KOBE ECONOMIC & BUSINESS REVIEW

25th ANNUAL REPORT

RESEARCH INSTITUTE FOR ECONOMICS
AND BUSINESS ADMINISTRATION
KOBE UNIVERSITY

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CONTENTS

REDUNDANCY OF SEAFARERS AND THE PRACTICE OF PERMANENT EMPLOYMENT

Hiromasa YAMAMOTO

In the deep-sea Japanese shipping industry all shipping companies employ seafarers as permanent employees. In this article the writer explains the reason why the practice of permanent employment has introduced in the industry after the World War II. The next part deals how this practice was evaluated by management and the seamen's union before recent depressed years. However, main concern of the article is to examine the attitude of labour and management toward this practice during recent depressed years. Labour costs, security of employment, adjustment of employment and also necessity of retaining qualified seafares within company are related problems that management and labour have to deal when they consider the pertinence of the current practice. In the development of depression a gap of company policy toward this practice has emerged between big companies and others. Based on the analytical description of those points the writer attempts to give some perspective to the future of the current practice.

1. Introduction of the practice of permanent employment by deep-sea shipping companies

It was in 1947 that all Japanese deep-sea shipping companies adopted without exception the practice of permanent employment for seafarers. In order to make clear the situations, it is better to describe in brief the hiring practice of seafarers by Japanese shipping companies before the World War II and also the war-time governmental control on maritime labour.

In the prewar period only two liner companies, the N.Y.K. Line and the O.S.K. Line, employed both officers and ratings as permanent employees in the shipping industry while most shipowners hired seafarers on voyage basis though many of them hired captains and a few other officers in supervising position continuously. In those days the Japan Shipowners Association and two seafarers' unions, the Japan Seamen's Union and the Seafaring Officers Association kept harmonious labour-management relations. Cooperation of them led in 1927 to the establishment of the Kaiji-Kyodokai, which maintained job exchange offices for seafarers in main ports[1]. Most shipowners hired seafarers through it. In the prewar period there

1) The Kaiji-Kyodokai had an another important function as standing negotiating committee between labour and management to determine the minimum wage and other working conditions.

were in general redundancies of seafarers, and consequently shipowners felt no difficulty of hiring qualified seafarers.

Outbreak of the war with China in 1937 influenced severely upon the industrial relations of the Japanese shipping industry. Under the pressure of militarism seafarers unions were forced to dissolve in 1940, and the Kaiji-Kyodokai destined to follow the same way. Wartime control upon the shipping industry became severer as the war enlarged. In the final stage of wartime control all merchant vessels and seafaring labour were under the unified control of the Sempaku-Uneikai (Ship Operation Corporation). For the purpose of full utilization of manpower, the government designated qualified seafarers as drafted worker, and put them into the single labour pool, from which the Ship Operation Corporation dispatched necessary numbers of crew to merchant vessels. Under the supervision of the government the Corporation determined the wage rates of seafarers and their working conditions, in which provisions of paid vacation and payment of basic wage to seafarers on land waiting for next voyage were newly introduced. During wartime period seafarers were provided stability of income and employment as permanent employees, though they were in a status of the drafted workers.

After the end of war, wartime economic control was abolished. However, ocean transportation was an exception. In need of emergent import of food and repatriation of overseas armed forces, the Ship Operation Corporation continued its activities until 1950. At the end of 1945 the All Japan Seamen's Union was reorganized as the unified organization for officers and ratings. Hereafter wages and working conditions of seafarers were negotiated and agreed between the Ship Operation Corporation and the A.J.S.U..

In March 1947 the decree on mobilization of seafaring labour was abolished. In consequence seafarers were released from the status of drafted workers. However, they lost at the same time the legal ground of securing governmental support on stability of their income and employment. The Ship Operation Corporation was also expected to be abolished in near future. Fear of unemployment spread widely among seafarers, and it might become social problem. In order to relieve the uneasiness, the government suggested to the Ship Operation Corporation to negotiate with the union and also with the Nippon Kaiun Kyokai, the predecessor of the Japan Shipowners Association, on the necessary measures for securing full employment of seafarers. Thus, tripartite negotiation began and concluded an agreement on employment in the same month. Main points of the agreement were that with the support of the government the Ship Operation Corporation would continue to employ seafarer with the same conditions as before, and that when the Corporation were not be able to hire them due to its dissolution or some other reasons the Shipowners Association would consend in principle to hire all seafaring employees

of the Corporation[2].

In April 1949 as a final step of transition to peacetime activities, the Ship Operation Corporation determind to utilize the vessels which owned by private shiponwers on time charter basis instead of bareboat charter basis which had been the practice[3]. At that time the Corporation employed thirty-nine thousand seafarers, and three fourths of them were crew and reserve personnels working on board vessels which were owned by private shipping companies. Consequently, along with that determination of the Corporation, thirty thousand seafaring employees were required to be hired by respective shipowners. After several negotiations with the Corporation and the union, the Shipowners Association agreed to employ all of them with the same wages and working conditions as the Corporation[4]. Therefore, henceforth all shipping companies employed seafarers as permanent employees.

In April 1950 all governmental control over shipping activities were abolished. However, there was no attempt for shipping companies to change the system of seafarers' employment.

2. "Joint hiring system"—proposal of the A.J.S.U. and the response of shipowners

In the annual convention of 1957 the A.J.S.U. adopted the policy, as one of main policies, to establish the joint hiring system for the purpose of promoting the stability of employment for union members. In the next year the union adopted the resolution of promoting that policy.

According to the opinion of the union, the current system of permanent employment was effective to attain the stability of employment to some degree. However, in that system the stability depends too much upon the activities of each company. For example, a failure of company policy might result its employees loss of job opportunities. In addition, permanent employment puts inevitably large cost burden to small shipowners, because in order to grant crew vacations it becomes necessary for them to retain reserved members within their companies for every kind of jobs, resulting a high ratio of reserved members against crew for small shipowners who own only a vessel or two. In consequence, a small shipowner finds difficulty of granting a member of crew vacation immediately as he wishes when the shipowner does not retain adequate reserved personnels. Sometimes he tends to compensate

2) Ministry of Transportation, *Kaijo Rodo Junen-shi* (*Ten Years of Seafaring Labour*), 1957, p. 153.

3) In case of bareboat charter the crew is hired by the charterer, but in case of time charter the shipowner hires crew members.

4) Ministry of Transportation, op. cit., pp. 204–10.

a part of vacation days with cash payment. Thus, the union contended that for the purpose of securing the stability of employment it was desirable to introduce the industry-wide device, the joint hiring system.

Outline of the joint hiring system which the A.J.S.U. proposed was as follows;

1. in order to hire seafarers jointly shipping companies would incorporate the joint hiring corporation (the J.H.C.),
2. the J.H.C. would hire and retain enough numbers of seafarers to dispatch crew to the vessels which were owned by member companies,
3. when a seafarer was dispatched to some vessel, his wage and allowances were paid by shipowner of the vessel. Costs of the paid vacation was also covered by the shipowner,
4. when a seafarer came in the status of waiting next duty after his vacation, allowances were paid by the J.H.C.,
5. costs and expenses of the J.H.C. were contributed by member companies, and
6. wages and working conditions of seafarers were bargained and determined by the trade agreement between the J.H.C. and the A.J.S.U.

In explaining the J.H.C. plan, the union made clear its intention that as a realistic approach the J.H.C. should be incorporated by the joint cooperation of shipping companies of small-and medium-sized which found many demerits in the current system of permanent employment. It was desirable, the union contended, that at the final stage the J.H.C. would enlarge its activities to dispatch seafarers exclusively to all shipping companies.

Opposed to the proposal of the union, the Jurokushakai, the employers' organization which represented sixteen big shipping companies, made public a pamphlet. It was full of the contention of large shipping companies that the present system of permanent employment was an indispensable element for attaining the goal of personnel management[5]. As is shown henceforth, in their contention shipowners laid stress on the loyalty of seafarers to employers and also their high morale. According to the opinion of shipowners efficiencies on board ship depend upon competencies, motivation for work and also team work of the crew. In some trades and vessels seafarers are required to have the specialized qualifications to fulfil their duties. In case of permanent employment system management can select and employ qualified personnels for a long period. Management can offer adequate training courses for employees if necessary, without fear of diseconomy due to resignation. Through promotion and the increase of wage which are based on the seniority within company, management can expect employees' high morale and loyalty to the company, which lead to friendly cooperation between crew, the improvement of efficiencies and also

5) Jurokushakai, *Kyodo Koyo no Mondai-ten*, undated.

prevention of disasters at sea. In contrast, under the joint hiring system management cannot hire desirable personnels, and it seems impossible to expect good team work on board ship.

Shipowners asserted also in the pamphlet that the comparison of labour costs did not justify the introduction of the joint hiring system as the union contended. According to shipowners' opinion it is true that under the permanent employment system additional labour costs become necessary in order to retain the reserved personnel when compared with the hiring system of seafarers on voyage basis. However, when a company has more than eight vessels, the reserve ratio for every job is stable[6]. Therefore, in case of such a company, management cannot expect to lower labour cost when the joint hiring system is introduced. On the other hand, even in case of small shipping companies, they can reduce the costs of reserved personnel under the permanent employment system through cooperation between companies of dispatching and rehiring of reserved personnels.

3. Depression and the practice of permanent employment

Since the oil shock of 1973 Japanese shipping companies have suffered from severer competition as shipping market went bad to worse. During these years, especially after 1975 most Japanese shipping companies except a few big ones have not been able to make profit. There have reported a series of failures of small Japanese shipowners who had engaged in lumber and tramp trades in the Far East.

In the survey of the Japanese shipping industry of 1976, the ministry of transport pointed out that competitive power of the Japanese merchant fleet had been decreasing due to the rapid increase of its labour costs[7]. To recoup its competitive power, the survey continued, co-operative actions by labour and management were necessary to reexamine the current practice of permanent employment and to take such adequate measures for the decrease of labour costs as had been adopted by merchant fleets of other developed countries. For example, improvement of the system of employment and remedy of hiring practice which included hiring seafarers of developing countries as a part of crew members were worth to consideration.

Then, as the survey decribed, has the practice of permanent employment resulted in the increase of labour costs of the Japanese shipping? What kind of device have been adopted by the management for the purpose of decreasing labour costs? Dose

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6) This assertion is based on the manning scale and also on the vacation clause in the trade agreement which was effective in 1958. In recent years the number of crew has been decreased due to rationalization and automation on board ship and the paid holidays has been improved considerably. Consequently the reserve ratio against crew has increased considerably as we will decribe later.

7) Ministry of Transport, *Nihon Kai-un no Genjo*, July 1976. p. 56.

the management need remedy or abandonment of the present practice of permanent employment? Hereafter we will consider those questions. However, before considering them it is necessary to sketch briefly the trend of labour costs of the Japanese shipping.

Labour costs

In recent years labour costs of the Japanese deep sea shipping have inceased considerably due to the following two reasons: (1) increase of wage and allowances, and (2) rapid increase of the ratio of reserve seafarers against crew (the reserve ratio).

Monthly earnings of seafarers who worked on board ship of the deep sea trade increased 250 per cent during the period from 1970 to 1975[8]. Improvements of basic wage and overtime payment led to the increase of monthly earnings. According to trade agreement shipowners have to contribute to retirement annuity and retiring allowance, and the sum of those contributions is proportionate to basic wage. In addition, the union succeeded to improve vacation clauses in the negotiations of 1974 and 75, and got longer holidays and better allowances. Therefore, overall increase of wage costs seemed larger than that of monthly earnings[9].

On the increase of the reserve ratio some explanatory comment is needed. The reason why retaining reserve seafarers within a company comes from the necessity of providing crew with vacation. Accordingly, as period of vacation becomes longer, the reserve ratio increases proportionately. By the deep sea agreement of 1974 and 1975 a considerable improvement was attained on the length of the compensated leave on land, which was afforded in compensation of weekend (Saturday and Sunday) and national holidays that had been spent on board ship, notwithstanding either at sea or in port. According to the agreement of 1975, when a seafarer had been in continuous service of six months, he was entitled to take paid vacation and the compensated leave amounting together to longer than two and a half months[10]. Thus, in order to provide crew with vacations as was determined by the vacation

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8) Figure is based on *the Sen-in Rodo Tokei* (*the Statisties of Seafaring Labour*) by the ministry of Transport.

9) The writer attempted in other occasion the international comparison of labour costs between Japanese ships and those of several O.E.C.D. countries and also flag of convenience at the date of 1975. According to that estimate labour costs of deep-sea Japanese cargo ships of 10,000 d.w.t. were, generally speaking, on higher level of most European countries, while in case of large container ship difference of costs were negligible. Labour costs of cargo ships flying flag of convenience which were manned by Asian crew were nearly a third of those of Japanese ships.

See. H. Yamamoto, International Comparison of Labour Costs; the Deep-sea Shipping (Japanese) in Kaiji Sangyo Kenkyusho, *Sen-in Chingin ni kansuru Chosa-Kenkyu*, 1977.

10) When in paid vacation, a seafarer was paid basic wage, family-, tanker-, meal-allowances and several other allowances. When in the compensated leave, he was paid almost the same amount of wage and allowances except meal allowance.

clauses of the agreement, shipowners had to retain reserve seafarers as many as nearly a half of crew members[11]. In 1950 vacation was twenty five days after one year's continuous service. When compared to it, the recent improvement on vacation has been quite large. Together with increase of wage costs and the improvement of vacation, costs of retaing reserve seafarers have also increased considerably.

Here we should pay attention to the fact that increase of the costs of retaining reserve seafarers does not always come from the practice of permanent employment. For example, even when a shipowner hires crew on voyage basis, he has to pay vacation benefits to them. Therefore, so far as increase of the costs of retaing reserve seafarers is due to the improvement of vacation, that increase has no relation to the hiring practice. Description of the survey that mentioned before might be misleading.

However, it is also true that in the practice of permanent employment management has to bear some cost burden peculiar to that practice. If a seafarer comes in a status of waiting for next service after his vacation, management has to pay him an adequate sum of wage and allowances until he goes on board ship. It is an additional costs peculiar to the permanent empolyment, which is unnecessary in case of hiring on voyage basis. Further, there is another reason that the practice of permanent employment might lead to increase of labour cost in depression years. It is the difficulties for management to adjust employment to decreasing demand.

Permanent employment and redundancy —difficulties of adjusting employment—

In the practice of permanent employment in Japan, both labour and management have, as is widely admitted, attached importance to the stability of employment. During depression period this attitude of labour and management often leads to refrain from discharge of workers if possible. Sometimes it causes an inadequate adjustment of employment to the decreasing demand.

However, in recent years cut down of employees has been carried out by many companies in the depressed shoreside industries including textile and shipbuilding. For that purpose various device has been adopted; encouragement of spontaneous retirement through better retirement allowance, replacement of workers to other jobs within company and lay off. Discharge by nomination was the last resort for management, because it had often led to serious labour disputes.

In the deep sea shipping industry, which has been also one of the depressed

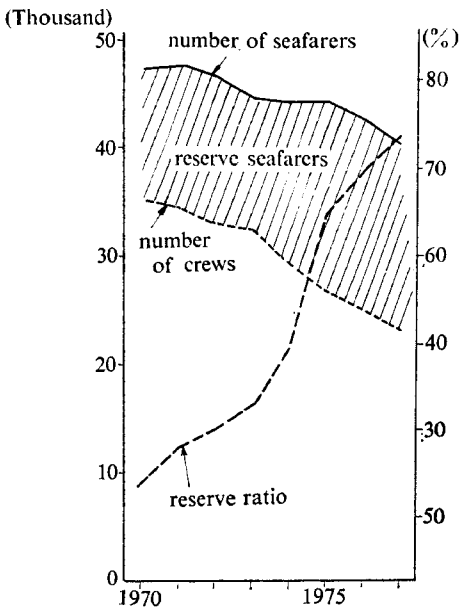
11) Also in order to replace the sick or injured personnel and to provide seafarers training courses on land, shipowners had to retain reserve seafarers. Consequently, under the conditions determined by the agreement of 1975 the optimal reserve ratio was estimated as about fifty per cent.

industries since 1975, cut down of seafarers has not been carried out. Because in the fall of 1972 the seamen's union succeeded in concluding the agreement of employment security, and in consequence management has had retain idle seafaring labour force within company. Rapid increase of the reserve ratio during recent few years has been the combined results of both the improvement of vacation clauses and poor adjustment of idle working force. Hereafter we will trace the process of negotiation on employment security since 1972 in the deep sea shipping industry.

After the historical strike of 1972 which had lasted for three months, shipowners began to sell ships of conventional type to foreign shipowners, because those ships were, according to shipowners' opinion, no more able to operate profitably under new trade agreement. For fear that overseas sales of many Japanese ships would be detrimental to seafarers' employment, the A.J.S.U. demanded the deep-sea shipping employers' organizations to stop overseas sales of ships and not to decrease available jobs. After several negotiations, in October 1972 the employers' organizations and the union concluded following agreement on stability of employment; the joint committee on employment would be set up in order to consider practical measures for stability of employment; and when a shipowner had to sell his ship abroad, he would not discharge his crew and endeavour to provide another job opportunities by new shipbuilding, etc. In June 1974 on the joint committee on employment the representatives of the deep-sea shipping employers' organizations admitted the union's demand that securing job opportunities for seafarers who were currently employed by member company was the collective responsibility of the whole group.

As shipping market declining, shipowners continued overseas sales of aged and uneconomical ships. However, it became impossible for shipowners to discharge or lay off their crews because of the agreement on stability of employment. They had to retain redundant seafaring labour within companies, resulting high reserve ratio against crew. Only measure that management could adopt for balancing the supply of labour to decreasing demand was to stop new

Trend of employment; Seafarers employed by deep-sea shipping companies



Source; Ministry of Transportation, *Sen-in Jukyu Sogo Chosa Hokoku*, 1978

hiring of seafarers. At the same time management had to provide some posts for redundant seafarers lest they should be idle. In many cases a replacement of ships by new construction was not possible during depression. Then, some reserve seafarers were dispatched to port relief work, some to desk work in container terminal and office. Some others were ordered to attend on the training course of automated apparatus. In some cases, however not often, seafarers were dispatched as a crew to ships flying a flag of convenience, which were under economic control of the company. When those device were not enough to provide work for whole redundant seafarers, management had to order the rest of them to wait for next duty at home, with pay of basic wage and several allowances.

Retaining redundant seafarers was one of the important factors which caused the increase of labour costs per ship of company fleet than before. It was an additional disadvantage in labour costs comparison that the deep-sea Japanese shipping had been incurred. Though the big six companies and their affiliated companies could secure employment of their seafarers, independent small shipowners who had little financial ability suffered from increased labour costs. In those situations, there occurred the close down of small shipping companies which had mainly engaged in near-sea trades. Seafarers who had been employed by those companies lost their jobs[12]. In severe slump, it was quite difficult for the seamen's union to make other shipping companies rehire the unemployed, though the collective responsibility for securing job opportunities had been declared in 1974.

Different responses—big companies and small ones

When we consider the response of the deep-sea Japanese shipowners to the increase of labour costs, due attention should be paid to the fact that a large difference is found in the fleet policy and also employment policy between big companies and small and medium sized ones. In the category of big companies we include twenty-two companies which organize the Employers Association of the Deep-Sea Shipping. The big six nuclear companies such as the N.Y.K., the Mitsui-O.S.K. are included among them. Though there are differences in the size of fleet and areas of shipping activities among them, those companies have common features on fleet policy and also employment policy. In the category of small and medium sized companies there are fifty companies which organize the Association of Small and Medium sized Shipowners. The E.A.D.S. and the A.S.M.S. have kept joint bargaining with seamen's union and concluded the unified labour agreement. But in the bargaining

12) According to the estimate of the A.J.S.U., the unemployed seafarers who had worked in the deep-sea shipping amounted to nearly four thousand at the end of 1978. A.J.S.U., *The Kai-in*, April 1979, p. 8.

of 1978 members of the latter claimed separate or individual bargaining by reason of their economic difficulties, though they did not succeed to attain their aim fully. As the fact that mentioned above shows, a gap of interests in bargaining and employment policy has become clear among companies.

Most of big companies cover all or many fields of shipping activities; container- and conventional-liner, tramp, tanker and bulk carriers. Main part of their tanker and bulk carrier fleet were operated under long term charter. Therefore in recent depression years those companies have been able to get comparatively stable earnings through liner service and long term charter of tankers and bulk carriers. In addition, since about 1970 those companies have developed and enlarged the economic control over flag of convenience ships through the establishment of foreign subsidiaries and other means[18]. Along with the development of indirect ownership of flag of convenience ships by big companies, the composition of their company fleets have been also changing. Those companies sold out conventional cargo ships and small bulkers. They tend to have larger and automated vessels of capital intensive type such as large container ships and tankers of 150,000 d.w.t. and over, while they have chartered those vessels of labour intensive type with long term charter from foreign subsidiaries. They have also chartered various types of vessels from foreign shipowners according to market conditions. In consequence, of total tonnage which the big six companies operated in 1975 more than fifty per cent was those chartered from foreign subsidiaries and other foreign shipowners. Further, generaly speaking, those big companies have financial abilities to carry out the replacement and modernization program of company fleet. It may be supposed that the composition of those company fleets will change further to more capital intensive type.

Situations of small and medium sized shipping companies are quite contrary to the above. Most of those companies, having no liner service, specialize to tramp, bulk or tanker shipping. Though a part of their vessels are operated under long term charter, the rest are operated in free market where they have suffered from competition with flag of convenience and developing countries. Consequently they have incurred severe damages in slump of tanker and tramp market. Though those companies also began to charter flag of convenience ships under long term charter basis and some of them established foreign subsidiaries, they could not necessarily get enough advantages of costs because their financial conditions enabled full utilization of flag of convenience. Thus, for small and medium sized shipowners, what they have to do is not how well to make up the long term management policy but how to survive in slump.

As we have described above, there are cut-clear differences of earnings and

13) H. Yamamoto, Bengi-Chiseki-sen to Sen-in Mondai, *Keizai Keiei Kenkyu Nenpo*, No. 25 (I), 1974, pp. 150–64.

fleet policy between big companies and small and medium sized companies. These differences lead to the difference of company policy toward the practice of permanent employment between them.

In case of big companies there is no symptom of changing the current practice of permanent employment. They need to proceed further the modernization program of company fleet which is now under way. Modernization program intends to put automated vessels which are operated by crew of twelve or thirteen members to practical use in near future. For that purpose it is necessary for those companies to retain well qualified and skilful seafarers within company and give them pertinent training on automated apparatus. That seems the main reason why those companies continued the current practice of permanent employment.

Here we should also pay attention to the problem of adjusting employment. Big companies have kept the agreement on stability of employment without any counterproposal notwithstanding the fact that retaining excessive sefaring labour within company put some cost burden to them. At a glance it looks quite curious. However, we should be reminded that for the development of modernization program of company fleet the co-operation of the union is indispensable. Necessary steps of modernization program such as amendment of seamen's act, remedies of license system and reorganization of jobs on board ships can not be realized if the union is against them. Most important things that big companies have to do is to maintain co-operative relations with the union. Consequently they do not want to adjust employment with the cost of delay of the modernization program through the deteriozation of labour-management relations.

Economic situations have not allow small and medium sized shipowners to follow the same policy as big companies choosed. Most of them are obliged to cost down labour costs by any means. One of their attempt was the proposal of the joint hiring organization. In October 1977 twenty-two independent small shipowners, who were members of the A.S.M.S., proposed the establishment of the joint hiring organization to the seamen's union. Outline of the proposal was as follows;

1. the group of independent owners would establish the joint hiring organization for the purpose of dispatching crew to ships owned by member companies,
2. company would discharge whole seafarers who were employed at the date of establishment of the organization, and register all of them to the organization,
3. company would hire ex-employees from the organization on voyage basis, and
4. when waiting for next duty, a seafarer would be paid unemployment allowance from the Seafarers' Insurance Fund[14].

14) *The Kaiun*, No. 603, Dec. 1977.

That proposal showed clearly that independent small shipowners were going to adopt pay-off system, abandoning the practice of permanent employment. At the same time an abolition of compensated holidays and decrease of the manning scale were also demanded by them. In face to that drastic proposal, the union contended that measures for securing stability of employment should be dealed on the joint comittee of employment, and after negotiations shipowners withdrew their proposal, though the union agreed to deal with an individual shipowner on employment problem in an emergent crisis of management.

It seems that small shipowners will propose again to change the present system of permanent employment into pay-off system so long as slump of shipping market continues. However, there is little possibility that the union will agree with the introduction of pay-off system, because employment and income of seafarers will become unstable under that system. As a counter-proposal the joint hiring system will be reconsidered by the union. It is quite difficult to predict what kind of system of employment will be introduced by the future negotiations between small shipowners and the union. However, it is clear that small shipowners will not be able to continue the practice of permanent employment so long as they have to retain excessive seafaring workers within companies. Medium-sized shipowners are, if not all, also in similar situations.

In those economic circumstances the agreement on stability of employment will not be effective to secure employment for small shipowners. If the union sticks to the agreement, it will result further decrease of job opportunities through bankruptcy of them. Therefore, it seems that small shipowners and the unions are going to negotiate the measures for adjustment of employment together with the problems relating to the hiring system.

Among methods of adjusting employment, to stimulate spontaneous retirement through the improved retirement allowance is seemed most desirable to both parties concerned. But spontaneous retirement is not supposed to be able to decrease employment to an adequate level. Then, other methods are to be considered. Discharge by nomination is far from agreeable to the union. For labour and management lay off is seemed to be the method worth to negotiate. However, lay off is rather a new and unfamiliar method in Japan, in contrast to the United States where it has become the well established practice. Therefore, if management and labour agree to adjust employment by means of lay off, it becomes necessary to determine the procedure of lay off in details; when, who and how many of them to be laid off, and guarantee of re-hire. Early retirement with pension right may be also to be examined by each party.

Employment problem that small and medium sized shipowners have to deal comes from market conditions, but also from the structural factor that they lack the

ability to carry out the modernization program of company fleet. Therefore, when they reach to agreement with the union on the adjustment of employment and remedies of hiring practice, those agreements destine to be short lived. In the world market competition declining sector of the deep-sea Japanese shipping industry will bring new employment problem still further.

JAPANESE MULTINATIONAL ENTERPRISES: A VIEW FROM OUTSIDE

Hideki YOSHIHARA

1. Defining Multinational Enterprises

The aim of the paper is to identify Japanese multinational enterprises (industrial firms) and to take a general view of these enterprises. It is also expected to make clear features of Japanese multinationals by comparing with U.S. counterparts. In the paper the attention is focused upon the external appearances of the enterprises. The internal mechanisms and their workings are mostly left untouched.

To identify multinational enterprises, we need to define what these enterprises are. No unanimous definitions exist at the present time[1]. In the paper the definition of the Harvard Multinational Enterprise Project is adopted for the following reasons. First, the Harvard definition is in line with the common understanding in the field. Second, it is convenient for the comparative analysis between Japanese and U.S. multinational enterprises.

In the Harvard Project the multinational enterprises are defined as the firms having the following attributes[2]:

1. They are large firms. Specifically, they are included in the list of *Fortune's* 500 largest U.S. industrial firms.
2. They are engaged in manufacturing and/or extractive activities abroad.
3. Their foreign subsidiaries are widely scattered all over the world. Specifically, they have foreign production subsidiaries in six or more countries.
4. A parent company and its foreign subsidiaries make up a multinational enterprise system, which has access to a common pool of resources and is reponsive to a common strategy.

Let us adapt this definition to the Japanese setting. In the paper the Japanese multinational enterprises are defined as follows:

1. They are included in the *President's* list of 500 largest industrial firms (September 1975 issue).
2. They have production subsidiaries in five or more foreign countries.
3. They themselves are not subsidiaries of other companies.

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1) Yair Aharoni, "On the Definition of a Multinational Corporation," in A. Kapoor and Phillip D. Grub, eds., *The Multinational Enterprise in Transition*, Darwin Press, 1972, pp. 3–20.

2) Raymond Vernon, *Sovereignty at Bay: The Multinational Spread of U.S. Enterprises*, Basic Books, 1971, pp. 4–11.

Overseas production subsidiaries are identified in terms of the following three attributes. First, they are engaged in manufacturing and/or extractive activities abroad. Second, management commitment of parent companies is substantial. Operationally, this means that at least one of the following three conditions is met; (1) parent company's ownership is 25 percent or more, (2) parent company's ownership is 15 percent or more, and largest among Japanese investors whose total ownership is 25 percent or more, and (3) full-time topmost management is sent from parent companies. Third, the date of investment of parent companies is prior to January 1, 1974, and in operation at the time of the research (the first half of 1976).

The data were obtained from two sources; (1) the published data book *Kaigai-shinshutsu-Kigyo-Soran* (Japanese Multinationals Facts and Figures), 1975 edition[3] and (2) mail questionnaires sent to prospective multinational enterprises.

Thirty-seven companies represented in Table 1 are the Japanese multinational enterprises (industrial). For each of these Japanese multinational enterprises, the table shows; (1) size ranking in terms of sales, as of 1974, (2) name of the company, (3) numbers of foreign production subsidiaries and numbers of foreign countries where they exist, (4) respective figures of foreign sales subsidiaries, and (5) average export ratio (export-to-sales ratio) for the recent past three years.

2. Export-oriented Enterprises

Enterprises engaging in international operations are divided into two major groups; (1) multinational enterprises and (2) export-oriented enterprises. The hallmark of the multinational corporations is their commitment to overseas production. In the case of export-oriented enterprises, although their foreign operations are heavily concentrated on exporting, their overseas production is however non-existent or at most very limited.

This export-oriented enterprise deserves our attention for the following reasons. First, there are many such companies in Japan and have played important roles in the internationalization process of Japanese economy. Second, many of these companies are anticipated to become multinational enterprises in the future. Third, comparative analysis of these two types of international companies may hopefully highlight characteristics of multinational enterprises.

Export-oriented enterprises are defined in terms of the following attributes;

1. size: to be in the *President's* list of 500 largest industrial enterprises
2. export: to meet at least one of the two conditions; (1) export ratio is continuously 20 percent or more for the recent past three years, and (2) to have

3) The publisher is Toyokeizai-shinposha.

Table 1 Multinational Enterprises

Serial number	Size (sales) ranking	Company name	Overseas production subsidiary		Overseas sales subsidiary		Export ratio (%)
			Country	Number	Country	Number	
1	25	Asahi Chemical Industry	6	7	0	0	15.96
2	51	Ajinomoto	8	9	4	5	7.16
3	97	Kao Soap	5	6	1	1	1.70
4	30	Kanebo	8	12	1	1	15.98
5	10	Kawasaki Steel	6	6	0	0	27.63
6	182	Kyokuyo	6	7	1	1	5.76
7	31	Kubota	5	5	1	3	4.08
8	33	Sanyo Electric	14	16	5	5	30.00
9	237	Shikishima Spinning	5	7	0	0	21.65
10	35	Showa Denko	5	6	1	1	7.86
11	1	Nippon Steel	5	6	0	0	27.73
12	80	Sekisui Chemical	5	6	3	3	4.40
13	74	Dainippon Ink and Chemicals	6	6	2	2	4.93
14	54	Dai Nippon Printing	5	5	2	2	1.86
15	28	Taiyo Fishery	10	11	5	6	12.36
16	50	Takeda Chemical Industries	6	6	5	5	4.86
17	161	Omron Tateisi Electronics	5	5	2	2	31.41
18	37	Teijin	11	16	2	2	31.41
19	3	Toyota Motor	6	6	3	3	27.96
20	11	Tokyo Shibaura Electric	9	11	6	8	13.63
21	428	Toko	8	9	2	2	19.53
22	41	Toyobo	7	10	2	2	23.48
23	34	Toray Industries	11	10	2	2	23.48
24	66	Toppan Printing	5	5	0	0	——
25	99	Nichiro Gyogyo Kaisha	8	9	2	2	11.06
26	4	Nissan Motor	7	7	3	3	32.30
27	79	Nippon Suisan Kaisha	5	6	0	0	7.61
28	32	Nippon Electric	6	6	4	5	20.43
29	241	Nippon Paint	5	5	1	1	1.46
30	7	Hitachi	9	12	4	4	14.28
31	46	Bridgeston Tire	5	5	5	5	18.41
32	6	Matsushita Electric Industrial	21	26	4	5	20.48
33	65	Mitsui Mining and Smelting	5	7	0	0	5.45
34	8	Mitsubishi Heavy Industrial	5	6	1	1	26.53
35	87	Mitsubishi Rayon	6	9	1	1	19.58
36	56	Unitika	8	10	0	0	17.56
37	390	Riken Piston Ring Industrial	5	5	1	1	7.18

Note Source: Author's Multinational Enterprise Data Base

Table 2 Export-oriented Enterprises

Serial Number	Size (sales) ranking	Company name	Overseas production subsidiary		Overseas sales subsidiary		Export ratio (%)
			Country	Number	Country	Number	
1	430	Akai Electric	1	1	1	1	90.66
2	414	Asahi Optical	1	1	1	1	46.53
3	15	Ishikawajima-Harima Heavy Industries	3	4	1	1	37.91
4	123	NTN Toyo Bearing	4	4	5	5	24.80
5	342	Olympus Optical	1	1	2	2	42.30
6	298	Casio Computer	0	0	2	2	44.23
7	21	Kawasaki Heavy Industries	1	1	2	2	35.68
8	196	Canon	3	4	5	5	57.76
9	75	Kuraray	2	2	2	2	25.35
10	458	Kokoku Steel Wire	1	1	0	0	51.16
11	121	Koyo Seiko	3	3	10	12	28.11
12	39	Komatsu	2	3	5	5	22.38
13	330	Sakai Textile Mfg.	0	0	0	0	23.88
14	172	Sasebo Heavy Industries	0	0	0	0	56.78
15	321	Sankyo Seiki Mfg.	0	0	3	3	28.95
16	443	Sansui Electric	0	0	2	2	79.96
17	268	Citizen Watch	3	3	0	0	43.98
18	70	Sharp	3	3	3	3	42.20
19	73	Suzuki Motor	1	1	2	2	29.96
20	9	Sumitomo Metal Industries	3	3	1	2	32.73
21	242	The General (electric)	0	0	0	0	29.73
22	40	Sony	3	3	9	10	48.21
23	346	Daido Steel Sheet Mfg.	0	0	0	0	28.83
24	470	Teac	0	0	2	3	61.53
25	386	Toyo Kanetsu	0	0	0	0	37.60
26	392	Trio Electronics	0	0	3	3	49.68
27	20	Toyo Kogyo	1	1	5	7	39.41
28	151	Toyo Kohan	0	0	0	0	31.11
29	71	Nippon Gakki	4	5	5	5	16.11
30	209	Nippon Metal Industry	0	0	0	0	31.65
31	252	Nippon Kogaku	0	0	4	4	43.63
32	5	Nippon Kokan	2	2	0	0	27.95
33	248	Nippon Stainless Steel	0	0	0	0	27.71
34	353	Noritake	2	4	6	6	31.03
35	474	NGK Spark Plug	2	2	1	1	27.43
36	168	Nippon Yakin Kogyo	0	0	1	1	28.78
37	138	Pioneer Electronic	1	1	3	4	44.76
38	286	The Hakodate Dock	0	0	0	0	70.73
39	42	Hitachi Shipbuilding & Engineering	1	1	0	0	38.48
40	173	Brother Industries	1	1	2	2	31.01
41	19	Honda Motor	4	4	8	10	50.43
42	493	Mitsumi Electric	4	6	2	2	25.70
43	283	Minolta Camera	1	1	3	3	65.15
44	48	Mitsui Shipbuilding	0	0	0	0	40.88

(Table 2 continued)

Serial Number	Size (sales) ranking	Company name	Overseas Production subsidiary		Overseas sales subsidiary		Export ratio (%)
			Country	Number	Country	Number	
45	16	Mitsubishi Electric	4	5	9	10	9.30
46	86	Yamaha Motor	2	2	3	3	68.40
47	163	Yodogawa Steel	2	2	0	0	30.30
48	112	Ricoh	3	3	3	3	24.51

Note Source: Author's Multinational Enterprise Data Base

sales subsidiaries in five or more foreign countries

3. not to be subsidiaries of other companies
4. not to be multinational enterprises

Data collection and analysis of the same kind were employed to identify the export-oriented enterprises. The result is represented in Tabel 2. Forty-eight companies shown in the table are the Japanese export-oriented enterprises.

3. Profiles of Parent Companies

3.1 Size

Table 3 shows that 31 companies (84 percent) out of 37 multinational enterprises are among the 100 largest firms. There are only 6 companies which are in the smaller group. Size of the export-oriented enterprises is not so heavily concentrated on the largest company group and more evenly distributed in the smaller group. The largeness of multinational enterprises is again evident in the figures in Table 4. In terms of sales, the multinational enterprises are 2.5 times as large as the export-oriented enterprises, and 5.5 times as large as the domestic firms.

In the United States an average size (in terms of sales) of 187 multinational enterprises is 3.3 times as large as 304 non-multinational large firms[4]. Thus, with

Table 3 Size Distribution of Multinational and Export-oriented Enterprises

Size (sales) ranking	Multinational Enterprises	Export-oriented Enterprises	Total
1~100	31	16	47
101~200	2	10	12
201~300	2	8	10
301~400	1	7	8
401~500	1	7	8
Total	37	48	85

Note Source: Author's Multinational Enterprise Data Base

4) Vernon, *Sovereignty at Bay* (op, cit.), Table 1-1, pp. 8-9.

Table 4 Size of Multinational Enterprises

	Annual sales, 1974 (million yen)	Total assets, 1974 (million yen)	Employees, 1974
Multinational enterprises (37)	459,453	445,997	22,399
Export-oriented enterprises (48)	185,587	220,686	10,243
Domestic enterprises (415)	83,697	72,675	3,504
Large enterprises (500)	121,284	114,510	5,549

Note Source: *President*, September 1975, extra issue

respect to the corporate size, both U.S. and Japanese multinational enterprises share the same feature.

3.2 Profitability and Growth

With respect to profit performance, no significant differences exist among the multinational enterprises, the export-oriented enterprises and the 500 largest industrial firms. As it is shown in Table 5, after-tax profit as percent of sales in 1974, is 1.8 percent for the multinational enterprises, 2.0 percent for the export-oriented enterprises and 1.7 percent for the 500 largest industrial corporations. After-tax profit as percent of total assets in 1974, is 1.8 percent, 1.7 percent and 1.9 percent respectively. A yearly growth rate of sales over the period from 1969 to 1974 is shown in Table 6. The growth rate shows 15.8 percent for the multinational enterprises, 17.3 percent for the export-oriented enterprises, and 20.6 percent for the 500 fastest grown listed companies. Eighteen enterprises out of the 37 multinationals are in the 500 fastest grown listed companies. Thus, the growth rate of the 37 multinational enterprises is rather mediocre.

Table 5 Profitability of Multinational Enterprises

	After-tax profit as percent of sales, 1974	After-tax profit as percent of total assets, 1974
Multinational enterprises (37)	1.8	1.8
Export-oriented enterprises (48)	2.0	1.7
Large enterprises (500)	1.7	1.9

Note Source: *President*, September 1975, extra issue

Table 6 Growth Rate of Multinational Enterprises

	Yearly growth rate (1969~1974)
Multinational enterprises (37)	15.8%
Export-oriented enterprises (48)	17.3%
Fastest grown listed enterprises (500)	20.6%

Notes 1. Source: *President*, October 1975

2. Sales growth rate (r) is calculated in the following way;

$$r = \sqrt[5]{\frac{B}{A}} - 1$$

A: Annual sales (1969)

B: Annual sales (1974)

3.3 Industry Characteristics

Let us next take a look at the industry characteristics of the 37 multinational enterprises. Table 7 shows the numbers of the multinational enterprises classified by the industry. There are eight multinational enterprises in textile industry and seven in electric machinery. These two industries are followed by chemicals (six companies) and foodstuff (five companies).

The pattern of industrial distribution is rather different in the case of the export-oriented companies. Electric machinery, transportation equipment, iron and steel, and precision machinery are leading industries. Textile industry has only two export-oriented companies.

The trend that textiles and electric machinery are leading industries in the multinationalization process is again evident in Table 8. In textile industry eight companies out of 32 large companies are multinational enterprises. The ratio of multinational enterprises to large corporations is 0.25. In electric machinery the ratio is 0.11 which is higher than the average ratio of 0.07 .

In the United States the multinational enterprises are most prominent in such industries; motor vehicles, fabricated metals, petroleum, drugs, and other chemicals. Textile industry has only four multinational enterprises and they occupy only 5.9 percent share in terms of sales[5]. So, the pattern of industrial distribution is rather different between the U.S. and the Japanese multinational enterprises.

Table 7 Industry of Multinational Enterprises

Industry	Multinational enterprises	Export-oriented enterprises	Total
Foodstuffs (including Fishery)	5	0	5
Textiles	8	2	10
Pulp and paper products	0	0	0
Chemicals	6	0	6
Petroleum and coal	0	0	0
Rubber products	1	0	1
Stone, clay and glass products	0	2	2
Iron and steel	2	9	11
Nonferrous metals	1	0	1
Fabricated metal products	0	0	0
Machinery	2	5	7
Electric machinery	7	11	18
Transportation equipment	3	10	13
Precision instruments	0	8	8
Miscellaneous products	2	1	3
Total	37	48	85

Note Source: Author's Multinational Enterprise Data Base

5) *Ibid.*, Table 1–2, pp. 14–15.

Table 8 Industry Concentration of Multinational Enterprises

Industry	(A) Multinational enterprises		(B) Export-oriented enterprises		(C) Large enterprises
	Number of companies	Concentration ratio $\left(\frac{A}{C}\right)$	Number of companies	Concentration ratio $\left(\frac{B}{C}\right)$	Number of companies
Fishery, agriculture and forestry	4	0.67	0	0.00	6
Mining	0	0.00	0	0.00	4
Foodstuffs	1	0.02	0	0.00	52
Textiles	8	0.25	2	0.06	32
Pulp and paper products	0	0.00	0	0.00	26
Chemicals	6	0.07	0	0.00	87
Petroleum and coal	0	0.00	0	0.00	10
Rubber products	1	0.09	0	0.00	11
Stone, clay, and glass products	0	0.00	2	0.08	24
Iron and steel	2	0.05	9	0.22	41
Nonferrous metals	1	0.05	0	0.00	21
Fabricated metal products	0	0.00	0	0.00	11
Machinery	2	0.05	5	0.13	40
Electric machinery	7	0.11	11	0.18	62
Transportation equipment	3	0.06	10	0.21	47
Precision instruments	0	0.00	8	0.73	11
Miscellaneous products	2	0.13	1	0.07	15
Total	37	0.07	48	0.10	500

Note Source: Author's Multinational Enterprise Data Base

3.4 Strategy Characteristics

The 187 U.S. multinational enterprises are found to have the following features regarding their strategic behavior; (1) high R & D intensity, (2) relatively heavy expenditures for advertising, and (3) high product diversity[6]. Then, how about the 37 Japanese multinational enterprises?

The data on R & D, advertising, and product diversification are available for 118 very large companies in which 30 multinational enterprises are included[7]. So, these 30 multinational enterprises are compared with the remaining 88 non-multinational companies. The result is shown in Table 9. With respect to R & D, advertising, and product diversification, no significant differences exist between these two kinds of enterprises. So, the U.S. features don't hold in this case.

6) *Ibid.*, pp. 12–13.

7) These 118 companies are the sample companies of the Corporate Resources Project Data Base. The multinational enterprises which are not included in this data base are Kao Soap, Kyokuyo, Shikishima Spinning, Omron Tateisi Electronics, Toko, Nippon Paint and Riken Piston Ring Industrial. The size ranking of Kao Soap is 97th, but the remaining six companies are all below 100th ranking.

Table 9 Strategy Characteristics of Multinational Enterprises

	Advertising expenditures as percent of sales	R & D expenditures as percent of sales	Herfindal index 1963	1968	1973
Multinational enterprises (30)	1.026	0.489	0.566	0.560	0.536
Non-multinational enterprises (88)	1.097	0.625	0.646	0.635	0.615

Notes 1. Source: Data Base of Corporate Resources Project. See footnote on page 22.
2. Advertising expenditures and R & D expenditures, both as percent of sales are averaged for the period 1969–73.
3. The Herfindal index in each year is defined as $\sum_{i=1}^{n} b_i^2$ where b_i is the share of the firm's sales in the ith industry (3-digit industries).

4. Overseas Production Subsidiaries

4.1 History

The 37 multinational enterprises have 310 overseas production subsidiaries. Table 10 shows these subsidiaries classified by the year when they were established or acquired by the parent companies. One hundred and fifty-seven subsidiaries (50.6 percent) were established or acquired in the 1970's. Indeed, three fourths of 310 subsidiaries were newly established or acquired within the ten-year period.

Corresponding U.S. data are shown in Table 11. Of 3,646 subsidiaries, 2,658 (72.9 percent) were established or acquired after 1950. Multinational spread of U.S. industrial enterprises gained momentum in the late 1950's and thus is rather a recent phenomenon.

As the overseas production subsidiaries have mostly a short history, so their parent companies have also a short history as the multinational enterprises. According

Table 10 Increase of Foreign Production Subsidiaries

Period	Number of subsidiaries (share)
1955–59	13 (4.2%)
Average yearly increase	2.6
1960–64	36 (11.6%)
Average yearly increase	7.2
1965–69	104 (33.5%)
Average yearly increase	20.8
1970–73	157 (50.6%)
Average yearly increase	39.3
Total	310 (100.0%)

Notes 1. Source: Author's Multinational Enterprise Data Base
2. When date of establishment or acquisition is unknown, date of investment approval or starting operation is substituted.

Table 11 Increase of Foreign Production Subsidiaries of U.S. Multinational Enterprises

Period	Number of subsidiaries (share)
–1901	47 (1.3%)
1902–39	668 (18.3%)
Average yearly increase	17.6
1940–50	273 (7.5%)
Average yearly increase	24.8
1951–59	903 (24.8%)
Average yearly increase	100.3
1960–67	1,755 (48.1%)
Average yearly increase	219.4
Total	3,646 (100.0%)

Note Source: R. Vernon, *Sovereignty at Bay*, Table 3–2, p. 62

Table 12 Increase of Multinational Enterpreise

Period	Number of companies (share)	
1955–59	0	(0.0%)
1960–64	1	(2.7%)
1965–69	9	(24.3%)
1970–73	27	(73.0%)
70	2	
71	3	
72	5	
73	17	
Total	37	(100.0%)

Note Source: Author's Multinational Enterprise Data Base

to the data shown in Table 12, twenty-seven (73.0 percent) companies became multinational in 1970's. In the most recent year of 1973, seventeen companies became mulatinational. Thus, in the case of Japanese industrial enterprises, it may well be said that multinationalization process has gained momentum in the 1970's.

4.2 Geographical Pattern

The home grounds of Japanese overseas production are the developing countries, especially in Asia. As it is shown in Table 13, 166 (53.5 percent) subsidiaries are located in Asia, and then 64 (20.6 percent) subsidiaries are in Latin America. Only 47 (15.2 percent) subsidiaries are found in the advanced countries.

This geographical pattern is in sharp contrast with the U.S. case. There are 1,881 (51.6 percent) subsidiaries in Canada and Europe (see Table 14). Asia and Africa have only 454 (12.5 percent) subsidiaries.

When we take a look at the geographical distribution by country basis, Indonesia ranks first having 32 production subsidiaries. In Table 15 twelve countries are

Table 13 Geographical Distribution of Overseas Production Subsidiaries

Area	Numbers of subsidiaries (share)	
Asia	166	(53.5%)
The Middle and Near East	8	(2.6%)
Africa	20	(6.5%)
Europe	12	(3.9%)
North America	23	(7.4%)
Latin America	64	(20.6%)
Oceania	17	(5.5%)
Advanced Area	47	(15.2%)
Developing Area	263	(84.8%)
Total	310	(100.0%)

Notes 1. Source: Author's Multinational Enterprise Data Base
2. The advanced area covers Europe, North America, Australia and New Zealand. The other countries are in the developing area.

Table 14 Geographical Distribution of Foreign Production Subsidiaries of U.S. Multinational Enterprises

Area	Numbers of subsidiaries (share)	
Canada	443	(12.2%)
Latin America	950	(26.1%)
Europe	1,438	(39.4%)
Southern dominions	361	(9.9%)
Asia and other Africa	454	(12.5%)
Total	3,646	(100.0%)

Note Source: R. Vernon, *Sovereignty at Bay*, Table 4–3, p. 124.

Table 15 Major Host Countries

Country	Numbers of subsidiaries (share)	
U.S.A.	16	(5.2%)
Australia	11	(3.5)
Brazil	25	(8.1)
Mexico	11	(3.5)
Republic of China	26	(8.4)
Hong Kong	10	(3.2)
Indonesia	32	(10.3)
Korea	14	(4.5)
Malaysia	21	(6.8)
Philippines	11	(3.5)
Singapore	17	(5.5)
Thailand	25	(8.1)
Sub total	219	(70.6)
Total (including other countries)	310	(100.0%)

Note Source: Author's Multinational Enterprise Data Base

Table 16 Industry of Overseas Production Subsidiaries

Industry	Numbers of subsidiaries (share)	
Fishery, agriculture and forestry	25	(8.1%)
Mining	4	(1.3)
Foodstuffs	20	(6.5)
Textiles	85	(27.4)
Pulp and paper products	0	(0.0)
Chemicals	33	(10.6)
Petroleum and coal	0	(0.0)
Rubber products	5	(1.6)
Stone, clay, and glass products	0	(0.0)
Iron and steel	9	(2.9)
Nonferrous metals	6	(1.9)
Fabricated metal products	1	(0.3)
Machinery	10	(3.2)
Electric machinery	84	(27.1)
Transportation Equipment	18	(5.8)
Precision instruments	0	(0.0)
Miscellaneous products	10	(3.2)
Total	310	(100.0%)

Note Source: Author's Multinational Enterprise Data Base

Table 17 Manufacturing Processes and Products of Subsidiaries of Textiles and Electric Machinery

Manufacturing processes and products	Number of subsidiaries	
Textiles	85	
Silk products		0
Cotton products		10
Wool products		4
Hempen products		0
Raw materials for synthetic fibers		1
Polymerization and fiber manufacturing		14
Spinning and false twisting		34
Weaving and knitting		12
Dyeing and finishing		6
Apparel products		2
Other textile products		2
Electric machinery	84	
Industrial electric machinary		2
Electric home appliances		53
Communication equipment and computers		5
Components		20
Other electric machinery		4

Notes 1. Source: Author's Multinational Enterprise Data Base
2. Subsidiaries' (textiles) manufacturing processes are classified according to their most upstream processes.
3. As for "Spinning and false twisting" through "Apparel products," products are synthetic textiles and/or sysnthetic mixed with natural textiles.

represented which have 10 or more subsidiaries. These countries have in total 219 (70.6 percent) subsidiaries. Of these twelve countries eight are in Asia, and two in Latin America. There are only two advanced countries, U.S.A. and Australia, which have 10 or more subsidiaries.

4.3 Industry Characteristics

In Table 16, 310 overseas production subsidiaries are classified by their industry. Eighty-five subsidiaries are in textile industry and 84 in electric machinery industry. These two outstanding industries are followed by chemicals (33 subsidiaries), forestry and fishery (25), foodstuff (20), and transpotation equipment (18).

Table 17 shows industry characteristics in more detail in the two industries, textile and electric machinery. In textile industry synthetic fibers occupy central role. Sixty-nine subsidiaries are in synthetic fibers industry. Of these 69 subsidiaries, 14 have polymerization and fiber manufacturing process, 34 have spinning and/or false twisting process, and 12 have process of weaving and knitting.

In electric machinery, 53 subsidiaries are in electric home appliances. They manufacture and sell a variety of goods; radio and TV sets, refregerators, air conditioners, batteries, and others. Subsidiaries manufacturing components amount to 20. Overseas assembling of major electric home appliances companies has recently pulled electric components manufactures to go abroad.

Table 18 Industry of Parent Company and Industry of Subsidiary

Industry of parent companies	All subsidiaries	Subsidiaries engaging in the same industry as parent companies	Matching rate
Fishery, agriculture and forestry	33	23	69.7%
Mining	0	0	——
Foodstuffs	9	8	88.9
Textiles	88	85	96.6
Pulp and paper products	0	0	——
Chemicals	35	31	88.6
Petroleum and coal	0	0	——
Rubber products	5	5	100.0
Stone, clay, and glass products	0	0	——
Iron and steel	11	9	81.8
Nonferrous metals	7	3	42.9
Fabricated metal products	0	0	——
Machinery	10	6	60.0
Electric machinery	84	84	100.0
Transpotation equipment	18	14	77.8
Precision instruments	0	0	——
Miscellaneous products	10	10	100.0
Total	310	278	89.7%

Note Source: Author's Multinational Enterprise Date Base

Let us next see whether or not overseas subsidiaries are engaged in the same industry as their parent companies. According to the data represented in Table 18, 278 (89.7 percent) subsidiaries are in the same industry as their parent companies. When we look into activities of individual subsidiaries and compare them with their parent companies' activities, then similarity of industry becomes even stronger than the data show. For example, four fishery parent companies have in total 33 subsidiaries, of which 10 are not in fishery industry. But these 10 subsidiaries are in foodstuff industry. Their products are processed sea food products.

5. Ownership Pattern

In this section we take a look at ownership pattern of the 37 Japanese multinational enterprises and compare it with that of the U.S. counterparts.

Table 19 shows ownership of the parent companies classified by the area of the overseas production subsidiaries. At the bottom row of the table, 310 subsidiaries are classified by the parent companies' ownership. There are 165 subsidiaries in the minority ownership (10~49 percent) category. Wholly-owned (95~100 percent) subsidiaries are only 50.

When we pay attention to the area, it is clear that the parent's ownership differs among the areas. The parent's ownership is highest in Europe, then followed by Latin America and Oceania. The lowest area is the Middle and Near East, then followed by Africa. Average ownership of the developing area is 51.9 percent and substantially lower than the advanced area (64.3 percent). But, simple dichotomy of ownership pattern is not observed. In the advanced area sixteen subsidiaries

Table 19 Ownership of Parent Companies, Classified by Area

Ownership of parent companies (%) / Area	10 ~24	25 ~49	50	51 ~94	95 ~100	Average ownership
Asia	17	78	16	37	18	50.5%
The Middle and Near East	2	6	0	0	0	32.5
Africa	3	15	0	1	1	39.0
Europe	0	2	1	5	4	80.0
North America	2	9	4	1	7	57.7
Latin America	9	17	4	18	16	61.0
Oceania	1	4	3	5	4	59.2
Advanced area	2	14	8	9	14	64.3
Developing area	32	117	20	58	36	51.9
All subsidiaries (share)	34 (11.0%)	131 (42.3)	28 (9.0)	67 (21.6)	50 (16.1)	53.7

Notes 1. Source: Author's Multinational Enterprise Data Base
2. The advanced area covers Europe, North America, Australia and New Zealand. The other countries are in the developing area.

are in the minority ownership category. On the other hand, in the developing area thirty-six subsidiaries are wholly-owned by their parent companies.

Comparative data of Japanese and U.S. multinational enterprises are shown in Table 20. In the case of U.S. multinationals, 1,733 (61.8 percent) subsidiaries are wholly-owned, and the minority-owned subsidiaries are 646 (23.0 percent). Contrasting ownership pattern is evident in the Japanese multinationals; wholly-owned subsidiaries are 50 (16.1 percent) and minority-owned ones are 193 (62.3 percent).

Regarding area differences in the ownership pattern, U.S. and Japanese multinationals again differ each other. In the case of American multinational enterprises, the same ownership pattern is observed both in the developing area and the advanced area. In the advanced area wholly-owned subsidiaries are 944 (62.9 percent), majority-owned ones are 215 (14.3 percent), and minority-owned ones are 341 (22.7 percent). Corresponding figures for the developing area is 789 (60.5 percent), 210 (16.1 percent) and 305 (23.4 percent). On the other hand, ownership pattern of Japanese multinationals is rather different between the developing area and the advanced area. For example, wholly-owned subsidiaries are 14 (29.8 percent) in the advanced area, but 36 (13.7 percent) in the developing area. Thus, relative share of wholly-owned subsidiaries in the advanced area is more than twice as large as in the developing area. The opposite pattern is observed for the minority-owned subsidiaries; 51.1 percent in the advanced area versus 64.3 percent in the developing area.

The above comparative analysis of ownership data of Japanese and U.S. multi-

Table 20 Ownership Pattern of Japanese and U.S. Multinational Enterprises

Ownership of parent companies	Subsidiaries in the advanced area	Subsidiaries in the developing area	Total subsidiaries
Wholly-owned	Japanese 14 (29.8%)	Japanese 36 (13.7%)	Japanese 50 (16.1%)
(95–100%)	U.S. 944 (62.9)	U.S. 789 (60.5)	U.S. 1,733 (61.8)
Majority-owned	Japanese 9 (19.1)	Japanese 58 (22.1)	Japanese 67 (21.6)
(51– 94%)	U.S. 215 (14.3)	U.S. 210 (16.1)	U.S. 425 (15.2)
Minority-owned	Japanese 24 (51.1)	Japanese 169 (64.3)	Japanese 193 (62.3)
(5– 50%)	U.S. 341 (22.7)	U.S. 305 (23.4)	U.S. 646 (23.0)
Total	Japanese 47 (100.0%)	Japanese 269 (100.0%)	Japanese 310 (100.0%)
	U.S. 1,500 (100.0%)	U.S. 1,304 (100.0%)	U.S. 2,804 (100.0%)

Notes

1. Source: Author's Multinational Enterprise Data Base. J. M. Stopford and L. T. Wells, Jr., *Managing the Multinational Enterprise*, Basic Books, 1972, Table 7–3, p. 142.
2. Subsidiaries in Japan, Spain, Sri Lanka, India, Mexico, Pakistan are not included in the U.S. case.
3. Minority-owned category means 10–50% for the Japanese case.
4. In the case of U.S. multinational enterprises, ownership data are as of the time of establishment or acquisition of subsidiaries. In the Japanese case, ownership data are as of 1974 or 1975.

national enterprises thus shows us Japanese ownership pattern; a majority of overseas production subsidiaries are joint ventures and this tendency toward joint ventures is more evident in the developing area than in the advanced area.

Let us next see whether ownership pattern is different or not among industries. Table 21 shows ownership of parent companies classified by the industry of subsidiaries. Average ownership in iron and steel is only 24.4 percent and lowest. Textile (41.5 percent) and foodstuff (44.5 percent) are substantially lower than the overall average of 53.7 percent. On the other hand, electric machinery (67.0 percent) is on the higher end of the scale. This industry has 30 wholly-owned subsidiaries.

Let us see ownership pattern of two leading industries, textile and electric machinery, in more detail. According to the data shown in Table 22, in textile industry relatively low ownership of parent companies is observed in almost every subsidiary regardless its manufacturing processes or products. Only in apparel products parent's ownership (62.5 percent) is higher than the overall average of 53.7 percent.

In electric machinery subsidiaries assembling electric home applicances have relatively low parent's ownership (56.5 percent). On the other hand, parent's ownership of subsidiaries manufacturing electric and electronics components is very high (88.0 percent). Thirteen subsidiaries are wholly-owned by parent comapnies.

Table 21 Ownership of Parent Companies, Classified by Industry of Subsidiaries

Ownership of parent companies (%) / Industries of subsidiaries	10 ~24	25 ~49	50	51 ~94	95 ~100	Average ownership
Fishery, agriculture and foretry	1	11	3	7	3	53.6%
Mining	0	1	1	1	1	62.8
Foodstuffs	3	10	0	7	0	44.5
Textiles	16	42	9	14	4	41.5
Pulp and paper products	0	0	0	0	0	——
Chemicals	2	14	2	9	6	60.5
Petroleum and coal	0	0	0	0	0	——
Rubber products	0	1	2	2	0	53.8
Stone, clay, and glass products	0	0	0	0	0	——
Iron and steel	6	3	0	0	0	24.4
Nonferrous metals	0	3	2	1	0	46.3
Fabricated metal products	0	0	0	1	0	90.0
Machinery	2	4	0	4	0	49.3
Electric machinery	2	31	5	16	30	67.0
Transportation equipment	1	8	3	3	3	57.3
Precision instruments	0	0	0	0	0	——
Miscellaneous products	1	3	1	2	3	62.2
Total	34	131	28	67	50	53.7%

Note Source: Author's Multinational Enterprise Data Base.

Table 22 Ownership of Parent Companies, Classified by Manufacturing Processes and Products of Subsidiaries in Textiles and Electric Machinery

Ownership of parent companies (%) / Manufacturing processes and products	10 ~24%	25 ~49%	50%	51 ~94%	95 ~100%	Average ownership
Textiles						
Cotton products	2	5		2	1	43.2%
Wool products		3		1		45.8
Raw materials for synthetic fibers			1			50.0
Polymerization and fiber manufacturing	2	5	4	3		45.8
Spinning and false twisting	6	20	2	5	1	39.7
Weaving and knitting	2	6	2	2		37.9
Dyeing and finishing	4	1			1	35.2
Apparel products		1			1	62.5
Other textile products		1		1		41.5
Electric machinery						
Industrial electric machinery					2	98.5%
Electric home appliances	2	26	5	9	11	56.5
Communication equipment and computers		2			3	77.8
Components		2		5	13	88.0
Other electric machinery		1		2	1	72.3

Notes 1. Source: Author's Multinational Enterprise Data Base.
2. As for the definition of manufacturing processes and products of textile industry, see notes of Table 17.

In Table 23 ownership is represented by company basis. In textile industry Toyobo has relatively high parent's ownership (60.2 percent) and Shikishima Spinning has low parent's ownership (25.3 percent). Toray Industries and Teijin, two leading companies in textile industry, have similar ownership pattern.

In electric machinery Toko's nine subsidiaries are all wholly-owned. The subsidiaries are located in Korea, Republic of China, Hong Kong, Singapore, Malaysia, Brazil and Malta. They manufacture various electric and electronics components. Substantial portion of their products are exported to foreign markets including Japan.

Different ownership pattern of Sanyo Electric and Matsushita Electric Industrial also attracts our attention. They are leading companies in electric home appliances industry in Japan, and forerunners in overseas assembling. Matsushita has 25 production subsidiaries abroad, and Sanyo has 16. Their ownership pattern is in sharp contrast. First, average parent's ownership of Matsushita is 70.0 percent which is much higher than Sanyo's 49.1 percent. Second, wholly-owned subsidiaries are nine in Matushita, but only two in Sanyo. Third, Japanese trading companies

Table 23 Ownership of Parent Companies, Classified by Individual Companies in Textiles and Electric Machinery

Ownership of parent companies (%)	10 ~24%	25 ~49%	50%	51 ~94%	95 ~100%	Average ownership
Textiles						
Toyobo		4	1	3	2	60.2%
Kanebo	2	7		3		39.2
Unitika	2	5		2	1	43.9
Shikishima Spinning	2	5				25.3
Teijin	1	11	3	1		42.6
Toray Industries	4	10	3	2	1	39.5
Mitsubishi Rayon	4	2		1		31.0
Asahi Chemical Industry	1		2	3		54.7
Total	16	45	9	15	4	42.1
Electric Machinery						
Hitachi		4		3	5	73.9%
Tokyo Shibaura Electric	1	7	1	1	1	46.5
Omron Tateisi Electronics		1		3	1	72.8
Nippon Electric		3			3	71.5
Matsushita Electric Industrial		6	3	7	9	70.0
Sanyo Electric	1	10	1	2	2	49.1
Toko					9	100.0
Total	2	31	5	16	30	66.2

Note Source: Author's Multinational Enterprise Data Base.

Table 24 Breakdown of Japanese Partners of Subsidiaries

	Number of subsidiaries (share)	
Subsidiaries having no Japanese partners other than parent companies	153	(49.4%)
Subsidiaries having other Japanese partners in addition to parent companies	157	(50.6)
Industrial companies	27	(8.7)
Trading companies	150	(48.4)
Others	1	(0.3)

Note Source: Author's Multinational Enterprise Data Base

are present as partners in seven subsidiaries of Sanyo, but in only one of Matsushita (see Table 23). This last point leads us to unique characteristics of Japanese ownership pattern: joint ventures with multi-Japanese-partners.

Table 24 shows that more than half of 310 subsidiaries, 157 (50.6 percent), have one or more Japanese partners in addition to their parent companies. Of these 157 subsidiaries, trading companies are partners in 150 subsidiaries, industrial enterprises are partners in 27, and a bank is partner in one subsidiary. Thus, nearly half of the total overseas production subsidiaries have trading companies as their

Table 25 Ownership of All Japanese Partners

	Advanced area Number of subsidiaries (share)	Developing area Number of subsidiaries (share)	Total Number of subsidiaries (share)
Wholly-owned (95–100%)	20 (42.6%)	54 (20.5%)	74 (23.9%)
Majority-owned (51–94%)	9 (19.1%)	82 (31.2%)	91 (29.4%)
Co-owned (50%)	10 (21.3%)	35 (13.3%)	45 (14.5%)
Minority-owned (10–49%)	8 (17.0%)	92 (35.0%)	100 (32.3%)
Total (average ownership)	47 (100%) (74.3%)	263 (100%) (63.7%)	310 (100%) (65.3%)

Note Source: Author's Multinational Enterprise Data Base

partners. Of these trading companies general trading companies (Sogoshosha) are most important. They have played an important role in the multinational spread of Japanese industrial enterprises.

It may be that Japanese partners have common interests and that they co-operatively behave to safeguard their common interests against local partners. If so, total ownership of Japanese partners may be relevant. Table 25 represents ownership pattern in terms of total ownership of Japanese partners. An overall average ownership is now 65.3 percent and 11.6 percent higher than that of parent companies (see Table 19). Minority-owned subsidiaries are now 100 (32.3 percent). Wholly-owned subsidiaries increase to 74 (23.9 percent) from 50 (16.1 percent).

Let us next compare this new ownership pattern with the U.S. pattern. (see Table 25 and Table 20). Relative share of wholly-owned subsidiaries is 23.9 percent in the Japanese multinationals and 61.8 percent in the U.S. counterparts. Thus, there still exists a fundamental difference between the Japanese and the U.S. multinationals.

6. Foreign Commitment

In this last section we take a glance at the foreign content of operations of the 37 Japanese multinational enterprises. The foreign commitment is measured in terms of the following four ratios;

(1) foreign direct investment to paid capital
(2) foreign direct investment to total assets
(3) sales of overseas production subsidiaries to sales of parent companies

(4) employees of overseas subsidiaries to employees of parent companies

Table 26 represents these ratios for each of the 37 companies. Considering very high debt ratio of average Japanese companies, the third and the fourth ratios seem more relevant than the first and the second ratios as an index of the foreign

Table 26 Foreign Content of Operations of Multinational Enterprises (%)

Serial number	Size (sales) ranking	Company name	Investment /Paid capital	Investment /Total assets	Foreign production /Sales	Foreign employees /Employees
1	25	Asahi Chemical Industry	24.12	1.85	——	16.16
2	51	Ajinomoto	80.70	5.56	9.39	65.98
3	97	Kao Soap	51.52	2.23	——	——
4	30	Kanebo	50.00	2.64	3.37	42.99
5	10	Kawasaki Steel	6.61	0.51	——	2.32
6	182	Kyokuyo	120.00	12.57	——	——
7	31	Kubota	2.60	0.35	——	6.23
8	33	Sanyo Electric	20.96	2.18	11.43	51.73
9	237	Shikishima Spinning	13.33	1.06	——	126.70
10	35	Showa Denko	21.09	2.35	——	15.23
11	1	Nippon Steel	6.35	0.60	——	3.27
12	80	Sekisui Chemical	14.29	0.62	——	——
13	74	Dainippon Ink & Chemicals	11.27	0.89	5.41	6.88
14	54	Dai Nippon Printing	24.68	2.16	5.99	21.42
15	28	Taiyo Fishery	41.33	2.96	——	23.19
16	50	Takeda Chemical Industries	7.23	0.71	——	7.63
17	161	Omron Tateisi Electrics	102.44	6.28	——	11.57
18	37	Teijin	90.79	7.62	15.03	121.43
19	3	Toyota Motor	20.00	1.49	7.77	16.96
20	11	Tokyo Shibaura Electric	7.16	0.67	1.53	10.53
21	428	Toko	170.59	13.36	41.50	——
22	41	Toyobo	63.36	6.20	9.27	45.39
23	34	Toray Industries	20.49	2.27	7.52	109.78
24	66	Toppan Printing	13.08	1.36	——	——
25	99	Nichiro Gyogyo Kaisha	13.41	0.79	——	8.97
26	4	Nissan Motor	20.59	1.06	5.56	9.85
27	79	Nippon Suisan Kaisha	46.00	3.82	——	17.17
28	32	Nippon Electric	28.86	2.46	9.33	19.16
29	241	Nippon Paint	——	——	——	——
30	7	Hitachi	7.36	0.78	2.82	8.19
31	46	Bridgestone Tire	116.55	7.53	——	11.14
32	6	Matsushita Electric Industrial	69.58	4.64	8.60	38.79
33	65	Mitsui Mining and Smelting	31.69	3.79	——	77.45
34	8	Mitsubishi Heavy Industries	15.24	0.81	1.62	4.35
35	87	Mitsubishi Rayon	42.07	3.03	——	54.65
36	56	Unitika	20.09	1.84	——	33.28
37	390	Riken Piston Ring Industrial	——	——	——	——

Notes 1. Source: *President*, May 1976, pp. 112–127. *Kaigaishinshutsu-Kigyo-Soran*, 1975 edition, pp. 2–4.

2. See the text on pp. 33–35 for the definition of the foreign content ratios.

commitment. Regarding the third ratio there is only one multinational enterprise (Toko) that exceeds the 20 percent level. As for the fourth ratio eleven companies exceed the 20 percent level. Thus, the foreign commitment of Japanese multinational enterprises is still limited. Domestic operations still occupy a dominant position in many Japanese multinational enterprises. This may be due to the fact that multinationalization of Japanese industrial enterprises is a recent phenomenon.

A COMMENT ON THE BAZARAA'S ALOGORITHM

Komayuki Itow

1. Introduction

The algorithm in Mokhtar S. Bazaraa's paper "An Efficient Cycle Coordinate Method for Optimizing Penalty Functions", Naval Research Logistics Quarterly, Vol. 22, No. 2, pp. 399~pp. 404 (June 1975) consists of two Steps. We take issue with Step 2, which has some facts that should be paid attention to concerning choice of parameters. Our purpose of this comment is to discuss the above problem with Step 2.

Consider the following non-linear programming:

$$\text{Minimize } f(x) \tag{1}$$

Subject to:

$$g_i(x) \geq 0 \quad i=1, 2, \ldots, m \tag{2}$$

$$h_i(x)=0 \quad i=1, 2, \ldots, k. \tag{3}$$

By a penalty function technique, this constrained non-linear problem can be transformed into an unconstrained problem of the form

$$\underset{x \in R_n}{\text{Minimize}} \; f(x)+\lambda I(x) \tag{4}$$

where

$$I(x)=\sum_{i=1}^{m}(\max\,(0, g_i(x)))^2+\sum_{i=1}^{k}h_i^2(x) \tag{5}$$

λ: a large positive number.

2. Bazaraa's Algorithm

Bazaraa's algorithm uses the imperfect line search as a line search, which has been developed by him. However it is not described here because it has no relation with the discussion in the following section.

The following notation and terminology is used.

$d_i=i$ th coordinate axis, d_i is a vector of zeros, except one at the i th position.

$y_{i+1}=n$-dimensional vector obtained from y_i by optimizing along d_i.

Δ=initial step size.

Δ_{min}=minimum step size used.

β=reduction rate of the step size.

λ=initial penalty parameter.

λ_{max}=maximum penalty parameter used.

γ=penalty acceleration factor.

ε=minimum displacement allowed per iteration.

t=iteration counter.

x_{t+1}=best available n-dimensional vector at the end of iteration t.

l=switching factor beyond which the parameter and/or the step size are changed.

$|x|$=denotes the sum of the absolute values of the x components.

$p(x, \lambda)=f(x)+\lambda I(x)$.

Initialization Step

Choose an arbitrary x_1 and choose the above parameters.

Let $y_1=x_1$, $i=t=1$, and go to Step 1

Step 1: Find the imperfect minimum of $p(y_i+\mu d_i, \lambda)$ with step size Δ. Let the minimum be μ^* and $y_{i+1}=y_i+\mu^* d_i$. If $i \leq n$, replace i by $(i+1)$ and repeat Step 1. Otherwise go to Step 2.

Step 2: Let $x_{t+1}=y_{n+1}$. If $|x_{t+1}-x_t| \geq \varepsilon$, let $i=1$, $y_1=x_{t+1}$, and repeat Step 1. Now suppose that $|x_{t+1}-x_t|<\varepsilon$. If $\lambda \geq \lambda_{max}$ and $\Delta<\Delta_{min}$, then stop, with optimal x_{t+1}. Otherwise check whether $\lambda\Delta$ is smaller than or greater than or equal to l. In the former case, λ is replaced by $\gamma\lambda$ and in the latter case, λ is replaced by 2λ, and Δ is replaced by $Max(\beta\Delta, \Delta_{min})$. Let $i=1$, $y_1=x_{t+1}$, and repeat Step 1.

Bazaraa recommends that the following table may be helpful as a general guide line for the selection of parameter values when the above algorithm is applied:

Table 1 Parameter Values

Parameter	Δ	Δ_{min}	β	λ	λ_{max}	γ	ε	l
Recommended.....	0.1 to	0.00001	0.1 to	0.1 to	100.0 to	5.0 to	0.0001	0.1
Range	1.0	to 0.001	0.4	1.0	1,000,000	100.0	to 0.01	to 2.0

3. Problems with the algorithm

According to Bazaraa's paper, if $\lambda\Delta<l$, then Δ is kept constant and the penalty parameter increased. On the other hand, if $\lambda\Delta \geq l$, then Δ is reduced, whereas λ is slightly increased. This device helps in executing incomplete minimization with small initial value of λ and large value of Δ, while executing more precise minimization with small value of Δ, during later stages of the optimization.

His explanation appears to be right. We have found, however, that the algorithm does not work effectively if selections of several parameters are not suitable to problems. The following description would give us a better understanding of

this point.

Let a combination of parameters be selected from Table 1. We define case A as $\lambda\Delta<l$ and case B as $\lambda\Delta\geq l$. Let case B occur after case A occurred t_0 times and let λ, Δ be λ_0, Δ_0 when case A occurred first.

At the case A Δ is kept constant and λ is replaced by $\gamma\lambda$. Therefore

$$\gamma^{t_0}\lambda_0\Delta_0\geq l \tag{6}$$

must hold, and also

$$\gamma^{t_0-1}\lambda_0\Delta_0<l \tag{7}$$

holds immediately before the occurrence of case B. The following inequality is derived from the above both inequalities;

$$\frac{\log(l/\lambda_0\Delta_0)}{\log\gamma}+1>t_0\geq\frac{\log(l/\lambda_0\Delta_0)}{\log\gamma} \tag{8}$$

where $\log\gamma>0$, for $\log\gamma>0$ holds because $\gamma\geq 5$ at Table 1. There exists an integer satisfying this inequality (8) because $\log l/\lambda_0\Delta_0>0$ for $\lambda_0\Delta_0(<l)$.

On the other hand, in the last step of case B

$$\frac{\lambda_0\Delta_0}{2\beta}\geq l \tag{9}$$

must hold with the exception of $\Delta=\Delta_{min}$. Therefore

$$\frac{1}{2\beta}\geq\frac{l}{\lambda_0\Delta_0}>1 \tag{10}$$

The inequality

$$\frac{\log(1/2\beta)}{\log\gamma}+1>\frac{\log(l/\lambda_0\Delta_0)}{\log\gamma}+1>t_0 \tag{11}$$

is derived from the inequality (8) and (10).

Likewise, let case A occur after case B occurred t_1 times. And let λ, Δ be λ_1, Δ_1 when case B occurred first.

When case B occurs, λ is replaced by 2λ and Δ is replaced by $max\ (\beta\Delta, \Delta_{min})$. Then

$$(2\beta)^{t_1}\lambda_1\Delta_1<l \tag{12}$$

must hold with the exception of $\Delta=\Delta_{min}$. As described above,

$$(2\beta)^{t_1-1}\lambda_1\Delta_1\geq l \tag{13}$$

holds immediately before the occurrence of case A.

The following inequalty is derived from both inequaties (12) and (13);

$$\frac{\log(l/\lambda_1\Delta_1)}{\log 2\beta}+1\geq t_1>\frac{\log(l/\lambda_1\Delta_1)}{\log 2\beta} \tag{14}$$

where $\log(l/\lambda_1\Delta_1)\leq 0$, for these λ_1 and Δ_1 have values in a series of case B, that is to

say, $\lambda_1 \Delta_1 \geq l$, and also $\log 2\beta < 0$ because $\beta \leq 0.4$ according to Table 1.

Thus, there exists an integer t_1 satisfying the above inequality (14). The existence of these integers t_0 and t_1 shows that the algorithm has fluctuations between case A and case B.

Also, in the last step of the case A

$$\frac{\lambda_1 \Delta_1}{\gamma} < l \tag{15}$$

must hold. Therefore

$$\frac{1}{\gamma} < \frac{l}{\lambda_1 \Delta_1} < 1 \tag{16}$$

From the above description concerning t_1

$$\frac{\log(1/\gamma)}{\log 2\beta} + 1 > \frac{\log(l/\lambda_1 \Delta_1)}{\log 2\beta} + 1 \geq t_1 \tag{17}$$

holds.

Let us consider the exceptional case $\Delta = \Delta_{min}$. Minimum step size Δ_{min} is kept constant. When Δ_{min} is used at case B, the following inequality (18) holds at the same condition as that of the inequality (9):

$$\frac{\lambda_0 \Delta_0}{2\alpha} \geq l \tag{18}$$

where α is greater than β and is determined by the definition $\Delta = \max\{\beta\Delta, \Delta_{min}\}$. After this event, case A continues, and at the time of the occurrence of case B,

$$\lambda \gamma_1 \Delta_{min} > \gamma_1 \Delta_{min} \geq l \tag{19}$$

holds. Thereafter case A never occurs. Of course when Δ_{min} is used in a series of case B, the inequality (12) holds. Therefore case A never occurs thereafter.

Now let us consider the constraint between t_0 and t_1.

Set

$$A = \frac{\log(1/2\beta)}{\log \gamma} \tag{20}$$

or

$$\frac{1}{\mathrm{A}} = \frac{\log(1/\gamma)}{\log 2\beta} \tag{21}$$

Let the inequality (20) be substituted into (11) and the inequality (21) into (17). The following inequalities (22) and (23) are gained;

$$A + 1 > t_0 \tag{22}$$

$$1/A + 1 > t_1 \tag{23}$$

This shows that either $t_0 \leq 1$ or $t_1 \leq 1$ must hold. If A is less than one, t_0 is equal to

zero or one. This fact results in the frequent occurrence of case B, which suggests that the switching factor l does not work effectively.

Suppose $A<1$,

that is, $\dfrac{\log(1/2\beta)}{\log\gamma}<1$

This inequality is rewritten as follows,

$$2\beta\gamma>1 \tag{24}$$

Speaking of β, γ which do not satisfy the inequality (24), $\beta=0.1$ and $\gamma=5$ are all we can find at Table 1. As compared with the search at case B only, his algorithm does, at least, make the intended improvement through switching factor since it can take case A. However, our above discussion shows that the previously described, by himself, efficiency cannot be realized by his algorithm.

EFFECTS OF SHIPS' SIZE AND CARGO LOTS ON THE OCEAN FREIGHT RATES

Tetsuji SHIMOJO

1. Expansion of Ships' Size

As the seaborne trade of goods, especially of the bulky materials becomes more active and steady, the tools to carry them, the ships become larger in their size. If the capacity to collect, store and handle these massive cargo is assured, and the depth and width of ships are admitted in canals or ports, the larger sized ships enjoy lesser transport costs per unit. These phenomena are seen in general as well as in the shipping.

As for ships, their building costs are a function of size while other conditions are equal[1]. According to available figures of the annual weighted average of ships prices for a few categories calssified by size, the gross prices for each year show a linear correlation with the size. In other words, denoting the gross price by P and the size by S, we can approximately express

$$P=aS+b.$$

In this case, a represents the costs for steel and b other fixed costs such as machinery.

Transport costs for cargo depend on the operating costs of ships. The operating costs of ships can be classified into three categories, ship owning expenses (indirect ship costs), fundamental management expenses (direct ship costs) and navigation and cargo expenses (voyage costs). Among these costs, the voyage costs consisting of fuel, port and cargo expenses increase for larger ships, but the wages for seamen, a major item of the direct costs, do not depend significantly on the size of ships.

As the cargo capacity increases greatly according to the size of ships, we can expect more utility in proportion to size, in form of carrying capacity of the ship in a private carrier, or in form of freight revenue in a common carrier. The relation between costs and utility will show us a rule of the economy of scale, for the larger the ships' size may be, the greater the utility per cost will become.

Marshall said, "A ship's carrying power varies as the cube of her dimensions, while the resistance offered by the water increases only a little faster than the square of her dimensions; so that a large ship requires less coal in proportion to its tonnage than a small one. It also requires less labour, especially that of navigation: while to passengers it offers greater safety and comfort, more choice of company and

1) See Appendix I.

better professional attendance. In short, the small ship has no chance of competing with the large ship between ports which large ships can easily enter, and between which the traffic is sufficient to enable them to fill up quickly[2]".

In such a situation and with increasing seaborne trade the tendency of expansion of the size of tankers and bulk carriers has become more apparent since the end of 1950's. The tendency was so speedy as shown in Table 1. There also appears a qualitative change such that different rates are quoted and fixed for different size of ships in the recent shipping exchanges.

Table 1 Trend of Average Size of World Fleet

Year	All		Tanker		Bulk Carrier		Others
1955	3095		7400				2563
		2.9		4.2			
1960	3574		9127				2563
		1.0		1.2			
1963	3686		9454				2566
		1.6		4.3			
1964	3745		9856		12780		2492
		2.3		5.2		4.6	
1965	3831		10372		13369		2463
		3.8		6.4		7.5	
1966	3978		11040		14378		2438
		3.2		5.2		9.3	
1967	4104		11615		15713		2401
		−0.03		5.6		7.4	
1968	4092		12263		16871		2267
		2.9		7.5		4.2	
1969	4210		13187		17574		2200
		3.0		7.0		5.0	
1970	4338		14114		18454		2161
		3.5		8.3		5.6	
1971	4491		15280		19492		2115
		4.1		6.5		6.9	
1972	4676		16269		20829		2083
		4.0		7.3		5.6	
1973	4864		17461		21995		2051
		4.6		9.3		3.5	
1974	5087		19085		22755		2011
		5.5		11.9		1.3	
1975	5369		21363		23053		2011
		5.2		12.1		1.2	
1976	5646		23955		23331		2041
		2.6		5.2		0.3	
1977	5794		25192		23399		2091

(Source) Calculated from Lloyd's Register of Shipping, 'Statistical Tables'.
(Unit) G/T., Rate of Increase %. For reference, annual rates of increse are 2.9% for All ships, 5.7% for Tanker, 4.8% for Bulk Carrier, and −1% for Others.

2) Marshall, Alfred, *Principles of Economics*, London, 1952, p. 241 (footnote).

Here we would like to pick some topics of change in the shipping market related to the expansion of the size of ships, and to discuss the empirical studies we have made for some of these changes.

2. World Scale System and Ships' Size

Before WW II, it was common to express freight rates per ton in dollars of shillings for transport of crude oil by tankers as for other cargo carried by tramps. As the number of loading and unloading ports for crude oil increases, it becomes, however, inconvenient to compare rates between different routes. During WW II, British government adopted a rate system to her requisitioned British ships. The rate system assured an equal daily net return for every kind of tankers on whatever route the oil companies might operate them. This was so called MOT rate system, in which a standard rate was given for every pair of loading and unloading ports.

After the war, the tanker market came back to the free market, but the MOT rate system was taken over, and since then, the expression of plus or minus so-and-so percent of the base rate became popular all over the world. In the United States where a similar rate system was in force during the war, the USMC rate system was applied to the routes not covered by the MOT rate system.

As time went on, however, these rate systems became unsuitable for the actual requirements of most routes. So that the Scale Rate (1952), the ATRS Rate (1956), the Intascale Rate (1962) and other scale systems were proposed and used instead. And at last the Worldscale Rate System, a revised Intascale Rate came to be used since September 15th, 1969, by the brokers in London and New York.

The current Worldscale Rate system adopts a diesel tanker of 19500 tons dead weight and of 14 knots, as the standard ship, which consumes 28 tons of heavy oil a day at sea and 5 tons in port, and which incurs $1800 of ship's expenses a day. The Worldscale rates are based on the estimated expenses per ton of crude oil carried on the respective routes. These rates are periodically revised due to the changes in the unit prices of fuel and the port charges.

The freight rates in the tanker contracts are expressed in percentage of the Base Rate for the respective route, and at present almost all rates reported from the markets are based on this system[3].

The reasons for such a scale system are related to the simplification of various calculation at the time of contracts. Norman arranged these effects in the following manner[4];

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3) The Base rate is sometimes called "Reference Rate" or "Standard Rate."

4) Norman, Victor D., 'An Assessment of the World Scale System', presented at the Intertanko Annual Meeting, March 18, 1977.

a) Simplification of communication: Simple expression of freight rates.
b) Simplification of contract: Simple expression of optional clauses.
c) Simplification of modification: Automatic revision of freight rate for long term contract.
d) Simplification of comparison: Comparison of correspondent rates between routes can be made easily.

Norman pursued theoretically to compare the rates by routes according to the above classification, and concluded that the Worldscale system was not very convenient for the rate comparison because the fuel prices were almost identical and the fuel costs were the dominant part for navigation costs. He proposed to replace the "standard" vessel of the unrealistic 19500 t.d.w. and 14 knots by a "composite" vessel, to divide the current base rate into two parts, a fixed part of charter hire and a variable part of operating cost, and to revise the base rates every 3 months.

For a tanker owner, the most important problem is to decide to which route he should assign his tanker, or which tanker he should offer for assignment. The comparison of rates means in a sense to ask if a certain tanker can make the same profit on different routes with same level of Scale Rates. When it can make the same profit in spite of differing routes, then the Scale Rates can be said to satisfy its objectives.

The same profit may be assured in case of a flat base rate (or W100 in customary notation) if the tanker is a standard vessel. But even if it is a standard tanker, in the case where the rate is not W100, it can be expected that the profitability varies considerably according to routes. According to Norman's calculation, as seen in Table 2, the net return per day varies more on shorter routes.

In another sense, the comparison of rates means to ask how profit may vary applying the same level of Scale Rates to different types of tankers. As we have seen, it is clear that the same rates bring greater net returns to the larger types of tankers. Norman further made a comparison of the profitability of different types of tankers on several principal routes in case of W100. As can be seen in Table 3, the greater

Table 2 Costs and Net Return by Route (Standard Ship)

Route	Operating Cost per day ($)	Net Return per day	
		W50	W150
PG/W.Europe	2548	−374	3974
PG/Japan	2496	−348	3948
PG/USAC	2496	−348	3948
Med./USAC	2627	−413	4014

(Source) Norman 'Assessment of World Scale System' p. 10.

return are taken by the larger tankers.

It is not very fruitful, however, to compare only the profitability of different types of tankers at the same level of rates. That is the very economy of the scale, and it is rather self evident that larger vessels make greater profits under such an assumption. Behind a problem which tanker an owner should assign to a certain offer of carriage, there exists another aspect of the problem.

Table 3 Net Return and TCE for Various Sized Ships ($)

	Route	PG/W. Europe	PG/ Japan	PG/ USAC	Med./ USAC	Max/Min in TCE
M/T 50000	Net Return	8137	7932	7984	7645	1.06
	TCE	4.96	4.84	4.87	4.66	
M/T 70000	Net Return	12543	12164	12318	12020	1.04
	TCE	5.47	5.30	5.37	5.24	
M/T 100000	Net Return	19387	18764	19065	18565	1.04
	TCE	5.91	5.72	5.81	5.66	
M/T 230000	Net Retrun	49385	47817			1.03
	TCE	6.55	6.34			
T/T 230000	Net Return	46833	45439			1.03
	TCE	6.21	6.03			

(Source) Norman 'Assessment of World Scale System' p. 13.
Max/Min in TCE was calculated by Shimojo.

What I am interesting in is to calculate the scale rates in such a way that the different types of tankers earn the same profit on a certain route, based on the Base Rate Tables by routes. In the most simple case, it can be said otherwise to look up a break-even Scale Rates by route and by size of tankers.

In case we apply the Worldscale System in practice, we can prepare a table of daily net return or of TCE (time charter equivalent) by route and by size, rearranged from the Base Rate Tables by route according to size of tankers. Or, it seems to us more convenient to prepare a daily net return table arranged by route and by several levels of scale rates for a certain tanker. It is very easy for an owner to prepare such tables for all tankers owned by him.

In any way, there are several levels of scale rates, several routes and several sizes of tankers. There must be a 3-dimensional table. When we try to make a simpler table of two dimensions from the original one, which dimension should we simplify? For the owner of a tanker, it is most convenient for his particular

tanker to have a table of only two dimensions, of scale rates and routes.

For our purpose, however, it may be desirable to prepare a table showing such scale rates by route and by size which produce zero net return. But unfortunately, at times, it may be impossible to prepare such a table as the the necessary information on port charges or ships' expenses are not available for all types of tankers, even if we can use the information which were used in compilation of Base Rates for the Worldscale System and which were only for the standard vessels.

Fortunately we can use a table supplied by R.S. Platou A/S, Oslo, although it contains only a single route (Ras Tanura/Rotterdam via Cape of Good Hope)[5]. The table contains daily net returns and TCE for 38 scales of rates between W20 to W200 and for 24 types of tankers. We can choose the scale rates for each type of tankers that make zero net return on the route.

The break-even scale rates by types of tankers from Platou's conversion tables from 1976 to 1978 are shown in Table 4, together with TCE corresponding to the respective scale rates. The differences of the break-even scale rates and the break-even TCE by size of tankers and by type of engines appear very clearly. These figures can also be read as unit costs by size of tankers.

The calculation of the relation of the total costs and the ships' size are shown in Appendix II. The total freight costs measured by the scale rate and the total charter costs measured by TCE are explained by the ships' size in linear equations[6], and the effects of turbine engines on costs are expressed by parameters on dummy variables. The total charter costs in 1978 (equation No. 6 in Appendix II), for example, are divided into \$157,160 for fixed costs and \$354 for size proportional costs per 1,000 tons d.w., and tankers of average size, a 163,400 tonner is shown to require \$210,463 for monthly charter hire. While the total freight costs measured by the scale rates in 1978 (equation No. 3) consist of, $32{,}060 \times 17.55 = \$562{,}653$ of fixed costs and $181.9 \times 17.55 = \$3{,}192$ of proportional costs per 1,000 t.d.w. when a base rate of \$17.55 for the route in 1978 is used, an average tanker of 163,400 t.d.w. requires \$1,145,241 for freight revenue for one voyage.

By the way, let's consider the significance of parameters for a turbine dummy. As for charter costs, turbine tankers are cheaper by about \$10,000 than diesel tankers, while for freight costs, on the contrary, turbine tankers cost \$7,583 more for one voyage than diesel tankers, with the exception for charter costs for turbine tankers in 1977, which is not significant as the estimated error being too large.

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5) R. S. Platou A/S, 'Tanker Trip to T/C Conversion Tables and Net Return', Oslo, Jan. 1978, etc.

6) In contrast, Goss calculated the total costs per day and the costs per 1000 G/T per day in log linear forms. Results are shown in Appendix III. Goss, R. O. and M. C. Mann, 'The Cost of Ships' Time', cited in Goss, R. O. "Advances in Maritime Economics", Cambridge, 1977.

Table 4 Break-even Rate and TCE in Las Tanura/Rotterdam

		1976		1977–1978		1977		1978	
Size	Eng.	Scale Rate	TCE	Size	Eng.	Scale Rate	TCE	Scale Rate	TCE
D/W			$	D/W			$		$
19500	M	150.0	6.84	19500	M	195.4	7.34	162.8	7.51
28000	M	114.3	4.88	25000	M	131.3	5.86	128.6	5.97
35000	M	96.0	4.09	32000	M	108.9	4.67	107.3	4.78
55000	M	69.9	3.01	50000	M	84.4	3.58	81.3	3.51
55000	T	90.0	2.91	75000	M	66.7	2.70	61.1	2.48
70000	M	63.7	2.62	75000	T	81.2	2.62	74.1	2.38
70000	T	76.7	2.54	85000	M	57.8	2.26	56.0	2.22
85000	M	55.8	2.26	85000	T	69.6	2.20	67.4	2.15
85000	T	66.3	2.19	100000	M	51.7	1.95	50.5	1.95
100000	M	51.1	2.07	100000	T	61.2	1.87	59.6	1.85
100000	T	59.5	1.97	130000	M	43.7	1.55	43.8	1.64
130000	M	45.0	1.79	130000	T	50.4	1.49	49.5	1.50
130000	T	51.0	1.72	150000	M	40.6	1.41	39.8	1.41
150000	M	42.7	1.69	150000	T	47.0	1.42	45.1	1.34
150000	T	47.6	1.63	210000	M	34.1	1.11	34.2	1.16
210000	M	35.3	1.31	210000	T	38.0	1.06	37.7	1.10
210000	T	30.7	1.26	230000	M	32.8	1.06	32.7	1.10
230000	M	34.2	1.28	230000	T	36.1	1.01	35.7	1.04
230000	T	37.1	1.22	250000	M	32.3	1.01	32.9	1.01
250000	M	32.8	1.20	250000	T	34.7	0.96	34.3	0.96
250000	T	35.4	1.15	285000	M	29.0	0.91	30.4	0.90
285000	T	31.9	1.05	285000	T	31.1	0.88	31.5	0.86
350000	T	31.8	0.92	350000	T	31.6	0.77	28.2	0.73
415000	T	28.2	0.81	415000	T	28.0	0.68	26.7	0.66

(Source) Conversion Tables of R. S. Platou A/S.
Figures between Scale Rates are calculated by pro rata.

When we adopt a linear equation for the total costs, we have got a comparatively good approximation in view of the determination coefficients. But when we adopt a log linear equation for net returns or TCE per unit such as

$$C=aW^{-b},$$

we can get a much better fitness. We tried to include the turbine dummy in this case too. The results are shown in Table 5. The significance of the turbine dummy will be deemed as a multipler to the costs for turbine tankers.

This type of equation is used very frequently to measure elasticity. Here, the elasticities of the unit costs or break-even freight rates to the ship's size are expressed as

$$E=\frac{dC}{C}\Big/\frac{dW}{W}=\frac{dC}{dW}\cdot\frac{W}{C}=-b.$$

In other words, an exponent for W is the proportion of the variation of the freight rates to the variation of the ship's size, the proportion which we can call 'Ship's Size

Effect'. This is the subject of our present paper.

Table 5 Relations between Break-even Points and Size

C_1 = Break-even Scale Rate (Base Rate=100)
C_2 = Break-even TCE ($)
T = Turbine dummy
W = Ship's Size (TDW)

1976	$C_1 = 778.1 \cdot W^{-0.582} \cdot 1.127T$	
	(73.4) (29.3) (3.8)	
	$\bar{R}^2=0.9759$ $\bar{S}=7.3\%$	$d=2.18$
1977	$C_1 = 959.1 \cdot W^{-0.623} \cdot 1.155T$	
	(109.1) (45.9) (6.5)	
	$\bar{R}^2=0.9900$ $\bar{S}=5.1\%$	$d=1.54$
1978	$C_1 = 907.5 \cdot W^{-0.614} \cdot 1.120T$	
	(112.9) (47.1) (5.3)	
	$\bar{R}^2=0.9907$ $\bar{S}=4.8\%$	$d=1.53$
1976	$C_2 = 41.28 \cdot W^{-0.643} \cdot 0.953T$	
	(179.5) (63.3) (3.0)	
	$\bar{R}^2=0.9954$ $\bar{S}=3.7\%$	$d=0.76$
1977	$C_2 = 70.94 \cdot W^{-0.774} \cdot 0.972T$	
	(170.0) (68.7) (1.5)	
	$\bar{R}^2=0.9960$ $\bar{S}=4.2\%$	$d=0.74$
1978	$C_2 = 69.35 \cdot W^{-0.768} \cdot 0.944T$	
	(234.4) (94.3) (4.4)	
	$\bar{R}^2=0.9979$ $\bar{S}=3.0\%$	$d=0.86$

3. Ship's Size and Shipping Markets

It is easy to recognize that the larger ships can earn greater net returns if the same freight rates can be obtained on the same route. As we have seen above, the larger ships can bear lower freight rates and be operated profitably with lower charter hire rates. And this fact is said to be the reason for the tendency of a comparative decrease in the shipping market levels along with an increase of larger ships.

Many studies based on the size distribution of world fleet or, more simply, on average sized ships at each point of time have appeared to explain the long-term trend of the shipping markets.

Hawdon, in his re-examination of Zannetos' freight level determining formula which uses a reciprocal of the laid-up tonnage ratio, trys to explain the considerable difference in fitness of the same form of equation $R=a+b\ (1/LU)$ seen between Zannetos' period (1950–1960) and the period thereafter (1961–1971) as a result of the appearance of combination carriers, the expansion of ship's size, the change in operating costs etc. (Correlation coefficients are 0.831 for Zannetos' period and 0.539 for the later period respectively, by annual data.)[7] He estimates also supply functions of shipping services in which the dependent is the reciprocal of the laid-up

7) Hawdon, D., 'Tanker Freight Rates in the Short and Long Run', University of Surrey, 1977.

tonnage ratio and the explanatory variables are

R: freight rates for tanker cargo,

DR: freight rates for dry cargo,

F: tonnage of tankers,

CC: tonnage of combination carriers,

AS: average size of tankers,

BC: bunker cost,

Lab: labour cost, and

PS: price of ship.

An example of his results is the following:

$$1/LU = -104.37 + .37R + 0.9DR + 1.31F - 7.23CC/F + .25AS + 3.56BC - 1.78Lab + .22PS$$
$$(2.55)\quad (3.17)\quad (.30)\quad (.65)\quad (.84)\quad (.33)\quad (1.44)\quad (.89)\quad (.62)$$

$R^2 = .85 \quad s = 18.48 \quad d = 2.25 \quad OLS$

In fact, this function seems to lack sufficient information. It has been suggested long before that the average size of ships as well as the average speed must be considered to explain the long-term trend of shipping supply and freight levels in addition to other growing indicators. The average size is, however, rarely applied as an explanatory variable in shipping supply function. Is it considered that the average size has less effect on the shipping supply than the average speed? Hawdon contributed to make us reconsider such a problem.

There is a study which uses the average size in the process of calculating the shipping supply[8]. In this study, the volume of the tramp shipping supply in the unit of efficiency ton was calculated basing on the carrying capacity per month of a tramp ship of average size and average speed on the wheat trade route from the North Pacific to Japan, using the tramp statistics issued by W.G. Weston Ltd.

In this case, the average size contributes to an increase of shipping supply, and has a negative effect on the freight level. In many other studies on estimates of the freight level determining functions, the technical progress or the tendency of expansion of the average size and the average speed of ships are taken up only to explain the unfitness of these estimated functions[9].

There is another study interesting us. Miyashita uses the ratio of the average size of laid up tonnage to the average size of whole tonnage as an operation ratio[10].

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8) Shimojo, T., 'Shipping Markets in 1950's (5)—Supply of Shipping Services and Freight Level—', "Kaiun", 1960.

9) Shimojo, T., 'Quantitative Analyses on the Shipping Markets—A Survey of Studies Weighting on Japanese works—, Kobe University of Mercantile Marine, 1973.

10) Miyashita, Kunio, 'A Measurement on the Investment Behavior in the Tanker Industry' "Kokumin Keizai Zasshi" Vol. 137, No. 4, 1978.

According to him, the decision planning investment in the tanker industry can be explained by the operation ratio of free tankers and combination carriers and the growing rate in transport demand in tons. For the operation ratio, Miyashita utilizes such a variate as [(Arithmetic average size of tankers and combination carriers owned by independent owners)/(Arithmetic average size of tankers and combination carriers laid-up)]. And he says to explain the reason: 'Even if the short term planning of investment is affected by the immediate future state of the operation ratio in the oil tanker market, the former is also affected to a degree by the expectation to the future. And the expectation seems to depend much more upon the average size than on laid-up tonnage itself'[11].

The ordinary concept of the operation ratio represents a ratio of tonnage excluding the laid-up tonnage to the whole tonnage at a certain point of time. Meanwhile, Zannetos' reciprocal laid-up tonnage ratio seems to be a concept emphasizing the operation ratio which is a complement of the laid-up tonnage ratio to 1. The concept is based on the experience that the freight level explained by the concept will never fall down below a certain level because of the lay-up point.

To express the supply curve of shipping services, a hyperbolic model is frequently used. In the simplest form, it is

$$(R-a)\,(1-B)=C,$$

where R denotes the freight level, B the operation ratio, and a and C are constants. It represents a hyperbola in the north-west side of two straight lines, $R=a$ and $B=1$. As 1 means 100% operation ratio, $1-B$ is the ratio of idle tonnage or laid up tonnage ratio. So, if LU denotes the laid up ratio, then

$$R=a+\frac{C}{1-B}=a+C\frac{1}{LU},$$

and the freight level R is expressed by the reciprocal of LU. We should better understand the Zannetos' theory in this manner.

Instead of this concept, Miyashita has used a very similar concept of Zannetos' reciprocal laid-up ratio, by dividing both numerator and denominator by the respective numbers of ships. Denoting whole tonnage by A, laid-up tonnage by L, and respective numbers of ships by a and l respectively, Zannetos' reciprocal of laid-up ratio is

$$\frac{1}{L/A}=\frac{A}{L}$$

and Miyashita's operation ratio is

$$\frac{A/a}{L/l}=\frac{A}{L}\cdot\frac{l}{a}.$$

11) Miyashita, ibid, p. 102.

Not only for tankers, but shipping services, the supply scheme is represented by a J-shaped curve. As the ship's cost per unit depends upon the ship's size and tonnage of larger ships is naturally much greater than that of smaller ships, the J-sahped curve in the supply scheme is rather popular. Based on the curve, Miyashita seems to assume that the average size of the laid-up tonnage represents the operation ratio.

In addition to the relation quoted by Hawdon, Zannetos pursued the relations between laid-up tonnage and freight rates in several other manners. But he did not show much interest in the ship's size. This might be due to the fact that in his days the trend for larger tankers was not yet very prominent. As seen in his data, T-2 tankers or tankers of similar size were dominant, and only a few tankers of 45,000 tons d.w. or so were seen in fixtures several years ahead[12].

Since then, however, the importance of the ship's size has gradually been noted. Zannetos did not fail to point out: the average sizes in tonnage ordered, delivered and scrapped have shown very interesting contrasts, and the ship's size was one of the most important factors in his model of long term charter hire[13]. In the latter case, the ship's size effects (in our own terminology, or a parameter on ship's size in a log linear equation) on long term charter hire were -0.193 for the higher portion and -0.213 for the lower portion.

Serghiou who studied under Zannetos' guidance the various factors affecting tanker rates attempted to explain the single voyage rates in the short term S with the operating costs of marginal vessels R^m, the proportion of tonnage being operated in the spot market X_1, the proportion of the capacity of a particular ship to that of a marginal vessel X_2, and the proportion of laid-up tonnage in the whole tonnage X_3[14]. In this case, the marginal vessel represents a certain ship's size range at which partial quantity of fixtures accumulated from smaller side of ship's size ranges comes up to 5% of whole quantity of fixtures.

In the process of estimating his theoretical equations, Serghiou utilized the operation costs by size for each year based on the following equation of Polemis[15].

1971 $C=12.8680\ W^{-0.59891}\quad R^2=0.973$
1972 $C=12.6416\ W^{-0.57901}\quad R^2=0.948$
1973 $C=13.1422\ W^{-0.55860}\quad R^2=0.912$
1974 $C=17.9869\ W^{-0.61411}\quad R^2=0.965$
1975 $C=19.6263\ W^{-0.57790}\quad R^2=0.945$

And for the year 1976 he calculated them with the annual rate of change in Base Rate for the PG/UK route ($1.11\times C$ of 1975). It is very interesting for us to note that

12) Zannetos, Zennon S., 'The Theory of Tank-ship Rates', MIT Press, 1966.

13) Zannetos, ibid. Fig. 5.13 in p. 123 and Chapter 10 in pp. 251~.

14) Serghiou, Serghios S., 'Transportation costs and Oil Prices'. MIT Master Thesis, Feb. 1978.

15) Polemis, 'Tanker Time Charter Rates', MIT Master Thesis, 1976.

the marginal vessel had been 45–55 (000 t.d.w.; same thereafter) in 1971, 55–65 in 1972 to 1973, 75–100 in 1974 to 1975, and 100–150 in 1976.

He analysed a modified equation for 1630 fixtures on the PG/UK route for various periods from September 1971 to December 1976 by

$$S/R^m = aX_1{}^bX_2{}^cX_3{}^d.$$

Here, S/R^m was the proportion of a particular spot rate to the cost of the marginal vessel at the respective point of time. His purpose was to clarify the economy of scale by explaining the proportion in rate and cost with the proportion of size to that of the marginal vessels. His results are shown in Table 6, it does not en sure entire satisfactory because of the unconformity between his objectives and the method he used.

Table 6 Analyses of Tanker Rates (Serghiou)

$S/R^m = aX_1{}^bX_2{}^cX_3{}^d$

- S : Spot Rates
- R^m : Operating Cost for Marginal Vessel
- X_1 : Ratio of Tankers operated in Free Market
- X_2 : Ratio of Ship's Size to Marginal Vessel
- X_3 : Ratio of Idle Tonnage.

Period	Whole Period 1971-9～1976-12	Low Period 1971-9～1972-12 1973-12～1976-12	High Period 1973-1～1973-11	Deperessed P. 1975-1～1975-12	Peak Period 1973-6～1973-11
No. of Fixtr.	1630	1122	508	168	235
a	10.4781	8.8248	6.8176	11.3705	5.5873
	(79.5)	(76.3)	(17.5)	(11.5)	(10.3)
b	−1.1167	−0.6225	−0.8096	−1.0191	−0.3664
	(34.2)	(22.7)	(9.0)	(5.3)	(3.6)
c	−0.2778	−0.3512	−0.1744	−0.5582	−0.2057
	(13.5)	(20.0)	(6.0)	(15.8)	(5.0)
d	−0.3887	−0.2404	+0.8671	−0.3813	+1.0869
	(36.6)	(27.8)	(9.1)	(3.9)	(6.6)
R^2	0.6858	0.6223	0.3436	0.6179	0.2881
d.w.	0.3042	0.5866	0.4316	1.3	0.691

In any way, however, it is worth noting that he attempted to explain individual spot rates by the peculiarity of the respective ships and the macro-scopic indicators which was prevailing in the market at the respective time. It can be considered as an inheritance of Zannetos.

4. Ship's Size Effect on Individual Rates

The factors affecting individual freight rates can easily be understood through the items in the daily market reports of shipping exchanges. The items identifying a fixture from another are: (a) loading and unloading ports, or route, (b) commodity

and its shape, (c) quantity of cargo, (d) ship to be used, (e) date of readiness or cancelling date, (f) principal terms of contract. These six items and the date of fixture are the determining factors for freight rates[16].

We would like to summarize them into the following four elements in order to simplify our discussion.

(1) Route: Cargo is always indivisible from its route, so that we will combine these two items into one. This item, however, is a non-numeric variate.

(2) Size: Cargo lot is also indivisible from ship's size. We will take it up as cargo tonnage in fixtures.

(3) Prepositive time: Days from date of fixture to date of readiness as well as days needed for execution of contract are one of the most important factors affecting rates through expectation in the future. We will combine them into one concept, prepositive time. Prepositive time is defined as [(days from date of fixture to date of readiness)+(days needed for execution of contract)/2][17].

(4) Date of fixture: Shipping markets, as well known, vary from time to time. The time is a vital factor affecting rates. We will defer till another occasion our analysis of factors modifying the market level at a certain time, and, here, will consider the date of fixture as a factor affecting individual rates.

The data used here are fixture reports of the free tanker market. We have picked up mainly spot voyage charter contracts for crude oil on the principal world routes during the six years from 1970 to 1975[18]. The freight rates are expressed according to the Worldscale. We selected only fixtures to load the crude oil at the Caribean Sea, Persian Gulf, West Africa, and Meditarranean ports and to discharge it on the Atlantic Coast of the United States, the European Contionent, the United Kingdom, and Japan. Number of fixtures picked up for the period was 9573.

Our objective is to observe and analyze the effects of the four above mentioned factors on the individual rates. At this stage, the first problem is to find the most appropriate form of equation to express our model.

For the ship's size and cargo lots, as we have seen, a log linear equation is considered to be the most proper. But there are some difficulties with respect to the prepositive time[19]. We will attempt, here, for the time being, the following three types of equations:

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16) Shimojo, T., 'Determining factors of the freight rates and their influences', Annual Review of the Japanese Shipping Economics Association, No. 9, 1975.

17) Shimojo, T., 'Expectation in the Shipping Exchanges', Economic and Business Review, No. 22, 1976.

18) Collected from Maritime Research Inc. 'Chartering Annual' 1970–1975.

19) See Appendix II in Shimojo, T., 'Some Bargaining Process Models in the Shipping Exchanges', Economic and Business Review No. 23, 1977.

$$R=aW^bP^c \qquad \text{(a)}$$
$$R=aW^b10^{cp} \qquad \text{(b)}$$
$$R=aW^b10^{cp+dp^2} \qquad \text{(c)}$$

where the freight rates are represented by R, the ship's size by W and the prepositive time by P. For the other two factors, route and date, we have evaded to make them explanatory variables by estimating these equations seperately by route and date. But we have partially neglected the differences among the routes as we have adopted the Worldscale rates in order to assume as if they were for the same route. Data have been classified into 72 months[20].

The results are shown in Table 7 and 8, where the effects of the ship's size gives a rather satisfactory estimation, regardless of the type of equation applied. Leaving the prepositive time for another occasion, let us here observe only the size effects.

As we have already seen, the cost elasticity of tankers in relation to their size ranges from -0.5 to -0.7. Although we have considered only 1976 and the following years but not for the period covered by these data, we can assume them to be of similar value as those estimated by Goss and Polemis. As far as we see in Table 7 and 8, however, size effects b vary from time to time. Eliminating the ones that is not apparently significant, they range between -0.011 (Aug. 1973) and -0.793 (Dec. 1975). The absolute value will be for greater if we calculate only a particular route.

Small absolute values of size effects mean that there is no difference between rates by size, and that the larger ships enjoy greater profit regardless of the freight level. From the reverse point of view, if the absolute value of size effects is large, it means that the larger a ship is the less she can earn, and that the market is less favourable for larger ships when the absolute size effects of rate is greater than the size effects of cost. By comparing the size effects observed here with the size effects of cost, we can judge whether the market of a given period is favourable for larger ships or not.

Our problem is to find out what makes the market comparatively favourable for larger ships sometimes and less favourable at other times. As far as we can see in Table 7 and 8, the absolute values of size effects are generally smaller in more prosperous periods, or the larger tankers have enjoyed greater profits in those prosperous periods. This tendency, however, faded away in 1974 and after, and, on the contrary, an unfavourable market for larger tankers became conspicuous.

The favourable market for larger tankers derives from the bias of larger lots in the size distribution of cargo. In such a market, there are insufficient occasions

20) In the results of calculation of the same data classified into 313 weeks, we found a better estimation in some parts. But there is too little apparent improvement in view of the ship's size effects to be introduced here.

for larger lots of cargo to find appropriate ships while there is a surplus of ships for smaller lots of cargo. Such a connection is easily understood from the fact that the size distribution of tankers is constant in the short run, although the lot distribution of cargo does not appear in any statistical data.

Let us arrange the problems we have faced here. There is the phenomena called economy of scale can apparently be seen in ships. As the cost per unit of larger ships is lower, an identical freight rate or an identical charter hire rate will bring larger ships greater profits. We have expressed the degree of lower costs by a parameter named 'size effect'.

In the actual market, however, we can find many differences in the relation between freight rates by size. There are fewer differences in some periods between freight rates for larger and smaller ships, but in other periods there can be greater discounts on freight rates for larger ships than their size effects of costs[21].

Such phenomena naturally depend on differences between the size distribution of the fleet available in the market at a given time and the lot distribution in cargo demanding shipping services at that time. Compared with the lot distribution of cargo, the size distribution of the fleet is completely inelastic, and it can not adapt itself to the changes in the lot distribution. Therefore, by watching the trend of freight rates by size, we can learn the changes in the lot distribution of cargo.

It is easy to divide the market in such a way that the different size of ships supplies different services. But any size of ships has the possibility to be substituted to a similar size of ships, and a cargo lot can be split or consolidated into another lot size. Our ultimate objective is to make up a market model including as wide a domain as we can by means of sufficient consideration of mutual substitution between the size distribution of the fleet and the distribution of cargo.

5. Application to the market model

There is the size distribution of ships on one hand, and there is the lot distribution of cargo on the other hand. Even if there are sufficient of ships and cargo to make an equilibrium, the individual ships or the individual lots of cargo can not always find their appropriate partners. Some sizes of ships may be scarce and at the same moment some sizes may be in surplus.

This means that it is not sufficient to assume only one supply scheme for the shipping market model. If one assumes that only one commodity is exchanged in a market, then different ships with different sizes must be exchanged in respective

21) This is seen not only in the tanker market. We applied the same analyses on the charter hire rates of recent tramp markets. The figures calculated from the tramp market reports are shown in Appendix IV.

Table 7 Size and Prepositive Time Effects

Date	Fixture	$R = aW^b P^c$				$R = aW^b 10^{cp}$				$R = aW^b 10^{cp+dp^2}$				
		log a	b	c	R^2	log a	b	c	R^2	log a	b	c	d	R2
1970	1 220	2.64	−0.111	−0.146	0.261	2.66	−0.110	−0.027	0.280	2.66	−0.113	−0.017*	−0.002*	0.278
	2 242	2.59	−0.094	−0.136	0.452	2.68	−0.123	−0.005	0.466	2.63	−0.109	−0.010	0.000	0.472
	3 236	2.61	−0.100	−0.012*	0.047	2.49	−0.069	−0.007	0.079	2.58	−0.095	0.002*	−0.000	0.086
	4 124	2.73	−0.153	0.083	0.103	2.71	−0.146	0.011	0.076	2.72	−0.157	0.036	−0.003	0.111
	5 184	2.69	−0.131	−0.003*	0.093	2.71	−0.137	0.001*	0.095	2.72	−0.138	−0.002*	0.000*	0.093
	6 251	2.78	−0.123	0.026	0.086	2.76	−0.114	−0.000*	0.075	2.76	−0.122	0.007	−0.000	0.147
	7 89	2.49	−0.041	−0.005*	0.000	2.45	−0.031*	−0.001	0.004	2.42	−0.028*	0.003	−0.000	0.030
	8 124	2.51	−0.028	−0.059	0.215	2.53	−0.039	−0.002	0.151	2.53	−0.036	−0.005	0.000	0.187
	9 102	2.67	−0.056	−0.071	0.131	2.73	−0.070	−0.004	0.120	2.70	−0.063	−0.008	0.000*	0.116
	10 103	2.53	−0.014	−0.051	0.077	2.54	−0.019*	−0.003	0.063	2.53	−0.014*	−0.006	0.000*	0.059
	11 119	2.62	−0.028	−0.156	0.324	2.67	−0.047	−0.010	0.200	2.67	−0.040	−0.026	0.001	0.260
	12 107	2.62	−0.069	−0.040*	0.017	2.62	−0.070	−0.042*	0.016	2.61	−0.068	−0.008*	0.000*	0.008
1971	1 138	2.14	0.033	0.026	0.016	2.12	0.039	0.002	0.024	2.18	−0.021*	0.008	−0.000	0.037
	2 123	2.15	−0.003*	0.115	0.083	2.11	0.005*	0.017	0.063	2.10	−0.001*	0.042	−0.004	0.075
	3 149	1.90	0.041	0.022*	0.020	1.86	0.051	0.000*	0.017	1.87	0.050	0.001*	−0.000*	0.010
	4 152	2.50	−0.100	0.061	0.336	2.56	−0.121	−0.000*	0.284	2.43	−0.079	−0.020	0.001	0.402
	5 120	2.49	−0.111	−0.061	0.162	2.50	−0.113	−0.009	0.163	2.50	−0.105	−0.027	0.002	0.165
	6 108	2.57	−0.173	0.115	0.161	2.50	−0.151	0.007	0.222	2.56	−0.166	0.011	−0.000	0.222
	7 85	3.71	−0.433	0.067	0.376	3.77	−0.449	0.011	0.476	3.69	−0.415	−0.020	0.001	0.529
	8 76	3.00	−0.249	−0.137	0.538	3.11	−0.276	−0.014	0.495	3.01	−0.235	−0.072	0.007	0.581
	9 76	3.48	−0.391	0.061	0.505	3.59	−0.415	0.010	0.560	3.53	−0.397	−0.001*	0.000	0.561
	10 129	2.75	−0.213	0.059	0.282	2.72	−0.205	0.005	0.287	2.75	−0.213	0.009	−0.000*	0.283
	11 117	2.34	−0.108	0.066	0.085	2.23	−0.079	0.002*	0.046	2.29	−0.098	0.014	−0.001	0.070
	12 92	3.17	−0.250	−0.153	0.647	3.27	−0.274	−0.018	0.607	3.21	−0.241	−0.085	0.010	0.667
1972	1 131	2.62	−0.167	0.041	0.216	2.62	−0.167	0.007	0.217	2.62	−0.168	0.010*	−0.000*	0.211
	2 136	3.23	−0.308	−0.121	0.667	3.51	−0.378	−0.001	0.638	3.47	−0.368	−0.005	0.000	0.647
	3 108	3.66	−0.421	−0.137	0.794	3.88	−0.478	−0.003*	0.762	3.63	−0.408	−0.040	0.002	0.802
	4 87	4.16	−0.541	−0.189	0.852	4.23	−0.555	−0.029	0.841	4.24	−0.534	−0.108	0.013	0.859
	5 107	3.73	−0.446	0.045	0.567	3.71	−0.440	0.006	0.579	3.67	−0.429	0.002*	0.000*	0.575
	6 158	2.57	−0.160	−0.030	0.319	2.48	−0.136	−0.008	0.355	2.59	−0.170	0.010	−0.001	0.384
	7 137	2.56	−0.171	0.057	0.193	2.43	−0.139	0.001*	0.178	2.51	−0.162	0.013	−0.001	0.187
	8 135	2.76	−0.195	−0.018*	0.437	2.79	−0.202	−0.001*	0.435	2.78	−0.201	−0.001*	0.000*	0.431
	9 145	3.02	−0.232	−0.021*	0.523	3.10	−0.252	0.002*	0.523	3.05	−0.237	−0.009	0.001	0.531
	10 135	2.29	−0.068	−0.105	0.352	2.35	−0.083	−0.010	0.310	2.31	−0.067	−0.026	0.001	0.348
	11 176	2.96	−0.184	−0.162	0.435	3.14	−0.234	−0.007	0.396	3.02	−0.199	−0.024	0.001	0.411
	12 159	3.15	−0.222	−0.109	0.577	3.20	−0.234	−0.013	0.565	3.18	−0.225	−0.027	0.002	0.568
1973	1 179	2.35	−0.042	−0.102	0.143	2.37	−0.049	−0.011	0.200	2.36	−0.046	−0.013	0.000*	0.195
	2 172	2.69	−0.116	−0.029*	0.179	2.68	−0.115	−0.005	0.183	2.73	−0.130	0.007*	−0.001	0.191
	3 173	2.53	−0.086	0.021*	0.078	2.49	−0.075	0.000*	0.076	2.53	−0.086	0.007*	−0.001*	0.075
	4 155	2.74	−0.123	−0.104	0.465	2.76	−0.128	−0.013	0.477	2.76	−0.127	−0.014	0.000*	0.474
	5 213	3.00	−0.174	0.096	0.126	2.79	−0.119	0.000*	0.093	2.91	−0.154	0.015	−0.000	0.124
	6 104	2.81	−0.075	−0.130	0.317	2.73	−0.061	−0.012	0.388	2.71	−0.051	−0.022	0.000	0.406
	7 164	3.35	−0.194	−0.143	0.437	3.41	−0.213	−0.010	0.428	3.40	−0.208	−0.016	0.000*	0.427
	8 150	2.51	−0.010*	−0.001*	0.000	2.44	0.007*	−0.003	0.074	2.50	−0.011	0.008	−0.001	0.239
	9 145	2.86	−0.070	−0.013*	0.098	2.82	−0.058	−0.006	0.160	2.84	−0.071	0.010	−0.001	0.238
	10 161	3.13	−0.121	−0.110	0.129	3.17	−0.131	−0.013	0.135	3.13	−0.116	−0.024	0.001	0.136
	11 135	4.95	−0.573	−0.119	0.673	5.06	−0.601	−0.009	0.667	4.98	−0.574	−0.027	0.001	0.671
	12 86	3.89	−0.368	−0.130	0.517	3.83	−0.345	−0.033	0.536	3.80	−0.369	0.083	−0.020	0.566
1974	1 111	3.62	−0.303	−0.114	0.685	3.68	−0.318	−0.012	0.675	3.65	−0.305	−0.029	0.002	0.682
	2 96	3.83	−0.363	−0.068	0.608	3.89	−0.379	−0.004*	0.600	3.87	−0.368	−0.020	0.001	0.606
	3 128	4.18	−0.428	−0.028*	0.615	4.25	−0.447	−0.002*	0.614	4.22	−0.431	−0.022	0.002	0.618
	4 120	4.54	−0.525	−0.017*	0.803	4.56	−0.530	−0.001*	0.803	4.55	−0.520	−0.033	0.004	0.806
	5 134	4.12	−0.440	0.058	0.704	4.11	−0.438	0.009	0.705	4.11	−0.439	0.012*	−0.000*	0.703
	6 138	4.03	−0.407	−0.106	0.764	4.10	−0.428	−0.005	0.753	4.06	−0.412	−0.020	0.001	0.759
	7 109	4.24	−0.488	−0.056	0.779	4.26	−0.492	−0.007*	0.777	4.32	−0.490	−0.063	0.009	0.783
	8 126	3.97	−0.432	−0.095	0.808	4.00	−0.441	−0.010	0.802	4.02	−0.432	−0.050	0.005	0.811
	9 153	3.99	−0.417	−0.087	0.733	4.07	−0.439	−0.003*	0.727	4.02	−0.417	−0.030	0.002	0.735
	10 124	3.72	−0.346	−0.159	0.742	3.83	−0.374	−0.014	0.709	3.75	−0.340	−0.060	0.005	0.754
	11 169	4.32	−0.486	−0.219	0.837	4.38	−0.503	−0.024	0.820	4.41	−0.490	−0.081	0.007	0.835
	12 132	4.87	−0.611	−0.230	0.801	4.90	−0.611	−0.044	0.802	4.92	−0.609	−0.071	0.005*	0.802
1975	1 111	4.59	−0.582	−0.004*	0.732	4.59	−0.583	−0.000*	0.733	4.58	−0.584	0.008*	−0.001*	0.731
	2 96	4.31	−0.546	−0.030*	0.721	4.33	−0.549	−0.004*	0.721	4.32	−0.544	−0.019	0.002	0.719
	3 106	4.46	−0.595	0.063	0.688	4.55	−0.615	0.008	0.727	4.55	−0.612	0.001*	0.000*	0.727
	4 87	4.83	−0.659	−0.166	0.877	4.82	−0.653	−0.033	0.878	4.82	−0.654	−0.032*	0.000*	0.877
	5 100	4.76	−0.653	−0.048*	0.615	5.03	−0.721	0.014	0.630	4.85	−0.650	−0.062	0.004	0.681
	6 105	4.42	−0.547	−0.182	0.760	4.45	−0.549	−0.033	0.761	4.47	−0.546	−0.059	0.004*	0.759
	7 150	4.37	−0.531	−0.093	0.830	4.37	−0.530	−0.017	0.831	4.37	−0.530	−0.017*	0.000*	0.830
	8 141	4.35	−0.549	0.061	0.796	4.33	−0.545	0.008	0.796	4.31	−0.537	−0.003*	0.001*	0.796
	9 92	4.71	−0.606	−0.095	0.789	4.71	−0.600	−0.025	0.795	4.63	−0.611	0.089	−0.021	0.802
	10 118	5.39	−0.761	−0.195	0.918	5.46	−0.771	−0.035	0.915	5.45	−0.751	−0.107	0.013	0.921
	11 120	5.08	−0.699	−0.062	0.805	5.10	−0.703	−0.009	0.804	5.07	−0.688	−0.045	0.005	0.805
	12 78	5.68	−0.791	−0.277	0.879	5.73	−0.794	−0.052	0.881	5.73	−0.793	−0.064	0.002*	0.880

* mark means t value being less than 1. R: Fixture Rates in World Scale, W: Tons Fixed, P: Prepositive Time

Table 8 Size and Prepositive Time Effects by Route

$R = aW^b\ 10^{cp+dp^2}$

Date	Carib/USAC				Carib/UKC				P.G./USAC				P.G./UKC				P.G./JAPAN			
	Fixture	b	c	d	Fixture	b	c	d	Fixture	b	c	d	Fixture	b	c	d	Fixture	b	c	d
70. 1	113	−0.123	0.149	−0.027	9	−0.022*	−0.149	0.016	—	—	—	—	35	−0.049	0.164	−0.020	23	−0.093	0.056*	−0.008*
2	89	−0.273	0.030*	0.002*	8	−0.627	0.784*	−0.115*	—	—	—	—	91	−0.022	−0.008	0.000	25	−0.189	−0.019	0.000
3	113	−0.161	0.285	−0.048	9	−0.299*	−0.149*	0.010*	—	—	—	—	64	−0.023	0.001*	−0.000	17	−0.022*	0.063	−0.006
4	47	−0.432	0.095	−0.012	7	−0.270*	−1.172*	0.186*	—	—	—	—	32	0.033*	0.125	−0.011	13	−0.116*	0.635*	−0.074*
5	40	−0.096	0.015*	−0.000*	11	−0.656	1.017	−0.138	10	−0.102*	0.157	−0.013*	76	−0.011*	0.002*	0.000*	20	−0.341	0.014*	−0.001*
6	38	−0.259	−0.011*	−0.000*	7	−0.026*	0.035*	0.000*	—	—	—	—	179	−0.098	0.008	0.000	—	—	—	—
7	33	−0.107	0.009*	−0.002*	—	—	—	—	—	—	—	—	30	0.006*	−0.001*	0.000	8	0.027*	−0.001*	0.000*
8	25	−0.232	0.005*	−0.002*	9	−0.395	0.336*	−0.045*	—	—	—	—	70	0.000*	−0.004	0.000	—	—	—	—
9	39	−0.129	0.081	−0.012	—	—	—	—	—	—	—	—	24	−0.002*	−0.006	0.000*	6	0.093	−0.008*	−0.000*
10	46	−0.113	−0.015*	0.003*	6	0.030*	0.900	−0.128	—	—	—	—	23	−0.059	0.027	−0.002	6	−0.021	0.002*	−0.000*
11	63	−0.048	0.013*	0.003*	—	—	—	—	—	—	—	—	20	−0.031	0.011	−0.001	—	—	—	—
12	49	−0.114*	−0.056*	0.018*	7	0.330*	−0.526*	0.071*	—	—	—	—	28	−0.052	−0.016	0.000*	7	0.096	−0.154	0.011
71. 1	60	−0.070	−0.032	0.008*	—	—	—	—	—	—	—	—	40	−0.020*	0.009	−0.000	6	−0.075*	−0.410	0.049
2	49	0.046*	−0.497	0.148	12	−0.061*	0.090*	−0.012*	—	—	—	—	30	−0.113	0.057	−0.005*	8	−0.225	0.238*	−0.028*
3	54	−0.085	0.071	−0.018	17	−0.194*	−0.007*	0.000*	—	—	—	—	35	−0.008*	−0.005*	0.000*	16	−0.095*	−0.310*	0.031*
4	55	−0.122	−0.002*	0.000*	7	−0.232	0.163	−0.023	6	−0.015*	1.187*	−0.143	35	−0.072	0.092	−0.011	18	−0.057	−0.033	0.001
5	50	−0.036*	0.003*	0.000*	—	—	—	—	6	−0.076*	−0.202	0.019	31	−0.162	0.027*	−0.002*	14	−0.183	−0.121	0.010
6	36	−0.217	−0.069	0.024*	—	—	—	—	—	—	—	—	30	−0.189	0.020	−0.000	14	−0.364	0.013*	−0.000*
7	31	−0.269	0.014*	−0.007	—	—	—	—	9	−0.379	−0.168*	0.015*	17	−0.204*	0.020*	0.000	—	—	—	—
8	24	−0.084*	1.217	−0.415	—	—	—	—	8	−0.064*	−0.010*	0.002*	19	−0.139	−0.511	0.081	—	—	—	—
9	13	−0.028*	−0.020*	0.003*	6	−0.668	−0.315	0.049	7	−0.217*	1.445*	−0.141*	28	−0.175	0.019	−0.000*	—	—	—	—
10	35	−0.156	0.058*	−0.014*	8	−0.314	−1.260	0.211	12	0.127	0.349	−0.036	40	−0.228	0.046	−0.002	—	—	—	—
11	34	−0.203	−0.020*	0.006	—	—	—	—	—	—	—	—	40	−0.158	0.021	−0.001	—	—	—	—
12	34	−0.309	−0.064*	0.011*	—	—	—	—	—	—	—	—	29	−0.110	−0.011	0.002	—	—	—	—
72. 1	46	−0.182	−0.010*	0.002*	—	—	—	—	—	—	—	—	29	−0.216	0.190*	−0.023*	16	−0.269	−0.303*	0.039*
2	43	−0.279	0.061	−0.027*	—	—	—	—	—	—	—	—	33	−0.217	0.047	−0.002	16	−0.059*	0.017*	−0.004*
3	41	−0.319	−0.026*	0.003*	—	—	—	—	—	—	—	—	29	−0.335	0.065*	−0.007*	10	−0.543	0.056	−0.002
4	28	−0.780	0.050	−0.012*	—	—	—	—	—	—	—	—	23	−0.424	0.131	−0.014	10	−0.694	0.035*	−0.003*
5	34	−0.664	0.068*	−0.018*	—	—	—	—	—	—	—	—	22	−0.351	0.176	−0.017	22	−0.228	0.107	−0.006
6	51	−0.363	0.078	−0.010	—	—	—	—	—	—	—	—	51	−0.095	−0.021*	0.000*	28	−0.138	−0.102	0.009
7	36	−0.242	0.024*	−0.009*	—	—	—	—	6	−0.298	−1.890	0.219	49	−0.204	−0.022	0.001	22	−0.393	0.306	−0.033
8	50	−0.311	−0.023*	0.003*	—	—	—	—	—	—	—	—	28	−0.266	0.029*	−0.002*	8	−0.211	−0.081	0.007*
9	56	−0.211	0.231	−0.051	—	—	—	—	—	—	—	—	52	−0.218	0.012	−0.000*	9	−0.166	0.044	−0.002
10	51	−0.061	−0.153	0.041	—	—	—	—	—	—	—	—	39	−0.175	−0.009*	0.000*	—	—	—	—
11	63	−0.287	0.081	−0.012	—	—	—	—	—	—	—	—	64	−0.033*	−0.009*	0.000*	8	0.030*	−0.139*	0.012*
12	66	−0.079	0.017*	−0.002	—	—	—	—	7	−0.150	−0.585*	0.067*	47	−0.124	0.031	−0.003	—	—	—	—
73. 1	60	−0.169	0.157	−0.033	—	—	—	—	7	−0.552	−0.951	0.105	69	−0.109	−0.018	0.000	—	—	—	—
2	55	−0.227	0.112*	−0.026*	7	−0.269	2.016	−0.303	—	—	—	—	74	−0.152	0.053	−0.003	14	−0.081	0.067*	−0.007*
3	63	−0.584*	0.039*	0.002*	—	—	—	—	6	−0.192	1.253	−0.134	51	−0.180	0.106	−0.013	9	0.077*	−0.425*	0.041*
4	69	−0.138	0.088	−0.016	—	—	—	—	6	−0.430	1.401*	−0.185*	48	−0.147	−0.004	−0.001	—	—	—	—
5	61	−0.335	0.074	−0.011*	—	—	—	—	8	0.121*	0.168*	−0.017*	106	−0.141	0.011	−0.000	10	0.050*	0.158*	−0.015*
6	41	−0.046	0.155	−0.027	—	—	—	—	6	0.187*	0.172*	−0.019*	32	−0.058	−0.041	0.001	—	—	—	—
7	57	−0.021	0.008	−0.002	—	—	—	—	—	—	—	—	63	−0.073	0.001*	−0.000*	—	—	—	—
8	46	−0.054	−0.014*	0.003*	—	—	—	—	—	—	—	—	66	−0.026	−0.001*	−0.000	—	—	—	—
9	57	−0.120	0.005*	0.000*	—	—	—	—	6	0.115	−0.079	0.006	47	−0.009*	0.005*	−0.001	—	—	—	—
10	76	−0.154	0.061*	−0.013*	—	—	—	—	—	—	—	—	41	−0.094*	−0.098*	0.005*	—	—	—	—
11	58	−0.430	−0.018*	0.003*	—	—	—	—	—	—	—	—	46	−0.428	0.131*	−0.017*	8	−0.633	0.138	−0.006
12	39	−0.158*	−0.076*	0.011*	—	—	—	—	—	—	—	—	22	−0.468	−0.136*	0.008*	—	—	—	—
74. 1	33	−0.344	0.048*	−0.009*	—	—	—	—	6	−3.982	8.019	−1.015	29	−0.165	0.004	−0.001*	8	−0.441	−0.343	0.036*
2	28	−0.367	−0.014*	0.001*	—	—	—	—	—	—	—	—	34	−0.286	0.040	−0.002	—	—	—	—
3	35	−0.227	0.064*	−0.003*	—	—	—	—	—	—	—	—	42	−0.358	0.046	−0.003*	15	−0.779	−1.375	0.163
4	28	−0.553	−0.176*	0.054*	—	—	—	—	17	−0.589	−0.152*	0.018	40	−0.320	0.059*	−0.004*	—	—	—	—
5	27	−0.365	0.121	−0.020	—	—	—	—	18	−0.392	0.083	−0.005*	48	−0.337	0.209	−0.021	—	—	—	—
6	33	−0.455	−0.074*	0.022*	—	—	—	—	9	−0.687	−0.385*	0.045*	49	−0.336	−0.015*	0.000*	—	—	—	—
7	24	−0.567	0.057*	−0.010*	—	—	—	—	—	—	—	—	40	−0.269	0.100*	−0.010*	—	—	—	—
8	21	−0.518	0.380*	−0.130*	11	−0.556	−0.413*	0.074*	11	−0.082*	0.145*	−0.012*	49	−0.327	0.022*	−0.002*	—	—	—	—
9	22	−0.325	−0.004*	0.001*	13	−0.297	0.906*	−0.152*	9	−0.070*	0.071*	−0.004*	66	−0.409	−0.010*	0.001*	—	—	—	—
10	38	−0.359	−0.006*	0.008*	14	−0.482	0.493*	−0.076*	10	−0.511	−3.057	0.364	34	−0.192	0.016*	0.000*	—	—	—	—
11	45	−0.237	0.022*	−0.001*	18	−0.328	0.261	−0.035	7	−0.616	0.018*	−0.002*	61	−0.410	0.049	−0.004	—	—	—	—
12	44	−0.587	−0.040*	0.015*	16	−0.633	0.057*	−0.010*	7	−0.518	−1.917*	0.236*	28	−0.466	−0.267	0.030	—	—	—	—
75. 1	30	−0.520	−0.425*	0.140*	—	—	—	—	7	−0.915	−0.088*	0.013*	30	−0.578	0.087*	−0.008*	—	—	—	—
2	27	−0.244	4.694*	−1.871*	11	−0.521	0.250*	−0.034*	—	—	—	—	29	−0.834	−0.037*	0.005*	—	—	—	—
3	29	−0.322	−1.071*	0.398*	16	−0.563	0.002*	0.001*	9	0.095*	3.101	−0.395	18	−0.869	−1.614*	0.253*	—	—	—	—
4	28	−0.674	−3.439	1.255	11	−0.385	−2.038	0.343	—	—	—	—	17	−0.646	0.544	−0.074	—	—	—	—
5	26	−0.642	−0.332	0.109	7	−1.046	−4.120*	0.761*	—	—	—	—	21	−0.244	0.246	−0.028	—	—	—	—
6	21	−0.674	0.695	−0.234	—	—	—	—	9	−0.646	0.102*	−0.003*	24	−0.592	0.144*	−0.023*	—	—	—	—
7	37	−0.356	−0.210	0.072	—	—	—	—	12	−0.398	−0.520	0.059	23	−0.566	−0.388	0.046	—	—	—	—
8	31	−0.305	0.038	−0.002*	—	—	—	—	—	—	—	—	45	−0.269	0.017*	−0.001*	7	−0.261	−7.109	1.005
9	18	−0.319	−0.264*	0.068*	—	—	—	—	8	−0.438	0.579*	−0.069*	19	−0.560	1.591	−0.248	—	—	—	—
10	55	−0.524	−0.022*	0.004*	—	—	—	—	10	−1.100	−0.075*	0.011*	13	−0.616	0.157*	−0.022*	—	—	—	—
11	44	−0.494	0.035	−0.003	—	—	—	—	8	−0.985	0.017*	0.004*	21	−0.572	1.257	−0.173	—	—	—	—
12	27	−0.570	0.016*	−0.005*	—	—	—	—	—	—	—	—	9	−0.562	0.257*	−0.031*	—	—	—	—

*mark means t value being less than 1. R: Fixture Rates in World Scale, W: Tons Fixed, P: Prepositive Time

different markets and matched with similar sizes of cargo lots. In reality, however, it is much more complicated.

Let us take up only the ship's size. A cargo lot of, say, 100,000 tons will be matched not only with a 100,000 tonner but also a 120,000 tonner or larger tankers. In recent years many fixtures of part cargo are reported, and not a few tankers have accepted 20 or 30% less cargo than their capacity. We should not overlook such

substitutions in the ship's size[22].

Suppose a cargo with a lot of L tons and a tanker of capacity of W tons. If the freight rates R are determined by the market size effects

$$R=\alpha L^{-\beta},$$

then as L must be less than W in general,

$$\alpha L^{-\beta}>\alpha W^{-\beta},$$

the shipowner's economy of scale x is

$$x=\left(\frac{L}{W}\right)^{-\beta}=\left(\frac{W}{L}\right)^{\beta}>1.$$

Is this always sufficient?

In fact, the total freight revenue he will earn is

$$TR=L\cdot\alpha L^{-\beta}=\alpha L^{1-\beta},$$

and the maximum freight revenue he can expect in the same market will be

$$XR=W\cdot\alpha W^{-\beta}=\alpha W^{1-\beta}.$$

Then the ratio will be

$$TR/XR=\left(\frac{L}{W}\right)^{1-\beta},$$

so that the closer L is to W the more favourable it will be for the shipowner.

Serghiou, in spite of his very detailed research on oil prices, failed to obtain any information about the lot size of crude oil shipments: who decides and how is the size of lots. We understand that the size of crude oil shipments depends on the tank size and the processing capacity of the oil refineries. If so, the average size of the cargo lot will increase every year.

The ship's size, corresponding to the trend, has been increased by about 5.7% a year during the last 20 years. When the expansion of the ship's size may exceed that of the cargo lots, then the market size effects will be smaller (larger in absolute value). As the effects of accepting smaller lots of cargo for larger ships will be proportional to $(L/W)^{1-\beta}$, regardless of their costs, the smaller the ratio of the lot to the ship's size is, the smaller the effects will be. And it can be said that the larger the absolute value of the market size effect is the smaller the loss in the operation of a ship with a small lot of cargo will be.

One point is to be noted. The trend to expand the absolute value of market size effect due to the surplus of larger ships has the effect of decreasing the loss ratio arisen from the part cargo. In other words, if a shipowner allows a certain rate of loss, the smaller the absolute value of the market size effects is, the smaller a ratio

22) We will neglect here the consecutive voyage relating to prepositive time or the temporal substitution. It is clear that much more substitutions are possible if we consider a larger range of time.

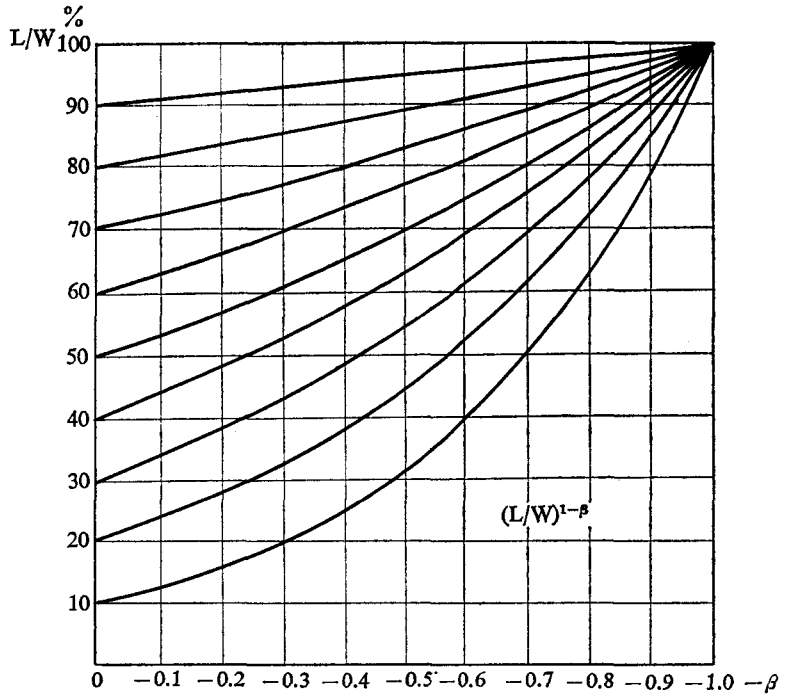

Fig. 1 Market Size Effects and Loading Ratio

of part cargo will he be able to accept. This also means that the range of substitution between different ship's sizes will be larger as the absolute value of the market size effects will be bigger.

This relation is shown in Fig. 1, in which the vertical axis denotes the percentage of cargo to the capacity as well as the percentage of real freight revenue to the expected revenue with full load, while the horizontal axis denotes the market size effect. For example, when the market size effect is −0.6, 80% of the part cargo will make 91% of the freight revenue. And when the market size effect is −0.7, even 70% of the part cargo can make 90% of the freight revenue.

In the recent tanker market, there are often part cargo fixtures of as small as 70% but no fixtures of smaller part cargo. From these facts we can guess that 90% of the freight revenue may be the limit of compromise in the short run. If we use this figure, the lower limit of part cargo, or the range of substitution among the ships' size will be a function of the market size effect, and can be expressed by

$$\frac{L}{W} \geq 0.9^{\frac{1}{1-\beta}}.$$

In connection with the above, however, there is a more important fact. The market size effect is determined by the relation between the lot distribution of cargo

offered and the size distribution of ships available in the market, but the fixtures utilized for this calculation are not reflecting the real size distribution of ships but merely a nominal one. Because, the larger the absolute value of the market size effect is the larger the difference between ships size and cargo lot in each fixture may be, and the larger the latter is, the cheaper the actual freight revenue per ton of the ship will be, even if the freight rate is comparatively high for a small cargo lot.

In any way, such phenomena are finally derived from the difference between the lot distribution and the size distribution. So we must not skip these two premises in our discussion on the market model.

The market model we are preparing has a data file on the world fleet on one hand with as realistic a structure as possible, and a data file on cargo generated from as realistic a distribution as possible on the other hand. We have to classify and summarize these two files as a first step in our model simulation. In these files, as we have seen above, the principal items are route, kind of commodity, lot size, date of readiness, etc. for the cargo file and kind of ship, size, position, date of availablility etc. for the ship file. We have observed only the ships' size and the cargo lots in this paper. The information we got through the discussion will be useful for our design of the market model.

In the traditional market models, both the demand and supply schemes have only a 2-dimensional relation between quantity and price. We are going to prepare multidimensional demand and supply schemes for our own model. One of the additional dimensions is the size effect in ships and cargo. In other words, what we have discussed in this paper is one of the new dimensions to be added to our own demand and supply schemes.

We plan to discuss another new dimension, the prepositive time effect, in greater detail, and the other dimensions of route, kinds of ships and cargo will be studied next. These dimensions are unavoidable for the shipping market model, because we have often experienced that an item can be easily separated from another in the demand scheme while they may be connected with the close substitution in the supply scheme, or vice versa.

Due to this fact, most available statistical data on the shipping market are very inconvenient for analysis. Hence we have to proceed by preparing raw and unprocessed data for ships and cargo, and make up our own endogeneous variables in the course of the model simulation[23]. (October 16, 1978)

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23) This type of model is named 'Behavioural Distribution Model', for more detail of which see Shimojo. T., 'On the Behavioural Distribution Model', Discussion paper presented to the Institute for Shipping Research, Bergen, Norway, 1977.

Appendix I Relation between Ship's Price and Size (Tanker)

(Size)	19,000tdw	41.5	90	135	220	265	330
1975	(2123.7)	3092.7	4716.0	(6589.7)	9900.0	(11594.7)	(14097.0)
1974	2635.3	3606.4	5256.0	8100.0	(10722.3)	12110.5	16962.0
1973	(2208.4)	3029.5	4392.0	6534.0	9108.0	11209.5	12837.0
1972	(1932.1)	(2717.4)	4680.0	5845.5	8338.0	10891.5	12837.0
1971	(2352.4)	(3173.7)	(4943.9)	6966.0	10296.0	9169.0	14883.0
1970	(2094.5)	(2704.3)	(4018.6)	4914.0	7766.0	9328.0	10032.0
1969	1525.7	(1934.9)	2817.0	4239.0	6072.0	7022.5	
1968	(1398.1)	(1773.0)	(2581.3)	3847.5	5676.0	6360.0	
1967	(1377.8)	(1747.3)	2781.0	3780.0	5368.0	(6267.6)	
1966	(1436.2)	(1821.4)	2619.0	3712.5	(5772.8)	6863.5	
1965	1345.2	(1834.4)	2889.0	3739.5			
1964	1265.4	(1797.0)	2943.0	4131.0			
1963	(1308.0)	(1857.4)	3042.0				
1962	(1466.7)	(2082.7)	3411.0				
1961	1417.4	2195.4	(3472.0)				
1960	1121.0	1942.2	(2943.8)				
1959	(1195.3)	2070.9	(3138.9)				
1958	(1295.9)	2245.2	(3403.1)				
1957	(1649.7)	3158.2	4032.0				
1956	1240.7	2328.2	4131.0				
1955	1198.9	1954.7					
1954	856.9	1610.2					
1953	1124.8	2025.2					

(Source) Calculated from Japan Maritime Research Institute 'History of 22 years in Post War Shipping Markets', Tokyo, 1975-5, pp. 138–139.
Adopted mid-values for respective ranks of size and total price in million Yen. Figures in ( ) are estimated by interpolation or extrapolation.

When an equation $P=aS+b$ is adopted for the data of each year, we get the following relations, where P is Price in mil. Yen and S is Size in 1000 TDW.

Year		
1975	$P=38.5S+1392.25$	$R=0.9996$
1974	$P=43.8S+1683.5$	$R=0.9918$
1973	$P=35.0S+1543.4$	$R=0.9973$
1972	$P=34.9S+1269.0$	$R=0.9934$
1971	$P=36.5S+1658.9$	$R=0.8961$
1970	$P=27.1S+1579.6$	$R=0.9766$
1969	$P=22.8S+1005$	$R=0.9977$
1968	$P=19.5S+1254$	$R=0.9936$
1967	$P=19.8S+1046$	$R=0.9987$
1966	$P=24.2S+446$	$R=0.9999$
1965	$P=20.7S+975$	$R=0.9973$
1964	$P=24.6S+657$	
1963	$P=24.4S+843$	
1962	$P=27.4S+945$	
1961	$P=34.5S+760$	
1960	$P=36.4S+428$	
1959	$P=27.3S+675$	
1958	$P=30.5S+715$	
1957	$P=33.5S+1011$	
1956	$P=40.7S+466$	
1955	$P=33.6S+559$	
1954	$P=33.5S+219$	
1953	$P=40.0S+363$	

Units for a and b are 1000 Yen and mil. Yen respectively. R is correlation coefficients, but they are calculated only partially as the others have insufficient degree of freedom.

Appendix II Relations between Break-even Total Costs and Size

TC_1 = Break-even Scale Rate × Size (Total Freight Costs)
TC_2 = Break-even TCE × Size (Total Charter Costs per Month)
T = Turbine Dummy
W = Size (TDW)

1976 $TC_1 = 29942 + 7136.6T + 201.4W$
(17.8) (3.6) (21.2)
$\bar{R}^2 = 0.9636$ $\bar{S} = 4459.2$ $d = 1.884$

1977 $TC_1 = 32319 + 10030.6T + 182.7W$
(28.8) (7.7) (29.6)
$\bar{R}^2 = 0.9827$ $\bar{S} = 2925.0$ $d = 1.469$

1978 $TC_1 = 32064.9 + 7583.6T + 181.9W$
(31.2) (6.4) (32.2)
$\bar{R}^2 = 0.9844$ $\bar{S} = 2678.0$ $d = 0.691$

1976 $TC_2 = 144043.6 - 8129.5T + 578.6W$
(22.8) (1.09) (16.1)
$\bar{R}^2 = 0.9264$ $\bar{S} = 16782.6$ $d = 0.280$

1977 $TC_2 = 156832.2 - 3918.6T + 347.6W$
(37.2) (0.81) (15.1)
$\bar{R}^2 = 0.9166$ $\bar{S} = 10963.1$ $d = 0.647$

1978 $TC_3 = 157164.4 - 9897.9T + 354.0W$
(38.2) (2.08) (15.7)
$\bar{R}^2 = 0.9191$ $\bar{S} = 10709.8$ $d = 0.371$

Appendix III Relation between Costs and Size (Goss)

$Y = aX^b$ Costs per day
$Y = cX^d$ Costs per day per 1000 D.W.

Types of Ships	a	b	R^2	c	d	R^2
Tanker	7.557	0.524	0.963	7,510	−0.475	0.956
Bulk carrier	4.183	0.568	0.949	4,184	−0.432	0.915
G. C. carrier	6.540	0.522	0.916	6,509	−0.477	0.900
OBO vessel	0.275	0.808	0.958	275.3	−0.192	0.599
Container vessel	22.47	0.701	0.949	2,248	−0.299	0.771
RORO vessel	8.525	0.622	0.999	8,209	−0.373	0.998
LASH vessel	687.5	0.161	0.151	693,800	−0.840	0.828

Discount rate in future price is 10%.
Goss 'Advances of Maritime Economics', pp 150–151.

Appendix IV Ship's Size Effects in Recent Tramp Markets

1st Quarter 1978 Time Charter Rate (59 fixtures)
$R = 158912W^{-1.038}$ $\bar{R}^2 = 0.991$ $\bar{S} = 5.1\%$
(89.5) (81.6)

2nd Quarter 1978 Time Charter Rate (118 fixtures)
$R = 20494W^{-0.816}$ $\bar{R}^2 = 0.976$ $\bar{S} = 6.2\%$
(79.6) (68.9)

May 1978 Trip Time Charter Rate (92 fixtures)
$R = 13731W^{-0.767}$ $\bar{R}^2 = 0.992$ $\bar{S} = 3.4\%$
(130.5) (107.5)

June 1978 Trip Time Charter Rate (105 fixtures)
$R = 10875W^{-0.743}$ $\bar{R}^2 = 0.998$ $\bar{S} = 1.5\%$
(285.2) (231.9)

DIRECT FOREIGN INVESTMENTS AND FOREIGN EXCHANGE RATE: A MODEL OF SPECIFIC FACTORS AND NON-TRADABLE GOODS

Kazuhiro IGAWA

1. Introduction

After the foreign exchange rate system moved from an adjustable-peg exchange rate system to a flexible exchange rate system, the value of the U.S. Dollar depreciated with respect to that of most of the other currencies, especially the German mark and the Japanese Yen. At the same period or with a short time lag, we experienced a change in the stream of direct foreign investments. Here, we use this word in a wide sense that foreign investments accompanied with real capital movements.

The main streams of direct foreign investments were from the United States of America to other countries (especially to Europe), when the U.S. Dollar was over-valued. However, after the depreciation of the Dollar, the direct foreign investment U.S.A. from European countries and Japan increased remarkably. In the present framework we wish to explain this phenomena.

Aliber in his pioneering works [1], analized the relation between the foreign exchange rate and direct foreign investments. Thereafter, the behavior of multinational firms, mainly their financial aspects have been analyzed. However it seems that we have no comprehensive theory on direct foreign investments related to the changes in the foreign exchange rate in a general equilibrium framework. The purpose of this paper is to propose such a framework, in which we can treat the above problems.

A basic framework for the production side which represents direct foreign investments and real capital movements was given by Mundell [10]. He used the Heckscher-Ohlin-Samuelson (H-O-S) model, where the ratios of endowments of generic factors of production play the important rules, and the model itself is theoretically interesting. However, the application of the H-O-S model to the complex real world phenmenon seems to be very limitted.

If we assume specific factors for production, as emphasized by Harrod [6], we will get a more powerful production framework to explane actual world problems, with stronger assumptions of "specific for industry". A specific factor model—two goods-the three factors H-O-S type model—was developed by Ikemoto [7] and Jones [9] and it has been applied to the problems related to direct foreign investments by

Caves [3] and Amano [2].

We adopt the specific factor model, in this paper, as a framework for production side of direct foreign investment, with the additional assumption that each country has its own non-tradable (non-traded or domestic) goods. Adding to this a demand side, a general equilibrium framework will be obtained.

The assumption of the existence of non-tradable goods is called for by the analysis of the effects of the foreign exchange rate movements as emphasized by Dornbusch [5]. With non-tradable goods, a change in the foreign exchange rate affects the relative prices of goods in the following way. For the country whose currency is depreciated (appreciated) the prices of tradable goods increase (decrease) in relation to non-tradable goods. However, the relative prices among tradable goods are ambigous. Therefore, to get interesting ralations from changes in relative prices the existence of non-tradable goods plays an important role. As the majority of situations of production are determined by the relative prices of goods, non-tradable goods bring on interesting conclusions. Not only from the theoretical point but also from the realistic point the share of non-tradable goods in each country is not negligible, and it seems necessary to make clear the role of these non-tradable goods.

The proposition of this paper is:

"real capital moves from an appreciating country to a depreciating country" We will explain this through the following procedure. In the next section, we investigate the production side and get the relations between relative prices and rental for specific factors, among others. In section 3, we investigate the demand side to complete a general equilibrium frame work and show market equlibrium conditions. In section 4, we get relations between relative prices and the foreign exchange rate and will explain the above proposition. In the last section, we summarize our conclusions and mention the limitations of our analysis and remaining problems.

2. Production relations with specific factors

In this section, we specify the production side, assuming situations used in the specific factor model by Ikemoto and Jones. In the model real capitals are industry specific and they do not move among different industries while the other relations are similar to the H-O-S model.

One of the strong limitation of these type models is that they neglect the financial aspects in the production. Although, the financial aspects may be important for the production in a firm, we consider these aspects only as a demand function for money, as will be shown in the following section. This implies that the production relations are mainly determined by the technological conditions.

As the properties of the production relation of the specific factor model are well known, it will be sufficient here to outline them briefly. To visualize the model, it may be helpful to emphasize the following points:

(i) each country has two kinds of industries, a tradable and a non- tradable goods industry.

(ii) real capital is specific for each industry and it cannot be used in a different industry.

(iii) tradable goods industries in different countries produce homogeneous goods and the specific factor for the industries can freely move from one country to the other.

(iv) non-tradable goods industries in different countries may produce heterogenous goods and specific factors for each industry do not move internationally.

(v) there exist no markets for real capital stocks.

Production relations of a country are expressed by the following system of equations (notations in foreign countries are expressed with asterisks).

Production function:

$$Q_i=L_i f_i\,(K_i/L_i) \quad ; \quad Q_i^*=L_i^* f_i^*\,(K_i^*/L_i^*)$$
$$(i=1,2) \qquad\qquad (i=1,2)$$

where, Q_1 (Q_2) is the output level of tradable (non-tradable) goods in the home country, L_1 (L_2) is the labor input in the tradable (non-tradable) goods industry and K_1 (K_2) is the specific capital input in the tradable (non-tradable) goods industry.

Factor endowment:

$$L_1+L_2=\bar{L} \quad ; \quad L_1^*+L_2^*=\bar{L}^*$$
$$K_2=\bar{K}_2 \quad ; \quad K_2^*=\bar{K}_2^*$$

where $\bar{K}_2$ and $\bar{L}$ are the factor endowment levels.

Factor price and marginal productivity:

$$\partial f_1/\partial(K_1/L_1)=r_1 \quad ; \quad \partial f_1^*/\partial(K_1^*/L_1^*)=r_1^*$$
$$p\partial f_2/\partial(K_2/L_2)=r_2 \quad ; \quad p^*\partial f_2^*/\partial(K_2^*/L_2^*)=r_2^*$$
$$w=f_1-(K_1/L_1)\partial f_1/\partial(K_1/L_1) \quad ; \quad w^*=f_1^*-(K_1^*/L_1^*)\partial f_1^*/\partial(K_1^*/L_1^*)$$
$$=p\{f_2-(K_2/L_2)\partial f_2/\partial(K_2/L_2)\} \quad =p^*\{f_2^*-(K_2^*/L_2^*)\partial f_2^*/\partial(K_2^*/L_2^*)\}$$

where, r_1 (r_2) is the rental for capital in the tradable (non-tradable) goods industry in terms of tradable goods and w is the wage for labor in terms of tradable goods. p is the relative price of non-tradable goods to tradable goods.

In the above system, we have ten variables and eight equations for each country and therefore, eight variables Q_1, Q_2, L_1, L_2, K_2, r_1, r_2 and w (which are treated as endogenous) can be expressed by two variables p and K_1, which are treated as exogenous variables in production. Of course, the exogenous variables become

endogenous in the general equilibrium framework.

From the above system of equations, we will get the following relations for the home country, where the variables with hat express the percentage changes in the variables (for example $\hat{x}=dx/x$)

$$
\begin{aligned}
&(1)\quad \hat{Q}_1=-{}_1Q_p\,\hat{p}+{}_1Q_k\,\hat{K}_1 \quad ; \quad \hat{Q}_1^*=-{}_1Q_p\,\hat{p}^*+{}_1Q_k^*\,\hat{K}_1^*\\
&(2)\quad \hat{Q}_2=Q_p\,\hat{p}-Q_k\,\hat{K}_1 \quad ; \quad \hat{Q}_2^*=Q_p^*\,\hat{p}^*-Q_k^*\,\hat{K}_1^*\\
&(3)\quad \hat{L}_1=-{}_1L_p\,\hat{p}+{}_1L_k\,\hat{K}_1 \quad ; \quad \hat{L}_1^*=-{}_1L_p^*\,\hat{p}^*+{}_1L_k^*\,\hat{K}_1^*\\
&(4)\quad \hat{L}_2={}_2L_p\,\hat{p}-{}_2L_k\,\hat{K}_1 \quad ; \quad \hat{L}_2^*={}_2L_p^*\,\hat{p}-{}_2L_k^*\,\hat{K}_1^*\\
&(5)\quad \hat{w}=W_p\,\hat{p}+W_k\,\hat{K}_1 \quad ; \quad \hat{w}^*=W_p^*\,\hat{p}^*+W_k^*\,\hat{K}_1^*\\
&(6)\quad \hat{r}_1=-R_p\,\hat{p}-R_k\,\hat{K}_1 \quad ; \quad \hat{r}_1^*=-R_p^*\,\hat{p}^*-R_k^*\,\hat{K}_1^*\\
&(7)\quad \hat{r}_2={}_2R_p\,\hat{p}-{}_2R_k\,\hat{K}_1 \quad ; \quad \hat{r}_2^*={}_2R_p^*\,\hat{p}^*-{}_2R_k^*\,\hat{K}_1^*
\end{aligned}
$$

where, the cofficients of $\hat{p}$ and $\hat{K}_1$ in each equation express the partial elasticities and they are positive if they have no minus sign. These relations are all familliar and it seems not necessary to show the processes of getting them.

In section 4, we will show that p decreases (p^* increases) and K_1 increases (K_1^* decreases) after a depreciation (appreciation) of the foreign exchange rate in the home (foreign) country. Combining these results to the above relations (1)~(7), we will get the following results about the effects of changes in the foreign exchange rate:

(i) In the depreciating (appreciating) country, Q_1 increases (Q_1^* decreases), Q_2 decreases (Q_2^* increases), L_1 increases (L_1^* decreases), L_2 decreases (L_2^* increases) and r_2 decreases (r_2^* increases). The change in the wage is ambigous in terms of tradable goods but increases (decreases) in terms of non-tradable goods in the depreciating (appreciating) country.

(ii) The changes of rental in the tradable goods industry are ambiguous. We can explain this in the following way. After a depreciation in the home country (therefore an appreciation in the foreign country), p decreases and p^* increases. When real capital does not move internationally r_1 increases and r_1^* decreases. Therefore, real capital in the tradable goods industry moves from the foreign country to the home country until r_1 decreases and r_1^* increases and they become equal. The new equilibrium levels of r_1 and r_1^* may be above or below their initial levels.

3. Demand relations and market equilibrium

In this section, we specify the demand side following Dornbusch and show the market equilibrium conditions. Goods are aggregated into two groups—tradable and non-tradable goods—and financial assect are aggregated into one asset called

money or currency. National income is distributed between expenditure for goods and accumulation of money. Assuming a separable utility function, demand for each goods can be expressed as a function of relative price and real expenditure.

$$(8)\quad D_i=D_i(p,\ e)\qquad (i=1,\ 2)$$

where, D_1 is the demand for tradable goods and D_2 is the demand for non-tradable goods and e is real expenditure in terms of tradable goods. We assume, considering finance for production, that a stock demand for money is expressed as a function of homogeneous of degree one with respect to the price levels of goods and a value of domestic products. That is,

$$(9)\quad a=a\,(p,\ q)$$

where "a" is the real demand for money balance in terms of tradable goods and q is the real domestic product in terms of tradable goods. It may be appropriate (or consistent) to use real national income instead of real domestic product. However, the conclusions in this paper do not change seriously by using real national income and we can avoid some complexities by using real domestic product.

As national income and expenditure are flow concepts, we must derive a flow demand for money (hoarding). Assuming a stock adjustment type of a hoarding function, the flow demand for money can be expressed as

$$(10)\quad h=s\,(a-m)$$

where h is the real hoarding and m is the existing real money balance, both in terms of tradable goods and s is the adjustment speed. Budget constraint is

$$(11)\quad y=e+h$$

where y is the national income in terms of tradable goods, which is determined by the factor income.

Differentiating demand function for goods and using constraint (11), we will get the following relations

$$(12)\quad dD_2=-D_2D_p\hat{p}-(c_2/p)dh+(c_2/p)Y_k y\hat{K}_1$$

where D_p is the compensated elastisity of demand for non-tradable goods, which is positive, and c_2 is a marginal propensity to spend on non-tradable goods, which is normally positive. Y_k is the elasticity of real national income with respect to real capital input in the tradable goods industry, and it will normally be positive because of an increase in wage.

Differentiating equation (10) and assuming that existing money stock is constant, we will get the following relations

$$(13)\quad dh=H_p\hat{p}+H_k\hat{K}_1+s/m\hat{P}_1$$
$$H_p=s\{\partial a/\partial p+(\partial a/\partial q)\,(\partial q/\partial p)\}\,p>0$$
$$H_k=s(\partial a/\partial q)\,(\partial q/\partial K_1)K_1>0$$

where P_1 is the price of tradable goods in the home currency. The signs of H_p and

H_k are clear because the increase in prices of goods or national products increases the demand for money stock, that is $\partial a/\partial p$ and $\partial a/\partial q$ are positive, and $\partial q/\partial p$ and $\partial q/\partial K_1$ are positive from relations in production.

So far the specifications are about the home country and we have the similar relations for the foreign country in the following way.

$$(11)^* \quad y^*=e^*+h^*$$

$$(12)^* \quad dD_2^*=-D_2^*D_p^*\hat{p}^*-(c_2^*/p^*)dh^*+(c_2^*/p^*)Y_k^*y^*\hat{K}_1^*$$

$$D_p^*>0,\ c_2^*>0,\ Y_k^*>0$$

$$(13)^* \quad dh^*=H_p^*\hat{p}^*+H_k^*\hat{K}_1^*+s^*/m^*\hat{P}_1^*$$

$$H_p^*>0,\ H_k^*>0$$

We are now in the position to show equilibrium conditions. Market clearing conditions for non-tradable goods for both countries are

$$(14) \quad Q_2(p,\ K_1)-D_1(p,\ e)=0$$

for the home country and

$$(15) \quad Q_2^*(p^*,\ K_1^*)-D_2^*(p^*,\ e^*)=0$$

for the foreign country. The market clearing condition for tradable goods is

$$Q_1-D_1+Q_1^*-D_1^*=0$$

This can be rewritten as follows, taking account of the budget constraints (11) and (11)* and the above market clearing conditions (14) and (15).

$$(16) \quad h+h^*=0$$

As the tradable goods are homegeneous for both countries, the commodity arbitrage ensures the following relations

$$(17) \quad P_1=P_1^*\pi$$

where, π is the foreign exchange rate (home currency value per unit of foreign currency).

Real capital used for production of tradable goods is also homogeneous for both countries and free international movements ensure the same rental in terms of tradable goods and thus

$$(18) \quad r_1=r_1^*$$

World endowment of the specific factor for tradable goods is assumed to be fixed as $\bar{K}$ and thus

$$(19) \quad K_1+K_1^*=\bar{K}$$

Of course, the level of the specific factor used in some countries is not necessarily equal to the level owned by the residence in that country. From these equilibrium conditions, (14), (15), (16), (17), (18), (19), and combining them with the previous production and demand relations, we can determine p, K_1, p^* and K_1^* (which are

treated as exogenous in production) and P_1 and P_1^* for given level of π.

4. The effects of a change in the foreign exchange rate

In this section, we investigate the relation of international real capital movements to the foreign exchange rate, which is treated as an exogenous parameter in this paper.

From the market clearing condition for non-tradable goods (14) and using relations (2) and (12), we will get the following relation.

$$Q_2Q_p\hat{p}-Q_2Q_k\hat{K}_1+D_2D_p\hat{p}-(c_2/p)Y_kyK\hat{K}_1=-(c_2/p)\,dh$$

We can rewrite this as

$$(20)\quad \hat{p}=-Adh+B\hat{K}_1$$
$$A=c_2/(Q_2Q_p+D_2D_p)p>0$$
$$B=\{Q_2Q_k+(c_2/p)Y_ky\}/(Q_2Q_p+D_2D_p)>0$$

For the foreign country, we will get a similar relation as

$$(20)^*\quad \hat{p}^*=-A^*dh^*+B^*\hat{K}_1^*$$
$$A^*>0,\ B^*>0$$

Combining these with the relations for hoarding functions (13) and (13)*, we will get

$$(21)\quad \hat{p}=-GAsm\hat{P}_1+GE\hat{K}_1$$
$$G=1/(1+AH_p)>0$$
$$E=B-AH_k$$
$$(21)^*\quad \hat{p}^*=-G^*A^*s^*m^*\hat{P}_1^*+G^*E^*\hat{K}_1^*$$
$$G^*=1/(1+A^*H_p^*)>0$$
$$E^*=B^*-A^*H_k^*$$

where, the sign of E is theoretically ambiguous. However, as the direct effects "B" of a change in K_1 on p will dominate the indirect effects through hoarding "AH_K", E will normally be positive. With similar reasonings, E^* will be positive.

From the conditions of equilibrium in international capital movements (18) and relations (6) in production, we get

$$-R_p\hat{p}-R_k\hat{K}_1=-R_p^*\hat{p}^*-R_k^*\hat{K}_1^*$$

Using the equation (19), we can rewrite this as

$$\hat{K}_1=-J\hat{p}+J^*\hat{p}^*$$
$$J=R_p/(R_k+R_k^*)>0$$
$$J^*=R_p^*/(R_k+R_k^*)>0$$

Putting into this the relations (21) and (21)* and using (19), we can get the following relations

$$(22)\quad \hat{K}_1 = NJGAsm\hat{P}_1 - NJ^*G^*A^*s^*m^*\hat{P}_1^*$$
$$N = 1/(1+JGE+J^*G^*E^*) > 0$$

Furthermore, using the equation (17), $\hat{K}_1$ can be expressed as

$$(23)\quad \hat{K}_1 = N(JGAsm - J^*G^*A^*s^*m^*)\hat{P}_1 + NJ^*G^*A^*s^*m^*\hat{\pi}$$
$$(23)^*\quad K_1^* = -N(JGAsm - J^*G^*A^*s^*m^*)\hat{P}_1^* - NJGAsm\hat{\pi}$$

From this equation, we can guess that $\hat{K}_1$ is positively related to $\hat{\pi}$ (therefore $\hat{K}_1^*$ is negatively related to $\hat{\pi}$), assuming that $JGAsm$ is not much different from $J^*G^*A^*s^*m^*$. That is, the specific factor for tradable goods moves from the foreign exchange rate appreciating country to the depreciating country.

Putting relations (21) and (21)* into hoarding relations (13) and (13)*, respectively, we will get

$$(24)\quad dh = GsmP_1 + (H_pGE + H_k)\hat{K}_1$$
$$(24)^*\quad dh^* = G^*s^*m^*\hat{P}_1^* + (H_p^*G^*E^* + H_k^*)\hat{K}_1^*$$

Putting these into the market clearing condition for tradable goods (16) and using relations (17) and (19), we will get

$$(25)\quad \hat{P}_1 = ZG^*s^*m^*\hat{\pi} - Z(H_pGE + H_k - H_p^*G^*E^* - H_k^*)\hat{K}_1$$
$$Z = 1/(Gsm + G^*s^*m^*) > 0$$
$$(25)^*\quad P_1^* = -ZGsm\hat{\pi} + Z(H_pGE + H_k - H_p^*G^*E^* - H_k^*)\hat{K}_1^*$$

From these relations, we can guess that P_1 will increase less than proportionally with an increase in π and P_1^* will decrease less than proportionally with a decrease in $(1/\pi)$, assuming $(H_pGE + H_k)$ is not much different from $(H_p^*\ G^*E^* + H_k^*)$. That is, the price of tradable goods increases in a foreign exchange rate depreciating country and it decreases in an appreciating country.

Using equations (23), (25) and (23)*, (25)*, we can solve $\hat{K}_1$, $\hat{P}_1$ and $\hat{K}_1^*$, $\hat{P}_1^*$ as a function of $\hat{\pi}$. However, relations previously guessed will not be changed.

The changes of p and p^* are dominated by the changes in $\hat{P}_1$ and $\hat{P}_1^*$, respectively, and p will decrease and p^* will increase when π increases. As P_1 and K_1 increase (P_1^* and K_1^* decrease), h will increase (h^* will decrease). This means that the current account improves (deteriorates) for a foreign exchange rate depreciating (appreciating) country. However, the service account will normally deteriorate (improve) for the depreciating (appreciating) country, because of a decrease (an increase) of income from abroad—or the increase of rental payments to abroad. Of course, the trade balance improves in the depreciating country and deteriorates in the appreciating country.

5. Conclusion

The intuitive explanations of the analysis of the previous three sections are as

follows. When the foreign exchange rate of a country depreciates, the real money balance decreases in the country because of an increase in the price of tradable goods. Therefore, accumulation of financial assets (money hoarding) is called for and the expenditure decreases. The decrease in expenditure reduces the demand for non-tradable goods and the relative price of non-tradable goods for tradable goods declines. This change in the relative price stimulates production of tradable goods and the rental of the specific factor for tradable goods increases. Therefore, real capital moves into the tradable goods sector in the country. Adjustments in the opposite direction will happen in an appreciating country.

In the above framework, we share the limitations of the H-O-S production model such as perfect competition, substitutable production function, diminishing marginal productivity and constant returns to scale. However, these limitations do not seem to be serious and do not change the basic idea of the general equilibrium analysis framework.

An alternative approach to a direct foreign investment is an analysis of the behavior of firms. In this analysis, direct foreign investment is considered to be one of the aspects of the growth of firms, which accumulate human and real capital embodied technique of management and production. If a firm has an advantage in human and real capital, it is natural to use them where they produce high profits. The place may be a foreign country. Thus, this theory emphasizes specific factors for a firm.

This theory and ours are mutual complementary in this paper. If we want to see the growth of direct foreign investment of firms, the theory of firm specific factors will be useful. If we want to see the equilibrium level of direct foreign investment of an aggregated industry, the industry specific factor theory will be useful and this theory will explain the problems of direct foreign investment of a country related to the foreign exchange rate.

Finally we have mentioned the important role of non-tradable goods and factors. In this paper, we emphasized that the existence of non-tradable goods ensures unambiguous relations between relative prices, international movements of capital and foreign exchange rate. In addition to these relations, rental for an internationally immobile capital and wage for laber, which also are immobile factors, will decrease in a depreciating country in terms of foreign currency. Therefore, the purchasing power of a foreign appreciating currency increases in the depreciating country. This will also increase the incentives for direct foreign investment by the appreciating country in a depreciating country. However, this aspect is beyond the scope of this paper.

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RESEARCH INSTITUTE FOR ECONOMICS AND BUSINESS ADMINISTRATION, KOBE UNIVERSITY

HISTORICAL SKETCH

In 1919, a research organization named the Institute for Commerce was founded in Kobe Higher Commercial School, one of the chief predecessors of Kobe University, with a gift made by F. Kanematsu & Company, a leading mercantile firm in Kobe. The organization was designed to carry on and facilitate integrated research on business and commerce and to formulate and publish the results of these studies and investigations in such form as to make them available to the business community.

With the founding of Kobe University of Commerce, successor of Kobe Higher Commercial School, in 1929, the Institute extended its research activities by adding several divisions. One was the famous Latin-American Library, which soon became the center of research in this field in Japan. A room for statistics equipped with various computing machines was established and began publication of *Jūyō Tōkei Keizai* monthly and *Sekai Bōeki Tōkei* annually. A filing room was prepared to deposit press clipping files systematically arranged by topics and dates. Another room was designed to become the center of all possible original records and data having to do with the beginning and progress of Japanese business.

On the campus of Kobe University of Commerce, another organization named the Institute for Business Mechanization was founded in 1941 utilizing

business machines donated by the IBM Corporation and others. With Professor Yasutaro Hirai as its head a broad and forward-looking plan for business mechanization in Japan was developed.

In 1944, Kobe University of Commerce changed its name to Kobe University of Economics. After the War, however, the University was consolidated with three other colleges in Hyōgo Prefecture to become Kobe University. With this development, the two Institutes were also amalgamated into the Research Institute for Economics and Business Administration, Kobe University. At present, the Institute, with its twenty four full-time professional staff members, carries on studies and investigations in international economy, business administration, and information systems in Japan.

LOCATION AND BUILDINGS

The Research Institute for Economics and Business Administration is located on the campus of Kobe University, Rokko, Kobe. It consists of two three-storied buildings. One is named the Kanematsu Kinenkan and has a floor space of about 2,900 square meters, which includes a president's room, forty-one offices, six rooms used as a library, a room for statistics, etc. Another is built in 1964. It has a floor space of about 1,900 square meters, which is chiefly used as the Documentation Center for Business Analysis, a library and a conference room.

ORGANIZATION

Under the directorship of the president, the Institute operates with two research groups. Each research group and its sections are as follows:

A Group of International Economy

(1) International Trade
(2) International Finance
(3) Maritime Economy
(4) Latin-American Economy
(5) Oceanian Economy
(6) International Labour Relations

B Group of Business Administration

(1) International Management
(2) Business Administration and Information Systems
(3) Accounting
(4) Business Statistics

Besides the regular work of the Institute, research committees may be created to carry on any special work requiring the joint study of academic and business circles. At present, there are five standing research committees, as follows: Experts Group on the World Trade Structure, Committee of International Finance, Committee of Information Systems, Committee of Oceanian Economy and Committee of Maritime Labour.

For convenience and greater efficiency in carrying out its research activities, the Institute has a general office which is responsible for 1) the collection and preservation of a comprehensive collection of books, periodicals, pamphlets, and original records and data of finance, trade, commerce, industry and business generally; 2) the classification, cataloguing, indexing arranging, annotation and compilation of these research materials; and 3) the formulation and publication of the results of the investigations and studies accomplished by the professional staff members of the Institute.

As an affiliated institute, the Documentation Center for Business Analysis has been established in 1964. It is the first systematic information facilities in the field of business administration in Japan that has been recognized and authorized by the Ministry of Education. The purpose is to collect and to make intensive control of all kinds of materials on business administration and to make them available to scholars, universities, governments, and business world with the aid of modern documentation techniques.

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