KOBE ECONOMIC & BUSINESS REVIEW

18th

ANNUAL REPORT

THE RESEARCH INSTITUTE FOR
ECONOMICS AND BUSINESS ADMINISTRATION
KOBE UNIVERSITY

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CONTENTS

ENVIRONMENTAL POLLUTION PROBLEMS FROM THE VIEW POINT OF BUSINESS MANAGEMENT

Minoru BEIKA

I

The problems of business and its environment include technical innovation, marketing conditions, social environment, relations with government and other institutions and so on. But the writer limits them here to the narrow meaning of direct or indirect environmental pollution.

The environmental problems in the narrow meaning have roughly two points or two stages in the problem consciousness of the Japanese. One concerns the aspect of environmental pollution or environmental disruption, the latter word being used by Prof. Shigeto Tsuru of Hitotsubashi University at the International Social Scientists Meeting about environmental problems in Tokyo, 1970. The other one concerns the human environmental problems, a term used internationally now, especially since U. Thant, Secretary General of the United Nations, entitled his report about these problems in May 1969: "Problems in Human Environment." These distinctions are not sufficient. Of course, the former, environmental pollution, is included in the human environmental problems. However, the grouping into the two stages will be useful for the understanding of the present problems in Japan.

II

In this chapter the problems of the first stage, environmental pollution, are dealt with. Every one who reads and understands Japanese, can find the Japanese word, "Ko-gai" in newspapers every day. In Japan, environmental pollution has been grasped and expressed by this word, "Ko-gai." Until recently, the concept of "Ko-gai" was interpreted in English as "public nuisance." Rather conversely, "public nuisance" might be interpreted as "Ko-gai." "Ko" means "public," and "gai" means "damage" or "trouble," or perhaps "nuisance." In other words, it means that the activities of some one or some ones cause "damage" or "trouble" to the surroundings. Then more theoretically, it means what we call "social costs" in private industrial activities. The term of social costs, a concept developed by Prof. K. W. Kapp. means the burden, caused socially by private enterprises, and thus originally liable to be absorbed as private costs by them. They comprise air pollution, water pollution, noise and some other troublesome consequences accompanying industrial activities. The problems of social costs include a wider sphere, for instance, that of traffic congestion, monopoly, research and development, land use and so on, but here we shall limit them to pollution.

Environmental pollution has existed in Japan for the last decades or longer. But most of the problems of the old times, especially of those before the World War II, were caused chiefly by certain single industrial factories in rural districts. Each problem itself was very severe for the surrounding communities, and even now some of them are still socially important. But they were relatively limited to some specific districts. After the War, the economic conditions of Japan, were for about ten years in the stage of reconstruction after war damage. The Japanese economic development began in 1955, slow at first, and then accelerating. Accordingly, industrial activities were not only more highly concentrated in the existing central industrial districts, but also developed in many new local districts. Particularly they increased since 1960.

The industrial development by private industrial firms has not always been left to be accomplished freely. The government has made general regional development plans since about 1955, and led industrial activities to follow them to some extent. But actually, on one hand, industrial development has not always followed to the desired way, and on the other, the government policies also have not always been appropriate to lead the industrial activities. The regional development plans themselves, and the planning have been relatively well integrated into the economic and social development, but the process of executing them has not worked very well. Excessive concentration of industries and bad use of land were found in the existing and newly industrial districts. As a result, environmental pollution, especially air pollution and water pollution, has rapidly been caused by industrial activities, here and there. Long-range visions or plans have been discussed earnestly, but there might have been lack of action programs or consciousness of the process for their realization.

Roughly speaking, these phenomena seem to be due to the two causes. One is related to national and local regional planning and their processes, and the other one is related to business policies of industrial firms. Sympathetically speaking, Japan had never experienced such an enormous industrial development and was not ready to deal with these environmental problems.

The first cause stems from national and regional plannings. There is the term of "comprehensive planning." It means that economic development and social development in a certain district should be well balanced and moreover balanced functions should be realized in physical planning. This concept was to be adopted for the general regional planning of Japan. But actually, the economic development has preceded the social development and an unbalance was found in the use of land. In other words, though planning itself seemed to be rather appropriate, the land use for industries and the physical realization of planning were not adequate, and environment consciousness was lacking. Such cases were often found in national and local regional development processes.

The second cause concerns the business and management policies of industrial firms. After World War II, Japanese industrial firms have energetically introduced many new management techniques from the U.S.A. and have applied them to their management and utilized them efficiently, such as marketing, industrial engineering, quality control, management information systems and so on. But at that time, they did not pay enough attention to environmental problems. Management techniques as public relations (in the original meaning — now the word is degraded), and community relations, and consumer movements are related to the business environmental problems. These techniques also were introduced in Japan, at the same time, together with other management techniques, but they were overlooked in their application, because there were no grave environmental problems in Japan at that time. Necessarily, there was a somewhat insufficient environment consciousness. Top managements in Japanese businesses knew about public relations and community relations as management techniques, but they were not very sensitive to them. Therefore, in the study of business management too, environment (in the wider meaning) has not attracted much attention. There are few business management books in Japan mentioning these subjects.

In these two or three years, air and water pollution and other pollution have been rising in industrial districts and certain industrial firms have been blamed for their insensible behavior. The social costs caused by the private industrial activities, and the social responsibility of business firms have been much discussed in the business world. Far-sighted top managements themselves have recognized their own social responsibilities. But environmental pollution problems are not so simple that they can be resolved in a short time, and moreover, there are not a few environment-unconscious industrial firms.

The government has revised and corrected its general regional plan and for the last several years social development has been given more priority in it. The government has established several laws to prevent environmental pollution, and local governments also have provided the relating regulations for these several years. They have begun to fix minimum level for harmful matter emitted through activities of industrial firms. Adding to these policies, recently some new means have been adopted. One of these is embodied in several kinds of agreement. To reduce air or water pollution bellow a certain level, agreements between the industrial firms and the local governments, in some cases, including representatives of the local inhabitants, have been concluded. But it needs a considerable long time to find a satisfactory effectiveness. Such means now just start. This is the Japanese environmental pollution or "Ko-gai" problem in its first stage.

III

The problems of the second stage concerning the human environment come next. While Japan is confronted with many unsolved problems of pollution, it involves also, necessarily, the global human environmental problems. The human environmental problems too are related to pollution caused by industrial activities, but they are so in greater dimension. They include a wider range and more far-reaching problems. Human environmental problems are related to all the aspects of our lives, and thus above the level of industrial activities. Technical innovation, urban concentration of population, motorization, many kinds of functional and physical conditions in urban living and our behavior as consumers are causes of human environmental problems, as the report of U. Thant has eloquently stated.

However, when deeper concern is given to these problems, it should be recognized that concentration of population, technical innovation, and urbanization are greatly connected with industrial activities, directly or indirectly. Accordingly, industrial firms and their top management should not be unconcerned with these phenomena. Each firm or each top management, respectively might not be responsible directly, but they owe their concern of this matter as members of the industrial world.

The problems of the level of the human environment seem to be given more attention in Western countries, while in Japan the problems of the level of pollution are given more importance. The first stage, environmental pollution problems are equally acute in Western countries now, but they have already been challenged for decades. A part of them has been overcome. At the end of 1968, human environmental problems in Stockholm were indicated by the U. N. In May 1969, as stated before, a relating report was made by U. Thant. He emphasized the crisis of human environment. In February 1970, there was "President Nixon's Message to Congress on Environmental Pollution Control." O. E. C. D., N. A. T. O. and E. C. also have studied these problems. Especially O. E. C. D. seems to deal actively with the permissible level of pollution as one of its subjects of discussion, in connection with unfair international trade competition. Japan should tackle to the human environmental problems, together with the problems of pollution which she has been begun to challenge just now.

IV

Environmental problems thus appear in Japan at both stages at the same time. Before Japan was ready to deal with the first stage or the problems of pollution and absorb the social costs of industrial activities, Japan is inevitably confronted with the human environmental problems in a greater dimension. The writer will explain his understanding of this point in greater detail, and compare it with the process in western countries.

We find in American and European countries the terms "industrial estate," "industrial district," and "industrial park." They are a sort of the physical systems. A certain number of industrial establishments located in certain arranged areas, according to a land-use plan, and assured to maintain a good balance with its environment; there is a public or private management body for maintaining its good external and internal conditions. It is "a planned and managed industrial estate." This type of industrial estate was experimented with in Manchester, England, in 1897, and in Chicago, U. S. A., in 1905, for the first time. Both still exist and are developing.

Aside from these, early in 1900, the so-called "Garden City Movement" was started by Ebenezer Howard in England. Two model garden cities were experimentally constructed by his Garden City Corporation. At that time, a few entrepreneurs tried to beautify the environment of their factories. Several such examples can be found in England and U. S. A. These trials show that the environmental problems had arisen through industrial activities at that time. More extremely to say, the land-use by industrial factories had begun to be criticized. In England, 100 years had elapsed since the Industrial Revolution. Industries had developed so enormously during this period that necessarily people engaged in these industries concentrated in certain districts, and many industrial towns had grown without any land-use planning. Then physical and social urban problems arose here and there. The behavior of industrial firms perhaps could generally be blamed for this. This was the back-ground or the environment condition under which several trials by a few creative entrepreneurs, the development of industrial estates, and the Garden City Movement were experimented with. The same conditions existed in U. S. A. All these trials concerned environmental problems. They were systematic attempt and a kind of physical system in present terms. We can now find in U. S. A. 1,000 and over industrial parks, research parks and newly planned towns and, in England, 20 or over New Towns thanks to the New Town Act and many industrial estates. These have been experienced for the past 50 years. But such experiences have not been made in Japan until recently.

V

Public relations and community relations with business policies are the next points. These management techniques also have been introduced into our business world after the War as a new knowledge. But they have practitionally been realized to a minor extent. Only "publicity" as part of the concept of public relations has been developed, mainly a means for sales promotion.

The concept of public relations seems to have been formed in the last fifty or sixty years in U. S. A. in the process of management execution. In the early 1900's, big businesses developed and some adopted unfair policies in their competition. This behavior was severely criticized by the general public. Reflecting on this, some big businesses began to adopt business policies toward the public in order to maintain better relations with various interest groups and so to recover their confidence. In the 1920's, they met consumer movements, and so they were inclined to become more public-conscious. At the end of the 1920's and the beginning of the 1930's, their public relations policies were tested during the unemployment conditions in the world-wide economic crisis. They executed seriously their business policies, with consideration of both self-interest and social responsibility.

In public relations, public means the interest groups of an industrial firm; they are the customers, suppliers, fellow traders, communities, central and local governments, labour unions, mass communications and so on. Public relations as a business policy means that the firm should have good relations with its groups, through management activities. Accordingly, their sphere is very wide.

After the War, business policies by public relations seemed to be inadequate, and requiring more care and attention. People, citizens, and communities began to have more environmental needs, and a better environmental climate. Moreover, environmental pollution problems developed seriously. The social costs caused by private enterprises were discussed. Industrial firms were often blamed for pollution problems. The importance of community relations, a branch of public relations, began to be recognized by industrial firms in about 1950.

Community relations as business policies have gone through roughly three stages. The first was the "not to do -stage." It means: "not to given any trouble through industrial activities to the community." Secondly: "to do the minimum for the communities," that is to assume the minimum obligation toward the community as a so-called corporation citizen. Thirdly: "to cooperate actively with the community" consisting in philanthropic and educative activities of the community through financial and physical help to the community, and passing know-how or management helps to the community.

It is said that since then environmental pollution and the social costs caused by industrial activities have been challenged relatively well in U. S. A., through business policies like public relations and community relations internally, and new physical systems like industrial estates and other land-use means, externally.

In spite of these activities, the industrial world could not avoid more serious environmental pollution because of enormous industrial developments, and thus human environmental problems arose again, in the latter half of the 1960's and 1970's. Some journals about "public relations" have called these phenomena a crisis in public relations, and a new dimension in public relations. This too shows the recent problem-consciousness.

Recently, the top-management in Japanese businesses has generally been conscious of the community, and is community-minded, but this tendency springs from the environmental conditions. Such is the Japanese dual environment problem.

VI

How to confront internally this dual environmental problem, in business policies, and through what systems to approach it externally, that is at present the important question.

At first, we will discuss the problem with regard to internal business policies concerning the environment. Of course, it is wrong to presume all Japanese industrial firms have not adopted business policies regarding community relations. Rather we can say that some industrial firms have endeavored to establish good relations with their communities. They are found in the local industrial districts, especially in single industry towns or company towns. In single industry or company towns, managements have been community-conscious, and adopted policies leading to good relations, because their industrial activities affect greatly the life of these communities. We can find many such cases in towns of the shipbuilding, metallurgical, and some other industries. These firms have done much for their commmunities.

However, the business policies of these firms have not always been systematic, and far-sighted enough; so to speak, the policies have come into being rather naturally or unconsciously.

However, such cases can be found only in local single industrial districts. In the principal industrial districts, there was until recently much less environment-or-community-consciousness. In other words, many industrial firms have not always been interested in their communities.

Therefore, it is very important now for them to establish business policies for community relations, as one of the basic factors to confront the pollution problems and to absorb the social costs caused by them.

In order to establish community relations, the industrial firms must execute internal and external policies.

At first, the top management must establish a basic external policy for community, and their complete internal company communication. Without good internal communication through organization, the firms can not establish good community relations, even if they establish a basic policy toward the community. The challenge to environmental pollution must be based on their community-minded polices. The policies of community relations consist in the three stages: "not to do," "to do the minimum," and "to cooperate actively," as stated before. Here, "not to do" is the most important of all.

To establish good community relations, several factors must be considered:

(1) A person of the top management must be in charge of community relations.
(2) Management staff for research and development of policies of community relations is needed.
(3) From the top level to the lower management level in line organization, these policies must be smoothly communicated.

Recently, a special section and staff responsible for environmental pollution have been established in many Japanese industrial firms, and they will be obliged soon by law to create responsible posts in their organizations. But all these actions should be based on community-consciousness and its action programs. The present environmental pollution should be solved as being one of the activities of community relations in view point of wider-range responsibilities by the firms. The environmental problems and community relations are linked to the philosophy of present business firms.

Environmental pollution in relation with management problems should be challenged in the following processes as a base of thinking:

(1) Recognize the existence of social costs as environmental pollution problems caused by industrial activities. There are some cases where recognition could induce them to settle their pollution problems and yet no private costs arise, because environmental pollution is due to the unconsciousness of industrial firms.

(2) Contrive to absorb technically and organizationally the social costs in the private costs.
(3) Solve pollution problem related to social costs by technical and management innovations.

Through these processes, it can be hoped that the pollution problems offer a chance to develop a higher level management, rather than being a troublesome obstacle for progress. Such positive thinking and behavior of management are most needed now.

VII

However, such internal positive action by the management is not yet enough to solve all the problems. We must also pay attention to external action. That means that the relations among industrial firms with each other, or with other organizations, are not indispensable. This is the so-called "systems approach." Of course the concept of systems approach is used internally and externally. But here it will be applied to external relations only.

Environmental pollution, in most cases, is not only due to the activities by a single factory, but also to the accumulation of pollution caused by other factories. Therefore, industrial firms must not only endeavor to overcome their own trouble, but also the accumulated phenomena must be faced and overcome. In the latter case, administrative actions by the central and local governments and other public organizations are necessary together with private actions by industrial firms. But the importance of cooperative actions by private firms should not be overlooked. These public and private actions should be organized systematically and management-orientedly. This means that positive cooperative actions by both sides are more desirable than legal and restrictive actions alone.

Many experiments such as in industrial estates, industrial parks and new towns mentioned before, are some kinds of the management oriented approaches or systems approaches. The writer calls these types of physical experiments "the planned multi-functional physical system." In other words, they are creative designs to decrease non-planned and uneconomical results of environment problems brought about by individual planning. This is the problem of non-planning by accumulation of individual planning. The physical results by non-planning must be overcome by some sort of physical systems. It is indispensable for developing such creatively planned multi-functional physical systems that knowledge and experiments related with these problems are accumulated and systematically and management-orientedly synthesized. These creativities need several factors for development:

(1) The need for groups concerned to cooperate
(2) The need to grasp and understand their respective functions, philosophies, logic of behavior and problems to be challenged
(3) The need of their research and development to realize an interdisciplinary approach
(4) The need, at first, to approach systematically to grasp the actual conditions related with the problems, and then secondly, to develop new systems to solve the problems.

VIII

Such a systems approach has close relations with management techniques. The term "system" has a wide meaning.

"System" has roughly the two meanings. One is the system which is naturally or spontaneously formed and exists actually and can be found by research and study of actual circumstances. The other is the system which is artificially formed to accomplish a certain aim, and is created for an optimum solution.

The former seems to have the two branches. One is related with the biological or organic system. Recently such systematic thinking is connected with the ecology or ecosystem to which great attention is paid now, regarding human environment. The other is related with the mathematical system, which is chiefly linked with the problems of the relationship of the factors quantitatively, rather than the substance of the factors as in the biological system. To solve the present problem, environmental pollution, we must first of all grasp systematically the actual condition. But how to integrate the biological system and the mathematical system is now one of the problems in systems approach.

The latter system solving seems to be a technological system, and to be found in management science. The concept of this system can be applied to solve many kinds of social and economic problems. Environmental problems are one of the typical cases to which it can be applied.

Thus, the systems approach to environment problems involves two processes. The first is to grasp systematically the actual conditions, and to clarify the focus points of the problems. The second is to create and organize an optimum system to solve the problems. Of course, these processes are very difficult, but at least, they are the best way to challenge the environment problems.

In environmental pollutions problems, many kinds of public and private bodies and individuals are complicatedly related with each other. Each body must be problem-conscious and cooperate-minded. Upon the base of this behavior, each body must endeavor to execute its social responsibilities in internal management control and external cooperation to solve systematically the problems by the technological and social systems approach.

IX

Japan has been confronted with the dual environmental problems as said repeatedly. The problems of the first stage, the direct environmental pollution, have rapidly increased, different from Western countries where it has been already dealt with for several decades. Japan has only recently begun to tackle it, following the experiences of those countries. And yet at the same time, Japan has been confronted with the problems of the second stage, the human environmental problems, alike those countries. The problems of the second stage are so difficult to overcome that their solution has only just now begun to be researched and taken up. Japan, too, must develop ways and means to overcome them, cooperating with the other countries.

Moreover, in Japan, there are certain characteristic circumstances, such as narrow space, limited flat land, abundant population and rapid development. Therefore, it is indispensable for Japan to create herself the ways and means to overcome these problems. At the same time, Japan must internationalize her industries and introduce freedom of trade and movement of capital. The importance of research and development of Japanese industries had increased greatly. Research and development in the field of environmental problems seem to be one of the most proper goals now. These problems or goals will constitute the useful means for the promotion of the abilities of research and development in the business world. The approach is not only useful for the practice of social responsibilities of the industrial firms, but also for the advance of business management. The research and development stated here include not only the technical side, but also the management side.

In conclusion, the Japanese environmental pollution problems are not only due to the behavior of industrial firms, and the process of the development of business management, but also due to the characteristic history of economic development, and the natural, economic and social conditions of Japan.

Anyway, these problems need positive actions of public organizations, but they must also energetically be taken up by the industrial firms through environment-conscious internal business policies and external cooperation based on the systems approach in a wider meaning. It will be their social responsibility and a new chance for their creative development.

PATTERNS OF THE JAPANESE ENGINEERING TRADE (1951–1970)

Fukuo KAWATA

I. Introduction

The purpose of this article is to make clear some of the features in the engineering trade of postwar Japan. By engineering products (in French "*produits mécaniques et électriques*") we mean machinery (electrical as well as non-electrical), transport equipments and precision instruments.

From 121 million dollars in 1951 the amount of export of engineering products from Japan increased 74 times to 8,941 million dollars in 1970, while the total amount of all commodities of her exports rose 14 times from 1,355 million dollars in 1951 to 19,318 million dollars in 1970. The share of engineering products in her total export commodities, therefore, came up from 9% in 1951 to 46% in 1970, showing their growing importance in the Japanese export trade. On the other hand, the amount of imports into Japan of this kind of products increased 38 times, from 61 million dollars in 1951 to 2,298 million dollars in 1970, whereas the total amount of all commodities of her imports grew 9.4 times from 1,995 million dollars to 18,881 million dollars. Thus the share of engineering products in her total imports moved up from 3% in 1951 to 12% in 1970.

In the prewar days, the share of engineering exports and imports was 7.2% and 4.7% respectively, while in the postwar years, these figures rose so rapidly as to register in 1970 46.3% in exports and 12.2% in imports.

Table 1. Development of the Japanese Engineering Trade (in million dollars)

Year	Total Exports (A)	Engineering Exports (B)	B/A (%)	Total Imports (C)	Engineering Imports (D)	D/C (%)
1934-36	928	67	7.2	951	45	4.7
1951	1,355	121	8.9	1,995	61	3.0
1955	2,011	276	13.8	2,471	142	5.7
1960	4,055	1,032	25.5	4,491	435	9.7
1965	8,452	2,976	35.2	8,169	760	9.3
1970	19,318	8,941	46.3	18,881	2,298	12.2

Source: Ministry of International Trade and Industry. Tsusho Hakusho (Annual Survey of International Trade of Japan), *Do*, Nippon Boeki no Tenkai (Development of Japan's Trade), 1956. *Do*, Sengo Nippon no Boeki Nijunenshi (Twenty Years of Japan's Postwar Trade), 1969.

Although both exports and imports of engineering products increased remarkably, the growth of exports was especially rapid. (See Table 1.) In 1951, the size of engineering exports was twice as large as that of engineering imports, but in later years, especially in the latter half of the 1960's, the formers increased more rapidly than the latters, so that in 1970 the ratio rose to four times.

The engineering exports also played a more important part than the engineering imports in the growth of Japan's total trade. For example, in the period from 1951 to 1955, her total exports increased by 655 million dollars, of which engineering exports took up 155 million dollars, that is, 23.6% of the increase.

In the later period this figure came up to 37.0% in the 1955–60 period, to 44.2% in the 1960–65 period and to 54.9% in the 1965–70 period. This means that more than half of the inciease of her total exports was made up of engineering exports. This is chiefly due to the large sums spent for investment in this branch of industry during the 1960's. On the side of import growth, the contribution of engineering products was not very large. In the 1951–55 period the share of engineering imports in the increment of total imports was 15.7%. This figure came down to 14.5% in the 1955–60 period, and 9.0% in the 1960–65 period, but in the 1965–70 period it recovered to 14.4%, the level of the 1955–60 period. (See Table 2.) The reason why the share of engineering imports in the

Table 2. The Contribution of the Engineering Trade to the Growth of Japan's Trade (in million dollars)

Period	Increase of Total Exports. (A)	Increase of Engineering Exports (B)	B/A (%)	Increase of Total Imports (C)	Increase of Engineering Imports (D)	D/C (%)
1951-1955	655	155	23. 6	516	81	15. 7
1955-1960	2, 044	755	37. 0	2, 020	293	14. 5
1960-1965	4, 397	1, 944	44. 2	2, 678	325	9. 0
1965-1970	10, 866	5, 696	54. 9	10, 712	1, 538	14. 4

Source: Same as in Table 1

total imports or in the increment of total import failed to increase is that Japan continued to import a growing amount of raw materials and fuels, accounting for almost 60% of her total imports. An international comparison as to the share of the engineering trade in the total trade of the leading industrial countries, reveals the fact that in all these countries the share of engineering exports in their total export is larger than that of engineering imports in their total imports.

In the case of Japan, the percentages in the early postwar days are the smallest both for exports and imports. The percentages of engineering exports, however, rose gradually and in recent years, they have overtaken those of other industrial nations, while the percentages of her engineering imports have come up so slowly that now they remain the samllest among leading industrial nations. (See Table 3.)

Table 3. The Share of the Engineering Trade in the Total Trade of Leading Industrial Countries (in %)

	Year	U. S. A.	Germany	U. K.	France	Italy	Japan
Exports							
	1955	35.0	40.0	37.3	16.4	20.0	12.3
	1960	34.4	43.8	43.1	24.7	27.7	23.2
	1965	36.9	46.2	42.0	26.3	30.3	31.2
	1967	40.2	45.0	41.9	29.0	33.9	36.6
	1968	42.2	45.7	42.0	29.4	34.4	37.9
	1969	43.8	46.0	42.0	30.9	35.0	38.6
Imports							
	1955	3.9	4.6	3.7	10.5	11.1	5.2
	1960	10.0	9.6	7.5	14.4	13.0	9.0
	1965	15.7	13.2	10.5	20.0	14.9	9.6
	1967	23.4	14.4	13.4	22.1	16.7	8.7
	1968	26.2	14.5	14.6	23.9	17.9	9.8
	1969	29.1	15.8	15.4	24.5	19.0	10.6

Source: The Bank of Japan, International Comparison Statistics
Note: Figures relate to machinery and transport equipments (SITC 7).

The ratio of exports to delivery shows us the degree of importance of the foreign market for the engineering industry of each country. This ratio differs not only according to branches but to countries as well.

As for the engineering industries as a whole, Japan's ratio ranks fifth, following that of Italy, Germany, the United Kingdom, and France. In each indivi-

Table 4. International Comparison of Ratio of the Engineering Export to Delivery (1966) (in %)

	U. S. A. (1965)	Germany	U. K.	France	Italy	Japan
Non-electric Machinery	12.0	51.0	36.1	29.0	(78.4)	11.1
Electric Machinery	4.8	27.6	19.3	17.8	(40.9)	14.6
Transport Equipment	5.4	54.4	30.5	(25.7)	(29.0)	17.7
Precision Instruments	8.8	62.0	32.4	23.4	(88.8)	31.7
Total	7.4	45.9	31.9	(24.8)	(49.2)	15.3

Source: OECD, The Engineering Industries in North America-Europe-Japan 1966–67 Paris 1967.
Kikai Kogyo Kenkyukai (Research Society of the Engineering Industry), Nippon no Kikai Kogyo, (The Engineering Industry of Japan) 1969
Note: Percentages in parentheses are derived from the estimated figures of delivery by the OECD.

dual branch, Japan occupies the fifth place with the exception of the precision instrument branch where she takes the fourth place. In general, Germany and Italy hold upper positions, while the United States and Japan lower. France and the United Kingdom take the intermediate places. (See Table 4.)

II. Commodity Pattern of the Engineering Trade

Engineering products are usually classified into four categories: that is, (1) non-electric machinery (machinery, other than electric) (in French "*machines non électriques*"), (2) electric machinery, apparatus and appliances, (3) transport equipment, and (4) precision instruments (including watches and clocks). The first group covers, for example, internal combustion engines, metal-working machinery, textile machinery, agricultural machinery, office machines (including electronic computers), sewing machines, mining and construction machinery, mechanical handling equipments and so on. (It should be noted that the electronic computers are included not in the electrical machinery, but in the office machines.) The second group includes, for instance, heavy electric machinery, television receiving sets, radio receiving sets, tape-recorders, insultated cable and wire for electricity. The third group comprises such items as railway locomotives, rolling stocks, automobiles, motor-cycles, aircrafts, ships, and boats. The fourth group consists of such kinds of commodities as scientific instruments, binoculars, cameras, 8 mm cinecameras, watches, clocks, and the like.

The relative importance of these four groups varies according to exports or imports.

1. Exports

As for export, non-electric machinery played an important part in the early postwar years, but later their relative weight declined gradually, whereas the share of electric machinery, though small at first, rose steadily throughout the postwar period. Precision instruments accounted for less than 10 per cent throughout this period.

Transport equipment took up the largest share (except in 1951) through the postwar period. (See Table 5.) Such predominance of transport equipments is one of the characteristics of the engineering exports from Japan. This is because of her active and efficient shipbuilding industry.

Each of the four groups of the engineering products is composed of various articles. The composition of each group on the export side will be analysed in the following.

(a) The non-electric machinery group

Table 5. Commodity Pattern of the Engineering Export from Japan (in million dollars)

Year	Total	Non-elctric Machinery	Electric Machinery	Transport Equipments	Precision Instruments
Amount					
1951	121	61	16	33	11
1955	276	97	33	119	27
1960	1, 032	212	291	433	96
1965	2, 976	624	865	1, 243	243
1970	8, 941	2, 006	2, 885	3, 443	628
Percentage					
1951	100. 0	50. 3	13. 2	27. 3	9. 2
1955	100. 0	35. 0	12. 0	43. 2	9. 8
1960	100. 0	23. 5	29. 7	37. 8	9. 0
1965	100. 0	21. 0	29. 1	41. 8	8. 1
1970	100. 0	22. 4	32. 2	38. 4	7. 0
Increment					
1951-55	155	36	17	86	16
1955-60	756	115	258	314	157
1960-65	1, 944	412	574	810	147
1965-70	5, 965	1, 382	2, 020	2, 200	405

Source: Same as in Table 1

Table 6. Exports of Non-Electric Machinery classified by Main Items (in million dollars)

Year	Total	Internal Combustion Engines	Office Machines	Metal Working Machinery	Textile Machinery	Sewing Machines	Mining & Construction Machinery	Mechanical Handling Equipments	Bearings
Amount									
1951	61	10	—	2	15	23	—	—	1
1955	97	4	—	3	26	39	6		2
1960	212	14	—	10	47	55	12		7
1965	624	39	24	45	82	83	73		43
1970	2, 006	143	329	116	196	129	131	120	134
Percentage									
1951	100. 0	15. 7	—	3. 6	23. 8	37. 8	—	—	2. 1
1955	100. 0	4. 5	—	3. 0	27. 0	40. 0	6. 4		2. 1
1960	100. 0	6. 7	—	4. 6	22. 0	25. 8	5. 5		3. 5
1965	100. 0	6. 3	3. 8	7. 2	13. 1	13. 3	11. 7		6. 9
1970	100. 0	7. 1	16. 5	5. 7	9. 8	6. 5	6. 5	6. 0	6. 7

Source: Same as in Table 1
Note: SITC 71

The main articles of non-electrical machinery exported from Japan are internal combustion engines, office machines, metal-working machinery, textile machinery, sewing machines, mining and construction machinery, mechanical handling equipments, bearings, and so on. In the early postwar years, textile machinery and sewing machines held an important part, but in later years their position came down. In recent years, office machines, especially desk-top calculators have made remarkable advance, taking up the first place in the non-electrical group. In 1970, the amount of exports of desk-top calculators reached 181 million dollars. (See Table 6.)

(b) The electrical machinery group

The main items of electrical machinery exported are heavy electric machinery, (e.g. generators, motors, transformers and so on) telecommunication equipments, tape-recorders, domestic electric equipment, insulated wire and cable, and the like.

The most important of all are telecommunication equipments which comprise chiefly TV sets and radio sets. In the 1950's their share in the total electric machinery was negligible but in the latter half of the 1960's it increased suddenly

Table 7. Exports of Electrical Machinery classified by Main Items
(in million dollars)

Year	Total	Heavy Electric Machinery	Insulated Wire & Cable	Telecommunication Equipments	of which: T. V. Sets	of which: Radio Receivers	Domestic Electric Equipments	Tape Recorders
Amount								
1951	16	3	2	—	—	—	—	—
1955	33	5	3	—	—	1	—	—
1960	291	20	15	—	3	145	—	9
1965	865	63	30	417	85	217	30	80
1970	2, 865	293	85	1, 404	384	695	112	451
Percentage								
1951	100. 0	20. 4	12. 5	—	—	—	—	—
1955	100. 0	15. 4	9. 3	—	—	3	—	—
1960	100. 0	6. 8	5. 1	—	1. 0	49. 9	—	3. 2
1965	100. 0	4. 3	3. 5	48. 0	9. 8	25. 0	3. 5	9. 2
1970	100. 0	10. 4	3. 0	49. 0	13. 3	24. 2	3. 9	16. 5

Source: Same as in Table 1
Note: SITC 72

and strikingly, reaching in 1965 and 1970 about one half of all electrical exports.

Other main items are tape-recorders and heavy electric machinery. The former increased suddenly like TV and radio sets, while the latter decreased its share, although it recovered a little in 1970. The fact tells us that Japan is handicapped in the export of heavy electric machines, in spite of her splendid

Table 8. Exports of Transport Equipment classified by Main Items (in million dollars)

Year	Total	Railway Vehicles	Road Motor Vehicles	of which: Passenger Cars	Buses & Trucks	Motor-cycles	Ships
Amount							
1951	33	3	3	—	2	—	16
1955	119	11	10	1	5	1	78
1960	433	22	96	16	60	10	288
1965	1, 243	41	266	115	85	162	748
1970	3, 442	72	1, 337	903	394	384	1, 410
Percentage							
1951	100. 0	8. 2	9. 0	—	5. 7	—	49. 5
1955	100. 0	9. 4	8. 3	0. 5	4. 1	0. 4	65. 7
1960	100. 0	5. 0	22. 1	3. 7	13. 9	2. 4	66. 5
1965	100. 0	3. 3	21. 4	9. 3	6. 8	13. 0	60. 3
1970	100. 0	2. 1	39. 0	26. 3	11. 4	11. 2	41. 0

Source: Same as in Table 1
Note: SITC 73

Table 9. Exports of Precision Instruments classified by Main Items (in million dollars)

Year	Total	Binoculars	Cameras	8 mm Cinema Cameras	Watches & Clocks
Amount					
1951	11	3	1	—	1
1955	27	9	6	—	2
1960	96	16	16	12	4
1965	243	28	58	23	26
1970	628	32	147	45	130
Percentage					
1951	100. 0	27. 0	10. 0	—	12. 9
1955	100. 0	31. 8	22. 2	—	6. 3
1960	100. 0	16. 6	17. 0	12. 4	3. 6
1965	100. 0	11. 6	24. 1	9. 5	10. 7
1970	100. 0	5. 1	23. 4	7. 2	20. 8

Source: Same as in Table 1
Note: SITC 861+864

success in the light electric machines. (See Table 7.)

(c) The transport equipment group

The principal articles of transport equipments are railway vehicles, road motor vehicles, ships and so forth.

The most distinguished item has been ships, although its share has lately been diminishing. In contrast, road motor vehicles have recently been increasing their share, approaching the ratio of ships. (See Table 8.)

(d) The precision instruments group

In the early postwar days, binoculars were the most significant item, but in later years their share declined heavily, coming down from 32% in 1955 to 5% in 1970. Taking the place of binoculars, cameras increased their percentage, in 1970, to 23%. The proportion of watches and clocks also increased during the 1960's, although in the 1950's their share had decreased. (See Table 9.)

2. Imports

On the import side, non-electric machines hold the major part except in 1951. This differs from the commodity pattern on the export side, where non-electric machinery takes third place following electric machinery and transport equipment. Electric machinery ranks second and transport equipment takes the third place. Precision instruments come last as they do on the export side.

Table 10. Commodity Pattern of Engineering Imports into Japan (in million dollars)

Year	Total	Non-electric Machinery	Electric Machinery	Transport Equipment	Precision Instruments
Amount					
1951	61	13	3	41	3
1955	142	92	17	23	9
1960	435	282	34	87	32
1965	760	451	111	154	44
1970	2, 298	1, 262	478	406	151
Percentage					
1951	100. 0	21. 0	5. 5	68. 0	5. 6
1955	100. 0	65. 2	12. 3	15. 9	6. 6
1960	100. 0	64. 7	7. 9	20. 0	7. 4
1965	100. 0	59. 2	14. 6	20. 4	5. 8
1970	100. 0	54. 9	20. 8	17. 7	6. 6
Increment					
1951-55	81	79	14	18	6
1955-60	293	190	17	64	23
1960-65	325	169	77	67	12
1965-70	1, 532	811	367	252	107

Source: Same as in Table 1

(See Table 10.)

Each of the four groups of imports consists of various articles. The breakdown of each group will be made clear in the following.

(a) The non-electric machinery group

Office machines, especially computers, are the most eminent item, taking up about a quarter of the total imports of non-electric machinery. Metal-working machinery comes next to computers, followed by textile machinery. Noteworthy is the fact that the proportion of internal combustion engines for aircraft has been rising gradually, according to the increase of aircrafts operated in Japan (See Table 11.)

(b) The electrical machinery group

Heavy electrical machinery, semi-conductor devices, and electric measuring equipment are the important commodities, each accounting for about 20% of the electrical imports. Telecommunication equipments are now less significant in percentage, although they were responsible, in 1951, for 66% of the electrical goods imported into Japan. (See Table 12.) Her imports are now limited to special articles, such as radars for ships and aircrafts, wireless equipments for aircrafts and so on.

(c) The transport equipment group

It is noticeable that the share of aircrafts registered is as high as 61% of the transport equipment imports in 1970, running far ahead of road motor vehicles and ships. This is due not only to the expansion of Japanese air transportation

Table 11. Imports of Non-Electric Machinery classified by Main Articles (in million dollars)

Year	Total	Office Machines	Of which: Computers	Metal-Working Machinery	Textile Machinery	Internal Combustion Engines for Aircraft
Amount						
1951	13	—	—	1	2.5	—
1955	92	—	—	13	8	1
1960	282	53	14	74	16	14
1965	546	133	76	95	50	21
1970	1,262	322	243	168	102	77
Percentage						
1951	100.0	—	—	8.6	19.5	—
1955	100.0	—	—	14.0	9.0	1.4
1960	100.0	18.8	5.0	26.5	5.5	4.8
1965	100.0	24.0	13.9	13.8	6.6	5.7
1970	100.0	25.5	19.3	13.4	8.0	6.1

Source: Same as in Table 1
Note: SITC 71

Table 12. Imports of Electrical Machinery classified by Main Articles

Year	Total	Heavy Electric Machinery	Telecommunication Equipment	Electric Measuring Equipment	Semi-Conductor Devices
Amount (in million dollars)					
1951	3	0.1	2	—	—
1955	17	5	4	—	—
1960	34	8	10	5	—
1965	111	18	11	23	7
1970	478	93	53	87	92
Percentage					
1951	100.0	4.2	66.2	—	—
1955	100.0	30.0	21.2	—	—
1960	100.0	23.5	29.4	14.7	—
1965	100.0	15.9	9.9	20.4	6.2
1970	100.0	19.4	11.0	18.3	19.3

Source: Same as in Table 1
Note: SITC 72

Table 13. Imports of Transport Equipment classified by Main Articles

Year	Total	Passenger-cars	Aircrafts	Ships
Amount (in million dollars)				
1951	41	14	1	25
1955	23	6	4	4
1960	87	9	44	29
1965	154	28	81	34
1970	406	54	249	61
Percentage				
1951	100.0	33.6	3.5	61.0
1955	100.0	28.2	17.5	16.2
1960	100.0	10.8	50.5	33.4
1965	100.0	18.2	52.6	22.1
1970	100.0	13.3	61.5	14.9

Source: Same as in Table 1
Note: SITC 73

but also to the purchase of huge aircrafts (for example, Boeing 747). The import of passenger cars also increased in 1970, owing to the reduction of tariff for small sized cars. (See Table 13.)

(d) The precision instruments group

Scientific and optical instruments take the major part of precision instruments imported into Japan, one half of which consists of measuring instruments. Watches and clocks accounted in 1951 for 54%, but later the percentage decreased to 10% in 1960. In the latter part of the 1960's, their share began to increase,

Table 14. Imports of Precision Instruments classified by Main Articles

Year	Total	Scientific & Optical Instruments	Watches & Clocks
Amount (in million dollars)			
1951	4	2	2
1955	9	7	2
1960	32	29	3
1965	44	33	11
1970	151	115	36
Percentage			
1951	100.0	46.0	54.0
1955	100.0	80.8	19.2
1960	100.0	89.7	10.3
1965	100.0	76.0	24.0
1970	100.0	76.0	24.0

Source: Same as in Table 1
Note: SITC 861+864

reaching 24% in 1970. This is mainly due to the increase in the import of cheap pin-lever watches. (See Table 14.)

III. International Comparison of the Commodity Pattern in the Engineering Trade

1. Exports

In the 1967–1969 period, Japan ranks fourth among the leading industrial nations as for the total amount of engineering exports, following the United States, Germany (F. R.), and the United Kingdom. The place of Japan differs, however, according to the group of engineering products. In respect to the non-electric machinery group, Japan ranks sixth. This means the weak competitiveness in the trade of this kind. Japan, however, occupies the second place, following the United States, in regard to precision instruments. Electrical machinery is also the strong side of Japan. Here Japan takes the third place following the United States and Germany. Japan ranks fourth as for the amount of transport equipment exported, following the United States, Germany, and the United Kingdom, but the difference in the amount between the United Kingdom and Japan is very small. The figures in Table 14 refer to the average of the period ranging from 1967 to 1969. The Japanese figure in 1968 and in 1969, however, amounted to 2,236 million dollars and 2,631 million dollars, while that of the U. K. amounted to 2,184 million dollars and 2,571 million dollars respectively. Consequently, Japan came up to the third place in 1968 and 1969. The strength of Japan in the category of engineering exports is chiefly due to her ship building industry. The amount of ships exported from Japan during this period occupies the top place, far exceeding that of other nations. Germany comes next to Japan in respect to the export of ships, but the amount is less than one third of that of Japan.

The comparison of the percentage of each category discloses to us that in all countries except Japan non-electric machinery accounts for more than or about 40% of the engineering exports. It is only in Japan that this kind of products takes only little more than 20%. This reflects the comparative weakness in this branch of Japanese industry. On the contrary, the percentage of ships exported from Japan shows an astonishingly high level, disclosing the relative strength of Japan in this field. Japan enjoys also an advantageous position in the electrical machinery exports. This is chiefly because of her strong telecommunication equipment industry, whose products exported account for almost half of the total exports of electrical machinery. (See Table 15.)

Table 15. Commodity Pattern of Engineering Exports from Leading Industrial Countries (1967–69 average)

	U. S. A.	Germany	U. K.	France	Italy	Japan
Amount (in million dollars)						
Total	15, 420	12, 276	6, 746	4, 112	3, 662	5, 445
Non-Electric Machinery	6, 486	5, 584	3, 101	1, 631	1, 754	1, 211
Electrical Machinery	2, 324	2, 037	1, 018	700	710	1, 544
(Telecommunication Equipment)	(619)	(508)	(262)	(129)	(144)	(907)
Transport Equipment	5, 632	3, 882	2, 253	1, 545	1, 058	2, 200
(Ships)	(104)	(294)	(175)	(117)	(74)	(1, 068)
Precision Instruments	949	772	373	237	141	476
Percentage						
Total	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0
Non-Electric Machinery	42. 0	45. 5	46. 0	39. 6	47. 9	22. 2
Electrical Machinery	15. 3	16. 6	15. 1	17. 0	19. 4	28. 3
(Telecommunication Equipment)	(4. 0)	(4. 1)	(3. 9)	(3. 1)	(1. 9)	(16. 7)
Transport Equipment	36. 5	31. 6	33. 4	37. 6	28. 9	40. 4
(Ships)	(0. 7)	(2. 4)	(2. 6)	(2. 9)	(2. 0)	(19. 6)
Precision Instruments	6. 2	6. 3	5. 5	5. 8	3. 8	8. 7

Source: United Nations, Commodity Trade Statistics
Note: SITC 71, 72, 73, and 86

2. Imports

The place of Japan is at the bottom of the leading industrial powers with regard to the value of engineering imports, not only in total, but also in every individual category of engineering products. The percentage of non-electric machinery in the total engineering imports of Japan reaches about 60%

during the period from 1967 to 1969. This ratio is the highest among advanced countries. The main items are computers, metal-working machinery and textile machinery.

Among the four categories the share of non-electric machinery shows the highest figure in each country's imports except for the United States, where the percentage of transport equipment shows the largest ratio owing to the enormous amount of automobile imports. The percentage of electrical machinery for all countries is nearly the same, centering around the level of 20%. The share of precision instruments imported into these six countries fails to come up to the level of 10%. (See Table 16.)

Table 16. Commodity Pattern of Engineering Imports into Leading Industrial Countries (1967–69 average)

	U. S. A.	Germany	U. K.	France	Italy	Japan
Amount (in million dollars)						
Total	8, 380	3, 437	3, 072	3, 703	1, 889	1, 359
Non-electric Machinery	2, 210	1, 415	1, 520	1, 887	924	802
Electrical Machinery	1, 521	750	571	670	390	242
Transport Equipment	4, 113	954	710	869	412	189
Precision Instruments	140	319	267	278	163	126
Percentage						
Total	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0
Non-Electric Machinery	26. 4	41. 4	49. 5	51. 0	49. 5	59. 0
Electrical Machinery	18. 2	21. 7	18. 6	18. 0	20. 8	17. 9
Transport Equipment	49. 0	27. 7	23. 2	23. 5	22. 8	14. 8
Precision Instruments	6. 4	9. 2	8. 7	7. 5	8. 7	9. 3

Source: Same as in Table 15
Note: SITC 71, 72, 73 and 86

IV. Geographical Pattern of the Engineering Trade of Japan

1. Exports

The principal markets of Japanese engineering products are the United and South East Asian countries. Since the beginning of 1960's, the share of the United States has been rising, whereas that of South East Asian countries has been falling. For instance, the percentage of the former rose from 18.8% in 1960 to 34.8% in 1970, while that of the latter fell from 37.6% in 1960 to 21.6% in 1970. Thus, the relative position of these two markets has been reversed. It is a noteworthy fact that these two markets are so important as to absorb more than one half of the Japanese engineering products. The large amount of export to South East Asian countries is partly due to the economic cooperation of Japan with these countries. Western Europe is the third largest market, whose share increased from 12.1% in 1960 to 17.4% in 1970. The percentage of Africa remained rather stagnant showing 10.8% in 1960 and 10.5% in 1970, although it increased to 16.2% in 1965. The share of Latin America was reduced by half from 13.0% in 1960 to 6.1% in 1970, notwithstanding the increase of the export value rising from 133 million dollars in 1960 to 588 million dollars in 1970. Oceania is expected to be a promising market, but its share is not very large at present. The percentage of the Sino-Soviet market is also quite small today. (See Table 17.)

Table 17. Geographical Pattern of Engineering Exports from Japan (in million dollars)

Destination	1960		1965		1970	
	Amount	%	Amount	%	Amount	%
Total	1, 023	100. 0	2, 975	100. 0	8, 941	100. 0
South East Asia	386	37. 6	783	26. 4	1, 938	21. 6
(S. Korea)	(37)	(3. 6)	(49)	(1. 6)	(296)	(3. 3)
(Taiwan)	(40)	(3. 9)	(94)	(3. 1)	(344)	(3. 8)
West Asia	29	2. 8	83	2. 8	196	2. 2
Western Europe	124	12. 1	399	13. 4	1, 555	17. 4
EEC	21	2. 1	123	4. 1	580	6. 5
(Germany)	(11)	(1. 0)	(61)	(2. 0)	(267)	(3. 0)
EFTA	54	5. 3	199	6. 7	637	7. 1
(U.K.)	(12)	(1. 1)	(49)	(1. 6)	(279)	(3. 1)
North America	200	19. 5	759	25. 4	3, 114	34. 8
(U.S.A.)	(189)	(18. 8)	(707)	(23. 6)	(2, 841)	(31. 8)
Latin America	133	13. 0	195	6. 5	588	6. 1
Africa	111	10. 8	483	16. 2	934	10. 5
(Liberia)	(76)	(7. 5)	(366)	(12. 5)	(577)	(6. 4)
Oceania	21	2. 0	115	3. 8	353	3. 9
Sino-Soviet Area	20	1. 9	158	5. 3	265	2. 8

Source: Same as in Table 1
Note: SITC 71, 72, 73 and 861+864
Exports to Liberia consist principally of ships under the flag of convenience.

2. Imports

The sources for the supply of engineering imports center on North America and Western Europe. The supply from these regions together comprise in 1960 98% and in 1970 97% of the Japanese engineering imports. This is because other regions have not been able to export engineering products in large quantities. The United States is by far the biggest supplier, accounting in 1960 for 63% and in 1970 for 61% of the total engineering products imported into Japan.

Western Europe comes next to the United States, recording 35% in the 1960's and in 1970. The proportions of EEC increased from 18.5% in 1960 to 21.1% in 1970, while that of EFTA decreased from 16.2% in 1960 to 13.5% in 1970. Thus the difference of the ratio between these two areas has widened. In 1970, even the share of Germany alone surpassed that of the EFTA countries put together. The percentage of the United Kingdom which showed 8.6% in 1960 rose a little in 1965, but declined to 5.6% in 1970. (See Table 18.)

Table 18. Geographical Pattern of Engineering Imports into Japan (in million dollars)

	1960		1965		1970	
	Amount	%	Amount	%	Amount	%
Total	435	100.0	760	100.0	2,298	100.0
South East Asia	0.5	—	2.1	0.2	37	1.7
(S. Korea)	—	—	—	—	(6)	(0.2)
(Taiwan)	—	—	—	—	(20)	(0.9)
West Asia	0.3	—	9.6	1.3	0.4	—
Western Europe	153	35.0	298	39.2	803	35.1
EEC	81	18.5	158	20.8	483	21.1
(Germany)	(607)	(13.8)	(115)	(15.2)	(334)	(14.5)
EFTA	71	16.2	139	18.2	311	13.5
(U.K.)	(37)	(8.6)	(72)	(9.5)	(128)	(5.6)
North America	274	63.0	428	56.2	1,425	62.1
(U.S.A.)	(267)	(62.0)	(416)	(55.0)	(1,412)	(61.2)
Latin America	2.9	0.6	3.2	0.4	1.4	—
Africa	2.2	0.5	14.1	1.8	5.1	—
Oceania	0.4	—	0.8	—	3.3	—
Sino-Soviet Area	1.6	—	4.3	—	23	(1.0)

Source: Same as in Table 1
Note: SITC 71, 72, 73 and 861+864
Imports from Africa consist chiefly of ships from Liberia.

It is to be remarked that the percentage of South East Asian countries in engineering imports, though negligible, has recently been increasing.

V. Geographical Pattern of Trade in Important Categories of Articles

1. Exports

(1) Exports of Non-electric Machinery

The principal markets for non-electric machinery are the United States and Asian countries, followed by Western Europe.

The United States raised its share from 14.7% in 1965 to 20.4% in 1970, chiefly because of its rapid import increase of office machines, especially desk-top calculators. In contrast, Asian countries are the chief market of such articles as metal-working, textile, mining and construction machinery. The main articles exported to Western Europe are office machines, bearings, sewing machines and mechanical handling equipments, although this market absorbs various kinds of non-electric machinery. (See Table 19.)

Table 19. Exports of Non-Electric Machinery classified by Regions (in million dollars)

Destination	1965		1968		1970	
	Amount	%	Amount	%	Amount	%
Total	624	100. 0	1, 167	100. 0	2, 006	100. 0
South East Asia	281	45. 0	544	46. 6	730	36. 5
(S. Korea)	(26)	(4. 2)	(143)	(12. 2)	(142)	(7. 1)
(Taiwan)	(35)	(5. 6)	(92)	(7. 8)	(114)	(5. 7)
West Asia	14	2. 3	45	3. 8	31	1. 5
Western Europe	64	10. 2	113	9. 6	306	15. 3
EEC	33	5. 2	87	5. 9	190	9. 5
(Germany)	(15)	(2. 4)	(29)	(2. 5)	(94)	(4. 7)
EFTA	16	2. 5	36	3. 1	85	4. 2
North America	100	16. 0	249	21. 3	461	23. 0
(U.S.A.)	(92)	(14. 7)	(227)	(19. 5)	(408)	(20. 4)
Latin America	31	6. 2	61	5. 2	123	6. 1
Africa	24	5. 0	42	3. 6	88	4. 3
Oceania	14	2. 9	47	4. 0	108	5. 4
Sino-Soviet Area	68	14. 2	67	5. 7	160	8. 0

Source: Same as in Table 1
Note: SITC 71

(2) Exports of Electrical Machinery

Almost one half of the electrical machinery flows into the United States market, while the share of Asian countries, the second largest market, remains about 20% and Western Europe, the third largest market, takes about 10% of the electrical goods exported from Japan. The main articles exported to the United States are telecommunication equipments such as TV sets and radio receivers, which account for about 60% of the total. Next come tape-recorders, comprising about 20% of the electrical exports to the United States. Heavy electrical machinery and domestic electric equipment are also principal exports, but their weight is very small as compared with that of telecommunication equipments. Asian countries import chiefly telecommunication equipments, heavy electrical machinery, tape-recorders, and domestic electrical equipments. Western Europe also imports telecommunication equipment, tape-recorders and heavy electric machinery in fairly large amounts but the imported amount of domestic electric equipment is very small. (See Table 20.)

Table 20. Exports of Electrical Machinery classified by Regions (in million dollars)

Destination	1965		1968		1970	
	Amount	%	Amount	%	Amount	%
Total	865	100. 0	1, 812	100. 0	2, 865	100. 0
South East Asia	208	23. 9	445	24. 5	603	21. 1
(S. Korea)	(12)	(1. 4)	(61)	(3. 4)	(72)	(2. 6)
(Taiwan)	(26)	(3. 0)	(78)	(4. 3)	(141)	(4. 9)
West Asia	32	3. 6	53	2. 9	87	3. 1
Western Europe	81	9. 4	159	8. 7	355	12. 3
EEC	39	4. 5	75	4. 2	198	6. 9
EFTA	34	3. 9	67	3. 7	134	4. 7
North America	396	45. 7	909	50. 1	1, 425	49. 8
(U.S.A.)	(376)	(43. 5)	(847)	(47. 0)	(1, 328)	(46. 5)
Latin America	62	7. 2	122	6. 7	186	6. 5
Africa	33	3. 8	57	3. 1	96	3. 4
Oceania	30	3. 4	42	2. 3	80	2. 8
Sino-Soviet Area	4. 1	0. 5	26	1. 4	32	1. 1

Source: Same as in Table 1
Note: SITC 72

(3) Exports of Transport Equipment

The important markets of Japanese transport equipments are the United States, Western Europe, Africa and the Asian Countries. The principal commodities exported to the United States are land transport equipments such as passenger cars, motor-cycles, trucks and busses, whereas those exported to Western Europe and Africa are mainly water transport equipments such as tankers and cargo boats. The Asian countries import both kinds, although the ratio of road motor vehicles is larger than that of ships. (See Table 21.)

(4) Exports of Precision Instruments

The leading markets of Japanese precision instruments are, in the order of their magnitude, the United States, Western Europe, and the Asian countries. The United States takes about one third, Western Europe about a quarter, and the Asian countries about one fifth of the exports in this category.

The principal commodities are cameras, 8 mm cinecameras, binoculars, watches and clocks. All of these items are enjoying steady expansion. Particularly watches, especially wrist watches, have been marking a remarkable advance

Table 21. Exports of Transport Equipment classified by Regions
(in million dollars)

Destination	1965		1968		1970	
	Amount	%	Amount	%	Amount	%
Total	1, 243	100. 0	2, 236	100. 0	3, 443	100. 0
South East Asia	259	20. 8	442	19. 7	469	13. 7
West Asia	31	2. 5	40	1. 8	61	1. 8
Western Europe	187	15. 1	515	23. 0	733	21. 4
EEC	16	1. 3	85	3. 8	86	2. 5
EFTA	121	9. 7	322	14. 4	372	10. 8
North America	172	13. 8	401	17. 9	1, 018	29. 6
(U.S.A.)	(158)	(12. 7)	(364)	(16. 5)	(915)	(26. 6)
Latin America	83	6. 7	212	9. 5	231	6. 7
Africa	415	33. 5	513	22. 9	730	21. 2
(Liberia)	(364)	(29. 4)	(429)	(19. 4)	(575)	(16. 7)
Oceania	49	3. 9	98	4. 4	140	4. 1
Sino-Soviet Area	47	3. 8	15	0. 7	60	1. 7

Source: Same as in Table 1
Note: SITC 73

Table 22. Exports of Precision Instruments classified by Regions
(in million dollars)

Destination	1965		1968		1970	
	Amount	%	Amount	%	Amount	%
Total	243	100. 0	441	100. 0	628	100. 0
South East Asia	36	14. 7	96	21. 8	136	21. 6
West Asia	6	2. 4	12	2. 7	17	2. 7
Western Europe	66	27. 2	103	23. 2	161	25. 6
EEC	35	14. 3	58	13. 3	106	16. 9
EFTA	29	12. 2	38	8. 7	45	7. 2
North America	91	37. 6	162	36. 8	209	33. 3
(U.S.A.)	(81)	(33. 3)	(149)	(33. 8)	(190)	(30. 4)
Latin America	16	6. 5	29	6. 5	48	7. 6
Africa	7	2. 9	12	2. 8	20	3. 2
Oceania	11	4. 6	18	4. 0	25	3. 9
Sino-Soviet Area	10	4. 0	9	2. 0	13	2. 1

Source: Same as in Table 1
Note: SITC 861+864

into the Asian market in recent years. (See Table 22.)

2. Imports

(1) Non-electric machinery

The principal articles of non-electrical imports are office machines, especially computers, metal-working machinery, textile machinery, and internal combustion engines for aircrafts. The suppliers are almost limited to the United States and Western Europe. In 1970 the United States accounts for 52% and Western Europe for 45%. The United States is stronger, as a supplier, in office machines and internal combustion engines for aircraft, but she is weaker than Western Europe in metal-working machinery and textile machinery. (See Table 23.)

Table 23. Imports of Non-Electric Machinery classified by Regions (in million dollars)

Provenance	1965		1968		1970	
	Amount	%	Amount	%	Amount	%
Total	451	100.0	822	100.0	1,262	100.0
U.S.A.	229	57.0	421	51.1	690	54.6
Western Europe	207	46.0	—	—	539	42.8
EEC	115	25.6	—	—	346	27.4
(Germany)	(85)	(18.8)	(16)	(19.5)	(238)	(18.8)
(France)	(14)	(3.1)	(24)	(2.9)	(49)	(3.8)
(Italy)	(13)	(2.9)	(31)	(3.7)	(42)	(3.3)
EFTA	91	20	—	—	188	14.9
(U.K.)	(48)	(10.7)	(65)	(7.9)	(86)	(6.8)
(Switzerland)	(16)	(3.5)	(40)	(4.8)	(50)	(3.9)
(Sweden)	(17)	(3.8)	(26)	(3.1)	(35)	(2.8)

Source: Same as in Table 1
Note: SITC 71

(2) Electrical machinery

The main commodities of electrical imports are heavy electrical machinery, telecommunication equipments, and electric measuring equipments. In 1970 the United States is responsible for about 70% and Western Europe for about 20% of electrical imports. The United States is, as a supplier, far stronger than Western Europe in respect to the above important commodities. (See Table 24.)

(3) Transport Equipment

The major commodities of transport equipments imported are aircrafts, passenger cars, and ships. In this field the United States is the biggest supplier accounting for about three quarters of the total imports., while Western Europe remains far behind. (See Table 25.) Almost all aircrafts are imported into Japan from the United States. More passenger cars, however, are supplied by Western Europe than by the United States. In 1970 the former furnished 30 million dollars of passenger cars while the latter 23 million dollars. Ships are chiefly imported from Western Europe and Liberia.

Table 24. Imports of Electrical Machinery classified by Regions
(in million dollars)

Provenance	1965		1968		1970	
	Amount	%	Amount	%	Amount	%
Total	111	100.0	241	100.0	478	100.0
U.S.A.	70	63.0	173	72.0	341	71.2
Western Europe	40	36.0	56	23.1	103	21.9
EEC	18	16.2	30	12.5	61	12.7
Germany	11	10.0	16	6.7	33	6.9
Italy	1	—	2	0.1	12	2.5
France	2	0.2	5	0.2	8	1.6
Netherlands	3	0.3	6	2.5	7	1.4
EFTA	21	18.1	24	10.1	39	8.2
U.K.	12	10.8	12	5.0	20	4.2
Sweden	5	0.4	5	0.2	8	1.6
Switzerland	2	0.2	3	1.2	7	1.4
South East Aisa	0.5	—	5	2.1	28	5.8
Taiwan	—	—	1	—	15	3.1
Hong Kong	0.4	—	3	1.2	7	1.4
S. Korea	—	—	0.5	—	6	1.2

Source: Same as in Table 1
Note: SITC 72
Imports from South East Asia are chiefly semi-conductor devices.

Table 25. Imports of Transport Equipment classified by Regions
(in million dollars)

	1965		1968		1970	
	Amount	%	Amount	%	Amount	%
Total	154	100.0	175	100.0	406	100.0
U.S.A.	95	60.0	112	64.0	302	74.4
Western Europe	30	19.5	40	23.1	93	22.9
EEC	16	10.4	19	11.1	48	11.8
Germany	13	8.4	16	9.1	42	10.3
Netherlands	0.5	0.3	0.2	—	4	1.0
EFTA	13	8.4	20	11.3	45	11.1
U.K.	10	6.5	13	7.4	16	3.9
Sweden	0.7	0.5	2	1.1	13	3.2
Norway	1.3	0.8	4	2.2	13	3.2
Others: Liberia	—	—	8	4.5	5	1.2

Source: Same as in Table 1
Note: SITC 73
Imports from Liberia are ships.

(4) Precision Instruments

Precision instruments imported are divided into two classes; the first includes scientific and optical instruments and the other watches and clocks. The main suppliers are, as in other fields, the United States and Western Europe. Although the United States furnishes more precision instruments, her superiority over Western Europe is not as large as in other branches. For example, in 1970, the share of the former is 52%, while that of the latter 45%.

As for scientific and optical instruments, the percentage of the United States reaches a high of 70%, while her share in watches and clocks is only about 10%. Western Europe, particularly Switzerland, holds the overwhelming supremacy for the imports of watches and clocks into Japan. (See Table 26.)

Table 26. Imports of Precision Instruments classified by Regions (in million dollars)

Provenance	1965		1968		1970	
	Amount	%	Amount	%	Amount	%
Total	44	100.0	89	100.0	151	100.0
U.S.A.	22	50.0	45	50.5	79	52.2
Western Europe	22	50.0	41	45.9	67	44.6
EEC	8.6	19.5	16	17.6	29	19.3
Germany	6	13.6	11	12.4	21	13.8
France	0.7	—	2	2.2	3.4	2.2
Italy	1.3	3.0	2	2.2	3.3	2.1
EFTA	13.2	30.0	25	29.3	38	25.3
Switzerland	9	22.0	18	20.2	29	19.2
U.K.	3	7.0	5	5.6	6	3.9
Others: Taiwan	—	—	0.1	—	2.3	1.5

Source: Same as in Table 1
Note: SITC 861+864

VI. International Comparison of Geographical Pattern of the Engineering Trade

1. Exports

The principal markets of the United States are Canada and Western Europe; these two markets accounted in 1969 for 31.5% and 25.6% respectively. In contrast, Germany, France and Italy largely depend upon Western European market, where intra-regional trade of the EEC plays an important role. The weight of the United States market is not very large for these three European nations, particularly not for France, whose dependance on the United States

Table 27. Geographical Breakdown of the Engineering Exports[1] from Leading Industrial Countries (1969) (in million dollars)

	U.S.A.		Germany		U.K.		France		Italy		Japan	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Total	16, 380	100. 0	13, 375	100. 0	7, 090	100. 0	4, 599	100. 0	4, 103	100. 0	6, 165	100. 0
U.S.A.	—	—	1, 680	12. 6	785	11. 1	205	4. 4	352	8. 6	1, 832	29. 6
Canada	5, 194	31. 5	170	1. 3	328	4. 6	38	0. 8	34	0. 8	176	2. 8
Latin American Republics	2, 286	13. 8	601	4. 5	333	4. 7	249	5. 4	303	7. 4	355	5. 7
W. Europe	4, 206	25. 6	8, 457	63. 2	2, 720	38. 5	2, 654	57. 6	2, 396	58. 5	817	13. 2
EEC	2, 348	14. 3	4, 522	33. 8	1, 313	18. 5	1, 791	39. 1	1, 486	36. 2	265	4. 3
EFTA	1, 346	8. 2	2, 973	22. 4	799	11. 3	573	12. 5	486	11. 8	326	5. 3
E. Europe	65	0. 4	510	3. 8	244	3. 4	288	6. 2	310	7. 5	95	1. 5
Middle East	665	4. 0	483	3. 6	569	8. 0	170	3. 7	218	5. 3	203	3. 3
Australia, New Zealand, South Africa	803	4. 9	425	3. 1	926	13. 1	132	2. 8	115	2. 8	331	5. 3
Other African countries	283	1. 6	287	2. 1	402	5. 7	575	12. 5	133	3. 2	581	9. 4
China (Main-Land)	—	—	40	0. 3	6	—	17	0. 4	11	0. 2	56	0. 9
Japan	811	4. 9	195	1. 5	95	1. 3	28	0. 6	29	0. 7	—	—
Other Asian countries	977	5. 9	487	3. 6	521	7. 4	156	3. 4	163	3. 9	1, 651	26. 8
(Sterling Area)	(2, 418)	(14. 8)	(1, 575)	(11. 8)	(2, 170)	(30. 6)	(442)	(9. 4)	(490)	(12. 0)	(1, 067)	(17. 3)
(Developing Countries)	(4, 443)	(27. 0)	(1, 898)	(14. 3)	(1, 983)	(28. 0)	(1, 237)	(27. 9)	(850)	(20. 3)	(2, 856)	(46. 3)

Source: Same as in Table 14

Note: (1) SITC 7

market is quite small, registering for example in 1960 4.4%. The exports of the United Kingdom are directed chiefly to Western Europe and the sterling area, the percentages of these two main markets were in 1969 38.5% and 30.6% respectively, while the United States market accounted for only 11.1%.

Japan concentrates her exports on the U. S. A. and on Asian countries, Western Europe ranking third in importance. The ratio of exports to developing countries to the total of exports is by far the largest for Japan when compared with other advanced nations. This is one of the characteristic features of Japan's trade.

The share of developing countries as a market of the engineering trade is the smallest for Germany and the largest for Japan, that of the other four countries lying in between. The magnitude of the engineering exports from Japan to developing countries, ranks second, following the United States. (See Table 27.)

2. Imports

The United States is supplied with engineering products chiefly by Canada, Western Europe and Japan. The dependence upon Canada is largest, followed by that upon Western Europe and Japan. Notwithstanding the small weight of Japan as a supplier to other industrial countries, the United States purchases a relatively large amount of engineering products from Japan. The comparatively large dependence of the United States on Canada and Japan is one of the main features of the United States' engineering imports.

On the other hand, the dependence of Japan's import upon the United States is so large that the percentage of her imports from there goes up to as high as 60%, far surpassing the corresponding figures from other countries. Germany, France and Italy are supplied with engineering products chiefly by Western Europe. Their dependence upon Western European sources rises as high as 70% to 80%, while the share of the United States as provenance ranges from 15% to 20%. The United Kingdom remains half way. Although her dependence upon Western Europe is larger, the United States accounts for a fairly high percentage as her supplier. (See Table 28.)

VII. Conclusion

The patterns of the Japanese engineering trade differ widely when compared with those of other leading industrial nations.

1. The first point is that, in comparison with other countries, Japan depends upon the United States to the highest extent not only as a market but as a source

Table 28. Geographical Breakdown of Engineering Imports into Leading Industrial Countries (1969) (in million dollars)

Provenance	U.S.A.		Germany		U.K.	
	Amount	%	Amount	%	Amount	%
Total	9,768	100.0	3,939	100.0	3,166	100.0
U.S.A.	—	—	676	18.7	1,244	39.4
Canada	4,201	43.0	10	0.2	58	1.8
Western Europe	3,406	35.0	3,082	78.0	1,686	53.2
EEC	2,199	22.6	2,122	53.7	1,225	38.8
EFTA	1,130	11.6	892	22.6	389	12.3
Japan	1,735	17.7	101	2.5	53	1.7
	France		Italy		Japan	
Total	4,217	100.0	2,366	100.0	1,501	100.0
U.S.A.	651	15.5	487	20.6	902	60.0
Canada	12	0.2	7	0.3	16	1.1
Western Europe	3,443	82.0	1,824	72.0	518	34.2
EEC	2,780	66.0	1,443	60.8	307	20.4
EFTA	631	15.0	356	15.0	208	13.8
Japan	52	1.2	20	0.8	—	—

Source: Same as in Table 14
Note: (1) SITC 7

of supply as well.

2. The second point is that ships hold an important part among engineering products exported by Japan. This is quite different from the export structure of other countries.

3. The third point is that the share of developing countries as markets for engineering exports is the largest in Japan and the amount of exports directed to these nations is the second largest only to that of the United States.

4. The fourth point is that Japan generally exports capital intensive products or producer goods, such as heavy machinery, to developing countries, and labour intensive goods or consumer goods, such as light machines, to industrial nations.

5. The fifth point is that as regards labour intensive commodities, for example transistor radio receivers, the competition with developing countries, such as Hongkong, Taiwan, and South Korea, has recently been growing keener owing to the rising wage costs of Japan, so that Japan's share in this branch has been declining, especially on the United States market. This tendency will be strengthened with the implementation of preferential tariff schemes for the products of developing countries.

In order to expand her engineering trade, Japan should, therefore, shift her emphasis from light or simple machines to heavy or sophisticated machinery.

OPTIMAL PROCESS OF ECONOMIC DEVELOPMENT

Hikoji KATANO

I. Introduction

Many descriptions of development processes have been given over these years(1): some of them show us the optimal patterns for development.(2) However, these do not consider the process with debt-servicing.(3) The objective of this study is to investigate an optimal development process with debt-servicing. This study is in the line of the "two-gap" theory to be developed towards a direction mentioned above.(4) And it will be developed in terms of Pontryagin's maximum principle.(5)

II. Theoretical Framework

Development processes of developing economies start with utilization of net capital inflows from abroad. However, this sort of net capital inflow may be not donation from abroad, but is to be paid back to the lending countries under certain conditions. We consider the developing countries to be self-sustained at the time when these two stages (both borrowing and debt-servicing) will be completed. And, we consider further that their economies will realize a target rate of growth of GDP at the time they realize their self-sustained situation.

Variables and parameters to be used in the following arguments are defined as follows.

V: GDP
I: investment
S: domestic savings
S^*: potential domestic savings
M: imports
M^*: minimum import requirement
E: exports
F: net capital inflow

(1) As the most typical one, we refer to [3].
(2) See, [1], [2], [4] and [5].
(3) [2] does implicitly consider this sort of problem, but is not decisive.
(4) This study mainly depends on [3].
(5) See [6].

C: consumption
λ: investment growth rate
β: investment productivity
s: marginal saving rate
α: average saving rate
μ: marginal import rate
m: average import rate
ε: export growth rate

As an initial situation of development, we postulate the conditions

$$V_0,\ I_0,\ S_0,\ M_0,\ E_0,\ S^*_0,\ M^*_0,\ C_0=\text{given},$$
$$I_0-S^*_0>M^*_0-E_0,$$

where the net capital inflow is determined by the saving-gap $(I_0-S^*_0)$. And, for some time, investment shall be financed by both domestic savings and net capital inflow.

$$I=S+F$$

Investment grows at λ, which is limited by a certain upper bound,

$$0\leqq\lambda\leqq\lambda^*,$$

The upper bound investment growth rate is determined by either an absorptive capacity of investment or the ability to finance by net capital inflow.(6) GDP increases due to investment for constant investment productivity,

$$\dot{V}=\beta I,$$

where we assume full utilization of capital equipment. The increase of GDP generates both certain increases of domestic savings and import requirements.

$$\dot{S}=s\dot{V}$$
$$\dot{M}=\mu\dot{V}$$

The marginal saving rate has its upper bound, and the marginal import rate has its lower bound.

$$s\leqq s^*$$
$$\mu^*\leqq\mu$$

The upper bound of the marginal saving rate is set so as to keep the per-capita consumption over its minimum level, and the lower bound of the marginal import rate is set so as to keep import requirements over the minimum level necessary for maintaining current economic activities. Exports grow at ε,

$$\dot{E}=\varepsilon E,$$

where the growth rate of exports reflects the endeavour for export promotion.

After some time in the development process, the trade gap (M^*-E) becomes larger than the corresponding saving gap.

$$I-S^*<M^*-E$$

In such a situation, the net capital inflow from abroad is determined by the trade-gap. Generally, the net capital inflow from abroad is determined by the dominant gap in the saving and trade gaps.

$$F=\max.\ [I-S^*,\ M^*-E]$$

When the net capital inflow is determined by the saving gap, the actual import requirement becomes

$$M=I-S^*+E\geqq M^*.$$

And, in case that the net capital inflow is determined by the trade gap, actual domestic savings become

$$S=I-M^*+E\leqq S^*.$$

In the development process, investment is financed only by domestic savings. At this time point, this economy transforms its characteristics from net capital inflowing to net capital outflowing; this economy goes to the stage of doing debt-servicing. And, after the debt servicing is completed, this economy can enjoy its self-sustained situation. Here we define the time point at which the developing economy switches from net capital inflowing to net capital outflowing as τ, and the time point at which it attains the self-sustained situation as T. Then we get the equation

$$\varphi\int_0^\tau F(t)\ dt+\int_\tau^T F(t)\ dt=0,$$

where φ stands for a coefficient to show the debt-servicing conditions.

After the self-sustained situation is realized,

(a) both internal and external equilibria will be maintained

$$I-S=M-E=0,$$

(b) the target growth rate of GDP will be realized

$$g^*=\alpha^*\beta,$$

and (c) a warranted rate of average imports to GDP will be kept

$$M=m^*V.$$

We postulate constant investment productivity, so we get the equation

$$S=\alpha^{*}V.$$

On the growth process to self-sustenance, in order to maintain the above-mentioned conditions, the change in investment is controlled by the equation

$$\dot{I}=\alpha^{*}\beta I+(\alpha^{*}\beta-\varepsilon)E.$$

Thus the time path of investment in this sort of growth process is:

$$I(t)=I_{T}e^{\alpha^{*}\beta(t-T)}+E_{T}[e^{\alpha^{*}\beta(t-T)}-e^{\varepsilon(t-T)}]$$
$$t\geqq T$$

Here, in order to maintain the postulated target growth rate, the equation

$$\alpha^{*}\beta=\varepsilon$$

should be satisfied.

III. Realization of a Self-sustained Situation in Minimum Time Horizon

As mentioned above, the development process towards a self-sustained situation is described as a process from a postulated initial situation

$$[V_{0}, I_{0}, S_{0}, S^{*}_{0}, M_{0}, M^{*}_{0}, E_{0} \mid I_{0}-S^{*}_{0}<M^{*}_{0}-E_{0}]$$

to a specified terminal situation

$$[V_{T}, I_{T}, S_{T}, M_{T}, E_{T} \mid I_{T}-S_{T}=M_{T}-E_{T}=0].$$

Here we consider an optimization to realize the above-mentioned process in minimum time horizon.

This optimization problem is mathematically formulated as follows:

To find the time patterns

$$\left.\begin{matrix}\lambda(t)\\ s(t)\\ \mu(t)\end{matrix}\right\} \quad 0\leqq t\leqq T$$

to minimize the functional

$$\int_{0}^{T}\mathrm{dt}$$

subject to

$$(1)\quad \dot{V}=\beta I$$
$$(2)\quad \dot{I}=\lambda I$$

(6) [3] considers that the upper bound of the investment growth rate is determined by the absorptive capacity of investment. However, we think, the ability to finance net capital inflow should be considered as an important element to determine it as well.

$$\left.\begin{array}{ll}(3) & \dot{S}=s\dot{V} \\ (4) & \dot{M}=\dot{I}-\dot{S}+\dot{E}\end{array}\right\} \text{ for } F=I-S$$

$$\left.\begin{array}{ll}(5) & \dot{S}=\dot{I}-\dot{M}+\dot{E} \\ (6) & \dot{M}=\mu\dot{V}\end{array}\right\} \text{ for } F=M-E$$

$$(7) \quad \dot{E}=\varepsilon E$$

$$(8) \quad F=\max\ [I-S,\ M-E]$$

$$(9) \quad \varphi\int_0^{\tau_2} F(t)\mathrm{d}t+\int_{\tau_2}^{T} F(t)\mathrm{d}t=0$$

$$(10) \quad 0\leqq\lambda\leqq\lambda^*$$

$$(11) \quad s\leqq s^*$$

$$(12) \quad \mu^*\leqq\mu$$

$$(13) \quad V_0,\ I_0,\ S_0,\ M^*_0,\ E_0=\text{given}$$

$$(14) \quad I_0-S^*_0<M^*_0-E_0$$

$$(15) \quad I_T=\alpha^* V_T$$

$$(16) \quad M_T=m^* V_T$$

$$(17) \quad I_T-S_T=M_T-E_T=0$$

As for the economic meaning, the problem is to find the optimal time patterns of investment growth rate, marginal saving rate, and marginal import rate so as to terminate the development process in minimum time horizon.

To determine the optimal solution for the problem stated above, we use Pontryagin's Maximum Principle.

Introducing five auxiliary variables $p_i(t)$ $(i=1,\dots,5)$ which are corresponding to $V(t)$, $I(t)$, $S(t)$, $M(t)$ and $E(t)$ respectively, we define the Hamiltonian as follows:

$$(18) \quad H=-1+p_1\dot{V}+p_2\dot{I}+p_3\dot{S}+p_4\dot{M}+p_5\dot{E}$$

The necessary conditions for time patterns $\lambda(t)$, $s(t)$ and $\mu(t)$ to be optimal are:
(a) the control variables $[\lambda, s, \mu]$ are chosen so as to maximize H subject to conditions (1)∼(17);
(b) there exist continuous functions $p_i(t)$ $(i=1, \dots, 5)$ which, together with the continuous functions $V(t)$, $I(t)$, $S(t)$, $M(t)$ and $E(t)$, satisfy the following canonical differential equations

$$(19) \quad \dot{p}_1=-\frac{\partial H}{\partial V}$$

$$(20) \quad \dot{p}_2=-\frac{\partial H}{\partial I}$$

$$(21) \quad \dot{p}_3=-\frac{\partial h}{\partial s}$$

(22) $\dot{p}_4 = -\frac{\partial H}{\partial M}$

(23) $\dot{p}_5 = -\frac{\partial H}{\partial E}$

(c) if the time patterns of control variables are optimal, the maximum value of H is zero through $0 \leqq t \leqq T$,

(24) $\max H = 0.$

We have postulated that the saving gap is larger than the corresponding trade gap at the initial situation, the following equations can be effective for some time after the initial time.

$$\begin{aligned} &\dot{V} = \beta I \\ &\dot{I} = \lambda I \\ (25)\quad &\dot{S} = s\dot{V} \\ &\dot{M} = \dot{I} - \dot{S} + \dot{E} \\ &\dot{E} = \varepsilon E \end{aligned}$$

In this case, the Hamiltonian takes the form

(26) $H = -1 + [p_1\beta + (p_2 + p_4)\lambda + (p_3 - p_4)s\beta]I + (p_4 + p_5)\varepsilon E.$

And the differential equations of auxiliary variables become:

(27) $\dot{p}_1 = \dot{p}_3 = \dot{p}_4 = 0$

(28) $\dot{p}_2 = -[p_1\beta + (p_2 + p_4)\lambda + (p_3 - p_4)s\beta]$

(29) $\dot{p}_5 = -(p_4 + p_5)\varepsilon$

Here it is clear that p_1, p_3, and p_4 take their values at certain constant values through $0 \leqq t \leqq T$.

To avoid distinction of many cases in the mathematical solution, we will consider only the most feasible case among them. The case, which we consider in the following argument, is to be derived under the following assumptions:

(30) $p_2(0) + p_4 > 0$

(31) $p_3 - p_4 > 0$

(32) $p_1 + s^*(p_3 - p_4) > 0$

(33) $p_1 - \mu^*(p_3 - p_4) < 0$

For the equation system (25) and (31), the marginal saving rate does always take its maximum value. In this case, full potential domestic savings are mobilized. And, so long as $[p_2(t)+p_4]$ is positive, the investment growth rate obtains its maximum value. Thus we have

$$(34)\quad p_2(t)+p_4=Ae^{-\lambda^* t}-\frac{[p_1+s^*(p_3-p_4)]\beta}{\lambda^*},$$

$$A=[p_2(0)+p_4]+\frac{[p_1+s^*(p_3-p_4)]\beta}{\lambda^*}.$$

Now we have assumed the condition (32); there exists a time point τ_1 such that

$$p_2(\tau_1)+p_4=0,$$

$$\dot{p}_2(\tau_1)+\dot{p}_4<0,$$

so that, for η sufficiently small,

$$\lambda(\tau_1+\eta)=0.$$

Then equation (34) has the solution, for $\tau_1<t$,

$$(35)\quad p_2(t)+p_4=-[p_1+s^*(p_3-p_4)]\beta(t-\tau_1),$$

so that $[p_2(t)+p_4]$ remains negative for $\tau_1<t$. In this situation, the investment growth rate becomes zero for $\tau_1<t$.

$$(36)\quad \lambda(t)=0 \quad \text{for } \tau_1<t.$$

Even though the investment growth rate is zero, a certain level of investment is processed at every time point, so that the level of GDP increases at a certain rate at every time point. In this process, domestic savings increase in accordance with the increase in GDP. Thus there exists a time point τ_2 when savings can finance investment. At this time point τ_2, the economy passes from its net capital inflowing stage to its net capital outflowing stage. And, on the net outflowing stage, the economy can be self-sustained when the debt-servicing process is over.

Now we consider the case where the trade gap becomes larger than the saving gap. Let τ_3 be the time point when the trade-gap becomes equal to the saving-gap. After the time point τ_3, the development process can be described as follows:

$$\dot{V}=\beta I$$

$$\dot{I}=\lambda I$$

$$(37)\quad \dot{S}=\dot{I}-\dot{M}+\dot{E}$$

$$\dot{M}=\mu\dot{V}$$

$$\dot{E}=\varepsilon E$$

In this case, the corresponding Hamiltonian is defined as

(38) $H=-1+[p_1\beta+(p_2+p_3)\lambda-(p_3-p_4)\mu\beta]+(p_3+p_5)\varepsilon E.$

Considering this Hamiltonian, the differential equations of auxiliary variables are

(39) $\dot{p}_1=\dot{p}_3=\dot{p}_4=0,$

(40) $\dot{p}_2=-[p_1\beta+(p_2+p_3)\lambda-(p_3-p_4)\mu\beta],$

(41) $\dot{p}_5=-(p_3+p_5)\varepsilon.$

For the equation system (37) and (31) with constant p_3 and p_4, the marginal import rate takes its minimum value, so that the import requirement is maintained at the level that is needed for keeping the current economic activities. And, we have considered $[p_2(\tau_3)+p_4]$ to be negative. However, we have $p_3>p_4$ due to (31). So that we can not have a definite sign of $[p_2(\tau_3)+p_3]$. But we proceed our argument under the assumption that

(42) $p_2(\tau_3)<0.$

In this case, the investment growth rate is still kept at the zero level.

Now we have a time path of $[p_2(t)+p_3]$

(43) $p_2(t)+p_3=\{-[p_1-(p_3-p_4)\lambda^*\beta]\}(t-\tau_3).$

But, considering the condition (33), there exists a time point τ_4 such that

$$p_2(\tau_4)+p_3=0,$$

$$\dot{p}_2(\tau_4)+\dot{p}_3<0,$$

so that, for η sufficiently small,

$$\lambda(\tau_4+\eta)=\lambda^*.$$

Then the equation (43) has the solution, for $\tau_4<t$,

(44) $p_2(t)+p_3=Be^{-\lambda^*(t-\tau_4)}+\dfrac{-[p_1-(p_3-p_4)\mu^*]\beta}{\lambda^*},$

$$B=[p_2(\tau_4)+p_3]+\frac{[p_1-(p_3-p_4)\mu^*]\beta}{\lambda^*},$$

so that $[p_2(t)+p_3]$ remains positive for $\tau_4<t$. Thus the investment growth rate takes its maximum value for $\tau_4<t$.

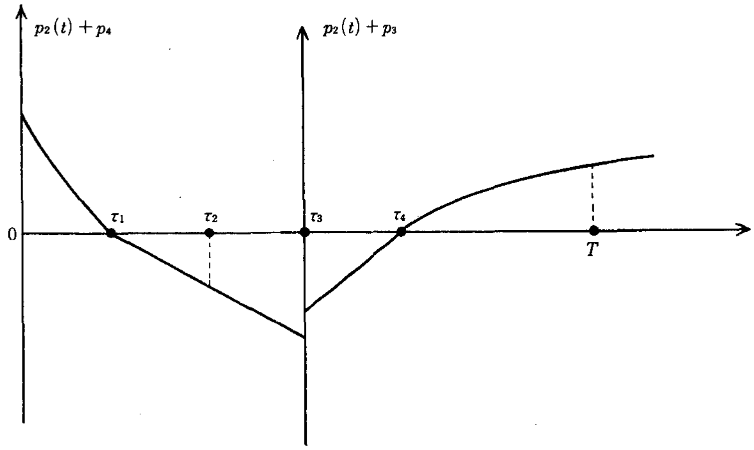
To summarize the arguments mentioned above, we have the following time paths of control variables.

(a) First Stage $(0\leq t\leq\tau_1)$

$\lambda(t)=\lambda^*$

$s(t)=s^*$

(b) Second Stage $(\tau_1\leq t\leq\tau_2)$



Eig. 1

$\lambda(t)=0$

$s(t)=s^*$

(c) Third Stage $(\tau_2 \leq t \leq \tau_3)$

$\lambda(t)=0$

$s(t)=s^*$

(d) Fourth Stage $(\tau_3 \leq t \leq \tau_4)$

$\lambda(t)=0$

$\mu(t)=\mu^*$

(e) Fifth Stage $(\tau_4 \leq t \leq T)$

$\lambda(t)=\lambda^*$

$\mu(t)=\mu^*$

However, we have never mentioned a terminal time point T. In our problem, the terminal conditions are difined in the state variables not in the auxiliary variables. Now we consider the time paths of state variables in order to determine the terminal time point T and the switching time points $(\tau_1, \tau_2, \tau_3, \tau_4)$. The time paths of state variables in the respective stages are as follows:

(a) First Stage $(0 \leq t \leq \tau_1)$

$I(t)=I_0 e^{\lambda^* t}$

$V(t)=V_0+\frac{\beta}{\lambda^*} I_0[e^{\lambda^* t}-1]$

$S^*(t)=S^*_0+s^*[V(t)-V_0]$

$M(t)=I(t)-S^*(t)+E(t)$

$E(t)=Eoe^{\varepsilon t}$

(b. c) Second and Third Stages $(\tau_1 \leq t \leq \tau_3)$

$I(t)=I_0 e^{\lambda^* \tau_1}$

$V(t)=V_{\tau_1}+\beta I_0 e^{\lambda^* \tau_1}(t-\tau_1)$

$S^*(t)=S^*_{\tau_1}+s^*[V(t)-V_{\tau_1}]$

$M(t)=I(t)-S^*(t)+E(t)$

$E(t)=E_{\tau_1} e^{\varepsilon(t-\tau_1)}$

(d) Fourth Stage $(\tau_3 \leq t \leq \tau_4)$

$I(t)=I_0 e^{\lambda^* \tau_1}$

$V(t)=V_{\tau_3}+\beta I_0 e^{\lambda^* \tau_1}(t-\tau_3)$

$S(t)=I(t)-M^*(t)+E(t)$

$M^*(t)=M^*_0+\mu^*[V(t)-V_0]$

$E(t)=E_{\tau_3} e^{\varepsilon(t-\tau_3)}$

(e) Fifth Stage $(\tau_4 \leq t \leq T)$

$I(t)=I_{\tau_4} e^{\lambda^*(t-\tau_4)}$

$V(t)=V_{\tau_4}+\frac{\beta}{\lambda^*} I_{\tau_4}[e^{\lambda^*(t-\tau_4)}-1]$

$S(t)=I(t)-M^*(t)+E(t)$

$M^*(t)=M^*_{\tau_4}+\mu^*[(t)-V_{\tau_4}]$

$E(t)=E_{\tau_4} e^{\varepsilon(t-\tau_4)}$

(f) Terminal Situation

$I(T)=\alpha^* V(T)$

$E(T)=m^* V(T)$

Now both the terminal time point (T) and the switching time points $(\tau_1, \tau_2, \tau_3, \tau_4)$ can be determined by the following five equations.

(45) $I(\tau_2)-S^*(\tau_2)=0$

(46) $I(\tau_3)-S^*(\tau_3)=M^*(\tau_3)-E(\tau_3)$

(47) $I(T)=\alpha^* V(T)$

(48) $E(T)=m^* V(T)$

(49) $\varphi \int_0^{\tau_2}(I-S^*)dt+\int_{\tau_2}^{\tau_3}(I-S^*)dt+\int_{\tau_3}^{T}(M^*-E)dt=0.$

The equation (45) shows the situation where investment is financed only by domestic savings. The equation (46) implies the situation where the saving-gap is equal to the trade-gap. The equations (47) and (48) stand for the terminal conditions. And the equation (49) gives the completion of the debt-service payment.

Thus the optimal process of economic development can be determined. However, we can not always expect the above-mentioned type of optimal process. The type of process depends on the given conditions (initial conditions, terminal conditions and values of parameters). Here we have considered only the most feasible case in an economic development.

IV. Economic Meaning of Optimal Development Process

The optimal process of economic development, which is mentioned above, has the following economic meanings.

In the earlier stages, the investment growth rate should be kept at a level as high as possible. The upper bound of the investment growth rate is determined either by the absorptive capacity of investment or the ability to finance investment funds. Thus if we can expect to increase the absorptive capacity of investment and manage to finance investment funds to be required, the economic development process can be effectively processed.

After the investment reaches a certain level, it is maintained at the level for some time. And, after some time, the investment grows again at the maximum rate. Thus, in the terminal situation, it reaches the target level. While the investment growth at the earlier stages is financed by both domestic savings and net capital inflow, the investment at the later stages is supported only by domestic savings.

The investment growth at maximum rate in the earlier stages helps to grow GDP at an accelerated rate and to mobilize domestic savings as well as possible. Here the increase in domestic savings should be supported by the development of capital goods industries in the economy concerned. In this development process, there exists a situation where investment can be financed only by domestic savings. And, after the situation is realized, the economy can refund the debt service. Thus the economy can be self-sustained after it completes the debt servicing.

Exports of the economy grow at a certain rate which reflects the economy's effort to promote its exports.

In the earlier stages, we consider, the saving-gap is larger than the trade-gap. Due to this postulation, the import requirement is financed by both export-earnings and the saving-gap in the earlier stage of development process. On the other hand, when domestic savings increase and investment is financed only by domestic savings, the import requirement can be financed only by export earnings.

In such a situation, debt-servicing can be expected.

In the development process, investment reaches a certain level, and it is maintained at the level for some time. In this sort of process, correspondingly, import requirements may decrease. However, there is a certain level of import requirements below which it can not go. This lower bound of import requirement is set by the minimum import requirements which are required for maintaining current economic activities at any time point. When the import requirements are held at this minimum level, imports increase in accordance with the growth of minimum import requirements. In this situation, the saving-gap is smaller than the trade-gap. And domestic savings are larger than investment which is financed by the trade balance. This sort of situation is maintained until debt-servicing is completed.

These are the outlines of the optimal economic development process. This shows every facts of the optimal process of economic development. And this also suggests some theorems of development economics.

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WAGE AND BEHAVIOUR DIFFERENCE IN COLLECTIVE WAGE BARGAININGS OF JAPANESE SHIPPING COMPANIES

—A Case Study of the Japanese Shipping Industry—

Hiromasa YAMAMOTO

Due to the lack of statistics and other data materials on wage it is quite difficult to report on seamen's wages. In this paper it is intended to examine the behaviour of the six big shipping companies of Japan in collective wage bargainings.

In 1964 the Japanese shipping industry experienced the amalgamation of shipping companies on a large scale. In consequence six big shipping companies emerged. They include the Nihon Yusen Kaisha Line, the Mitsui-OSK Line, the Kawasaki Steamship Company, the Yamashita-Shinnihon Steamship Company, the Japan Line, and the Showa Kaiun Steamship Company. All of them are engaged in various kinds of ocean-going ship operations and compete with each other. Then, how have they behaved in their collective wage bargainings? This is the concern of this study.

Before entering into the problem a preparatory survey on collective bargaining in the shipping industry and the characteristics of payment of seamen's wages may be useful.

I. Collective Bargaining of the Japanese Shipping Industry and the Payment of Wages

1. Organizations of Collective Bargaining

In the Japanese shipping industry the organizations for collective bargaining have changed considerably. With the end of the World War II, trade unionism among Japanese seamen, which had been prohibited by the government during the war, was immediately revived. In 1945 the All Japan Seamen's Union was organized on a national basis. It represented both licensed and unlicensed ratings. Representing the employers, the Japan Shipowners' Association maintained collective bargainings with the union on an industrywide basis. In 1951 the union succeeded in introducing into the industry minimum wages according to jobs.

In 1955 unified collective bargainings came to an end. In reluctance to the uniform wage agreements, the coastal shipowners organized their own bargaining groups on a regional basis and began to bargain separately. Also in the ocean shipping sixteen large shipping companies organized the predecessor of the "Gaiko Romu Kyōkai" and other companies formed two more groups for collective bargaining in the same year. Therefore on wage issues the union had to bargain with different employers' groups and conclude agreements separately, though the union concluded a uniform agreement with the joint committee of employers' groups on hours of work, the minimum wage rates and several other issues in which employers found common interests.

The amalgamation of shipping companies in 1964 had no great influence on the organization for collective bargaining. Since 1965 there have been two employers' organizations for collective bargaining in ocean shipping. One of them is the "Gaiko Romu Kyōkai" which represents 19 large companies including the "big six."

The agreement between the G. R. K. and the union is effective for a year and usually it is renewed in April.

2. Payment of Seamen's Wages

The payment of seamen's wages on Japanese-flag ships is very complicated. A glance at the wage clauses in the trade agreements does not reveal the actual wage rate which specified seamen will be paid. In determining the wage rate of specified seaman, two kinds of wage rates, i.e. the minimum wage rate and the personal wage rate must be taken into consideration. Minimum wage rates according to jobs are the minimum monthly wage rate that a seaman is guaranteed to receive when he is assigned to a certain job aboard ships. When the period of his service in the same job increases, his minimum wage rate will increase according to the length of the service. Minimum wage clauses are uniform for all employers' groups.

With regard to the personal wage rate, the seamen's union negotiates with each employer and concludes individual agreements. The personal wage rate is longevity pay in character. The personal wage rate is composed of the initial wage rates for different qualifications and the additional increase of rate according to the length of service with the company.

When a seaman is aboard ship, his personal wage rate is regarded as his "basic monthly wage rate aboard ship" if it is larger than the minimum wage rate of his job. If the opposite is true, then the minimum wage rate becomes his wage rate aboard ship. In calculating the amount of various kinds of allowances and overtime rates, "the wage rate aboard ship" is taken as a base.

Although the payment of wages during paid vacation is also based on the wage rate aboard ship, the personal wage rate is taken as a base for the period of staying on land as a reserve member of the company's crew or a trainee in a special study course regardless whether it is larger or smaller than the minimum rate.

The personal wage rate is peculiar not only for the employment system of Japanese seamen in general, but especially for the hiring policy of large shipping companies. Since World War II most Japanese shipping companies have employed seamen as permanent employees. For large shipping companies it has become common practice to select and hire employees exclusively from new graduates of the merchant marine academies or new trainees of the training course. As a rule they do not hire seamen who have been employed by other companies. In addition, they encourage continuous service within the company through wage advantages. By adopting the personal wage rate the companies pay higher wages to a seaman, as the period of his service within the company increases even if he fulfils the same duty. In case of promotion the priority is given to the seaman who has a longer period of service if the other qualifications are equal. In consequence employees of large companies have a disadvantage when they change to another company. The hiring policy of large companies discourages the movement of seamen among companies, by which the wage level among companies might tend to become equal. Then, can we find differences of wage rates among the "big six"?

II. Individual Agreements on Wages by the "Big Six"

1. Personal Wage Rate

As we have described in the preceeding section on personal wage rate, the seamen's union negotiates with each company separately and signs individual agreements. Personal wage agreements provide for the initial wage rates and different increments of rate according to the length of service and qualifications. The initial monthly wage rates are applied to new employees who have no experience of service on board ship.

Table 1 presents the initial monthly wage rates of the "big six" and also the standard, the highest and the lowest rates among the G. R. K. (Hereunder we shall denote the "big six" companies as Company A, B,...and F.)
Among the "big six" there was little difference in the initial wage rates in 1968. Most of them concluded agreements at the standard rate. The same thing took place in other years.

Detailed material on the increments of the personal rate is not available. However, the average personal wage rates of companies and the rate of increase

Table 1. Initial Monthly Wage Rates of 1968 (Yen)

Name of Company	2nd Mate(1) 2nd Engineer(1)	1st Class Wireless Operator(2)	Unlicensed Rating(3)
A	28, 300	24, 200	18, 300
B	〃	24, 160	〃
C	〃	24, 200	17, 850
D	〃	〃	18, 350
E	〃	24, 300	18, 300
F	〃	24, 200	〃
GRK			
Standard	28, 300	24, 200	18, 300
Highest	30, 800	26, 100	19, 100
Lowest	28, 290	24, 160	17, 450

(1) Graduates of the two national Merchant Marine Academies
(2) College graduates
(3) Men 18 years old and over who finished the national unlicensed personnel training course

in comparison to the previous year is at hand. The average personal wage rates among companies cannot be compared, because the composition of the labour force according to age and period of service within a company varies. In order to compare the personal wage rates of companies, it becomes necessary to standardize the composition of labour of each company. Therefore, by means of the rate of increase of the average personal rate, we estimate the average personal wage rates of the "big six" as it would be if the composition of the labour force according to age or period of service within the company would be same among the "big six." One part of the result is shown in Table 3.

According to Table 3 the differences of the estimated personal wage rates of the "big six" were in the range of 10 per cent in the case of officers and about 3 per cent in case of unlicensed ratings, while the difference between the highest rate and the lowest among member companies of the G. R. K. amounted to 20 per cent in the case of licensed ratings and 10 per cent in case of unlicensed ratings. This difference must come from the different amounts of longevity paid by the companies. Some companies put more stress on longevity pay while others do not. So far as our estimate is concerned, there is no clear movement among the "big six" to set personal wage rates for employees at the same level, though most of the initial wage rates among them are at the same level.

Our estimate on personal wage rates of various companies does not present the actual figure of wage rates which are applied to seamen when aboard ship. As we have mentioned already, higher rates in comparison with his personal wage rates and the minimum rate of his job are adopted as "wage rate aboard ship"

Table 2. Average Personal Wage Rates of Companies

	1967				1968				1969			
	Average age	Average years of service with the company	Rate of increase	Average personal wage rate (yen)	Average age	Average years of service within the company	Rate of increase	Average personal wage rate (yen)	Average age	Average years of service within the company	Rate of increase	Average personal wage rate (yen)
licensed ratings												
A	31. 8	11. 1	5. 9	47, 274	34. 0	11. 7	4. 6	53, 064	33. 8	11. 6	4. 6	60, 172
B	31. 5	12. 2	3. 6	49, 131	35. 3	12. 8	5. 4	55, 484	35. 7	13. 3	3. 9	63, 450
C	32. 4	9. 7	5. 1	38, 026	32. 4	9. 8	4. 9	47, 526	—	—	—	—
D	—	—	9. 8	41, 528	32. 6	9. 1	6. 1	43, 651	33. 5	9. 4	4. 9	54, 947
E	34. 1	12. 5	8. 0	45, 268	35. 0	13. 3	4. 4	51, 391	35. 3	13. 6	4. 9	58, 828
F	34. 4	10. 8	7. 4	45, 045	34. 2	10. 7	3. 9	48, 573	34. 0	11. 6	4. 5	55, 747
GRK	33. 4	10. 7	6. 2	44, 676	34. 0	10. 9	5. 2	49, 628	34. 4	11. 2	4. 6	57, 684
unlicensed ratings												
A	27. 0	12. 5	3. 8	31, 021	33. 6	14. 9	3. 2	34, 406	33. 3	14. 7	3. 1	39, 007
B	33. 1	15. 1	2. 8	30, 836	33. 3	15. 6	4. 2	32, 905	34. 3	16. 4	3. 1	40, 035
C	31. 6	12. 3	3. 9	24, 853	31. 8	12. 7	3. 5	31, 443	—	—	—	—
D	—	—	6. 8	26, 173	30. 0	10. 3	4. 5	27, 241	30. 1	11. 9	3. 9	34, 574
E	32. 6	14. 2	6. 5	29, 193	33. 5	15. 1	3. 6	33, 216	34. 1	15. 8	4. 2	38, 816
F	32. 6	12. 7	6. 0	29, 902	31. 9	12. 1	3. 3	32, 122	32. 0	12. 9	3. 4	37, 764
GRK	31. 8	14. 1	4. 8	27, 858	32. 8	13. 4	4. 0	31, 976	32. 9	13. 7	3. 5	37, 529

Table 3. Adjusted Average of Personal Wage Rates of Companies

	1968			1969		
	Average year of service within the company	Personal wage rate (yen)	A=100	Average year of service within the company	Personal wage rate (yen)	A=100
licensed ratings						
A	13.0	56,282	100	13.5	65,521	100
B	12.8	55,484	98.6	13.3	63,450	96.8
C	12.7	54,422	96.7	—	—	—
D	11.8	51,237	91.0	11.6	61,034	93.2
E	13.6	52,069	92.5	14.0	59,981	91.5
F	11.8	52,479	93.2	13.3	60,091	91.7
unlicensed ratings						
A	14.9	34,406	100	15.7	40,216	100
B	15.9	33,320	96.8	16.4	40,035	99.5
C	14.5	33,455	97.2	—	—	—
D	13.9	31,921	92.8	16.1	40,603	101.0
E	15.2	33,336	96.9	16.0	39,142	97.3
F	13.8	33,945	98.7	15.2	40,789	101.4

of a specified seaman. But no data are available for estimating wage rates aboard ship of the various companies. Therefore we have to give up any comparison of wage rates aboard ship among the "big six." The only point that we can contend is that the differences of the wage rates aboard ship might be smaller among the member companies of the G.R.K. than those of the personal wage rates. According to union sources, in 1968 the member of seamen to whom were applied the minimum rates amounted to 18 per cent of the total seamen being employees of the member companies of the G.R.K. However, among the "big six" any possible effect of the minimum wage rate upon the wage rate aboard ship was uncertain. We can not say any thing on the difference of the wage rates aboard ship between seamen of the same age or the same job employed by the "big six."

2. Semi-annual Extra Allowances

In addition to the monthly payment of wages, it has become the custom of the Japanese shipping industry to give semi-annual extra allowances in June and December to all seamen. Ordinarily the seamen's union has individual negotiations and makes agreements on this allowance with each company. The amount of the extra allowance is unstable in its character and varies largely depending upon a boom or slump on the shipping market. This fact lets expect a large variance of the amount of extra allowance paid by the companies even for the same period. Then, what was the reality in this regard among the "big six"?

The agreements express the amount of the extra allowance in terms of percentage of the basic rate which is one and a fifth of the average wage rate aboard ship applied by each company. Table 4 presents the terms of agreement on the extra allowance for the "big six." The terms of agreement showed considerable differences during the period of our study among the member companies of the G.R.K. According to the order of the rate of agreement against the basic rate nineteen companies belonging to the G.R.K. were grouped into three, i.e. the higher, the middle, and the lower group. Among the "big six"the rate of agreement varied over a rather wide range in 1966 and 1967 though the range narrowed in 1968 and 1969. In 1966 three companies of the "big six"were found in the higher group and the other three in the middle group. In 1967 Company E belonged to the middle and company F to the lower while the other four belonged to the higher group. In 1968 and 1969 four companies belonged to the higher group and company E and F to the middle.

Table 4. Semi-annual Extra Allowances

	1966			1967		
	The rate of demand against the base	The rate of agreement against the base	Amount of extra allowance (yen)	The rate of demand against the base	The rate of agreement against the base	Amount of extra allowance (yen)
A	600	499	245, 268	600	510+α	287, 466+α
B	550	445	231, 907	600	510+α	289, 822+α
C	550	470	214, 057	600	500	257, 410
D	550	470	198, 443	600	500	242, 220
E	470	420	201, 797	470+α	470	249, 100
F	470	420	196, 446	470+α	443	235, 857
GRK						
Highest	600	499	245, 628	600	510+α	289, 822
Lowest	430	390	163, 904	450	410	204, 566

	1968			1969		
A	600	537	335, 287	320	530+α	372, 453+α
B	600	533	322, 670	300	528+α	383, 402+α
C	600	513	290, 327	310	530	357, 744
D	600	510	277, 446	310	528	329, 171
E	550	500	300, 630	300	515	355, 886
F	500	500	288, 990	300	505	326, 810
GRK						
Highest	600	537	335, 287	320	530+α	383, 402+α
Lowest	450	430	236, 664	250	420	266, 129

Table 5. Per Capita Net Profit

	A	B	C	D	E	F
1965	100	75.7	47.5	67.9	30.0	33.5
1966	100	98.5	63.7	68.3	49.1	55.5
1967	100	96.2	81.7	60.9	63.7	64.9
1968	100	95.0	61.9	56.1	48.5	52.9
1969	100	83.9	47.1	61.6	38.1	65.2

What caused the difference of the rate of agreement among the "big six"? A possible explanation might be found in the difference of the company profits or in the difference of the productivity of labour. The per capita net profit of the "big six" is tabulated in Table 5. However, the per capita net profit does not explain adequately the grouping or the ranking of the "big six" as for the rate of agreement on the extra allowances. The differences of the per capita value added among the "big six" neither corresponds to the difference of the rate of agreement among them. (As for the per capita value added, refer to Figure 3.)

In contrast, the year-to-year comparison of the rates of the agreements among the "big six" reveals the next fact: among the "big six" Company A and B, C and D, and also E and F signed agreements of the same or a very similar level of the rates of agreement though several exceptions can be found when considered over the whole period of the research. This finding suggests that companies determine the rates of agreement in consideration of those of the other companies. Or possibly one company follows the rates of agreement of another, disregarding any profit difference which may exist between them.

III. Estimated Wage Earnings and Per Capita Value Added

1. Comparison of Per Capita Personal Expenses and Per Capita Seafaring Labour Costs

Using the statements of accounts handed to the Securities and Exchange Council, the per capita personal expenses and the per capita seafaring labour costs of the "big six" are calculated by each company on the base of their closing accounts of March 1965 through March 1970. Figure 1 shows the difference of the per capita personal expenses among them, setting the expenses of Company A as a base for each term. From Figure 1 it appears that the per capita personal expenses of the Companies C, D, E, and F moved in a similar pattern to Company A and the differences between these companies and Company A were gradually reducing. In the case of Company B the difference with Company A was smaller than with the other four in the earlier stages, and from the closing date of March 1968 the per capita personal expenses of Company B exceeded those of Company A.

Fig. 1. Per Capita Personnel Expenses

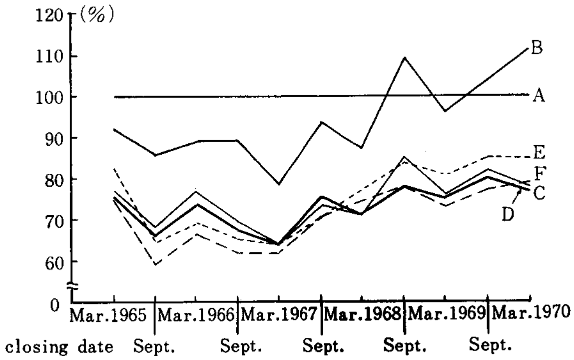


Fig. 2. Per Capita Seafaring Labour Costs

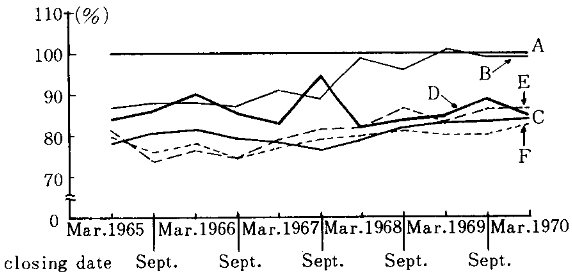
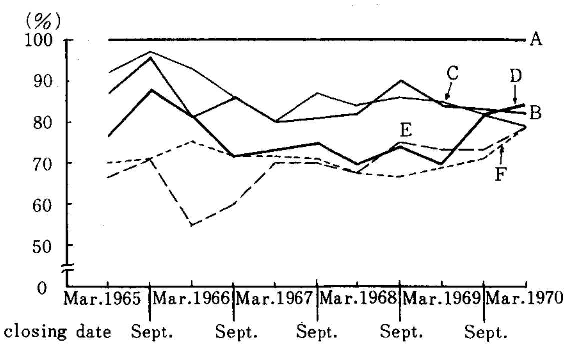


Fig. 3. Value Added per Capita



The personal expenses include not only the labour costs of seamen but also the costs of office clerks and workers on land. Therefore the personal expenses are not adequate for the purpose of estimating the trend of seamen's wage earnings. For this purpose a much better alternative may be found in the per capita seafaring labour costs. The seafaring labour costs are composed not only of the wage costs but also of other cost items which an employer has to burden, i.e., costs of fringe benefits, employers' contributions to social insurance for seamen and so on. Although the per capita seafaring labour costs which are calculated here include cost items other than wages, it might be allowed to use them as an alternative for seamen's average semi-annual wage earnings in the broadest meaning.

In a similar way to Figure 1, Figure 2 shows the difference of the per capita seafaring labour costs among the "big six." Figure 2 presents the following findings:

(1) The differences of the per capita seafaring labour costs among the "big six" were decreasing,

(2) After the closing data of March 1968 Company B maintained a comparable level with Company A,

(3) At the closing data of March 1968 four companies, i.e., C, D, E, and F showed resembling trends, and maintained the level of 80∼90 per cent of the base, and

(4) Differences of the per capita seafaring labour costs were smaller among the "big six" when compared with those of the per capita personal expenses. In other words, the labour costs per seamen showed smaller differences than the labour costs per office clerks.

2. Productivity of Labour and Relative Share of Labour

No indicator is available for physical productivity of labour in the shipping industry such as the per capita ton-miles of cargo carried during a year. However, as indicators for the potential physical productivity of labour in the shipping industry per capita the transport capacity (deadweight tonnage of company fleet ×average cruising speed / number of seamen employed by the company) and the per capita fixed assets may be used.

In the case of "big six," these indicators do not correspond to the change of the per capita personal expenses and the per capita seafaring labour costs. (See Table 6 and 7.) This result might have been predictable, because in the shipping industry the level of freight rates and the sales of cargo space influence greatly shipping earnings and the level of wage earnings is expected to correspond to shipping earnings rather than physical productivity of labour.

Then, as a next step, let us check the trends of value added per capita for the "big six." Figure 3 shows them. For four periods from the closing date of March 1965 the difference of value added per capita among the companies varied considerably. However, for the whole period the trends of companies B and C show resembling patterns. Campanies D, E, and F also show resembling patterns during the period from March 1967 to March 1969. At the closing

Table 6. Deadweight Tonnage of Company Fleet per Seaman

Name of Company / Closing date	A	B	C	D	E	F
March 1965	100	106. 9	139. 8	131. 0	106. 5	140. 6
March 1966	100	100. 0	146. 0	136. 5	129. 4	168. 4
March 1967	100	92. 7	138. 3	142. 0	133. 6	165. 0
March 1968	100	86. 6	111. 9	114. 3	104. 9	128. 7
March 1969	100	85. 0	118. 0	116. 7	117. 6	118. 2
March 1970	100	90. 1	112. 7	128. 1	130. 2	131. 7

Table 7. Per Capita Fixed Assets

Name of Company / Closing date	A	B	C	D	E	F
March 1965	100	108. 4	114. 7	102. 9	101. 5	99. 4
March 1966	100	69. 1	108. 4	85. 6	87. 2	93. 3
March 1967	100	64. 9	85. 9	83. 6	75. 6	75. 1
March 1968	100	71. 9	108. 4	85. 4	84. 4	82. 1
March 1969	100	70. 7	103. 9	83. 9	88. 5	76. 6
March 1970	100	79. 3	93. 4	79. 4	82. 2	78. 2

Table 8. Relative Share of Labour

Name of Company / Settlement term	A	B	C	D	E	F
Sept. 1964	30. 7	31. 1	25. 4	27. 0	34. 4	29. 0
March 1965	28. 0	29. 3	23. 4	28. 0	34. 6	30. 1
Sept. 1965	36. 5	33. 0	25. 8	27. 5	32. 5	30. 7
March 1966	32. 5	35. 3	26. 9	29. 4	41. 1	29. 0
Sept. 1966	32. 0	33. 0	25. 6	29. 8	35. 2	27. 6
March 1967	31. 1	30. 4	24. 9	27. 1	28. 4	26. 8
Sept. 1967	30. 9	35. 8	25. 8	31. 3	31. 4	31. 1
March 1968	29. 3	31. 1	24. 7	30. 0	34. 0	32. 4
Sept. 1968	29. 7	36. 3	29. 1	31. 3	33. 2	34. 3
March 1969	30. 2	34. 5	26. 9	32. 5	33. 6	32. 2
Sept. 1969	31. 3	39. 1	31. 3	30. 8	36. 6	34. 0
March 1970	31. 2	42. 2	30. 6	28. 4	33. 4	31. 4
Average	31. 1	34. 3	26. 7	29. 4	34. 0	30. 7

date of March 1970 the difference between the companies decreased to about twenty per cent at the largest.

When we compare the trend of value added per capita with that of the per capita personal expenses and the per capita seafaring labour costs for each company, the movement of the latters do not correspond to the former at all for three companies, i.e., the Companies B, C, and E. In the case of these three companies it is possible to conclude that the change of value added per capita had little influence upon the per capita personal expenses and the seafaring labour costs.

The relative share of labour by the "big six" is presented in Table 8. Company A averaged 31.3 per cent of the relative share of labour for the whole period, and its figures at each closing date were stable in comparison with the others. It is worth while to note that the companies C, D, and F kept their average relative share of labour at a similar level to Company A or lower than Company A, though the per capita personal expenses and the seafaring labour costs of these companies remained at lower levels than those of Company A.

If it is permitted to use the per capita seafaring labour costs as an alternative for the seamen's average wage earnings in its broadest meaning, then we may draw several conclusions from the above observations. The companies C, D, and F were able to maintain a comparable level of the relative share of labour with Company A, because they kept the seamen's wage earnings at a level lower by 10 to 20 per cent than that of Company A. The relative share of labour of Company E became higher due to the fact that its level of wage earnings was comparable with the Companies D and F. In the case of Company B, due to the decreasing difference of the seamen's wage earnings and the superior positions of wage earnings of all employees for several periods in comparison with Company A, its relative share of labour was pushed up to a higher level than that of Company A.

IV. Conclusion

In the preceeding section we have pointed out the relationship between the differences of the wage earnings among the "big six" and their relative share of labour. The movement of differences of wage earnings do not, needless to say, allow an explanations of the movement of the differences of wage rates between these companies. Even when uniform wage rates in the shipping industry prevail, the different composition of labour force among companies as to age, the period of service within a company and so on may result in differences of wage earnings among them. Different length of overtime hours also causes different wage earnings.

However, we should keep in mind the fact that the rates of agreement on extra allowances of the "big six" can be grouped into three and that this grouping does not correspond to the difference in company gains. This fact and the relationship between the differences of wage earnings and the relative share of labour will indicate the companies' behaviour and their performance in the collective wage bargainings with the seamen's union. Company A seems to have taken the leadership among the group of the "big six" at the table of wage bargainings. Company B might have set wage rates for its crew similar to those of Company A, in no relation to the movement of the per capita value added during the period of our obsevation. The companies C, D, E, and F might have set their wage rates lower than those of Company A. In other words, we may conclude that there has been no tendency among the "big six" for setting the seamen's wage rates at similar levels, though the difference of wage rates among them might have been decreasing due to the efforts of the seamen's union.

Our conclusion on the behaviour of the "big six" in collective bargainings must be tentative. More observations and materials should be added to come to a conclusive affirmation.

ON ACCOUNTING COMMUNICATION

Isao NAKANO

Recent years have seen a revolutionary change in the research methodology in accountancy. Once we often heard various discussions on "true," "actual" accounting figures whereas in these days the emphasis is placed upon the "usefulness" of accounting information to its receivers. Thus accounting has come to be redefined as "the process of identifying, measuring, and communicating economic information to permit informed judgements and decisions by users of the information."(1)

It seems this development of the information theory approach to accounting has been initiated by Professors Norton M. Bedford and Vahe Baladouni.(2) By applying a general communication model and several important concepts in the information theory they have succeeded in providing a new promising framework for further accounting research in a user-oriented way. In this paper we will adopt the same research methodology and try to apply to accounting processes several concepts in the information theory which still remain almost untouched by the accounting researchers.

I. A General Communication Model

We will start by showing below the communication model by Claude E.

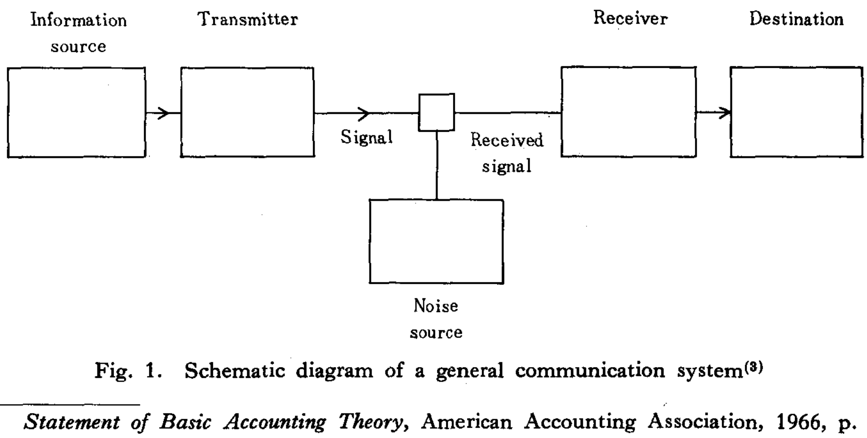


Fig. 1. Schematic diagram of a general communication system(3)

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(1) *Statement of Basic Accounting Theory,* American Accounting Association, 1966, p. 1.
(2) Norton M. Bedford and Vahe Baladouni, "A Communication Theory Approach to Accountancy," *The Accounting Review,* Oct. 1962, pp. 650–659.
(3) Claude E. Shannon and Warren Weaver, *The Mathematical Theory of Communication,* The University of Illinois Press, Urbana/Chicago/London, 1969, p. 34.

Shannon (Fig. 1).

Short explanations on the components of this communication system will be given below.

(1) The information source is a source of messages to be communicated to the destination. In the accounting context this will correspond to the "business entity."

(2) The transmitter is a mechanical device and / or a person (or persons) that will operate on the messages to produce signals suitable for transmission over a given channel. (This activity is called "encoding.") In telegraphy we have an encoding operation of converting human speech etc. into a sequence of signals of the Morse code. The transmitter in business accounting is the "accounting information (-generating) system" which produces a set of technical terms and numerical values as an expression of the result of business operations and of the financial position of a firm.

(3) The channel is the medium used to transmit the signals from transmitter to receiver. (Ex. a pair of wire, a band of radio frequencies) In business accounting the "financial statements" serve as the channel. During transmission, or at one of the terminals, the signals may be perturbed by "noise." Fig. 1 indicates the noise source acting on the transmitted signal to produce the received signal.

(4) The receiver is a performer of the inverse operation of that by the transmitter; it reconstructs messages from the signals. This operation is called "decoding." In accounting this function is performed essentially by the process of "financial statement analysis."

(5) The destination is the person or object for whom the messages are intended. The destination of accounting information may be considered as the judgement or decision-making activities done by the receivers of the information, relying on the accounting messages.

Concerning the accounting communication system composed of these elements the most important fact for us is that no messages can be encoded or decoded with 100% fidelity. "Just as in human communication signals may be perturbed by noise, so do signals in human communication suffer distortion. Thus the quality of messages is subject to variation introduced by noise."[1] This is also the case in the accounting situation. "Noise in accountancy may be defined as those factors that interfere with the quality of accounting messages."[2]

(1) Norton M. Bedford and Vahe Baladouni, "A Communication Theory Approach to Accountancy," *The Accounting Review*, Oct. 1962, p. 656.

(2) *Ibid.*, p. 656.

II. Information and Entropy

According to the information theory "information" means those signals (or messages as expressed by the signals) which provide "instruction to select" from among alternative hypotheses or possibilities with the result of reducing the uncertainty of the selection which existed before receiving the "instruction."

Some pieces of information serve to decrease the uncertainty of the selection to a great degree. They induce us to select such a possibility with a relatively low *a priori* probability. They can be said to possess a comparatively large amount of information (information content). On the other hand, information leading to the selection of a highly probable possibility can change the uncertainty situation little, so that its information content is small. Hence the amount of information varies inversely with the *a priori* probability of the possibility selected on the basis of the information.

This relationship is formulated as follows:

$$Q_i = \log_2 \frac{1}{P_i} \tag{1}$$

where Q_i denotes the information content of a reliable message instructing to select a possibility whose *a priori* probability was P_i.

Example 1: The probability that Company A would not suffer a loss in this period was estimated to be 80% and that of suffering loss to be 20%. And the published current financial statement shows the realization of a net income. In this case the information content of this income information is calculated:

$$Q_i = \log_2 \frac{1}{0.80} = 0.322 \text{ (bits).}$$

The information content of the message telling the incurring of a loss would have been

$$Q'_i = \log_2 \frac{1}{0.20} = 2.322 \text{ (bits).}$$

This concept of "information content" of a signal or a message leads to another important concept in the information theory, called "entropy" $H(X)$, which means the average of the information contents of all possible signals or messages from a given information source (ex. a business entity).

Hence

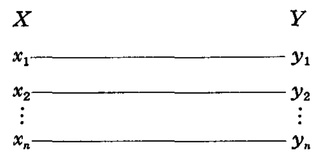
$$H(X) = \sum_{i=1}^{n} P_i \log_2 \frac{1}{P_i} \text{ (bits)} \tag{2}$$

where *Pi* is the *a priori* probability of the possibility *i* occurring.

Example 2: Assume the business entity as an information source in Example 1 above emits with 80% probability the message, "A non-negative income has been realized this period" and with 20% probability the message "a loss has been incurred this period." The "entropy," that is, the average amount of information of this source is

$$H(X)=0.80 \log_2\frac{1}{0.80}+0.20 \log_2\frac{1}{0.20}=0.722 \quad \text{(bits)}$$

In the absence of noise there exists a one to one correspondence between any emitted message x_i from an information source and the received message y_i (where $i=1, 2, \ldots, n$).
This is a characteristic of a "noiseless channel" (Fig. 2)



(Fig. 2)

Just as the entropy $H(X)$ of a source of transmitted messages has been conceived, so can the entropy $H(Y)$ of the set of the received messages be defined as the average of the *a priori* uncertainty about which message y_i would be received or the average amount of information of the receivable messages, and formulated as follows:

$$H(Y)=\sum_{j=1}^{m} p(y_j) \log_2 \frac{1}{p(y_j)} \tag{3}$$

Where $p(y_j)$ means the probability of y_j being received.
In the noiseless channel $p(y_j)=p(x_j)$, so that

$$H(Y)=\sum_j p(y_j) \log_2 \frac{1}{p(y_j)}=\sum_i p(x_i) \log_2 \frac{1}{p(x_i)}=H(X)$$

The average amount of information successfully transmitted over a channel is generally expressed as $I(X, Y)$. Using this symbol

$$I(X, Y)=H(X)=H(Y),$$

that is, no loss of information is possible on a noiseless channel.

The above survey would suggest the possibility of developing the concept of "ideal accounting communication" as a "noiseless" accounting channel. But in this paper we are more interested in the actual situation of a "noisy channel," so that an analysis of noise and an application of this concept to the accounting process will be attempted in the following.

III. Noise

"Noise" in the context of the information theory means "disturbances which do not represent any part of the messages from a specific source".(1) And according to Shannon and Weaver we must distinguish between "engineering noise" (distroyers of signals or simbols as such) and "semantic noise" (disturbing factors not of signals but of the meaning or message to be transmitted by the signals).(2)

Examples of engineering noise: the sporadic impulsive noise of "atmospherics" in radio reception, crackling and hissing noises on the telephone and Gaussian noise produced by the random superposition of a great numbers of independent causes.(3) In accounting communication, errors of calculations and deliberate manipulations of income, etc. which cause objects of accounting measurement to be uncorrectly encoded and reported may be said to illustrate engineering noise.

Examples of semantic noise: consider the case where a girl says to a youngster, "I love you" intending a lie or an irony but he takes it literally. This kind of misunderstanding may arise from: (1) his lack of experience in cummunication, (2) his insufficient knowledge of the communication partner and / or (3) his scarcity of understanding of the communication environment. Such causes of unsuccessful decoding with no effect on signals as such we would like to call "semantic noise."

It is our opinion that the most important cause of semantic noise in accounting communication is the general price level change as well as the specific price changes. Were it not for these price changes, a 10% increase in the current income of a given company computed according to the historical cost principle would signify the same rate of increase in its real income (free from the influences of the price changes) at the same time. But in case the price changes do occur, the realization of a 10% increase in the "historical cost" income may correspond to a 5% decrease in the real income. This possibility means that the correct decoding of the trend of the real income from the transmitted signal of the historical cost income can be subject to disturbances because of the price changes, so that the price changes do work as a sort of semantic noise provided the message

(1) Colin Cherry, *On Human Communication*, John Wily and Sons, Inc., New York, 1961, p. 307.
(2) Claude E. Shannon and Warren Weaver, *op. cit.*, p. 26.
(3) Colin Cherry, *op. cit.*, p. 199.

intended for transmission in accounting is the real income figure.

Before illustrating how the price changes as semantic noise will influence the effectiveness of the accounting communication, it is necessary to give some preliminary explanation of noise in general. In the absence of noise the received signals and the decoded message from the signals are the same thing as the transmitted signals and messages. But when there is noise, "the received noisy signals do not completely represent the messages from the source, but constitute only evidence of those messages."(1) No assurance exists that the received message y represents the transmitted message x faithfully, but there is just the conditional probability $p(x \mid y)$ with which the former would signify the latter. The receiver has no other way of arriving at the transmitted signal x than by resorting to his "best guess" on the evidence of the received message y. Hence "the process of communication in the presence of noise is essentially one of inference."(2)

And this necessity of additional inference for the determination of the transmitted signal or message even after the receipt of the signal will suggest that noisy signals cannot decrease the prior uncertainty of the communication situation to zero, and that the information content of a noisy signal is smaller than that of a noiseless signal by the amount of this remaining uncertainty. To give an exact mathematical expression to this situation, two variants of the entropy concept will be defined in the following.

(a) Joint entropy $H(X,Y)$: If the probability of an event X being x_i and the other event Y y_j at the same time, that is, the probability of a joint event (x_i, y_j) is expressed as $P(x_i, y_j)$, where X denotes the transmitted message and Y the received message, then

$$H(X, Y)=\sum_{i,j} P(x_i, y_j) \log \frac{1}{P(x_i, y_j)}$$

The joint entropy measures the average uncertainty as to what will be sent and what will be received in a communication process.

(b) Conditional entropy $H(X \mid Y)$ and $H(Y \mid X)$: $H(X \mid Y)$ is supposed to measure the average uncertainty of what value an event X will take in case the other event Y takes a given value. Hence

$$H(X \mid Y)=\sum_{i,j} P(y_j)P(x_i \mid y_j) \log \frac{1}{P(x_i \mid y_j)}$$
$$=\sum_{i,j} P(x_i, y_j) \log \frac{1}{P(x_i \mid y_j)}$$

(1) Colin Cherry, *op. cit.*, p. 200.
(2) *Ibid.*, p. 200.

where $P(x_i \mid y_j)$ denotes the probability of X being x_i when Y is y_j.

In the communication process $H(X \mid Y)$ is the measure of the average uncertainty as to what signal has been sent that remains after the reception of a noisy signal y_j because there are plural alternative signals which could have been transmitted. Hence the average amount of information realizable (that is, really capable of communication) on a noisy channel $I(X, Y)$ is defined as the difference between the entropy of a given transmission source $H(X)$ and $H(X \mid Y)$ which is called "equivocation."

$$I(X,Y)=H(X)-H(X \mid Y)$$

In a noiseless situation $H(X \mid Y)$ is zero.

Similarly, $H(Y \mid X)$ measures the average uncertainty of what value an event Y will take in case the other event X assumes a specific value. Hence

$$H(Y \mid X)=\sum_{i,j} P(x_i)P(y_j \mid x_i) \log \frac{1}{P(y_j \mid x_i)}$$

$$=\sum_{i,j} P(x_i, y_j) \log \frac{1}{P(y_j \mid x_i)}$$

In the communication situation $H(Y \mid X)$ measures the average uncertainty of what signal will arive at the destination when a signal has been sent from a transmitter. And since the actually communicated amount of information can also be calculated as a decrease in the uncertainty of the receivable signal or message,

$$I(X,Y)=H(Y)-H(Y \mid X)$$

According to Shannon there exists the following relationship:

$$I(X,Y)=H(X)-H(X \mid Y)=H(Y)-H(Y \mid X)$$
$$=H(X)+H(Y)-H(X,Y)$$

Now we can see that a noisy channel is a channel where all or part of the received messages correspond to possibly transmitted plural signals or messages, and it can be illustrated as in Fig. 3.

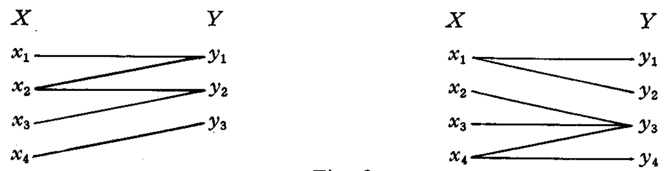


Fig. 3

Now we are in a position to mathematically calculate the undesirable effect of the price change as a sort of noise in accounting communication on the basis of a hypothetical example and thereby to conclusively justify our interpretation of the price change as a noise.

Assume that the only message to be transmitted in accounting communication is that the real income figure of Company A has increased or decreased this year in comparison with that of last year.(1) As explained above, there exists a possibility that a difference can occur between the transmitted message and the received message because an income figure on the basis of historical cost is used as a signal for the transmission of that message. Our assumptions are: (1) this business entity as an information source produces with 70% probability the message that the current real income has increased and with 30% probability the inverse message that it has decreased: (2) the use of historical-cost-based income figure as an encoded signal for the above message in this situation of price changes results in misunderstandings on the receivers' part sometimes such that (a) an actual transmitted message of an increase in real income is properly decoded as such with 90% probability but the same message is decoded as realization of a decrease in real income with 10% probability (perhaps in case of a drastic price decline), (3) the message of a decrease in real income leads to the same message on the receivers' part with 40% probability, but the same transmitted message induces the receiver to decode it as an increase in it with 60% probability (maybe due to a price rise). These hypothetical possibilities are figured below (Fig. 4).

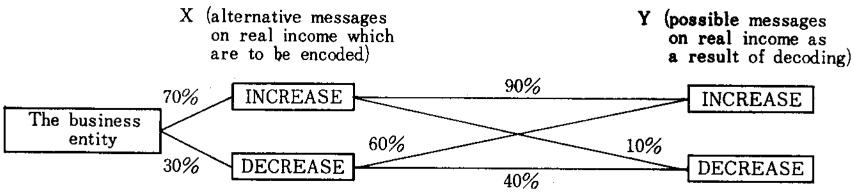


Fig. 4

The probabilities of the joint events of paired transmitted messages and received messages are calculated as follows:

$$P(+,+)^{(2)}=0.70\times0.90=0.63$$

$$P(+,-)=070.\times0.10=0.07$$

$$P(-,+)=0.30\times0.60=0.18$$

$$P(-,-)=0.30\times0.40=0.12$$

(1) The discussion in this section does not depend on how to define "real income," so long as this is something different from historical-cost-based income.

(2) e.g. $P(+,+)$ means the probability of the joint event occurring where the message to be encoded and that as the result of decoding are both "increase," and $P(+,-)$ the former "increase" and the latter "decrease."

$$\therefore \quad H(X)=0.70 \log_2 \frac{1}{0.70}+0.30 \log_2 \frac{1}{0.30}=0.88 \quad \text{(bits).}$$

$$H(X \mid Y)=0.63 \log_2 \frac{1}{0.90}+0.18 \log_2 \frac{1}{0.60}$$

$$+0.07 \log_2 \frac{1}{0.10}+0.12 \log_2 \frac{1}{0.40}=0.62 \quad \text{(bits).}$$

$$I(X, Y)=H(X)-H(X \mid Y)=0.88-0.62=0.26 \quad \text{(bits).}$$

These calculations will prove the validity of our proposition that price changes work as a sort of noise in accounting communication. The actually communicated amount of information $I(X,Y)$ is largely cut down by the amount of "equivocation" $H(X \mid Y)$. This equivocation can be considered as a mathematical expression of an undesirable effect (information loss) of price changes, and we think one of the problems of accounting measurement in the environment of changing prices lies in overcoming the effect of price changes as a semantic noise so that $I(X,Y)$ can be increased to the maximum by the reduction of the "equivocation."

IV. Redundancy

One of the common devices to cope with noise in the communication process is, according to the information theory, to introduce redundancy at the stage of the encoding operation. By "redundancy" is meant the existence of interdependence among the signals or messages to be transmitted (i.e. creation of the predictability of a forthcoming signal or message on the basis of the already received ones) which has been created by the use of excessive or redundant encoding rules or conventions above the minimum necessary for the communication.(1) And a distinction must be made between "syntactic redundancy" (the redundancy of cummunication signals as such) and "semantic redundancy" (an excess of messages for a given communication).

An example of syntactic redundancy: suppose that in communicating a sequence of independent letters, each letter has unnecessarily been repeated twice. Ex. "ABKLT" has been transmitted as "AABBKKLLTT." This redundant rule has added the same number of excessive signals as the mini-

(1) Claude E. Shannon and Warren Weaver, *op. cit.*, pp. 13–14. Colin Cherry, *op. cit.*, pp. 115–120.

(2) According to Shannon, the syntactic redundancy is formulated as one minus the relative entropy (H/H_{MAX}). This relative entropy is the ratio of the entropy of a source to the maximum value it could have while restricted to the same symbols. (Claude E. Shannon and Warren Weaver, *op. cit.*, p. 56)

mum necessary for the communication, but it has not changed the message to be transmitted by these signals. This constitutes an example of syntactic redundancy.(2)

An example of semantic redundancy: the sentence, "he is a hard worker, that is, he studies hard" not only denotes syntactic redundancy in the sense of unnecessary repetition of signals, but is also an example of semantic redundancy as a repetition of the same message.

In the absence of uncertainty surrounding communication or of the danger of distortion or destruction of transmitted signals or messages by noise, redundancy is unnecessary for communication, even cutting down the communication efficiency (per symbol or per second), so that it must be avoided as far as possible. A telegram is a good example. As an addressee of a telegram usually knows in advance the aim of the communication, the personality and the special usage of words of the addresser as well as his current situation, the former can understand the telegram worded with a minimum of redundancy. For the addresser there is enough time available for the composition of sentences with minimum redundancy which will be easily understood by the receiver at the same time. In other words telegrams are usually sent and received in a situation of scarce semantic noise.

More common forms of communication, however, are subject to various kinds of uncertainty and noise. Ex. uncertainty of speech sounds or acoustic patterning, uncertainty of language and syntax, environmental uncertainties due to street noise etc., and recognition uncertainties (resulting from unequal degrees of communication experiences or knowledges about the topic shared by the partners). As shown here, "there are many sources of uncertainty, yet speech communication works. It is so structured as to possess redundancy at a variety of levels, to assist in overcoming these uncertainties."(1) In a conversation "redundancy may be put in, in a changing, patchwork manner, moment by moment" watching and listning to the reaction of the partner to judge how far he understands the words, while in writing" the writer cannot observe his readers and can only make prior judgement of their difficulties. His writings are therefore premeditated and usually conform more closely to the rules."(2)

In the following we will reconsider the above example of syntactic redundancy, putting it in a noisy situation. Suppose that in the communication of that sequence of English letters occurrence of noise has completely hindered the reception of the letters corresponding to α_1 (i=1,2,3—) below,

$$AAB\alpha_1\alpha_2KLLT\alpha_3—$$

(1) Colin Cherry, *op. cit.*, p. 277.
(2) *Ibid.*, p. 120.

The foreknowledge of the rule that each letter will be repeated twice allows one to reconstruct the lost messages as follows.

$\alpha_1 = B, \qquad \alpha_2 = K, \qquad \alpha_3 = T$

From this example we can conclude that in the presence of noise an adequate degree of redundancy is indispensable for a reliable communication. And this conclusion will suggest that some way of introducing redundancy may be a good means to assure the transmission of the maximum amount of accounting information coping with price level changes as semantic noise.

V. An Example of Redundancy Introduced into Accountancy —— The Multi-Dimensional Measurement

Let the message of whether the historical-cost-income figure in the ith period has increased or not in comparison with that in the i-1th period be expressed as A_i, and the message about the increase or decrease of the real income of the ith period with that in the i–1th period be denoted as B_i. And we assume that the criterion of relevance[1] requires the communication of both messages to the interested parties. In the absence of price changes as a semantic noise the historical-cost-based income figure coincides with the real income figure, and hence the sequence of historical-cost-based income figures as is reported in the accounting practice simultaneously conveys both kinds of messages A_i and and B_i each period.

——A_2B_2	A_3B_3	A_4B_4——		(1)
the	the	the		
2nd	3rd	4th		
	period			

The historical-cost income calculation providing the set of income messages (A_i, B_i) is influenced by the price changes such that the message B_i in the set (A_i, B_i) is more or less perturbed or destructed as figured below:

$$——A_2(B_2)A_3B_3A_4(B_4)—— \qquad (2)$$

(where the letters in parentheses denote destructed messages).

Suppose that anticipating such a situation we measure for each period not only the historical-cost income but also the real income "explicitly" in accordance with the theory of the price level adjustment or the specific current cost valuation. A characteristic of this "explicit real income" in comparison with the "implicit real income" (the B_is in (1) above) is that the former income figures are

(1) Cf. A Statement of Basic Accounting Theory, *op. cit.*, p. 9–10.

free from the destruction due to the price changes as a semantic noise. A message about the increase or decrease of the explicit real income in the ith period when compared with that in the i–1th period shall be $\bar{B}_i$. And further we assume that the explicit real income is measured some way and shown with the historical-cost income figure in the same accounting report for every period. In this case the sequence of the communicated messages is chronologically shown as

——$A_2B_2\bar{B}_2$	$A_3B_3\bar{B}_3$	$A_4B_4\bar{B}_4$——	(3)
the 2nd period	the 3rd period	the 4th period	

The reporting of $\bar{B}_i$s in this sequence (3) shows the introduction of those messages which would be redundant in the absence of the price changes as a semantic noise, that is, the introduction of semantic redundancy. And this device will make it possible to successfully communicate A_i and (B_i and / or $\bar{B}_i$) to the interested parties overcoming the effects of any violent price change (as a semantic noise).

$$——A_2(B_2)\bar{B}_2A_3B_3\bar{B}_3A_4(B_4)\bar{B}_4—— \quad (4)$$

(The letters in parentheses denote destructed messages by noise.)

The above explanation will suffice to show that the essence of the "multi-dimensional income measurement" as a device of concurrent communication of plural different concepts of income consists in introducing a sort of semantic redundancy into accounting messages in order to cope with the price changes as semantic noise. (The best example of this kind of accounting report is found in the illustrative income statement proposed in ASOBAT,(1) where the revenues as well as the expenses are all valued twice, once on the historical cost basis and shown in the "Historical Cost" column, and once more on the current cost basis and reported in the "Current Cost" column.)

VI. Implications of These Interpretations for Accounting Communications

Thus far we have tried to develop and justify our interpretations of the price changes as a semantic noise and the multiple measurement as a device for introducing semantic redundancy into the accounting process. What are the implications of this conclusion?

Logically there seem to be two ways to overcome the undesirable effect of

(1) A Statement of Basic Accounting Theory, *op. cit.*, pp. 81–95.

any semantic noise. One is by introducing redundant messages into accounting for enhancing the probability of correct decoding while no effort is made to suppress the occurrence of the noise itself. Multiple measurement denotes such an attempt. And the other way is by trying to provide the interested groups with enough additional information about the business firm concerned (ex. physical information) as well as about its environment, to enable them to grasp the full meaning of the received accounting messages (historical-cost information). By this means the receivers of accounting information will have been notified in such a way — that is, their decoding capacity will have been so much improved — that price changes will stop working as a semantic noise to them. As mentioned above, this situation is similar to that in which addressees of telegrams will usually find themselves. Of cource, whether to include this additional information in accounting reports will depend on the definition of accounting.

It would be difficult, perhaps even unwise, to adopt any one of these devices to the exclusion of the other at this development stage of accountancy. We could even conceive a third possibility, an attempt to introduce semantic redundancy into accounting messages and moreover furnishing plenty of additional business and environmental information for the improvement of the decoding capacity at the same time. But an undeniable fact is that considering the general desirableness of promoting the understanding of a business enterprise by the interested groups, more and more additional non-accounting information should also be communicated to them besides the experimentation of introducing semantic redundancy into accounting messages.

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THE 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 *Juyo Keizai Tokei* monthly and *Sekai Boeki Tokei* 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 Hyogo 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 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 is a three-storied building 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, three conference rooms, etc. Adjoining is a one-story building recently built to install business machines.

ORGANIZATION

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

A Group of International Economy

(1) International Trade
(2) International Finance
(3) Maritime Economy
(4) Economy of Latin-America
(5) International Law of Economy

B Group of Business Administration

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

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 three committees, that is, International Finance Committee, the Committee of International Economic Cooperation and Overseas Business Operations in 1970's and Information Systems Committee.

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. It is the first systematic information facility 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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