussed in the last section, geographical location and physical constraints of the ports themselves are the two main obstacles which deter foreign lines. Geographically, any port north of Shanghai is off the mainstream container routes while virtually all the major container ports in China were designed to accommodate only second generation container vessels.

Currently in China, container handling in Shanghai has almost reached its full capacity, while the other ports are not successful in attracting enough traffic. For example, with the most sophisticated container handling facilities in China, Tianjin (Xingang) only handled 218,000 TEUs in 1988, half its design capacity. Huangpu, the major container facility in southern China, only attracted 84,448 TEUs in 1988, compared with its design capacity of 200,000 TEUs. This fact shows that there could be some fundamental errors in the layout of the container port system in China.

Geographically, the port of Tianjin (Xingang) is not on any major international container routes. Neither is it on the Far East-Europe route, nor the transpacific route. It is unlikely that main line container services would make direct calls at Tianjin because any such an attempt would involve a major diversion. Although the port of Huangpu (Guangzhou) is on the main container route, it is geographically too close to Hong Kong. Given the scale, the efficiency and the reputation of container handling in the Hong Kong terminals, it is very difficult for Huangpu to compete with it. Hong Kong has in fact become the main gateway for southern China and its role will become ever more significant as 1997 approaches.

It can clearly be seen that to-date, container handling facilities in both Tianjin and Huangpu are under-utilised and whether or no they can attract much more traffic in the near future is to be doubted. Nonetheless, further development of container facilities in southern China is still under consideration at several locations (Matthews 1989a). In particular Shekou of the Shenzhen Special Economic Zone, an immediate neighbour to Hong Kong, is planning for some major container handling facilities. The objective is to have two berths and five gantry cranes in operation by 1991 and extend that to four berths by 1992. It is perhaps worth to quoting the comment of Mark Leese, the Managing director of the Modern Terminals Ltd of Hong Kong (Lloyd's List 1989).

> ".... I believe that is developing very well but what you must remember is that they still have to develop road and rail links to say nothing of communications and technology to match.
>
> "The other important point is that the larger generation container vessels are not going to make two calls in this area and we will continue to see a great deal of container traffic barged down from the China coast ports to feed into large vessels."

This, he said, would become an increasingly important trend in the years ahead and Hong Kong already had facilities designed for this purpose which China was unlikely to establish. Thus the justification of a huge investment in Shekou is doubted.

While both Tianjin and Huangpu fail to attract enough traffic, Shanghai may indeed require more facilities in the near future to cope with the growing demand. Geographically, Shanghai is much superior to Tianjin. It is located at the mid point of the Chinese coast line and is geographically convenient on both the Far East-Europe route and the transpacific route. Unfortunately, Shanghai is limited by its water depth and can only accommodate second generation ships.

Geographically, Ningbo is an ideal alternative to Shanghai and it has very good deep water. However, the inland transport at Ningbo is poor and its immediate hinterland is too small to justify a large scale container port. Fortunately, the sea distance between Ningbo and Shanghai is merely 136 nautical miles (265km) compared with the railway distance of 340km. Therefore if the development of third generation facilities is successful, Ningbo could become the main gateway of Shanghai. Large container vessels would make direct calls at Ningbo and containers would then be relayed to Shanghai via feeder network. Thus, Ningbo could potentially takeover from Shanghai as the country's main container port.

In northern China, although Dalian's physical condition is much superior to that of Tianjin (Xingang), it's geographic location is also off the main route. It is anticipated that Dalian's function will be limited to that of a domestic centre serving northeastern China. This does not justify Dalian in the construction of any third generation facilities.

7.4 STRATEGIES OF PORT DEVELOPMENT

Having analysed the inland transport system and the strategy for port geographical locations, we will now turn to the problem of container port development strategies before reaching the final conclusions of the chapter. As indicated in section 7.1, the current mass approach towards the container port development in China could lead to serious misallocation of resources. This section tries to elaborate on the point in relation to the various types of container facilities and their market roles.

7.4.1 COST PROFILES IN CONTAINER PORT DEVELOPMENT

Although in the long run containerisation does achieve capital savings (Gilman 1988), the initial huge capital investment on modern container terminals is obvious (see table 7-7). Container terminals are extremely productive as compared with conventional ones (see table 7-8). Therefore, attention must be paid to the problem of over-investment which can result from competition in a context of expensive container handling technology. The example of European container berth investment during the 1960s, when the total capacity installed was several times greater than the demand, is one that China cannot afford to follow. A national approach is thus required for the development of the container terminals.

Capital is a scarce resource especially in a developing country such as China. Lack of national planning and coordination in the development of container terminals could cause enormous waste of precious capital. The logic of containerisation indicates that only some ports in each region would eventually become hub ports, others

Table 7-7 Average Container Terminal Investment Costs (In millions of US dollars--1983)

Capacity (000) TEU/yr	100	200	300	400	500
Bulkhead costs	25.0	42.5	57.5	70.0	80.0
Storage area costs	41.0	65.0	87.5	108.5	127.0
CFS building costs	6.0	9.5	12.0	14.0	15.5
Electrical, drainage, etc.	6.0	9.0	11.5	13.5	15.0
Fenders	2.0	3.4	4.6	5.6	6.4
RoRo ramp	6.0	6.0	6.0	6.0	6.0
Administration building	4.0	4.0	6.0	6.0	6.0
Equipment costs	18.6	32.9	44.3	53.4	60.0
Fence, gates, etc.	1.0	1.4	1.7	1.9	2.0
Maintenance shops	2.0	2.5	3.0	3.5	4.0
Total investment costs	111.6	176.2	234.1	282.4	321.9

Source: Frankel (1987).

Table 7-8 Average Empirical Port Capacities

Ship Type and Cargo-handling Method	Yearly Capacity per m Wharf (MT/m/yr)	Occupancy Degree (%)	Gross Gang Hour Rate/Crane Hour Rate (MT/h)	Berth Length (m)
Barge-carrier barges	3200	70	20	20[1]
Conventional ships no pallets	1000	50	15	180
Conventional ships 100% pallet	2700	50	40	200
Specialised pallet carriers	3300	50	80	210
Container feeder ships, two cranes	3700	50	116	160
Main container ships, two cranes	6000	30	325	280

1. Barge-carrying vessels themselves do not require any port facilities.

Source: Frankel (1987).

in the region would be relegated into feeder ports which are then connected with the hub ports by traffic relays.

7.4.2 TERMINAL TYPES AND ECONOMIES OF SCALE

In planning a national container port system, it is essential to determine how much container handling capacity is required based on the traffic forecast. It must also be made clear among the total traffic demand the proportion between deep-sea and short-sea traffic. Deep-sea trades are overwhelmingly dominated by large size fully cellular ships which require deep water, sophisticated container handling equipment and large areas of container yard; while short sea trades may be either container, ro-ro/container or trailer ro-ro. In any event the small ship size and short dwell times combine to give low requirements for depth of water, length of quay, crane outreach and space, and this makes a much cheaper design possible than is the case with deep-sea terminals.

(1). Deep-sea Terminals

The primary function of a deep-sea container terminal is the transfer of containers between ships and inland transport vehicles. A secondary function is the reception of less-than-container load (LCL) export cargoes and consolidation into containers and the unpacking of LCL import containers and the despatch of the unpacked cargoes by inland transport. Other secondary functions may include container and vehicle maintenance and repair workshops and the storage of empty containers.

A deep-sea container terminal should be close to as many major sea routes as possible so as to afford minimum diversion for the ships. It should be sheltered and should also be deep enough and tide-free enough to allow access of ships for 24 hours per day. There should be plenty of area available both for immediate use and for future expansion. In fact the availability of area is one of the most important factors in the precise siting of a terminal. Besides, on the land-side there should be ready access to major highway and railway networks. It would probably be cheaper to build a container terminal near good land-side connections, road and rail, than to build close to the sea and extend the roads and railways to meet it (Marshall 1983).

The deep-sea container terminal system can be broken down into three main sections: the ship shore interface which comprises the quay and cranes, the container yard plus land side interface and the ancillary facilities including container freight stations and cargo examination areas, lorry and car parks, gate house, offices, fuel bay and workshops (University of Liverpool Marine Transport Centre 1981).

The design of the ship shore interface is a function of throughput and ship size, and is largely independent of equipment choice within the terminal or method of operating the container yard. Parameters which control the design of quay are length, depth of water and depth of quay area, while of cranes are number, outreach, span between rails, backreach, width of legs, lifting capacity and clear lifting height.

The principal dimensions of full containerships are shown in table 7-9. The capacity ranges from 250 up to 3099 TEUs, which includes the traditional first, second and third generation container ships. Their dimensions are restricted by the Panama Canal. Nineteen eighty eight saw the emerge of the world's first ultra-panamax containership. The American President Line's C-10 class vessel have an overall length of nearly 903ft (275.2m), their beam is 129ft 3in (39.4m) and their draught 41ft (12.5m). Deadweight is put at 53,648 long tons (54,506 tonnes) and each ship loads 4,300 TEUs (Boyes 1988). Comparing the dimensions of C-10 with those listed in table 7-9, it can clearly be seen that the length and draught is not at all outstanding. The greatest impact that C-10s have caused is the breadth of beam, at 39.4m which far exceeds the normal panamax limit. This ultra-panamax beam requires that those ports which handle C-10s must be equipped with specially designed cranes with a very long outreach. Table 7-10 lists the pacific basin ports which are equipped with ultra-panamax cranes.

The container yard has the main function of marshalling of export containers and holding import containers awaiting collection. There are subsidiary functions like the holding of transshipment and re-stowed containers. The main design parameters of the container yard are the equipment choice and the area requirement.

Table 7-9 Principal Dimensions of Full Containerships (*metres*)

TEU Range	Length Overall		Breadth		Draught	
	Lower	Higher	Lower	Higher	Lower	Higher
250- 499	100	160	15.0	22.0	5.5	8.8
500- 699	145	180	19.0	24.0	8.3	10.5
700- 899	155	190	22.0	26.0	8.5	10.7
900-1099	170	210	23.0	30.0	9.5	11.4
1100-1299	185	220	23.0	31.0	10.0	11.4
1300-1499	200	235	26.0	32.3	10.0	11.5
1500-1699	210	240	29.0	32.3	10.0	11.8
1700-2099	210	265	30.0	32.3	10.5	12.0
2100-2599	255	290	32.3	32.3	11.0	13.0
2600-3099	255	290	32.3	32.3	12.0	13.0

Source: University of Liverpool Marine Transport Centre (1981).

Table 7-10 Ultra-panamax Cranes at Pacific Basin Ports Served by APL

Port Crane make (No)	Capacity under spreader (long tons)	Outreach (ft)	Lift height (ft)	Hoist speed loaded/empty (ft/min)	Trolley speed (ft/min)
Yokohama					
Hitachi(1)	40	141	104	164/394	590
IHI(1)	40	141	104	164/394	590
Mitsubishi(1)	40	141	104	164/394	590
Singapore					
Mitsubishi(3)	39	154	112	174/427	590
Oakland					
Mitsubishi(3)	40	152	105	170/365	600
Los Angeles					
Mitsubishi(5)	40	145	105	170/365	600
Kobe					
Mitsubishi(3)	40	146	103	164/394	590
Hong Kong					
Mitsui(3)	40	146	100	174/420	502
Kaohsiung					
Mitsui(3)	40	145	110	170/365	600
Seattle					
Paceco(4)	50	145	95	160/385	500

Source: Boyes (1988).

Container Yard Equipment Choice

There are basically four types of equipments used in CY handling:

1. Chassis tractor
2. Front-end loader
3. Straddle carrier
4. Yard gantry cranes

These equipments can be combined into various handling systems and those most commonly seen are:

1. tractor-chassis system
2. Straddle carrier (direct) system
3. straddle carrier (relay) system
4. yard gantry-chassis system
5. front-end loader system
6. combination system

There are three main factors which must be considered when selecting equipment: throughput, working area and flexibility. A rough estimate of the initial and fully developed throughput is an invaluable guide in assessing the type and phasing of the equipment required. An assessment of the working area enables the permitted ground loadings to be established together with the number of ground spaces possible in relation to the equipment alterations, while flexibility is broadly a function of the equipment type. From the engineering point of view, equipment choice depends on three main considerations: reliability, ease of maintenance and availability of spares. The six container handling systems will be examined below.

1. Tractor-chassis system

The elements of this system are heavy duty tractors and large numbers of chassis towed by them. With this system, chassis are parked back to back in rows with access roadways in between. Containers are stored one-high and therefore very large areas are required for the CY. The system is very flexible and operationally efficient because every container is immediately accessible by a tractor unit and basically all handling are productive since restowing is not required. However, it requires a large number of expensive chassis as well as needing a great deal of land.

2. Straddle carrier (direct) system

The straddle carrier has generally been found to be the best choice for a typical import/export common user terminal. Straddle carriers are versatile machines that can perform all terminal operations. They can stack containers two or three high, move them between quay crane and storage area, and load or unload them to/from road transport. The prime disadvantage of the equipment in the early days was the high breakdown time and the mess that spilled oil made on the terminal. However, operational improvements and simple mechanical drives now available have improved reliability and substantially reduced maintenance costs.

3. Straddle carrier (relay) system

In the straddle carrier relay system, the containers are relayed between the ship-to-shore gantry crane and the stacking area by yard tractors/trailers, and the straddle carriers pick up the containers from the roadway or transfer point and move along the rows to stack them, while the tractors with their trailers move off around the CY and back to the quay apron.

4. Yard gantry-chassis systems

In the yard gantry-chassis system, containers in the storage area are stacked by either rail-mounted or rubber tyred gantry cranes. Rail-mounted cranes can stack containers up to five high while rubber tyred cranes can normally stack containers two to three high. The system must be supplemented by tractor-trailer units for the transfer of containers between quay side and CY. The system is economical in land because of the high stacking, and is reliable and has low maintenance costs. The major disadvantage is the inflexibility especially with the rail-mounted cranes.

5. Front-end loader systems

Front-end loaders equipped with fixed or telescopic spreaders were developed from conventional fork-lift trucks for container handling. With this system pairs of containers are stacked side-by-side in rows up to two and three high. This provides a quick start of operation and the machines are reliable and simple to maintain. However, the heavily-loaded front axle (23,000-45,000kg) necessitates heavy-duty paved working areas. Front-end loaders are inefficient when used to transport containers and for large scale operations should be restricted to the stacking operation. Additional terminal owned tractor-trailer units are required for the transit of containers between quay-side cranes and CY.

6. Combination systems

A combination system is the one which combines the particular advantages of several of the four types of equipment in a hybrid operation, with more than one type of stacking equipment in use at a time. The straddle carrier/yard gantry crane/chassis operation, for example, has become quite common. In this system straddle carriers are used for extracting individual import containers and delivering them to road vehicles, while transfers between the ship and the CY are performed by the tractor/trailer sets. Gantry cranes are used in the CY for feeding exports to the ship where it is possible to work straight off an export stack. It appears that adopting a combination system is a very sensible and cost-effective approach. However, a comprehensive information system and rigid operating policies, together with excellent management skills are required for such a system to be successful. It is generally considered that combination systems are unsuitable for developing countries.

Area Requirement

The need to pay close attention to planning land use in port areas begins at the moment the idea of port development arises and does not stop until a port is closed. Land is a scarce resource and any neglect in planning of land use could lead to serious consequences for ports. The world is full of examples of ports which have been seriously affected or even closed by lack of attention to land use planning (UNCTAD 1983).

The container yard (CY) is by far the largest and most variable element within the total container terminal area. Up to 70% of the total terminal area is assigned to CY for stacking, while other terminal areas (the marshalling area, office/control room buildings, CFS, the gate complex, and road and rail (access) occupy only about 25% or so of the area. Early terminals, covering 4 to 5 hectares, were considered colossal in comparison with the 1 to 1.5 hectares of the average general cargo berth, but later designs grew to 8 to 10 hectares and now a land area of 15 to 20 hectares is not uncommon.

Expected annual and mean daily throughput at the proposed container terminal are important factors which influence the container yard area requirement. However, the areas required are not just a matter of mean throughput. Storage demand varies with time, and allowance must be made for peaks in throughput. Another primary factor for area requirement is the container dwell time.

The first step in deciding the CY area requirement is to determine the anticipated average daily throughput and choose an appropriate peaking factor. All terminals experience peaks and troughs in the flow of containers over a period of time and an allowance is needed so that the peak is not excessively exceeded. The peaking factor is expressed as a proportion of the average flow, i.e. a system rising 30% above the average would have a peaking factor of 1.3. At the design stage, real daily throughput is not available. The determination of the peaking factor is more or less an estimate based upon data available in an existing terminals in the region with similar trading characteristics to the proposed terminal. The peaking factor should be high enough so that it does not span over a long period to allow a recovery to most peaks. However, the maximum peak is not necessarily an appropriate measure since its occurrence may be relatively infrequent.

The second step is to estimate the container dwell times. The number of container units expected on the terminal is only part of the story. Just as significant is the time that a container can expect to remain in the stacking area. Clearly, the longer that containers are left in the CY, the more space is needed to accommodate a given throughput. Container dwell time varies tremendously at different terminals and with different status of container. Dwell times are not easy to establish and it is not wise to predict optimistically low values for the mean time spent in the port. The container revolution brought with it the hope that cargoes would flow through ports much more quickly and efficiently than in conventional form. This, however, is not necessarily true. In fact containers often spend as much time in ports as conventional break-bulk general cargoes. Usually export container dwell time are shorter than those for imports (documentation is less complex, consolidation is under control, customs procedures less protracted) but both imports and exports can suffer from poor organisation of inland transport. FCL (full container load) containers normally pass through the port more quickly than LCL (less than container load), while empty/recirculation containers regularly spend longest of all in port. For transshipment containers, dwell times are determined by the intervals between ship arrivals.

The third step is to apply the peaking factor to the mean daily throughput and then multiplied by the mean dwell time. The result represents the daily container slot requirement in the CY. Applying the peaking factor ensures that the CY has sufficient container slots to accommodate the expected flow of TEUs, but only assuming a relatively compact stacking pattern. In practice, containers need to be separated into groups in the CY, by type, by size, by ship call, etc, to allow easy access for in-terminal moves and operational flexibility. This extra space is allowed for by applying a separation factor. An extra space of 25% (a separation factor of 1.25) is a typical example.

The fourth step is to convert the daily container slot requirement (with separation factor) into actual twenty-foot ground slots (TGSs). To do this, the height to which the containers can be stacked must be taken into consideration. Stacking height depends on container status and on the container handling system adopted. If containers are to spend a long time in the CY (e.g. empties), it is usual for them to be stacked higher than those soon to be moved. Similarly, exports can be block-stacked because they will be handled together and accessibility is not such a problem. By taking all the factors into account (including the choice of equipment), it is possible to calculate a mean stacking height. TGSs can be derived by dividing the daily container slot requirement by the mean container stacking height.

The final step is to convert the TGSs into actual stacking areas required. The average areas occupied per TGS varies depending on different handling systems. Generally speaking, the yard gantry crane system has the best land utilisation. While the land utilisation of the straddle carrier system is relatively good, that of the chassis and the front-end loader systems is poor.

Ancillary Facilities

The most important ancillary facility of a container terminal is the container freight station (CFS). A CFS is a structure used for stuffing and stripping containers and for consolidating and sorting consignments. Due to the scarce of land areas inside the terminal, it is now quite a common practice to place CFS off-terminal. Unlike the CY, which has to be close to the quay simply because of its close association with the work of the ship, the CFS has more freedom with respect to its location. It can work quite efficiently at some modest distance from the terminal. In some cased CFSs are located in inland areas close to the origins and destinations of cargo, and this clearly make sense as it makes full use of the intermodal potential of the container.

In most developing countries where land is a scarce resource, the innovative idea of multi-storey CFS would probably provide a solution. According to Matthews (1988), the Asia Terminal Ltd (ATL) multi-storey CFS was conceived as a solution to the chronic space problems in Hong Kong and viewed as a trend-setter for other parts of the world with similar difficulties. The ATL multi-storey CFS is located on Sea-Land's Terminal Three at the Kwai Chung container complex and comprises six storeys of handling and storage areas with each floor accessed via a three lane vehicle ramp. Each floor has parking space for 102 containers vehicles and additional parking space is available on the roof. Total cargo storage space is 148,640m^2. The 3.2-hectare ground space under the building is used by Sea-Land for container storage and is able to accommodate up to 1,800 units stacked three high, handled by over-head bridge cranes.

(2). Short Sea Terminals

Short sea services are characterised by small ships operating with great regularity on frequent services, e.g. shuttle services. Container exchanges are of a moderate size and provide for a fairly even load on the facility. The fact that there is often a complete container exchange reduces the complexity of the terminal operation while the frequency of the service limits container dwell times (University of Liverpool Marine Transport Centre, 1981). Due to their nature, short sea terminals are relatively simpler in design. They do not require deep water and container handling equipment is less complicated. They impose little in the way of requirements for new infrastructure and in fact are sometimes tucked away in the older, smaller parts of conventional ports.

To sum up, the planning of the deep-sea container terminals is a complicated process. The planner must take into account every important factors which affects terminal planning and design. Any mistakes could lead to serious consequences and cause huge waste of scarce resources. Based on the previous discussions and analysis, the next section will try to draw some conclusions for the future development of China's container port and inland transport system.

7.5 CONCLUSIONS

It was forecast in Chapter 3 that by 1995 China's seaborne container traffic will probably reach 2.5 million TEUs (the medium case), including 1.2 million of deep and medium sea traffic and 1.3 million of short sea traffic (see table 3-19). How should China cope with this traffic demand?

Most of China's deep-sea traffic will come from North America, Europe and the Mediterranean. As can be seen from Chapters 4 & 5, these mainstream deep-sea routes are now dominated by large container ships. Even Cosco is up-grading its fleet rapidly. China's major container ports lack the ability to provide adequate services for these large box ships. Although there are reports that third generation terminal facilities are being built in Ningbo and Dalian, it is considered that they are not going to function at least in the near future due to limitations in inland connection or the geographical location. Fortunately, near neighbours of the China mainland, e.g. Hong Kong, Taiwan, Japan and South Korea, have already established first-class container handling facilities (see table 7-11). There is no reason in the short and medium term why China should not take advantage of these ports. Among the many Far East ports, two stand out as the best candidates, viz. Hong Kong and Kobe. In fact these two ports are already extensively used by several container lines as transshipment centre for cargoes to/from China, e.g. Maersk, APL, Sea-Land, the Ace Group and Cosco (see Chapter 6). The immediate task for China should, therefore, be to build enough capacity (around one million TEUs in total) in the major ports of Shanghai, Xingang, Dalian, Qingdao and Huangpu to serve the relay traffic to/from Hong Kong and Kobe. In addition, China will also have to provide about 0.2 million TEUs of port capacity to receive the medium sea traffic mainly from Southeast Asia and Southern Asia. That puts the total capacity at 1.2 million TEUs for the deep-sea (relay from Hong Kong and Kobe) and medium-sea traffic (direct service from Southeast and Southern Asia). The estimated allocation of the total traffic among the six major container ports is shown in table 7-12. It can be seen from the table that while Shanghai needs more capacity (one more container terminal is justified), both Huangpu and Tianjin (Xingang) have surplus capacity even in 1995. Dalian and Qingdao should each have a specialised container terminal. A total of 24,000 TEUs of throughput will not justify Xiamen to build any dedicated facilities.

In the longer term, however, it is possible that the port of Ningbo would play such a major role in China's seaborne container trade as to replace Kobe as the main gateway serving northern and central China. A sophisticated cost-benefit analysis is necessary to assess the justification of replacing Kobe with Ningbo. This, unfortunately, is beyond the scope of this thesis.

Deep and medium sea traffic only provides half the story. In fact more than half of China's seaborne container traffic by 1995 totalling 1.3 million TEUs will come from short-sea trades. Japan alone is responsible for 58% of the total short-sea traffic and the remaining 42% comes from the rest of Far East Asia (see table 3-19). Therefore, to build enough short-sea facilities would be a major task for container port development in China in the next few years. These short sea

Table 7-11 Container Handling Performance of Top Asian Ports (TEUs)

Port	1988	1987
Hong Kong	4033427	3457182
Singapore	3400000	2634500
Kaohsiung	3082837	2778786
Kobe	2232911	1996626
Busan	2200000	1949143
Keelung	1670000	1939854
Yokohama	1450000	1348383
Tokyo	1396026	1287974
Bangkok	791584	649530

Source: Lambert (1989)

Table 7-12 Estimated Deep and Medium Sea Traffic in Major Chinese Ports (TEUs)

Port	Current Capacity	Estimated Traffic in 1995
Dalian	--	120000 (10%)
Huangpu	200000	132000 (11%)
Qingdao	--	132000 (11%)
Shanghai	320000	468000 (39%)
Tianjin	400000	324000 (27%)
Xiamen	--	24000 (2%)
Total	920000	1200000 (100%)

container terminals do not require deep water and are not necessarily to be concentrated in the major ports. In fact virtually every coastal port including the major Yangtze river ports should prepare some facilities for the forthcoming traffic.

In the inland container transport sector, it can be clearly seen from the discussions in section 7.2 that China faces enormous difficulties on roads and railways. It is impossible that any significant improvement of the situation will take place in the foreseeable future. There is only one alternative left, i.e. the inland waterways and coastal shipping. As a matter of fact, inland waterways have already played a significant role in the transport of containers in China. Most inland waterway movements of containers transshipped at PRC ports take place on the Yangtze river from Shanghai. In 1988, around 13,000 TEUs moved on this river. Most containers move on the Yangtze to Nanjing, but some go further upriver as far as Wuhan (Hubei Province) and Chongqing (Sichuan Province). Containers are carried on self-propelled barges, each carrying 40-50 TEUs (Matthews 1989b).

While Matthews (1989b) made a fairly accurate analysis of China's inland container transport system, he failed to recognise the fundamental role that inland water and coastal shipping could play. It is perhaps true that in the longer term China would have to expand the railways sufficiently to consolidate intermodalism. But that probably needs decades of time and does not solve the immediate urgency in China's inland container transport.

The immediate solution is to make maximum use of coastal shipping and the Yangtze river. By doing that it is anticipated that the pressure of moving containers inland could be greatly eased. As has been pointed out in section 7.2, 80% of China's total container traffic is generated in the provinces and cities along the eastern coast and the Yangtze river. The Chinese coast line is basically South-Northwards whereas the Yangtze river in the middle is basically East-Westwards. This land shape puts the water transport in a very advantageous position. For example, the length of the coastal shipping route from Hong Kong up to Tianjin is about 1600 miles (2965km); while the railway distance between Canton and Tianjin is about 2450km. Therefore the convexity ratio is only 1.2, which justifies the use of coastal shipping service instead of land mode transport (see 6.2.2). On the Yangtze river, the distance between Shanghai and Chongqing in Sichuan province is 2495km; while the railway distance is slightly longer at 2501km. The water distance between Shanghai and Wuhan in Hubei province is 1125km whereas the rail distance is 1545km. Therefore using the Yangtze river to distribute/consolidate containers to/from Shanghai can actually achieve savings in distance, not to mention that water transport itself is much cheaper than railways. More importantly, by making more use of its relatively abundant inland waterways and the long coastal routes, this can change the habit of relying for everything on the railways in China. Thus it is possible to ease some of the pressure on the severely congested railways without too much investment.

The scarce resource of capital should be invested in those most needed, e.g. coastal and inland port facilities, inland container depots, roads connecting those ports with the depots and the container trucking companies, etc. China's railways should gradually play their role in the intermodal container transport in a much longer term. This will be the most cost effective approach towards the development of China's inland container transport system.

REFERENCES

Boyes, J. R. C. (1988), C-10s Enhance APC's Pacific Presence, *Containerisation International*,22: no.6, 33.

Frankel, E. G. (1987), *Port Planning and Development*, John Wiley & Sons, New York.

Gilman, S. (1988), *Deep Sea Container Shipping: a Further Evolution*, unpublished paper, Marine Transport Centre, University of Liverpool.

Lambert, M. (1989), Asian Ports Set New Pace, *Containerisation International*, 23: no.7, 44.

Lloyd's List (1989), MTL Is Positive Over Expansion, Supplement, *Hong Kong*.

Macdiarmid, K. J & Chambers, J. D. C. (1983), Inland Ports -- the UK Container Base System, in *Container Handling and Transport*, ed. H. K. Dally, C S Publications, Surrey.

Marshall, J. K. (1983), Basic Operational Design of Sea Container Terminals, in *Container Handling and Transport*, ed. H. K. Dally, C S Publications, Surrey.

Matthews, S. J. (1989a), Chinese Play Patience With Port Development, *Containerisation International*, 23: no.12, 63.

__ (1989b), PRC Maps Out Its Intermodal Future, *Containerisation International*, 23: no.9, 63-69.

__ (1988), Asia Terminals Takes Stock, *Containerisation International*, 22: no.5, 83.

National Statistic Bureau (1987), *China Statistics Yearbook 1987*, (in Chinese), China Statistics Publications, Beijing.

Shen, W. (1987), *China's Seaports: Development and Problems*, a paper delivered at the International Seminar: Waterfront Redevelopment and the Cityport Economy, University of Southampton Department of Geography.

UNCTAD (1983), *Monographs on Port Management*, Monographs No.2, *Planning Land Use in Port Areas: Getting the Most out of Port Infrastructure*, by R. E. Takel, United Nations.

__ (1978), *Port Development, a Handbook for Planners in Developing Countries*, United Nations, New York.

University of Liverpool Marine Transport Centre (1981), *Container Logistics and Terminal Design*, ed. S. Gilman, Liverpool.

CHAPTER 8 CONCLUSIONS

8.1 INTRODUCTION

Three major issues has been tackled in this study, the growth of container traffic volumes, development strategies for container shipping fleet and development strategies for container ports and inland transport systems. The aim of this chapter is to briefly summarise the discussions of previous chapters and will try to draw some final conclusions.

8.2 CONTAINER TRAFFIC FORECAST

The container traffic forecast for China is based on three scenarios relating to future economic growth: the optimistic, the intermediate and the pessimistic. The optimistic scenario (the high case) assumes a rate of growth of 8.0% per annum up to 1995 for Chinese real GDP. This is based on historic as well as recent economic growth rates and an optimistic view of the future sustained by the open door policy. The intermediate scenario (the medium case) assumes a rate of growth of 6.7%, which is the World Bank high case forecast for low-income countries. Under the pessimistic scenario (the low case), a growth rate of 4.6% is assumed, which is the World Bank low case for low-income developing countries. Section 2.2 of this thesis pointed out that trade and economic development were positively correlated with each other. A study of the annual growth of the container potential of China's seaborne trade and the growth of the Chinese GDP during the ten-year period 1975-1985 found out a ratio of 1.4 (see Chapter 3). It was assumed that this same ratio would apply in the period 1986-1995, which meant that a 1% increase in China's real GDP would cause a growth of 1.4% in China's seaborne container potential. Thus China's seaborne container traffic would grow at a rate of 11.2% under the optimistic scenario, 9.4% under the intermediate scenario and 6.4% under the pessimistic scenario. In most cases, only the intermediate result is used in the analysis of shipping , port and inland development strategies. The high growth rate of 11.2% per annum assumed in the optimistic scenario in this study is really rather exceptional and seems somewhat unlikely. The intermediate scenario of economic development assumed in this study can be realised if things go well for the Chinese economy. However, the first two month of 1990 saw negative growth of the nation's industrial output. On a pessimistic view of economic development, the entire strategy for China's containerisation would have to be reassessed. We assume that the downward turn of the economy is only a temporary phenomenon and will not last for too long.

Under the intermediate scenario, by 1995 China's seaborne container traffic will reach 2.5 million TEUs, including one million of deepsea, 0.2 million of medium sea and 1.3 million of short sea traffic (see table 3-19). This is based on the assumption that China will achieve 80% container penetration. North America, Europe, Mediterranean, Japan, Far East Asia and Southeast Asia are the main trading regions. They account for 93% of the total Chinese seaborne container traffic.

8.3 DEVELOPMENT STRATEGY FOR COSCO

It is assumed that Cosco will take a share of 50% of the total Chinese container traffic. Under this assumption, Cosco's present capacity on the transpacific route is already in surplus compared with the forecast of demand in 1995. However, it seems that Cosco is continuing to give priority to the expansion of its transpacific fleet. Perhaps Cosco is confident that it can acquire a bigger share of the Chinese traffic on the route, or is preparing to become heavily involved in cross-trading. It is considered risky to play this game in the highly competitive transpacific market. It will be extremely difficult for Cosco to compete for cargoes with the giant carriers of Taiwan, Japan and US. This is not only because they have larger, faster ships, but more importantly they are highly competitive in terms of intermodal through transport capacities. Cosco must lack some of the management experience as well as the capital resources to try to match these carriers. The market situation on the transpacific route is that it tends to be over-supplied and even with the present capping policy, capacity is at least adequate. Hence it is scarcely conceivable that Cosco could successfully attract much cross-trading cargo. It is also not safe for Cosco to count on acquiring more than a reasonable share of Chinese traffic, say a maximum of 50%. At least China's trading partners should have equal participation in the business. *Any practice of cargo reservation is* against the long term interest of the nation, and would itself mitigate against cross-trading opportunities.

It is strongly recommended that Cosco should shift its priority of fleet expansion from the pacific to the Far East-Mediterranean-Europe route. The fact that the transpacific route is the world's largest container transport market does not necessarily mean that Cosco has to put the majority of its resources into it. China's trading pattern is different from the general. Under the intermediate scenario of this study, by 1995 container traffic between China and the Mediterranean and Europe is estimated at a total of 0.55 million TEUs (see table 3-19). This compares with the total Cosco capacity of 0.14 million TEUs by 1987. If Cosco were to take 50% of the traffic as its share, there would be a total shortage of 0.13 million TEUs in capacity. Clearly, there is cargo available for Cosco on the Sino-Mediterranean-Europe route. Thus it does not make sense for Cosco to fight for cargoes on the pacific route while there is shortage of capacity on the Far East-Europe route. Although Cosco is now one of the top ten container carriers in the world, its ships are comparatively smaller and slower than those of its major competitors and it possesses poor capital recourses and lacks some of the required managerial experience. Therefore it would be unwise for Cosco to try to launch a full scale challenge. It would be better to concentrate its strength on the area where it has advantages in terms of cargo generation, Far East-Europe being the route in question.

Cosco currently runs two separate services on the Sino-Mediterranean and Sino-Europe routes. A modified Ryder and Chappell model was used in Chapter 5 to analyse the fleet operation strategies. Ship size, ship speed and fleet size are three interrelated factors which form the major part of the fleet operation strategy. Ship size is a function of the daily traffic demand and service frequency. When the two variables are fixed, then ship size becomes a constant. Ship speed and fleet size both have close relationship with the required round trip time and there exists a trade-off between the two. Longer round trip time results in slower ship speed and larger fleet size and vice versa. Fuel price is another important factor which affects the decision making on ship speed and fleet size. Cheaper fuel favours faster service speed and hence smaller fleet size while dearer fuel favours slower speed and larger fleet size. As indicated by the case studies in Chapter 5, if Cosco retains the two-service strategy by 1995, it will need a 7-ship fleet at 19 knots on the Sino-Mediterranean route (see table 5-8). Each ship should have the capacity of 1120 TEUs and the fleet would offer a weekly service. This produces a round trip time of 49 days and an annual fleet cost of US$27.3 million. On the Sino-Europe route an 8-ship fleet at 20 knots is required (see table 5-7). The service will be based on a weekly frequency with ships of 2100 TEUs. This produces a round trip time of 56 days and an annual fleet cost of US$46.6 million.

Another strategy open to Cosco is to merge the two separate services into one integrated service using larger ships (see 5.4.4 & 6.4). A multi-port direct service itinerary is assumed in 5.4.4. The most cost-effective fleet structure is a 10-ship fleet at 19 knots, as indicated in table 5-9. The service is of a weekly frequency with ship size of 3220 TEUs. This produces a turnaround time of 70 days and an annual fleet cost of US$72.4million. A concentrated service itinerary supported by feeder links is studied in 6.4. Under this operating strategy, Cosco is to drop direct calls at the China mainland except of course for Hong Kong and possibly Ningbo in the long run. The optimum mother ship fleet is suggested to be a fleet of 8 ships at 20.6 knots (see table 6-2). This produces a quick turnaround of 56 days and a low annual fleet cost of US$61.8 million. This service is supported by two feeder links. The Mediterranean feeder and the Hong Kong feeders would annually cost US$2.1 million and US$5.7 million respectively. The advantage of this strategy is that the mother ship turnaround time is greatly reduced. However, the financial savings thus achieved, using the ship cost data adopted in this study are not hugely significant. Whether or not Cosco should opt for the large ship strategy will depend on the future newbuilding price. There are now signs that the era of very low newbuilding costs is about to end. In the short and medium terms, if the second-hand market does not immediately reflect the newbuilding costs, Cosco will probably be better-off by keeping its low profile strategy. In the long run, it is highly possible that the newbuilding costs will remain high and that the second-hand market will eventually reflect the newbuilding costs. Cosco will probably have no choice but to adopt a large newbuilding strategy if it decides to remain in the business of deep-sea container shipping.

8.4 CONFERENCE STRATEGY

Cosco has so far remained as an independent carrier. It seems that "Cosco feels under no pressure to participate in any liner conferences or rate agreements". "The Cosco position on this matter is that it wants to see fair competition on international trade routes and does not therefore want to join any cartels or have any monopolistic powers" (Matthews 1989). Cosco believes that its status as an independent outsider will enable it to pick up more cargoes from both Chinese and foreign-based shippers than it would by being subject to conference restrictions and cargo allocation.

Arguably, the conference system is continuing to weaken, as claimed by the *Containerisation International Yearbook 1990* (CI 1990):

> "As shippers and carriers come closer together to cooperate in the transportation of goods between the world's three major trading blocs (North America, Asia and Europe), conferences will become less relevant to their needs. Already a coalition of shippers, which includes several multinationals, is calling for their virtual elimination in US trades and concerted lobbying to this end can be expected as a specially appointed advisory commission starts this year to scrutinise the role of conferences in US ocean shipping. In Europe, where conferences have been given the regulatory 'all clear' by the European Commission competition directorate, shippers' councils nonetheless continue to batter the directorate with anti-competition complaints.

> "Even some operators now question the merits of a price fixing system that can no longer regulate prices and has no control over capacity amongst its own membership. In addition the emergence of efficient independents, which have steadily eaten away at conference market shares in transpacific, transatlantic and Europe/Far East trades, has also reduced the significance of conferences in arterial routes. All of these pressures on the system seem irresistible and make it unlikely that conferences covering major east/west markets will survive the 1990s in their present form. In such trades they may well have outlived their usefulness since they can no longer guarantee the price stability which their members and shippers crave".

At the moment, there seems no particular reason for Cosco to join the conference camp. For it to do so would require an ability to match conference service quality, together with a good deal on capacity shares. Such carriers as Evergreen, Yangming and Hanjin, etc. are examples of the alternative non-conference strategy. Cosco, however, can for the moment leave its options open and can consider conference membership on a case by case basis as circumstances arise.

8.5 INTERMODALISM

Intermodalism is another big issue that Cosco will face in the future. If Cosco really wants to be successful in the business of mainstream container transportation, it will have to do it door-to-door. So far, Cosco has played little direct role in inland container transport operations. For the most part, Cosco has contracted with trucking companies and rail bureaux to carry container inland, although some local Cosco offices do have small container trucking fleets or participate in joint-venture trucking companies. At the US end, Cosco does not have any firm plans to set up its own intermodal operations, simply because it has neither the resources nor the cargo volume to manage its own links. It seems that this business will continue to be contracted to forwarders and rail-roads for at least the foreseeable future (Matthews 1989). At the European end, the Cosco practice is also to contract the inland distribution containers to forwarders, such as Lep International of the UK. At present, this is perhaps the only choice for Cosco. But Cosco should really try hard to develop its own intermodal door-to-door through transport system whenever possible. It can start with joint-ventures and then gradually establish its independent intermodal services as traffic volume grows.

The business of intermodal container transport is much more complicated at the Chinese end. Cosco is not in the position to solve the problem by its own. The main trouble is that China simply lacks the basic infrastructure for intermodalism and it is unlikely that there will be much improvement of the situation in the near future. It is, therefore, suggested that in the short run China should make maximum use of its relatively abundant waterway resources, especially the Yangtze river and coastal shipping, because China's population and its main economic activities are centred along the coastal area and the Yangtze river basin. By doing that, the use of the land transport modes can be reduced to the feasible minimum. In the meantime, long term development of the road and railway networks should be planned. This, of course, is not only for the sake of container transport. It is a well known fact that the backward transport infrastructure has already imposed great constraint on China's economic development.

Therefore, by any means development of China's inland transport infrastructure should be a priority.

8.6 PORT DEVELOPMENT STRATEGY

Last, but not least, there are some final comments to be made on the future development strategy for China's container port system. Nowadays the trend on the world mainstream container routes is to use larger and larger ships. Currently China's major container ports lack the ability to provide adequate services to these large box ships. It is thus recommended that in the short and medium term, China should use the ports of Kobe and Hong Kong to relay its deep-sea container traffic. The priority should be to build enough capacity (around one million TEUs) in the major Chinese container port of Shanghai, Xingang, Dalian, Qingdao and Huangpu to serve the relay traffic to/from Hong Kong and Kobe. As indicated in table 7-12, by 1995 the port of Shanghai would need one more specialised terminal. Traffics in Dalian and Qingdao would be sufficient to justify one specialised terminal at each port. Both Tianjin (Xingang) and Huangpu would have surplus capacity even by 1995. In Xiamen, an estimated demand of 24,000 TEUs does not justify any dedicated facilities. In the long term, China could develop the port of Ningbo to replace the Kobe feeder and to take mainline ships. The port of Dalian is geographically unsuitable to be a major container hub port. The current investment of third generation facilities at Dalian could prove to be a costly mistake. So could be the huge investment in

Shekou, a close neighbour of Hong Kong. It is anticipated that Hong Kong will play a more and more important role in the containerisation of China's seaborne trade, especially after 1997 when the British colony returns to Chinese rule.

Besides the port facilities for the deep-sea traffic, due attention should be paid to the construction of adequate short-sea terminals in the next few years. More than half of China's seaborne container traffic by 1995 totalling 1.3 million TEUs will come from short-sea. These terminals of course do not require deep water and virtually every coastal port including the major Yangtze river ports should and are able to prepare some facilities for the forthcoming traffic.

All in all, China has made a good start on the road to intermodalism. Cosco has successfully caught up the pace of container revolution, as Matthews (1989) praised: "One of the most remarkable and spectacular success stories in container shipping of recent years has been that of the PRC state-owned line, China Ocean Shipping Co (Cosco)". Yet they still have a long way to go. Looking towards the future, challenges and opportunities co-exist. However, we have every reason to believe that China will exert more and more influence in this intermodal era.

REFERENCES

CI (1990), *Containerisation International Yearbook 1990*, ed. M. R. Lambert etc, National Magazine, London.

Matthews, S. J. (1989), Cosco Moves Into The Big Time, *Containerisation International*, 23: no.8, 35.

APPENDICES: COMPUTATION OF VOYAGE COSTS AND FLEET OPTIONS

(1) Voyage Cost Far East -- Europe

	(1) Size (TEUs)	(2) Speed (knots)	(3) Initial capital (m$)	(4) Installed BHP	(5) Service BHP	(6) Manning	(7) Load factor	(8) Boxes Carried (TEUs)	(9) Route length (NM)	(10) Time at sea (Days)	(11) Time in port (Days)
Ship A	3428	20.7	42.7	23180	18544	16	0.9	3085	21715	45.7	10.9
Ship B	4300	24.2	50.7	57000	45600	16	0.9	3870	21715	39.4	13.2
Ship C	2214	19.0	30.6	16000	12800	16	0.9	1993	21715	49.6	7.7
Ship D	1686	17.5	24.9	14700	11760	34	0.9	1517	21715	53.7	6.4
Ship E	2700	19.0	35.6	22770	18216	34	0.9	2430	21715	49.6	9.0
Ship F	1318	17.5	20.6	13500	10800	34	0.9	1186	21715	53.7	5.4
Ship G	724	15.0	13.1	8086	6469	34	0.9	652	21715	62.3	3.9
Ship H_1	1218	21.2	5.0	21614	17291	34	0.9	1096	21715	44.7	5.2
Ship H_2	1218	21.2	5.0	21614	17291	34	0.9	1096	21715	44.7	5.2
Ship H_3	1218	21.2	5.0	21614	17291	34	0.9	1096	21715	44.7	5.2

	(12) Voyage time (Days)	(13) Annuity factor	(14) Annual capital (m$)	(15) Daily capital (US$)	(16) Voyage capital (US$)	(17) Daily MFO (US$)	(18) Daily Lub. (US$)	(19) Daily MDO (US$)	(20) Daily fuel at sea (US$)	(21) Voyage fuel at sea (US$)	(22) Daily fuel in port (US$)
Ship A	56.6	11.6896	3.65	10437	590815	6943	98	510	7551	345144	850
Ship B	52.6	11.6896	4.34	12392	651670	17073	241	510	17823	702030	850
Ship C	57.3	11.6896	2.62	7479	428711	4792	68	510	5370	266458	850
Ship D	60.1	11.6896	2.13	6086	365783	4403	62	510	4975	267171	850
Ship E	58.6	11.6896	3.05	8701	510073	6820	96	510	7426	368495	850
Ship F	59.1	11.6869	1.76	5036	297649	4044	57	340	4441	238468	680
Ship G	66.2	11.6869	1.12	3203	212075	2422	34	340	2796	174250	680
Ship H_1	49.9	7.7217	0.65	1850	92279	6474	91	340	6905	308510	680
Ship H_2	49.9	6.4632	0.77	2210	110248	6474	91	340	6905	308510	680
Ship H_3	49.9	4.3295	1.15	3300	164582	6474	91	340	6905	308510	680

	(23) Voyage fuel in port (US$)	(24) Total voyage fuel (US$)	(25) Daily I & M (US$)	(26) Voyage I & M (US$)	(27) Annual crew (US$)	(28) Daily crew (US$)	(29) Voyage crew (US$)	(30) Total voyage cost (US$)	(31) Cost per TEU (US$)
Ship A	9265	354409	3294	186472	45000	2057	116454	1248151	202
Ship B	11220	713250	3911	205680	45000	2057	108181	1678780	217
Ship C	6545	273003	2361	135309	45000	2057	117917	954940	240
Ship D	5440	272611	1921	115448	10000	971	58385	812227	268
Ship E	7650	376145	2746	160989	10000	971	56946	1104153	227
Ship F	3672	242140	1589	93922	10000	971	57414	691125	291
Ship G	2652	176902	1011	66919	10000	971	64327	520224	399
Ship H_1	3536	312046	1429	71256	10000	971	48454	524034	239
Ship H_2	3536	312046	1429	71256	10000	971	48454	542003	247
Ship H_3	3536	312046	1429	71256	10000	971	48454	596337	272

(2) Voyage Cost Far East -- WCNA

	(1) Size (TEUs)	(2) Speed (knots)	(3) Initial capital (m$)	(4) Installed BHP	(5) Service BHP	(6) Manning	(7) Load factor	(8) Boxes Carried (TEUs)	(9) Route length (NM)	(10) Time at sea (Days)	(11) Time in port (Days)
Ship A	3428	20.7	42.7	23180	18544	16	0.9	3085	13761	29.7	10.9
Ship B	4300	24.2	50.7	57000	45600	16	0.9	3870	13761	25.7	13.2
Ship C	2214	19.0	30.6	6000	12800	16	0.9	1993	13761	32.2	7.7
Ship D	1686	17.5	24.9	14700	11760	34	0.9	1517	13761	34.8	6.4
Ship E	2700	19.0	35.6	22770	18216	34	0.9	2430	13761	32.2	9.0
Ship F	1318	17.5	20.6	13500	10800	34	0.9	1186	13761	34.8	5.4
Ship G	724	15.0	13.1	8086	6469	34	0.9	652	13761	40.2	3.9
Ship H_1	1218	21.2	5.0	21614	17291	34	0.9	1096	13761	29.0	5.2
Ship H_2	1218	21.2	5.0	21614	17291	34	0.9	1096	13761	29.0	5.2
Ship H_3	1218	21.2	5.0	21614	17291	34	0.9	1096	13761	29.0	5.2

	(12) Voyage time (Days)	(13) Annuity factor	(14) Annual capital (m$)	(15) Daily capital (US$)	(16) Voyage capital (US$)	(17) Daily MFO (US$)	(18) Daily Lub. (US$)	(19) Daily MDO (US$)	(20) Daily fuel at sea (US$)	(21) Voyage fuel at sea (US$)	(22) Daily fuel in port (US$)
Ship A	40.6	11.6896	3.65	10437	423720	6943	98	510	7551	224253	850
Ship B	38.9	11.6896	4.34	12392	481963	17073	241	510	17823	457940	850
Ship C	39.9	11.6896	2.62	7479	298252	4792	68	510	5370	172791	850
Ship D	41.2	11.6896	2.13	6086	250526	4403	62	510	4975	172954	850
Ship E	41.2	11.6896	3.05	8701	358297	6820	96	510	7426	238959	850
Ship F	40.2	11.6869	1.76	5036	202274	4044	57	340	4441	154372	680
Ship G	44.1	11.6869	1.12	3203	141315	2422	34	340	2796	112472	680
Ship H_1	34.2	7.7217	0.65	1850	63357	6474	91	340	6905	200564	680
Ship H_2	34.2	6.4632	0.77	2210	75694	6474	91	340	6905	200564	680
Ship H_3	34.2	4.3295	1.15	3300	112999	6474	91	340	6905	200564	680

	(23) Voyage fuel in port (US$)	(24) Total voyage fuel (US$)	(25) Daily I & M (US$)	(26) Voyage I & M (US$)	(27) Annual crew (US$)	(28) Daily crew (US$)	(29) Voyage crew (US$)	(30) Total voyage cost (US$)	(31) Cost per TEU (US$)
Ship A	9265	233518	3294	133734	45000	2057	83519	874490	142
Ship B	11220	469160	3911	152117	45000	2057	80009	1183249	153
Ship C	6545	179336	2361	94134	45000	2057	82034	653756	164
Ship D	5440	178394	1921	79071	10000	971	39988	547978	181
Ship E	7650	246609	2746	113086	10000	971	40001	757993	156
Ship F	3672	158044	1589	63827	10000	971	39017	463162	195
Ship G	2652	115124	1011	44591	10000	971	42864	343895	264
Ship H_1	3536	204100	1429	48923	10000	971	33268	349648	159
Ship H_2	3536	204100	1429	48923	10000	971	33268	361985	165
Ship H_3	3536	204100	1429	48923	10000	971	33268	399290	182

(3) Voyage Cost Far East -- ECNA

	(1) Size (TEUs)	(2) Speed (knots)	(3) Initial capital (m$)	(4) Installed BHP	(5) Service BHP	(6) Manning	(7) Load factor	(8) Boxes Carried (TEUs)	(9) Route length (NM)	(10) Time at sea (Days)	(11) Time in port (Days)
Ship A	3428	20.7	42.7	23180	18544	16	0.9	3085	23197	48.7	10.9
Ship B	4300	24.2	50.7	57000	45600	16	0.9	3870	23197	41.9	13.2
Ship C	2214	19.0	30.6	16000	12800	16	0.9	1993	23197	52.9	7.7
Ship D	1686	17.5	24.9	14700	11760	34	0.9	1517	23197	57.2	6.4
Ship E	2700	19.0	35.6	22770	18216	34	0.9	2430	23197	52.9	9.0
Ship F	1318	17.5	20.6	13500	10800	34	0.9	1186	23197	57.2	5.4
Ship G	724	15.0	13.1	8086	6469	34	0.9	652	23197	66.4	3.9
Ship H_1	1218	21.2	5.0	21614	17291	34	0.9	1096	23197	47.6	5.2
Ship H_2	1218	21.2	5.0	21614	17291	34	0.9	1096	23197	47.6	5.2
Ship H_3	1218	21.2	5.0	21614	17291	34	0.9	1096	23197	47.6	5.2

	(12) Voyage time (Days)	(13) Annuity factor	(14) Annual capital (m$)	(15) Daily capital (US$)	(16) Voyage capital (US$)	(17) Daily MFO (US$)	(18) Daily Lub. (US$)	(19) Daily MDO (US$)	(20) Daily fuel at sea (US$)	(21) Voyage fuel at sea (US$)	(22) Daily fuel in port (US$)
Ship A	59.6	11.6896	3.65	10437	621948	6943	98	510	7551	367669	850
Ship B	55.1	11.6896	4.34	12392	683290	17073	241	510	17823	747509	850
Ship C	60.6	11.6896	2.62	7479	453018	4792	68	510	5370	283910	850
Ship D	63.6	11.6896	2.13	6086	387258	4403	62	510	4975	284726	850
Ship E	61.9	11.6896	3.05	8701	538352	6820	96	510	7426	392630	850
Ship F	62.6	11.6869	1.76	5036	315420	4044	57	340	4441	254137	680
Ship G	70.3	11.6869	1.12	3203	225259	2422	34	340	2796	185760	680
Ship H_1	52.8	7.7217	0.65	1850	97668	6474	91	340	6905	328622	680
Ship H_2	52.8	6.4632	0.77	2210	116686	6474	91	340	6905	328622	680
Ship H_3	52.8	4.3295	1.15	3300	174193	6474	91	340	6905	328622	680

	(23) Voyage fuel in port (US$)	(24) Total voyage fuel (US$)	(25) Daily I & M (US$)	(26) Voyage I & M (US$)	(27) Annual crew (US$)	(28) Daily crew (US$)	(29) Voyage crew (US$)	(30) Total voyage cost (US$)	(31) Cost per TEU (US$)
Ship A	9265	376934	3294	196299	45000	2057	122591	1317772	214
Ship B	11220	758729	3911	215659	45000	2057	113430	1771109	229
Ship C	6545	290455	2361	142981	45000	2057	124602	1011057	254
Ship D	5440	290166	1921	122226	10000	971	61813	861463	284
Ship E	7650	400280	2746	169914	10000	971	60103	1168650	240
Ship F	3672	257809	1589	99530	10000	971	60841	733599	309
Ship G	2652	188412	1011	71080	10000	971	68327	553078	424
Ship H_1	3536	332158	1429	75417	10000	971	51283	556526	254
Ship H_2	3536	332158	1429	75417	10000	971	51283	575544	263
Ship H_3	3536	332158	1429	75417	10000	971	51283	633051	289

(4) Voyage Cost Far East -- Oceania

	(1) Size (TEUs)	(2) Speed (knots)	(3) Initial capital (m$)	(4) Installed BHP	(5) Service BHP	(6) Manning	(7) Load factor	(8) Boxes Carried (TEUs)	(9) Route length (NM)	(10) Time at sea (Days)	(11) Time in port (Days)
Ship A	3428	20.7	42.7	23180	18544	16	0.9	3085	11796	25.7	10.9
Ship B	4300	24.2	50.7	57000	45600	16	0.9	3870	11796	22.3	13.2
Ship C	2214	19	30.6	16000	12800	16	0.9	1993	11796	27.9	7.7
Ship D	1686	17.5	24.9	14700	11760	34	0.9	1517	11796	30.1	6.4
Ship E	2700	19	35.6	22770	18216	34	0.9	2430	11796	27.9	9.0
Ship F	1318	17.5	20.6	13500	10800	34	0.9	1186	11796	30.1	5.4
Ship G	724	15	13.1	8086	6469	34	0.9	652	11796	34.8	3.9
Ship H_1	1218	21.2	5.0	21614	17291	34	0.9	1096	11796	25.2	5.2
Ship H_2	1218	21.2	5.0	21614	17291	34	0.9	1096	11796	25.2	5.2
Ship H_3	1218	21.2	5.0	21614	17291	34	0.9	1096	11796	25.2	5.2

	(12) Voyage time (Days)	(13) Annuity factor	(14) Annual capital (m$)	(15) Daily capital (US$)	(16) Voyage capital (US$)	(17) Daily MFO (US$)	(18) Daily Lub. (US$)	(19) Daily MDO (US$)	(20) Daily fuel at sea (US$)	(21) Voyage fuel at sea (US$)	(22) Daily fuel in port (US$)
Ship A	36.6	11.6896	3.65	10437	382439	6943	98	510	7551	194387	850
Ship B	35.5	11.6896	4.34	12392	440038	17073	241	510	17823	397639	850
Ship C	35.6	11.6896	2.62	7479	266022	4792	68	510	5370	149651	850
Ship D	36.5	11.6896	2.13	6086	222052	4403	62	510	4975	149678	850
Ship E	36.9	11.6896	3.05	8701	320802	6820	96	510	7426	206958	850
Ship F	35.5	11.6869	1.76	5036	178712	4044	57	340	4441	133597	680
Ship G	38.7	11.6869	1.12	3203	123834	2422	34	340	2796	97210	680
Ship H_1	30.4	7.7217	0.65	1850	56212	6474	91	340	6905	173896	680
Ship H_2	30.4	6.4632	0.77	2210	67158	6474	91	340	6905	173896	680
Ship H_3	30.4	4.3295	1.15	3300	100256	6474	91	340	6905	173896	680

	(23) Voyage fuel in port (US$)	(24) Total voyage fuel (US$)	(25) Daily I & M (US$)	(26) Voyage I & M (US$)	(27) Annual crew (US$)	(28) Daily crew (US$)	(29) Voyage crew (US$)	(30) Total voyage cost (US$)	(31) Cost per TEU (US$)
Ship A	9265	203652	3294	120705	45000	2057	75382	782179	127
Ship B	11220	408859	3911	138884	45000	2057	73049	1060830	137
Ship C	6545	156196	2361	83962	45000	2057	73169	579349	145
Ship D	5440	155118	1921	70084	10000	971	35443	482697	159
Ship E	7650	214608	2746	101251	10000	971	35815	672476	138
Ship F	3672	137269	1589	56392	10000	971	34472	406845	171
Ship G	2652	99862	1011	39075	10000	971	37562	300334	230
Ship H_1	3536	177432	1429	43406	10000	971	29516	306566	140
Ship H_2	3536	177432	1429	43406	10000	971	29516	317512	145
Ship H_3	3536	177432	1429	43406	10000	971	29516	350610	160

(5) Fleet Options on the Sino-Europe Route

(1) Size (TEUs)	(2) Speed (knots)	(3) Initial capital (m$)	(4) Installed BHP	(5) Service BHP	(6) Manning	(7) Load factor	(8) Boxes Carried (TEUs)	(9) Route length (NM)	(10) Time at sea (Days)	(11) Time in port (Days)	(12) Voyage time (Days)
2100	15.2	29.2	10461	8368	34	1	2100	21715	60	10	70
2100	17.2	29.2	15157	12125	34	1	2100	21715	53	10	63
2100	19.8	29.2	23122	18497	34	1	2100	21715	46	10	56
2100	23.4	29.2	38165	30532	34	1	2100	21715	39	10	49
2100	30.5	29.2	84513	67610	34	1	2100	21715	30	10	40

(13) Annuity factor	(14) Annual capital (m$)	(15) Daily capital (US$)	(16) Voyage capital (US$)	(17) Daily MFO (US$)	(18) Daily Lub. (US$)	(19) Daily MDO (US$)	(20) Daily fuel at sea (US$)	(21) Voyage fuel at sea (US$)	(22) Daily fuel in port (US$)	(23) Voyage fuel in port (US$)	(24) Total. voyage fuel (US$)
11.6896	2.50	7137	499589	3133	44	510	3687	219491	850	8500	227991
11.6896	2.50	7137	449630	4540	64	510	5114	269007	850	8500	277507
11.6896	2.50	7137	399672	6925	98	510	7533	344235	850	8500	352735
11.6896	2.50	7137	349713	11431	161	510	12103	467960	850	8500	476460
11.6896	2.50	7137	285480	25313	357	510	26180	776645	850	8500	785145

(25) Daily I & M (US$)	(26) Voyage I & M (US$)	(27) Annual crew (US$)	(28) Daily crew (US$)	(29) Voyage crew (US$)	(30) Total voyage cost (US$)	(31) Cost per TEU (US$)	(32) Annual ship cost (m$)	(33) Fleet size	(34) Annual fleet cost (m$)
2253	157680	10000	971	68000	953260	227	4.8	10	47.7
2253	141912	10000	971	61200	930249	221	5.2	9	46.5
2253	126144	10000	971	54400	932950	222	5.8	8	46.6
2253	110376	10000	971	47600	984149	234	7.0	7	49.2
2253	90103	10000	971	38857	1199585	286	10.5	6	63.0

(6) Fleet Options on the Sino-Mediterranean Route

(1) Size (TEUs)	(2) Speed (knots)	(3) Initial capital (m$)	(4) Installed BHP	(5) Service BHP	(6) Manning	(7) Load factor	(8) Boxes Carried (TEUs)	(9) Route length (NM)	(10) Time at sea (Days)	(11) Time in port (Days)	(12) Voyage time (Days)
1120	16.3	18.2	9421	7537	34	1	1120	19700	50	6	56
1120	18.9	18.2	14686	11749	34	1	1120	19700	43	6	49
1120	22.6	18.2	25110	20088	34	1	1120	19700	36	6	42
1120	27.9	18.2	47243	37794	34	1	1120	19700	29	6	35

(13) Annuity factor	(14) Annual capital (m$)	(15) Daily capital (US$)	(16) Voyage capital (US$)	(17) Daily MFO (US$)	(18) Daily Lub. (US$)	(19) Daily MDO (US$)	(20) Daily fuel at sea (US$)	(21) Voyage fuel at sea (US$)	(22) Daily fuel in port (US$)	(23) Voyage fuel in port (US$)	(24) Total voyage fuel (US$)
11.6896	1.56	4448	249110	2822	40	340	3201	161220	680	4080	165300
11.6896	1.56	4448	217972	4399	62	340	4801	208502	680	4080	212582
11.6896	1.56	4448	186833	7521	106	340	7967	289363	680	4080	293443
11.6896	1.56	4448	155694	14150	200	340	14690	432179	680	4080	436259

(25) Daily I & M (US$)	(26) Voyage I & M (US$)	(27) Annual crew (US$)	(28) Daily crew (US$)	(29) Voyage crew (US$)	(30) Total voyage cost (US$)	(31) Cost per TEU (US$)	(32) Annual ship cost (m$)	(33) Fleet size	(34) Annual fleet cost (m$)
1404	78624	10000	971	54400	547435	244	3.4	8	27.4
1404	68796	10000	971	47600	546949	244	3.9	7	27.3
1404	58968	10000	971	40800	580044	259	4.8	6	29.0
1404	49140	10000	971	34000	675093	301	6.8	5	33.8

(7) Fleet Options for the Combined Sino-Mediterranean-Europe Route

(1) Size (TEUs)	(2) Speed (knots)	(3) Initial capital (m$)	(4) Installed BHP	(5) Service BHP	(6) Manning	(7) Load factor	(8) Boxes Carried (TEUs)	(9) Route length (NM)	(10) Time at sea (Days)	(11) Time in port (Days)	(12) Voyage time (Days)
3220	17.0	40.7	18121	14497	34	1	3220	24490	60	17	77
3220	19.2	40.7	26106	20885	34	1	3220	24490	53	17	70
3220	22.2	40.7	40355	32284	34	1	3220	24490	46	17	63
3220	26.1	40.7	65579	52463	34	1	3220	24490	39	17	56

(13) Annuity factor	(14) Annual capital (m$)	(15) Daily capital (US$)	(16) Voyage capital (US$)	(17) Daily MFO (US$)	(18) Daily Lub. (US$)	(19) Daily MDO (US$)	(20) Daily fuel at sea (US$)	(21) Voyage fuel at sea (US$)	(22) Daily fuel in port (US$)	(23) Voyage fuel in port (US$)	(24) Total voyage fuel (US$)
11.6896	3.48	9948	765980	5428	77	510	6014	361001	850	14450	375451
11.6896	3.48	9948	696345	7819	110	510	8440	448538	850	14450	462988
11.6896	3.48	9948	626711	12087	170	510	12768	586862	850	14450	601312
11.6896	3.48	9948	557076	19642	277	510	20429	798706	850	14450	813156

(25) Daily I & M (US$)	(26) Voyage I & M (US$)	(27) Annual crew (US$)	(28) Daily crew (US$)	(29) Voyage crew (US$)	(30) Total voyage cost (US$)	(31) Cost per TEU (US$)	(32) Annual ship cost (m$)	(33) Fleet size	(34) Annual fleet cost (m$)
3140	241758	10000	971	74800	1457989	226	6.6	11	72.9
3140	219780	10000	971	68000	1447114	225	7.2	10	72.4
3140	197802	10000	971	61200	1487025	231	8.3	9	74.4
3140	175824	10000	971	54400	1600457	249	10.0	8	80.0

(8) Fleet Options for the Concentrated Sino-Mediterranean-Europe Route

(1) Size (TEUs)	(2) Speed (knots)	(3) Initial capital (m$)	(4) Installed BHP	(5) Service BHP	(6) Manning	(7) Load factor	(8) Boxes Carried (TEUs)	(9) Route length (NM)	(10) Time at sea (Days)	(11) Time in port (Days)	(12) Voyage time (Days)
3220	13.8	40.7	9693	7755	34	1	3220	21000	63	14	77
3220	15.6	40.7	14003	11202	34	1	3220	21000	56	14	70
3220	17.7	40.7	20453	16363	34	1	3220	21000	49	14	63
3220	20.6	40.7	32244	25795	34	1	3220	21000	42	14	56
3220	24.6	40.7	54909	43928	34	1	3220	21000	36	14	49

(13) Annuity factor	(14) Annual capital (m$)	(15) Daily capital (US$)	(16) Voyage capital (US$)	(17) Daily MFO (US$)	(18) Daily Lub. (US$)	(19) Daily MDO (US$)	(20) Daily fuel at sea (US$)	(21) Voyage fuel at sea (US$)	(22) Daily fuel in port (US$)	(23) Voyage fuel in port (US$)	(24) Total. voyage fuel (US$)
11.6896	3.48	9948	765980	2903	41	510	3454	219024	850	11900	230924
11.6896	3.48	9948	696345	4194	59	510	4763	267171	850	11900	279071
11.6896	3.48	9948	626711	6126	86	510	6723	332329	850	11900	344229
11.6896	3.48	9948	557076	9658	136	510	10304	437661	850	11900	449561
11.6896	3.48	9948	487442	16446	232	510	17188	611376	850	11900	623276

(25) Daily I & M (US$)	(26) Voyage I & M (US$)	(27) Annual crew (US$)	(28) Daily crew (US$)	(29) Voyage crew (US$)	(30) Total voyage cost (US$)	(31) Cost per TEU (US$)	(32) Annual ship cost (m$)	(33) Fleet size	(34) Annual fleet cost (m$)
3140	241758	10000	971	74800	1313462	204	6.0	11	65.7
3140	219780	10000	971	68000	1263196	196	6.3	10	63.2
3140	197802	10000	971	61200	1229942	191	6.8	9	61.5
3140	175824	10000	971	54400	1236861	192	7.7	8	61.8
3140	153846	10000	971	47600	1312164	204	9.4	7	65.6

(9) Fleet Options for the Mediterranean Feeder

(1) Size (TEUs)	(2) Speed (knots)	(3) Initial capital (m$)	(4) Installed BHP	(5) Service BHP	(6) Manning	(7) Load factor	(8) Boxes Carried (TEUs)	(9) Route length (NM)	(10) Time at sea (Days)	(11) Time in port (Days)	(12) Voyage time (Days)
642	13.3	11.9	4471	3577	34	1	642	870	3	3	6
535	18.0	10.4	10117	8094	34	1	535	870	2	3	5

(13) Annuity factor	(14) Annual capital (m$)	(15) Daily capital (US$)	(16) Voyage capital (US$)	(17) Daily MFO (US$)	(18) Daily Lub. (US$)	(19) Daily MDO (US$)	(20) Daily fuel at sea (US$)	(21) Voyage fuel at sea (US$)	(22) Daily fuel in port (US$)	(23) Voyage fuel in port (US$)	(24) Total voyage fuel (US$)
11.6896	1.02	2909	17451	1339	19	340	1698	4628	680	2040	6668
11.6896	0.89	2542	12710	3030	43	340	3413	6873	680	2040	8913

(25) Daily I & M (US$)	(26) Voyage I & M (US$)	(27) Annual crew (US$)	(28) Daily crew (US$)	(29) Voyage crew (US$)	(30) Total voyage cost (US$)	(31) Cost per TEU (US$)	(32) Annual ship cost (m$)	(33) Fleet size	(34) Annual fleet cost (m$)
918	5508	10000	971	5829	35456	28	2.1	1	2.1
802	4011	10000	971	4857	30492	28	2.1	1	2.1

(10) Fleet Options for the Hong Kong Feeder

(1) Size (TEUs)	(2) Speed (knots)	(3) Initial capital (m$)	(4) Installed BHP	(5) Service BHP	(6) Manning	(7) Load factor	(8) Boxes Carried (TEUs)	(9) Route length (NM)	(10) Time at sea (Days)	(11) Time in port (Days)	(12) Voyage time (Days)
1050	13.9	17.4	5657	4525	34	1	1050	3200	10	4	14
900	16.7	16.7	9082	7266	34	1	900	3200	8	4	12

(13) Annuity factor	(14) Annual capital (m$)	(15) Daily capital (US$)	(16) Voyage capital (US$)	(17) Daily MFO (US$)	(18) Daily Lub. (US$)	(19) Daily MDO (US$)	(20) Daily fuel at sea (US$)	(21) Voyage fuel at sea (US$)	(22) Daily fuel in port (US$)	(23) Voyage fuel in port (US$)	(24) Total voyage fuel (US$)
11.6896	1.49	4253	59540	1694	24	340	2058	19742	680	2720	22462
11.6896	1.43	4082	48981	2720	38	340	3099	24739	680	2720	27459

(25) Daily I & M (US$)	(26) Voyage I & M (US$)	(27) Annual crew (US$)	(28) Daily crew (US$)	(29) Voyage crew (US$)	(30) Total voyage cost (US$)	(31) Cost per TEU (US$)	(32) Annual ship cost (m$)	(33) Fleet size	(34) Annual fleet cost (m$)
1342	18792	10000	971	13600	114395	54	2.9	2	5.7
1288	15459	10000	971	11657	103557	58	3.0	2	6.0

NOTES ON COMPUTATION OF VOYAGE COSTS AND FLEET OPTIONS

NB. Numbers in () represent columns.

(1). Ship Size (TEUs).

(2). Ship Speed (knots).

(3). Initial Capital Cost (million US dollars).

(4). Installed BHP.

(5). Service BHP = (4) × 0.8.

(6). Manning.

(7). Load Factor.

(8). Boxes Carried on Board (TEUs) = (1) × (7).

(9). Route Length (nautical miles).

(10). Ship's Time at Sea (days) = (9) ÷ (2) ÷ 24 + 2.

(11). Ship's Time in Port (days).

(12). Total Voyage Time (days) = (10) + (11).

(13). Annuity Factor.

(14). Annual Ship Capital Cost (million US dollar) = (3) ÷ (13).

(15). Daily Ship Capital Cost (US$) = (14) ÷ 350 × 1000000.

(16). Voyage Ship Capital Cost (US$) = (12) × (15).

(17). Daily MFO Cost (US$) = (5) × 130 × 24 ÷ 1000000 × 120.

(18). Daily Lubricating Oil Cost (US$) = (5) × 24 ÷ 1000000 × 220.

(19). Daily MDO Cost (US$) = 3 × 170 or 2 × 170.

(20). Daily Fuel Cost at Sea (US$) = (17) + (18) + (19).

(21). Voyage Fuel Cost at Sea (US$) = (10) × (20).

(22). Daily Fuel Cost in Port (US$) = 5 × 170 or 4 × 170.

(23). Voyage Fuel Cost in Port (US$) = (11) × (22).

(24). Total Voyage Fuel Cost (US$) = (21) + (23).

(25). Daily I & M Cost (US$) = 0.027 × (3) × 1000000 ÷ 350.

(26). Voyage I & M Cost (US$) = (12) × (25).

(27). Annual Crew Cost (US$).

(28). Daily Crew Cost (US$) = (27) ÷ 350 × (6).

(29). Voyage Crew Cost (US$) = (12) × (28).

(30). Total Voyage Cost (US$) = (16) + (24) + (26) + (29).

(31). Cost per TEU (US$) = (30) ÷ (8) ÷ (2).

(32). Annual Ship Cost (million US$) = (30) ÷ (12) × 350 ÷ 1000000

(33). Fleet Size

(34). Annual Fleet Cost (million US dollar) = (32) × (33).

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