BALANCE OF TRADE AND ECONOMIC GROWTH IN JAPAN[1]

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I. *Balance of Trade and Steady Growth of Economy*

In the open system of national economy, the balance between investment and savings is formed as follows:

$$S = V_d + (X - M)$$

Where S, V_d, X and M show the values of saivings, domestic investment, exports, and imports respectively. Restated, it becomes as follows:

$$S + M = V_d + X$$

If there is such a relation as $X = \beta M$ between the value of imports and that of exports, the following equation holds:

$$S + (1 - \beta)M = V_d$$

In the open system of national economy, even if savings and domestic investment, or imports and exports are not balanced, a balance in the national economy can be made. If there is the trend $S > V_d$, the balance may be formed, provided that it has a tendency toward excess of exports, and is $\beta > 1$, such as follows:

$$S - (\beta - 1)M = V_d$$

For a national economy which has a trend of excess savings, excess of exports is essntial to form the balance. In the opposite case, that is, in case it has a tendency $S < V_d$, excess of imports is essential. Because, under the condition of $\beta < 1$, it is balanced in the shape of the following form:

$$S + (1 - \beta)M = V_d$$

A balance in national economy is formally explained in above form. However, it is hard to establish the condition that β has a numerical value other than 1 and that unmerical value to be stable. Because β is to be determined under the complex structure of international economy, its numerical value easily undergoes a change. National economy which has to keep excess of exports at a fixed rate owing to excess savings is unable to attain this desirable favorable balance because of bad turns of international economic conditions. And it is easily touched by alien influences. On the other hand, national economy which has always to keep excess of imports at a fixed rate owing to insufficient savings, is placed in a unstable situation by foreign conditions. To stablize the economy, it is

[1] This is a English translation of the Chapter II of my book, *Economic Aanalysis of Japanese Foreign Trade*, Tokyo 1959, in Japanese.

desirable to realize a growth of national economy conditioned upon the balance of trade. As the Japanese economy has a tendency $S<V_d$, excess of imports is desirable to realize the balance. However, trade policy has never been framed for the aim of unfavorable balance, but has been adopted to adjust the growth rate of economy to get rid of the unfavorable balance. For it must have been considered that the balance conditional upon excess of imports at the fixed rate was unstable.

It is the essential condition for the steady growth of national economy to maintain the balance of trade. The necessary condition to maintain the balance of trade in the dynamic process of economy is established, if the trade was balanced at the initial condition, by uniformity of the increase rate of subsquent imports and exports. This is expressed in the following equation:

Assuming $X_0=M_0$

It is expressed as $G_x=G_m$ (1. 1)

G_x and G_m show the increase rate of exports and imports respectively. In this case, however, both increase rates should be expressed by the same unit of value, such as the standard export price. If G_x and G_m are expressed by the increase rate of each quantity, the equation should be as follows:

$$G_x \pm G_t = G_m \tag{1. 2}$$

G_t means the rate of variation in the terms of trade t. But, as the first approximation, G_t is from now on disregarded in this section. This ,however, will be corrected later. If the import function is given with a equation such as

$$\log M = \eta_m \log Y_d + \alpha' \tag{1. 3}$$

using the domestic national income, Y_d, as the explanatory variable, the increase rate of the total import is explained by the rate of growth of domestic income, G_d:

$$G_m = G_m(G_d) \tag{1. 4}$$

Accordingly, the equation (1. 1) becomes

$$G_x = G_m(G_d) \tag{1. 5}$$

This corresponds to

$$\log Y = k \log X + \alpha$$

Increase of national income is determined by expansion of exports. If exports can be politically adjusted, growth of national income must be also settled to cope with it. Exports, however, cannot always politically be adjusted with ease. In the international economic structure, exports are woven unto the net work of inter-dependence. The strategic variable explaining export behavior must be selected from that interwoven net. The formula which most easily suggests itself to our mind as the export behavior equation is, for example,

$$\log X = \eta_f \log Y_f + \alpha'' \tag{1. 6}$$

using income of foreign economy, Y_f, as the explanatory variable. Therefore, the increase rate of exports is formulated as the function of the rate of growth in foreign economy:

$$G_x = G_x(G_f) \tag{1. 7}$$

Under this condition the equation (1. 5) is rewritten as

$$G_x(G_f)=G_m(G_d) \qquad (1.\ 8)$$

This becomes the conditional formula which settles the equilibrium rate of growth, $\hat{G}_d$, in domestic economy. From the import and export behavior equation, they become $G_m=\eta_m G_d$ and $G_x=\eta_f G_f$ respectively; and the equilibrium rate of growth corresponding to the balance of trade becomes $\hat{G}_d=[\eta_f/\eta_m]G_f$. By being rewritten, it is formed as

$$\hat{G}_d=\mu G_f \qquad (1.\ 9)$$

μ is tentatively called hereafter the coefficient of comparative growth. It is nothing but the ratio of elasticity coefficients of export and import. This expresses the thesis that the equilibrium rate of growth of domestic national economy is determined by the rate of growth of foreign economy. This means that if the actual rate of growth of national economy is higher than that equilibrium rate, it causes excess of imports, and if contrarily lower, it leads to excess of exports. In the following, this conditional formula is applied to Japanese economy.

In applying this, we encounter the question of what the rate of growth of foreign economy is expressed by. So long as reliable data of national income of all the nations of the world cannot be obtained, the equation (1. 6) cannot be applied just as it is. Two short cut methods are used in this paper: One is to use the trend of production in the mining and manufacturing industries of the world instead of the growth rate of the world income. The other is to use the growth rate of the total international trade as the explanatory variable. Both are only approximation. At first, the analysis is made of the post-war period.

Table (1.1) shows production index of the world mining and manufacturing industry, Z_f, and the index of Japanese total export, X_d, for the period from 1950 to 1956, formulated by taking 1952 to be 100.0. An alyzing the correlation between indicated figures, we obtain the result as follows:

Table (1. 1) *Analysis of Export Behavior 1950–1956*

index numbers base year: 1952

	exports $\log X_d$	world production $\log Z_f$	world trade $\log M_t$	domestic production $\log Z_d$
1950	1.9267	1.9558	1.9563	1.8059
1951	1.9741	1.9905	2.0046	1.9532
1952	2.0000	2.0000	2.0000	2.0000
1953	2.0352	2.0315	2.0268	2.0954
1954	2.1598	2.0315	2.0480	2.1321
1955	2.2751	2.0729	2.0837	2.1695
1956	2.3527	2.0922	2.1203	2.2591

X_d is estimated by Japanese Ministry of Finance, Z_f and M_f by United Nations, Z_d by Japanese Economic Planning Board.

$$\log X_d=3.25 \log Z_f-4.4776 \qquad (1.\ 6,\ 1)$$

$$r^2=0.9265, \quad r=0.9626$$

Export elasticity coefficient is 3.25. Table (1. 2) shows the index of Japanese national income, Y_d, and index of the total import, M_d, for the same period. By analyzing it, it becomes as follows:

$$\log M_d = 2.3095 \log Y_d - 2.6057 \qquad (1.\ 3,\ 1)$$
$$r^2 = 0.9739 \qquad r = 0.9869$$

Import elasticity coefficient is 2.31. The conditional formula maintaining the balance of trade is obtained by combining these two equations. It becomes as follows:

From $2.31\hat{G}_d = 3.25\, G_f$,

it is formed as $\hat{G}_d = 1.406\, G_f$ (1. 9, 1)

Production of the world mining and manifacturing industry, however, was increasing with the average annual rate of 5.4% during the period. By inserting this numerical value into the above formula, the equilibrium rate of growth of the Japanese economy becomes 7.56%. If national income in Japan will expand at the rate greater than 7.56%, the rate of growth in imports becomes larger than of exports. Consequently, the balance of trade becomes adverse. As the rate of growth of Japanese national income during that period was 8.2% in average, it can be said that Japan had a tendency to increase the unfavorable balance.

If the index of the world trade, M_f, during that period is taken as the explanatory variable of the exports behavior equation, the result of correlation analysis

Table (1. 2) *Analysis of Import Behavior 1950-1956*

index numbers base year: 1952

	imports $\log M_d$	real nalt. income $\log Y_d$
1950	1.7862	1.9189
1951	1.9566	1.9605
1952	2.0000	2.0000
1953	2.1314	2.0327
1954	2.1468	2.0420
1955	2.1686	2.0819
1956	2.2723	2.1236

M_d is estimated by Japanese Ministry of Finance and Y_d by Japanese Economic Planning Board.

is as follows:

$$\log X_d = 2.814 \log M_f - 3.6209 \qquad (1.\ 6,\ 2)$$
$$r^2 = 0.9285 \qquad r = 0.9686$$

Export elasticity coefficient is 2. 8. The condition necessary to maintain the balance of trade is obtained by combining this export elasticity coefficient with that of import already mentioned. That is

$2.309\, \hat{G}_d = 2.814\, G_f$

therefore, $\hat{G}_d = 1.218\, G_f$ (1.9.2).

As the average annual rate of growth of the world trade in the same period was 6.5%, the equilibrium rate of growth of Japanese national income is 7.971%. This a little higher than the preceding estimated value. Although both corrlation coefficients are considerably high, difference of this degree are inevitable, for it is a matter of course that there are errors in estimation. It is, anyway, certain that a rate of growth more than 8% of national income is apt to cause an excess of imports. As a matter of fact, exports during the period increased at an average annual rate of 17.8%, while imports increased at a rate of 20.6%.

Business recessions experienced twice in post-war years in Japan occurred as reactions of the excessive growth of Japanese economy, which bumped into "the wall of international payment", and caused heavy deficits in that balance. Morever, both occurred in a period during which a government tight money policy was carried out. The fact that the relation which excessive growth of economy bears to intensifying an excess imports was emphasized as the basis of the policy is still fresh in our memory. It seems that what is analyzed here supports this political idea. The coefficient of comparative growth μ, mentioned above, gives an effective key to judge the propriety of rate of growth of national economy.

Rates of growth of economy in Britain in the 19th Century and in the United States of America in the 20 th Century were higher than those of other countries. For all that they showed a remarkable excess of exports, it must not be concluded that this analysis is not appropriate. It merely shows that the coefficient of comparative growth, μ, was large in both countries. This coefficient consisted of the ratio of elasticity coefficients of import and export. In case the elasticity coefficient of export is larger than that of import, the coefficient becomes higher. Thus, even though the rate of growth of national economy is high, an excess of exports can be made.

It is well-known that, reflecting on Britain's experience in the 19th Century, R.F. Harrod stated that a high rate of growth does not always develop a tendency to unfavorable balance.[2] He tried to elucidate the relation between rate of growth and the balance of trade by the doctrine of comparative costs. His claim was that: In case the high rate of growth is chiefly supported by a industry which has a comparative advantage in the cost of production—it may be briefly called an export industry—it causes, at the same time, a marked expansion of exports. It must, therefore, be able to bring about an excess of exports. It may be said that when this theory is compared with the above analysis of ours, it is critical of the latter. However, it is yet insufficient to negate the validity of the analysis completely. Because even in such examples that seem not to be applicable to this analysis at first sight, with the interpretation that it formed a high coefficient of comparative growth by making the export elasticity coefficient large, the analysis is able to escape from criticsm by this theory. Yet, the analysis (this will be hereafter called the "A" formula for short) and the theory are not constructed from a similar approach, for they hold a completely different opinion from each other about the export function.

In the "A" formula, the behavior of export is interpreted by the trend of

[2] R. F. Harrod, *Towards a Dynamic Economics*, London 1948, pp. 108～109.

foreign economy. On the other hand, it is understood that in the Harrod theory it is setteled by the trend of the export industry. The former is passive, while the latter is active. It may be an issue to be discussed which is right. For my opinion, it is more important to coordinate the two. For prepartion of the co-ordination, it is necessary to formulate the Harrod theory or its basic doctrine of comartive costs into a formula which is easily compared with the analysis now mentioned. In the following, the formulation will be made: the following formula is derived from the Harrod theory as the export function:

$$\log X = \eta_z \log Z_d + \alpha'' \qquad (1.\ 3)$$

Z_d shows production quantities of the domestic export industry. By uniting this formula with the import function, the condition maintaining the balance of trade becomes $G_x(G_z) = G_m(G_d)$, where G_z is the rate of growth in the export industry. By expanding this formula,

$$\eta_z G_z = \eta_m G_d \qquad (1.\ 11)$$

is derived. From it, the equilibrium rate of growth in the export industry is formed as

$$\hat{G}_z = [\eta_m / \eta_z]\, G_d.$$

Abbreviated, it is rewritten as

$$\hat{G}_z = \lambda G_d.$$

λ shows the tilting coefficient. If the growth of national economy puts a greater emphasis than this coefficient into the export industry, an excess of exports occurs. In the converse case, it is apt to cause an excess of imports. The Harrod theory can probably be generalized by being formulated like this. Hereinafter, the theory is called the "B" formula.

In the following, the "B" formula will be applied to the Japanese economy: Analyzing the Japanese economy for the period 1950–1956, the export behavior is measured as follows:

$$\log X = 0.975 \log Z_d + 0.0938 \qquad (1.\ 10,\ 1)$$

$$r^2 = 0.8337 \qquad r = 0.9131$$

However, the manufacturing industry is considered here as the export industry. (cf. Table (1. 1)) By uniting this with the above-mentioned formula of import function (1.1, 1), the condition maintaining the balance of trade becomes as follows:

$$0.975\, \hat{G}_z = 2.3095\, G_d$$

Accordingly, $\hat{G}_z = 2.366 G_d$

The tilting coefficient is 2.366. If the rate of production increase in the export industry is smaller than 2.366 times the rate of growth of national income, it must have a tendency to an unfavorable balance. As the average annual rate of growth in national income in this period was 8.2%, the rate of production increase in the export industry which is essential to maintain the balance of trade was 19.4% where, as a matter of fact, its average actual rate was 19.0%

According to this analysis, it can be said that, contrary to the previous one, an excess of imports was made due to the fact that the growth of national income was not made to the export industry with sufficient emphasis of weights. The necessary policy to maintain the balance of trade is not to control import by restraining the growth rate of national income, but to expand export by promoting the development of the export industry. The positive policy is much more desirable than the passive. Thus opinions which are contrary to each other are derived as political proposals. On the other hand, the theoretical analysis is as if both of them were looking only on one side of the shield.

An analysis of Japanese economy in per-war days will now be described. For the "A" formula, data of production index numbers of the world mining and manufacturing industry and index numbers of the world trade, which had been collected over a long time, have not yet put in order. So, the analysis is made with data in two limited periods—from 1920 to 1929 and from 1928 to 1937. The following is the analysis between 1920 and 1929:
Instead of index numbers of the world income, those of manufacturing production were applied. The behavior of Japanese export was analyzed according to the index of the world manufacturing production as the explanatory variable:

$$\log X = 1.1873 \log Z_f - 0.3774 \qquad (1.\ 6,\ 3)$$
$$r^2 = 0.8688$$

The export elasticity coefficient is 1.1873. The behavior of the Japanese import is explained by the index of national income as the explanatory variable:

$$\log M = 0.5956 \log Y_d + 0.8741 \qquad (1.\ 3,\ 2)$$
$$r^2 = 0.7308$$

As the import elasticity coefficient is 0.5956, the appropriate rate of growth corresponding to the balance of trade is shown by $\hat{G}_d = 1.9934\, G_f$. (cf. the Table 1.3).

The period between 1928 and 1937 was a time of upheaval involving a state of the Great Depression and the recovery from it. Amidst the worldwide depression, Japanese trade expanded with a low ecxhange rate of yen as its lever, and

Table (1. 3) *Analysis of Export and Import Behaviors 1920–1929*

Index numbers base year: 1928

	exports log X	world production log Z_f	imports log M	real natl. income log Y_d
1920	1.7681	1.8179	1.8140	1.6870
1921	1.7411	1.7575	1.8378	1.7610
1922	1.8667	1.8464	1.9308	1.7751
1923	1.7423	1.8675	1.9246	1.7952
1924	1.8520	1.8936	1.9662	1.8174
1925	1.9356	1.9302	1.9620	1.8387
1926	1.9423	1.9505	1.9994	1.8833
1927	1.9769	1.9770	2.0231	1.9004
1928	2.0000	2.0000	2.0000	2.0000
1929	2.0472	2.0340	2.0134	2.0107

X and M are estimated by Toyo Keizai Shimpo Sha (Oriental Economist Co.), Z_f by League of Nations, Y_d by Hitotsubashi Keizai Kenkyujo (Hitotsubashi Economic Research Institute).

helped the national economy to recover from the depression. The reason why the expansion of exports was made cannot be sufficiently explained merely by the behavior of world economy. It seems that Japanese trade policy was a powerful factor in its expansion. Therefore, this period is not suitable for the "A" formula to be applied. Between Japnese total export and the world manufacturing production, only the following weak correlation can be seen:

$$\log X = 0.9539 \log Z_f + 0.2014 \qquad (1.\ 6,\ 4)$$
$$r^2 = 0.4794$$

Again, between the Japanese exports and the world trade, there is as abnormal relation like a negative correlation. This shows that the world trade is not the proper factor to interpret the behavior of demand for Japanese exports. In addition, between import demand and national income in Japan, there was only a weak correlation, which is not significant from the statistical point of view (cf. Table 1. 4):

$$\log M = 0.6562 \log Y_d + 0.6571 \qquad (1.\ 3,\ 3)$$
$$r^2 = 0.5104$$

The following is the application of the "B" formula: As only domestic data are necessary, the formula is easily applied. The analysis over a long period is made with this description.

The period from 1878 to 1932 is divided into ten parts. The index number of exports and that of production in the manufacturing industry, and also that of imports and that of real national income are shown in the Table (1. 5). Now the figures will be analyzed in the following. As the export equation, the following is obtained:

$$\log X = 0.9637 \log Z_d - 0.0525 \qquad (1.\ 12,\ 2)$$
$$r^2 = 0.9898 \qquad r = 0.9944$$

Table (1. 4) *Analysis of Export and Import Behaviors 1928–1937*

Index numbers base year: 1928

	exports $\log X$	world production $\log Z_f$	imports $\log M$	real natl. income $\log Y$
1928	2.0000	2.0000	2.0000	2.0000
1929	2.0472	2.0340	2.0134	2.0107
1930	1.9956	1.9867	1.9534	2.0704
1931	2.0093	1.9366	2.0057	2.1099
1932	2.0701	1.8832	1.9968	2.1082
1933	2.0939	1.9336	2.0231	2.1068
1934	2.1623	1.9832	2.0576	2.1202
1935	2.2176	2.0375	2.0677	2.1519
1936	2.2555	2.0986	2.1082	2.1769
1937	2.2730	2.1402	2.1350	2.1601

X and M are estimated by Toyo Keizai Shimpo Sha and Yokohama Specie Bank, Z_f by League of Nations, Y_d by Hitotsubashi Keizai Kenkyujo.

As the import equation, the following is derived:

$$\log M = 1.5371 \log Y_d - 1.1158 \qquad (1.\ 3,\ 5)$$
$$r^2 = 0.9755 \qquad r = 0.9877$$

Table (1. 5) *Analysis of Export and Import Behaviors 1978–1932*

Index numbers base year: 1931

	exports $\log X$	domestic production $\log Z_d$	imports $\log M$	real natl. income $\log Y_d$
1878—1887	1.0319	1.1476	1.0216	1.4464
1883—1892	1.2130	1.3189	1.1979	1.5364
1888—1897	1.3615	1.4955	1.4239	1.6402
1893—1902	1.5023	1.6500	1.6105	1.7530
1898—1907	1.6544	1.7346	1.7676	1.8179
1903—1912	1.7881	1.8506	1.8504	1.8820
1908—1917	1.9742	2.0252	1.9102	1.9583
1913—1922	2.0785	2.2004	2.0386	2.0444
1918—1927	2.1253	2.3013	2.1897	2.1513
1923—1932	2.2314	2.4211	2.2645	2.2683

X and M are estimated by Toyo Keizai Shimpo Sha, Z_d by former Nagoya Commercial College, Y by Hitotsubashi Keizai Kenkyujo.

The condition maintaining the balance of trade is as follows:

$$0.9637\,\hat{G}_z = 1.5371\,G_d$$

Then, the following is derived:

$$\hat{G}_z = 1.54\,G_d \qquad (1.\ 12,\ 2)$$

The tilting coefficient is 1.54. The average annual rate of growth in national income during period was 4.30%. Therefore, the required rate of production increase in the export industry is to be 6.93%, where it was actually 6.73%. That is, it was a little lower than the required one. While the average rate of increase of import during the period was 6.57%, that of export was practically 5.89%, which is considerably lower than the former. There was an obvious tendency to an unfavorable balance of trade.

The fact that the rate of growth of Japanese economy was remarkably higher over a long period than that of any other country is now a matter of common knowledge. Nonetheless, what differs from Britain in the 19th Century and the United States of America in the 20th Century is that Japan had a tendency to an unifavorable balance of trade. This cannot be interpreted by the Harrod theory of comparative costs. The high rate of growth in the Japanese economy was mainly supported by the export industry, so that the condition of the favorable balance described in the Harrod theory was fully exemplified. However, an excess of imports occurred. By generalizing the theory of comparative costs in our revised form, this Japanese instance can be explained. But, we do not claim that the "B" formula is a theory having already sufficient generality. In order to generalize it further, it is necessary to coordinate the relation between this "B" formula and the abovementioned "A" formula.

II. *Balance of Trade and Terms of Trade*

The problem in this section is to coordinate the relation between two formulas —"A" and "B" formulas. Both formulas follow the same method to obtain import equation. However, they differ in obtaining the export one. In the "A" formula, export equation makes the movement of income in foreign economy the important explanatory variable. Accordingly, it has the interpretation that the balance of trade is determined by reciprocal demands between one country and others. It may be safely said that it is connected to the reciprocal demands theory in its fundamental view, while the "B" formula take the movement of export industry as the explanatory variable of export behavior, and relates to the theory of compartive costs as mentioned before.

In this way, it is easily understood that coordination of these two formulas can be done by re-examining the relation between these two theories. Far back in the mid–19 Century it was already made clear by John S. Mill (1806–73) that both theories have the relation of complementing each other. The theory of international equilibrium propounded afterwards is accomplished by making itself more elaborately along the lines of Mill's proposal. Therefore, the problem is not a new one. However, the two formulas mentioned above are considerably different from that of reciprocal demands and that of compartive costs in their analytical contents, so that the difference of contents must be examined.

The theory of reciprocal demands is as follows:
Export in Japan, X_d, is in other word import in foreign countries, M_f. Thus, the balance of trade is as follows:

$$M_f = M_d \qquad (2.\ 1)$$

It was interpreted that import demands in a country and the other were functions which made the terms of trade the pricnipal explanatory variable respectively:

$$\begin{aligned} M_f &= M_f(t) \\ M_d &= M_d(t) \end{aligned} \qquad (2.\ 2)$$

In this way, the equilibrium of reciprocal demands was thought to be established by making the terms of trade the adjusting variable:

$$M_f(t) = M_d(t) \qquad (2.\ 3)$$

The equilibrium terms of trade were assumed to be more profitable than the price ratio which would have been settled by domestic costs of production in each nation. The foreign trade stimulated by the difference in comparative costs between the countries reaches the balance of trade under these equilibrium terms of trade. Then the gains from trade are divided between each country under the same terms. This is the core of Mill's doctrine. The theory of international equilibrium held fundamentally the same view which the former held until comparatively recent years.

The biggest defect in this theory seems it was formed on the method of economic statics. The equilibrium shown in the formula (2. 3) is only formed on the assumption that the reciprocal demand curve in each country does not shift. The theory of comparative costs is the dynamic theory in its foundation: each country puts emphasis on the export industry from the standpoint of comparative advantage and reorganizes its industrial structure, then places it in the system of international specilization and fosters its economic development. This is the consistent conviction in the latter. This dynamic idea cannot directly be united with the statical theory of the former. In this way, the gap develops between the vision and the analytical framework. In order to fill up the gap, the variable settling the shift of the demand curve must be adapted to the formula of the balance of trade in a clear statement. The revision of the analytical framework must be accomplished.

The above-mentioned "A" formula made the formulation of the function of reciprocal demands by making shift variable only an explanatory variable. Assuming that:

$$M_f=M_f(Y_f) \qquad (2.\ 4)$$
$$M_d=M_d(Y_d)$$

The balance of trade was expressed in the following form:

$$M_f(Y_f)=M_d(Y_d) \qquad (2.\ 5)$$

By uniting this with the theory of reciprocal demands, the function of reciprocal demands is as follows:

$$M_f=M_f(t,\ Y_f) \qquad (2.\ 6)$$
$$M_d=M_d(t,\ Y_f)$$

The balance of trade is formed as follows:

$$M_f(t,\ Y_f)=M_d(t,\ Y_d) \qquad (2.\ 7)$$

As shown above, by applying the shift variable of the reciprocal demand curve into the formula specifically, the gap between the static equilibrium analysis and dynamic theory of comparative costs can be reduced. From the standpoint of adjustment of the "A" formula, by adding the terms of trade as the explanatory variable, the "A" formula approaches a step toward the theory of comparative costs, accordingly toward the "B" formula.

With the same reason, the latter can approach the former in the following way. The necessary adjustment is as follows: The export function becomes:

$$X_d=X_d(t,\ Z_d) \qquad (2.\ 8)$$

As the above mentioned import function can be used without any change, the balance of trade becomes as follows:

$$X_d(t,\ Z_d)=M_d(t,\ Y_d) \qquad (2.\ 9)$$

In this way, the "B" formula approaches the "A" formula. Of course, by this adjustment, the difference of basic idea existing between the two formulas is not always wiped away perfectly. Yet the "A" formula propounds the passive view about exports while the "B" propounds the active. However, so long as the statistical survey is continued with observable data, it might not be very difficult to reconcile the difference of opinions between the two. If the difference of opinions is taken up as they are without considering this survey, there is no room to reconcile it. Following the previous section, the statistical analysis for Japanese trade will be carried out in the following. It is a matter of course that both revised formulas are statistically applied closely, and the results of measurements are compared and examined. Now both formulas must be expanded into applicable forms. For the sake of convenience, the "B" formula will be explained first. The import equation is mainly formed as follows:

$$\log M = e_m \log t + \eta_m \log Y_d + \alpha \qquad (2.\ 10)$$

Also the export equation in the "B" formula is supposed as follows:

$$\log X = -e_x \log t + \eta_z \log Z_d + \alpha' \qquad (2.\ 11)$$

Under this supposition, if the rate of variation in the terms of trade is G_t, the rate of growth of the import value at the export price base is as follows:

$$G_m = (e_m - 1)G_t + \eta_m G_d \qquad (2.\ 12)$$

The rate of growth of the export value at the same base is as follows:

$$G_x = -e_x G_t + \eta_z G_z \qquad (2.\ 13)$$

The condition required to maintain the balance of trade in the dynamic process is, if it was balanced at the initial stage, as follows:

$$\eta_z G_z = (e_m + e_x - 1)G_t + \eta_m G_d \qquad (2.\ 14)$$

If the left side of the above equation is larger than the right, it means an excess of exports. Oppositely, it means an excess of imports. Comparing this equation with the balance equation which was expanded in the previous section (1. 11), $\eta_z G_z = \eta_m G_d$, two pieces of impormation are obtained: One is that: In cases where the rate of production increase in the export industry is relativeley higher than that of growth in national income, if it does not accompany any improvement of productivity of the export industry and causes the relative rise of export price, it might bring an unfavorable balance of trade through the action of the terms of trade, even if it becomes $\eta_z G_z \geq \eta_m G_m$. On the countrary, if the improvement of productivity of that industry is sufficient, it has the possibility of preserving the favorable balance by making comparatively cheap the export price, even though it becomes $\eta_z G_z \leq \eta_m G_d$. The other is that: The sum of price elasticity coefficients of imports and exports has to be larger than I to realize the above-mentioned possibility. If it is $e_m + e_x < 1$, the balance of trade enters into unfavorable condition by deterioration of the terms of trade. Therefore, $e_m + e_x = 1$ is, as it were, the critical point. This was explained by J. Robinson.[3]

These two pieces of information probably play an important part in the study of the problem of the balance of trade. However, in case of statistical measurement, attention must be previously paid to the fact that price elasticity of import and export, e_m and e_x, is apt to contain considerable errors of estimation, and there are not a few occaions when useful judgments can hardly be made at all.

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[3] Joan Robinson, *Essays in the Theory of Employment*, Oxford 1947, pp. 142–3

It means that, at the time of application of import and export functions, the scheme obtaining as significant results of statistical analysis as possible must be made by modifying functional forms.

The export equation in the "A" formula is shown below:

$$\log X = -e_x \log t + \eta_x \log Y_f + \alpha'' \qquad (2.\ 15)$$

The condition required to maintain the balance of trade are:

$$\eta_x G_f = (e_m + e_x - 1) G_t + \eta_m G_d \qquad (2.\ 16)$$

The equation similar to this was already expanded by G. H. Johnson.[4] The meaning of his equation is the same as the equation (2. 16) of ours. With these preparations, I hope the measurement can easily be accomplished.

Analysis for the post-war days will be made in the following: in a period from 1950 to 1956, the import equation is:

$$\log M = 0.4942\,t + 2.0859 \log Y_d - 2.8045 \qquad (2.\ 10,\ 1)$$

$$R^2 = 0.9892 \qquad (cf.\ \text{the Table 2. 1})$$

The income elasticity coefficient of import in the equation mentioned before (1. 3, 1) is 2.3095. In this equation containing the terms of trade as an additional explanatory variable, the value is 2.0859, a little lower than the former. The price elasticity coefficient of import is easily measured from parameter 0.4942 which is affected by the terms of trade. Its average elasticity coefficient is 1.1208. In import, the income elasticity is 2.0895, and the price elasticity is 1.1208. It is understood that import demand is considerably elastic. These parameters contain estimated errors, which must be examined. Errors in the price elasticity are greater than that of income. However, both values are, anyhow, statistically significant. That is:

the income elasticity	2.0859 ± 0.1626
the price elasticity	1.1208 ± 0.5299

In export, according to the "A" formula, two methods of measurment are made; one is the method using the index number of production of the world mining and

Table (2. 1) *Analysis of Import Behavior 1950–1956*

index numbers base year: 1952

	imports $\log M$	termes of trade t	real natl. income $\log Y_d$
1950	1.7862	0.9701	1.9189
1951	1.9566	1.0986	1.9605
1952	2.0000	1.0000	2.0000
1953	2.1314	1.0515	2.0327
1954	2.1468	1.0533	2.0420
1955	2.1686	1.0497	2.0819
1956	2.2723	1.1158	2.1236

M and t are estimated by Japanese Ministry of Finance, Y by Japanese Economic Planning Board.

[4] H. G. Johnson, "Increasing Productivity, Income and Price Trends, and the Trade Balance" *Economic Journal*, Sept. 1954.

manufacturing industry instead of the world income, and the other is to use the index number of the world trade. In the former method, the statistical equation explaining the export behavior is as follows:

$$\log X = -0.1893\,t + 3.3825 \log Z_f - 4.5474 \qquad (2.\ 15,\ 1)$$
$$R^2 = 0.9245$$

In the latter, the result is:

$$\log X = -0.5643\,t + 3.1156 \log M_f - 3.6428 \qquad (2.\ 15,\ 2)$$
$$R^2 = 0.9416 \qquad (\textit{cf.}\ \text{the Table 2. 2})$$

Parameters affected by the terms of trade must theoretically be equivalent to each other. However, they are unequal in the above measurements. Estimated errors between the two are markedly great. Each elasticity coefficient taking estimated errors into consideration is as follows:

The elasticity coefficient related to production in the world mining and manufacturing industry	3.3825 ± 0.6661
The elasticity coefficient related to the world total trade	3.1156 ± 0.5187
The price elasticity coefficient (1)	-0.4569 ± 1.4449
The price elasticity coefficient (2)	-1.3621 ± 1.3780

As indicated above, errors in price elasticity coefficients are great. Therefore, these values are not significant.

According to the "B" formula, the export behavior equation is as follows:

$$\log X = -0.1864\,t + 1.0280 \log Z_d + 0.1817 \qquad (2.\ 11,\ 1)$$
$$R^2 = 0.8358$$

The price elasticity coefficient in the above equation has also a large error. Two elasicity coefficients and their errors are as follows:

The elasticity coefficient related to the export industry	1.0280 ± 0.3201
The price elasticity coefficient	-0.4499 ± 2.2625

Though the former is anyhow, the latter is not significant (cf. the Table 2. 2).

As described above, even the revision of "A" and "B" formulas is tried by adding the terms of trade to them as additional explanatory variables, and the compartive study of both formulas is also attempted, it is impossible to obtain the meaningful results from data in post-war days. Each export behavior equa-

Table (2. 2) *Analysis of Export Behavior 1950–1956*

index numbers base year: 1952

	exports $\log X$	terms of trade t	world production $\log Z_f$	world trade $\log M_f$	domestic production $\log Z_d$
1950	1.9267	0.9701	1.9558	1.9563	1.8059
1951	1.9741	1.0986	1.9905	2.0046	1.9532
1952	2.0000	1.0000	2.0000	2.0000	2.0000
1953	2.0352	1.0515	2.0315	2.0268	2.0954
1954	2.1598	1.0533	2.0315	2.0480	2.1321
1955	2.2751	1.0497	2.0729	2.0837	2.1695
1956	2.3527	1.1158	2.0922	2.1203	2.2591

X and t are estimated by Japanese Ministry of Finance, Z_f and M_f by United Nations, Z_d by Japanese Economic Planning Board.

tion itself has anyhow a considerably high coefficient of determination. However, it is dangerous to derive some economic judgement from it concerning the action of terms of trade. Useful results to supplement the analsyis in the previous section could not be obtained.

Now an analysis of pre-war years will be made in the following. Firstly, the "B" formula is applied. Analysis over a long period from 1878 to 1932 is made. The import behavior equation in this period is:

$$\log M=0.5038\,t+1.6955\log Y_d-1.9513 \qquad (2.\ 10,\ 2)$$
$$R^2=0.9824 \qquad (cf.\ \text{the Table 2. 3})$$

Two elasticity coefficients obtained from this are:

The income elasticity coefficient	1.6955 ± 0.1286
The price elasticity coefficient	1.7024 ± 0.8633

In this case, the price elasticity coefficient also has a considerably large error, but is significant at any rate.

The export behavior equation in the same period is:

$$X=-1.5195\,t+0.9517\log Z_d+0.7650 \qquad (2.\ 11,\ 2)$$
$$R^2=0.9570$$

The average elasticity coefficients are:

The elasticity coefficient related to the export industry	0.5851 ± 0.1118
The price elasticity coefficient	-2.5317 ± 1.1990

The error of price elasticity coefficient is also large, but it is anyhow statistically significant. The condition required to maintain the balance of trade is:

$$0.5851\hat{G}_z=3.2341G_t+1.6955G_d$$

The average annual growth rate of national income during that period was 4.30%, and that of the terms of trade was minus 0.38%. Applying these value into the above equation, it is understood that the annual growth rate of the export industry required to maintain the balance of trade must be 10.60%. However, the actual average growth rate was 6.73%. There exists the reason why it brought

Table (2. 3) *Analysis of Import Behavior 1878–1932*

index numbers base year: 1913

	imports $\log M$	terms of trade t	real natl. income $\log Y_d$
1878—1887	1.0216	1.2441	1.4464
1883—1892	1.1979	1.2558	1.5364
1888—1897	1.4239	1.2424	1.6402
1893—1902	1.6105	1.2550	1.7530
1898—1907	1.7676	1.2980	1.8179
1903—1912	1.8504	1.2537	1.8820
1908—1917	1.9102	1.0736	1.9583
1913—1922	2.0386	1.0138	2.0444
1918—1927	2.1897	1.0847	2.1513
1923—1932	2.2645	1.0478	2.2683

M and t are estimated by Toyo Keizai Shimpo Sha, Y by Hitotsubashi Keizai Kenkyujo.

Table (2. 4) *Analysis of Export Behavior 1878–1932*

index numbers base year: 1913

	exports X	terms of trade t	domestic production $\log Z_d$
1878—1887	0.1076	1.2441	1.1476
1883—1892	0.1636	1.2558	1.3189
1888—1897	0.2299	1.2424	1.4955
1893—1902	0.3179	1.2550	1.6500
1898—1907	0.4512	1.2980	1.7346
1903—1912	0.6138	1.2537	1.8506
1908—1917	0.9423	1.0736	2.0252
1913—1922	1.1979	1.0138	2.2004
1918—1927	1.3346	1.0847	2.3013
1923—1932	1.7042	1.0478	2.4211

X and t are estimated by Toyo Keizai Shimpo Sha, Z_d by former Nagoya Commercial College.

about an excess of imports. From the other point of view, where the increasing rate was 6.73%, an effort must still be taken to lower, still more, the terms of trade by improving the productivity to maintain the balance of trade. It may also be safely said that the necessary lowering rate of terms of trade had to be 1.03%, which is far larger than the actual lowering rate, 0.38%.

Secondly, an analysis of the period from 1894 to 1915 will be made in the following:

The import behavior equation is obtained analyzing figures indicated in the Table (2. 5):

$$\log M = 0.4477t + 1.8112 \log Y_d - 2.117 \qquad (2.\ 10,\ 3)$$

$$R^2 = 0.9863$$

The export behavior equation is obtained by analyzing that of Table (2. 6):

$$\log X = -0.3049t + 0.7302 \log Z_d + 0.8150 \qquad (2.\ 11,\ 3)$$

$$R^2 = 0.7054$$

Elasticity coefficients concerned are:

income elasticity coefficient of import	1.8112 ± 0.0558
elasticity coefficient of export related to the export industry	0.7302 ± 0.1669
price elasticity of import	1.2589 ± 0.1133
price elasticity of export	-0.8573 ± 0.6598

The price elasticity coefficient of export has a large error. The condition required maintain the balance of trade are:

$$0.7302\,\hat{G}_z = 0.5875\,G_t + 1.8112\,G_d$$

During this period, national income increased by the average annual rate of 3.50%, and the terms of trade decreased by that of 1.23%. Therefore, the growth rate of production in the export industry which is asked to maintain the balance of trade should be 7.84%. This required rate of 7.84% higher than the actual rate of 7.02%. If the adjustment is made in the terms of trade, supposing that this actual rate of 7.02% was maintained, the terms of trade must decrease by the

Table (2. 5) *Analysis of Import Behavior 1894–1915*

index numbers base year: 1913

	imports $\log M$	terms of trade t	real natl. income $\log Y_d$
1894—1896	1.4893	1.2365	1.7043
1895—1897	1.5676	1.2557	1.7040
1896—1898	1.6662	1.2601	1.7373
1897—1899	1.6888	1.2906	1.7670
1898—1900	1.6994	1.3032	1.7933
1899—1901	1.6581	1.2323	1.8020
1900—1902	1.6752	1.1935	1.8090
1901—1903	1.6978	1.2150	1.8215
1902—1904	1.7452	1.2511	1.8191
1903—1905	1.8147	1.2832	1.8129
1904—1906	1.8387	1.3161	1.8161
1905—1907	1.8714	1.3960	1.8309
1906—1908	1.8412	1.3941	1.8719
1907—1909	1.8451	1.3592	1.8900
1908—1910	1.8381	1.2345	1.8924
1909—1911	1.8533	1.1527	1.9114
1910—1912	1.8919	1.0590	1.9417
1911—1913	1.9362	1.0300	1.9810
1912—1914	1.9552	0.9842	1.9934
1913—1915	1.9451	0.9804	1.9882

M and t are estimated by Toyo Keizai Shinpo Sha, Y by Hitotsubashi Keizai Kenkyujo.

average annual rate of 2.19%.

Thirdly, in the period from 1919 to 1928 the import behavior equation is as follows (cf. Table. 2. 7):

$$\log M = 0.2037t + 0.7725 \log Y_d + 0.3010 \qquad (2.\ 10,\ 4)$$

$$R^2 = 0.7609$$

The export behavior equation is (cf. Table 2. 8):

$$\log X = -0.2751t + 0.9178 \log Z_d + 0.2884 \qquad (2.\ 11,\ 4)$$

$$R^2 = 0.8630$$

Elasticity coefficients are:

of import related to income	0.7725 ± 0.1906
of export related to the export industry	0.9178 ± 0.1612
of import related to price	0.5174 ± 0.3513
of export related to price	-0.6987 ± 0.3235

The condition required to maintain the balance of trade is:

$$0.9178\hat{G}_z = 0.2161G_t + 0.7725G_d$$

The sum of elasticity coefficients of import and export has not a significant difference from unity, taking estimated errors into consideration. It can be said that it is almost close to a critical point. However, according to the above-mentioned equation, the condition required to maintain the balance will be examined in the following.

Table (2. 6) *Analysis of Export Behavior 1894–1915*

index numbers base year: 1913

	exports log X	terms of trade t	domestic production log Z_d
1894—1896	1.4066	1.2365	1.4365
1895—1897	1.4407	1.2557	1.4932
1896—1898	1.4559	1.2601	1.5382
1897—1899	1.5189	1.2906	1.5507
1898—1900	1.5189	1.3032	1.5658
1899—1901	1.5744	1.2323	1.5729
1900—1902	1.6011	1.1935	1.6012
1901—1903	1.6644	1.2150	1.6187
1902—1904	1.6909	1.2511	1.6609
1903—1905	1.7023	1.2832	1.7127
1904—1906	1.7241	1.3161	1.7515
1905—1907	1.7254	1.3960	1.7843
1906—1908	1.7393	1.3941	1.7863
1907—1909	1.7564	1.3592	1.8056
1908—1910	1.8082	1.2345	1.8222
1909—1911	1.8491	1.1527	1.8659
1910—1912	1.8894	1.0590	1.9220
1911—1913	1.9276	1.0300	1.9660
1912—1914	1.9776	0.9842	1.9898
1913—1915	2.0189	0.9804	1.9965

Base year for index numbers is 1913

X and t are estimated by Toyo Keizai Shinpo Sha, Z_d by former Nagoya Commercial College.

Table (2. 7) *Analysis of Import Behavior 1919–1928*

index numbers base year: 1913

	imports log M	terms of trade t	real natl. income log Y_d
1919	2.1014	1.000	2.1304
1920	2.0930	0.974	2.0398
1921	2.1168	1.132	2.1138
1922	2.2098	1.287	2.1279
1923	2.2036	1.293	2.1490
1924	2.2452	1.125	2.1702
1925	2.2410	1.044	2.1915
1926	2.2784	1.083	2.2361
1927	2.3021	1.090	2.2532
1928	2.2790	1.004	2.3528

M and t are estimated by Toyo Keizai Shinpo Sha, Y by Hitotsubashi Keizai Kenkyujo.

This period involves the years from the Armistic of World War I to the Great Depression (The so-called *Showa Kyoko*, in Japanese). The wave of business fluctuation was rather strong. According to the logarithmic linear trend

Table (2. 8) *Analysis of Export Behavior 1919–1928*
index numbers base year: 1913

	exports $\log X$	terms of trade t	domestic production $\log Z_d$
1919	2.1052	1.000	2.2430
1920	2.0334	0.974	2.2455
1921	2.0064	1.132	2.2227
1922	2.0920	1.287	2.2967
1923	2.0076	1.293	2.3139
1924	2.1173	1.125	2.3483
1925	2.2009	1.044	2.3464
1926	2.2076	1.083	2.4232
1927	2.2422	1.090	2.4314
1928	2.2653	1.004	2.4771

X and t are estimated by Toyo Keizai Shimpo Sha, Z_d by former Nagoya Commercial College.

equations derived from the fluctusting annual national income data shows at the annual rate an increse of 6.22%, and the terms of trade shows the decrease of 0.10%. By substituting these into the above equation, the annual rate of increase in the export industry which is required to maintain the balance of trade is 5.24%. The actual increasing rate was, however, a little higher: 6.62%. Thus, it can be seen that there was a trend toward improvement of the balance of trade through the period. As a matter of fact, the trend of foreign trade was that export increased by the annual tate of 6.25%, and import increased only by that of 5.86%, even if it was converted into the export price base including the decrease of terms of trade. Therefore a 0.39% improvement of the balance of trade was made annually. Nonetheless an excess of imports was noted during the period. The unfavorable balance was made at the initial stage of the period and it was not erased in spite of the favorable trend.

Fourthly, in the period from 1928 to 1937—the period involving the Great Depresein mentioned before and its recovery—it was difficult to analyze the behavior of import and export, as was explained in a previous section. Can improvement be made in this respect by adding the terms of trade as the explanatory variable? As mentioned below, a considerable improvement was made. Yet a really satisfactory result of statistical anaylsis cannot be obtained. The import behavior equation is obtained by analyzing the data indicated in the Table (2. 9)

$$\log M = -0.4903 \log t + 0.1352 \log Y_d + 2.6922 \qquad (2.\ 10,\ 5)$$
$$R^2 = 0.7401$$

Price and income elasticity coefficients are shown with their estimated errors:

price elasticity	-0.4903 ± 0.1783
income elasticity	0.1352 ± 0.2484

Contrary to examples indicated heretofore, the income elasticity is lacking in significance. By analyzing the Table (2. 10), the following export equation is obtained:

$$\log X = -1.0624 \log t + 0.1962 \log Z_d + 3.9731 \qquad (2.\ 11,\ 5)$$
$$R^2 = 0.9282$$

Each elasticity coefficient is shown with each error:

price elaslicity	-1.0624 ± 0.5415
elasticity coefficient related to the export industry	0.1962 ± 0.4768

Each coefficient has not enough significancs. The condition required to settle the proper rate of growth in the export industry is:

$$\hat{G}_z = -2.1809 G_t + 0.6890 G_d$$

Now the "A" formula will be applied:

The adequate data are available only for the period from 1920 to 1937. In the following, analysis will be made in two separated periods 1020 through 1929 and 1928 through 1937—as was done in previous section

Table (2. 9) *Analysis of Import Behavior 1928—1937*

index numbers base year: 1928

	imports log M	terms of trade log t	real natl. income log Y_d
1928	2.0000	2.0000	2.0000
1929	2.0134	2.0081	2.0107
1930	1.9534	1.9778	2.0704
1931	2.0057	1.9991	2.1099
1932	1.9968	1.9476	2.1082
1933	2.0231	1.9131	2.1068
1934	2.0576	1.8598	2.1202
1935	2.0677	1.8519	2.1519
1936	2.1082	1.8383	2.1769
1937	2.1350	1.7821	2.1601

M and t are estimated by Toyo Keizai Shimpo sha and Yokohama Specie Bank, y by Hitotsubashi Keizai Kenkyujo.

Table (2. 10) *Analysis of Export Behavior 1928—1937*

index numbers base year: 1928

	exports log X	terms of trade log t	domestic production log Z_d	world production log Z_f
1928	2.0000	2.0000	2.0000	2.0000
1929	2.0472	2.0081	2.0447	2.0340
1930	1.9956	1.9778	2.0765	1.9867
1931	2.0093	1.9991	2.0848	1.9366
1932	2.0701	1.9476	2.1028	1.8832
1933	2.0939	1.9131	2.1499	1.9336
1934	2.1623	1.8598	2.2302	1.9832
1935	2.2176	1.8519	2.2939	2.0375
1936	2.2555	1.8383	2.3297	2.0986
1937	2.2730	1.7821	2.3519	2.1406

X and t are estimated by Toyo Keizai Shimpo Sha and Yokahama Specie Bank, Z_d by former Nagoya Commercial College., Z_f by League of Nations.

The period from 1920 to 1929: Analyzing the Table (2. 11) the import equation is:

$$\log M = 0.3989 \log t + 0.6495 \log Y_d - 0.0660 \qquad (2.\ 10,\ 6)$$
$$R^2 = 0.7789$$

Analyzing the Table (2. 12), the export equation:

$$\log X = -0.2584 \log t + 1.1377 \log Z_f + 0.2442 \qquad (2.\ 15,\ 2)$$
$$R^2 = 0.8769$$

Elasticity coefficients concerned are:

of the price for import	0.3989 ± 0.3018
of income for import	0.6495 ± 0.1225
of the price for export	-0.2584 ± 0.3551
of income for export	1.1377 ± 0.1717

Errors of price elasticity coefficients are as great as those of previous analysis. The condition to settle the proper rate of growth in the national economy is:

$$\hat{G}_d = 0.5276 G_t + 1.7516 G_f$$

The period from 1928 to 1937: The import equation is the same as in the "B" formula:

$$\log M = -0.4903 \log t + 0.1352 \log Y_d + 2.6922$$
$$R^2 = 0.7401$$

Analyzing the Table (2. 10), the export equation is:

$$\log X = -1.1441 \log t + 0.2291 \log Z_f + 3.8474 \qquad (2.\ 15,\ 4)$$
$$R^2 = 0.9440$$

In this equation, errors are relatively large in the income elasticity coefficient as shown below:

of the price	-1.1441 ± 0.1400
of income	0.2291 ± 0.1452

Table (2. 11) *Analysis of Import Behavior 1920—1929*

index numbers base year: 1928

	imports $\log M$	terms of trade $\log t$	real natl. income $\log Y_d$
1920	1.8140	1.9869	1.6870
1921	1.8378	2.0522	1.7610
1922	1.9308	2.1079	1.7751
1923	1.9246	2.1099	1.7952
1924	1.9662	2.0494	1.8174
1925	1.9620	2.0153	1.8387
1926	1.9994	2.0329	1.8833
1927	2.0231	2.0357	1.9004
1928	2.0000	2.0000	2.0000
1929	2.0134	2.0081	2.0107

M and t are estimated by Toyo Keizai Shimpo Sha, Y by Hitotsubashi Keizai Kenkyujo.

The condition to settle the proper rate of growth in the national economy is:

$$\hat{G}_d = 2.5606\, G_t + 1.6945\, G_f$$

Table (2. 12) *Analysis of Export Behavior 1920—1929*

index numbers base year: 1928

	exports $\log X$	terms of trade $\log t$	world production $\log Z_f$
1920	1.7681	1.9869	1.8179
1921	1.7411	2.0522	1.7575
1922	1.8667	2.1079	1.8464
1923	1.7423	2.1099	1.8675
1924	1.8520	2.0494	1.8936
1925	1.9356	2.0153	1.9302
1926	1.9423	2.0329	1.9505
1927	1.9769	2.0357	1.9770
1928	2.0000	2.0000	2.0000
1929	2.0472	2.0081	2.0340

X and t are estimated by Toyo Keizai Shimpo Sha, Z_f by League of Nations.

In this period, the "A" formula obtained slightly better results than the "B" formula. However, results are not so reliable as that the proper economic judgment can be formed on the basis of it.

For the first approach to the coordination of "A" and "B" formulas, the terms of trade as the explanatory variables were added to functions of import and export behavior. There is no quetion about the import functions, for both formulas accept the same equation. However, there is a question about the export function. As the export function has different way of using the variables which explain the shift of export curve, the coordination of the two equations of different types is to be made mainly by parameters concerning the terms of trade which are held in common by both equations. If both formulas contain structual equations to determine statistically significant export behaviors, parameters concerning the terms of trade must be the same. Both formulas, as a matter of fact, have not statistically significant results as to the said parameters. Under these circumstances, it is almost impossible to examine which formula is superior as the working hypothesis for the statistical analysis. Another method has to be studied for the coordination.

III. *Model Analysis*

By coordinating "A" and "B" formulas, models are hypothetically formed. In the following, model will be verified in comparison with economic data. At first, by taking the "B" formula into the "A" formula the model "A" will be formed.

As to the export function, the equation of the "A" formula is used without change:

[The export equation] $\log X = -a \log t + b \log Z_f + h_1$ (3. 1)

Then, the relation in which the export demand brings about production of the domestic export industry will be explained by reversing the variables of export equation in the "B" formula:

[The export industry] $\log Z_d = c \log t + d \log X + h_2$ (3. 2)

As to the import function, the previous equation is used:

[The import equation] $\log M = e \log t + f \log Y_d + h_3$ (3. 3)

The equation shown the behavior of balance of trade is added:

[The behavior of banalce of trade]

$$\log M = l \log t + g \log X + h_3 \qquad (3.\ 4)$$

If the trade is always balanced, it must be:

$$\log M = \log t + \log X$$

However, it is not always, in reality, balanced, and it is presumed to be like the equation (3.4). It seems that this is the necessary step to make the application of the model possible.

The model is formed with above-mentioned four equations. As their variables are six—Z_f, t, X, M, Y_d and Z_d, it is regarded that two variables out of the six are given to national economy as exogenous variables. Doubltessly, Z_f is predetermined. As the terms of trade have the marked tendency to be easily influenced by the behavior of the the world economy, it is assumed as the predetermined factor in this model. There is no way except verifying empirically whether it is proper to regard it as a predetermined one.

In this way, if Z_f and t are regarded as predetermined factors, which are determined exogenously by the tendency of the world economy, the system of simultaneous equations consisting of above-mentioned four equations contains the sufficient information which settles endogeneous variables, X, M, Y_d and Z_d. In order to solve this equations, it is required to derive the equations which explain the dispersion of each endogeneous variable by only exogeneous variables as the exlanatory variables. The following reduced froms are derived by simple algebra:

[The export demand] $\log X = -a \log t + b \log Z_f + h_1$ (3. 1)

[The export industry]

$$\log Z_d = (c - ad) \log t + bd \log Z_f + (h_1 d + h_2) \qquad (3.\ 5)$$

[National income]

$$\log X = \frac{l - ag - e}{f} \log t + \frac{bg}{f} \log Z_f + \frac{gh_1 + h_4 - h_3}{f} \qquad (3.\ 6)$$

[The banace of payments]

$$\log M = (l - ag) \log t + bg \log Z_f + (gh_1 + h_4) \qquad (3.\ 7)$$

After applying these equation to observable data, each parameter is determined. Then the parameter of the origninal model is derived from them.

As it will be explained later, the model "A" is probably useful to make considerably clear the relation between the foreign trade and national economy, as far as Japan continues to develope her trade in line with the behaivior of the international economy without forming strong export drive policy. In short, this model is a useful working hypothesis under normal conditions.

(Post-war days). The model will be applied to the period betwen 1950 and 1956. The necessary data are described in the Tables (2. 1) and (2. 2) of the previous section.By analyzing them, the following equation are obtained:

$\log X = -0.1893t + 3.3825Z_f - 4.5474$ (3. 1, 1)
$R^2 = 0.9245$
$\log Z_d = 0.2500t + 2.8750 \log Z_f - 4.0243$ (3. 5, 1)
$R^2 = 0.9486$
$\log Y_d = -0.0984t + 1.5189 \log Z_f - 0.9499$ (3. 6, 1)
$R^2 = 0.9922$
$\log M = 0.3636t + 3.0454 \log Z_f - 4.4819$ (3. 7, 1)
$R^2 = 0.9545$

From these equations, the model "A" is derived

$\log X = -0.1893t + 3.3825 \log Z_f - 4.5474$ (3. 1, 1)
$\log Z_d = 0.4108t + 0.8499 \log X - 0.1595$ (3. 2, 1)
$\log M = 0.5609t + 2.0050 \log Y_d - 2.5780$ (3. 3, 1)
$\log M = 0.5340t + 0.9003 \log X - 0.3879$ (3. 4, 1)

The results which were solved by a simple lesat square method are as follows:

$\log Z_d = 0.6413t + 0.7267 \log X - 0.1415$ (3. 2, 1)
$R^2 = 0.8653$
$\log M = 0.4942t + 2.0859 \log Y_d - 2.8045$ (3. 3, 1)
$R^2 = 0.9892$
$\log M = 0.7759t + 0.7175 \log X - 0.2656$ (3. 4, 1)
$R^2 = 0.8082$

Except for equation (3. 1, 1) ,those solves by the former simultaneous equations have errors smaller than those by the latter. Nonetheless, parameters concerning the terms of trade are as yet unreliable.

(Pre-war days) Model analysis will be conducted for the period between 1920 and 1929, using the data of (2. 11) and (2. 12) Table of the previous section:

$\log X = -0.2584 \log t + 1.1377 \log Z_f + 0.2442$ (3. 1, 2)
$R^2 = 0.8769$
$\log Z_d = 0.0797 \log t + 1.1052 \log Z_f - 0.3862$ (3. 5, 2)
$R^2 = 0.9621$
$\log Y_d = 0.0886 \log t + 1.1084 \log Z_f - 0.4480$ (3. 6, 2)
$R^2 = 0.8406$
$\log M = 0.5740 \log t + 0.8637 \log Z_f - 0.8711$ (3. 7, 2)
$R^2 = 0.9192$

From the above equations the model is:

$\log X = -0.2584 \log t + 1.1377 \log \quad - 0.2442$ (3. 1, 2)
$\log Z_d = 0.3307 \log t + 0.9714 \log X - 0.6234$ (3. 2, 2)
$\log M = 0.5050 \log t + 0.7792 \log Y_d - 0.5302$ (3. 3, 2)
$\log M = 0.7701 \log t + 0.7591 \log X - 1.0564$ (3. 3, 2)

Comparing these with the equations, derived by the simple least square method, import functions of the former and the latter are as follows:

[The former] $\log M = 0.5050 \log t + 0.7792 \log Y_d - 0.5302$
$\quad\quad(0.1694)\quad\quad(0.0686)$

[The latter] $\log M = 0.3989 \log t + 0.6495 \log Y_d - 0.0660$
$\quad\quad(0.3018)\quad\quad(0.1225)$

The equation of the former, on the whole, has small estimated error, and each parameter has considerably the more minor errors (as shown in parentheses). The condition settling the required rate of growth of national income which corresponds to the equilibrium between incoming and outgoing of trade becomes:

$$\hat{G}_d = 0.3036 G_t + 1.4600 G_f$$

In fact, as indicated in the equation (3. 6, 2,) the actual rate of growth was:

$$G_d = 0.0886 G_t + 1.1084 G_f$$

Therefore it may be safely said that, G_d being smaller than $\hat{G}_d$, the balance of trade tended toward improvement.

Japanese economy at that time was remarkably influenced by the world economy. The expansion of production of the world manufacturing industry was increasing the total export, manufacturing production and national income in Japan at almost the same rate as that of its own expansion. The total import was increasing at a little slower rate than that. It can be said that, for Japanese economy, it was proceeding along the normal road of economic development.

The application of the model "A" is dificult in the case of the following period —from 1928 to 1937. The results of analysis of the Table (2.9) and 2.10) are shown:

$$\log X = -1.1441 \log t + 0.2291 \log Z_f + 3.8474 \quad (3.\ 1,\ 3)$$
$$R^2 = 0.9440$$
$$\log Z_d = -1.0160 \log t + 0.1500 \log Z_f + 3.7534 \quad (3.\ 5,\ 3)$$
$$R^2 = 0.9561$$
$$\log Y_d = -0.7573 \log t - 0.2422 \log Z_f + 4.0389 \quad (3.\ 6,\ 3)$$
$$R^2 = 0.7590$$
$$\log M = -0.4756 \log t + 0.2419 \log Z_f + 2.4635 \quad (3.\ 7,\ 3)$$
$$R^2 = 0.8774$$

From them, the model is:

$$\log X = -1.1441 \log t + 0.2291 \log Z_f + 3.8474 \quad (3.\ 1,\ 3)$$
$$\log Z_d = -0.3656 \log t + 0.6547 \log X + 1.2345 \quad (3.\ 2,\ 3)$$
$$\log M = -1.2319 \log t - 0.9987 \log Y_d + 6.4971 \quad (3.\ 3,\ 3)$$
$$\log M = 0.7321 \log t + 1.0556 \log X - 1.5978 \quad (3.\ 4,\ 3)$$

Where production of the export industry ought to have a positive correlation to the terms of trade, the parmeter of the terms of trade in the equation (3. 2, 3) is negative. The response of import demand to the terms of trade also ought to be positive, but it is negative (cf. the equation (3. 3, 3)). Owing to the sudden fall in exchange rate after the Depression, the terms of trade were rapidly getting worse. Responding to the expansion of export despite the decline of terms of trade, the export industry continued to increase productions. Import also increased. By analyzing this very fact, such relations as the production of the export industry and the total import increase by the decline of terms of trade are obtained, but these results are lacking in economic meaning. This shows that the hypothesis taken up in analyzing was clearly a wrong one. That is the model "A" is not proper working hypothesis to explain the movement at that time.

The hypothesis which formed the basis of the model was taken up to interpret the trend of domestic economy by production of the world manufacturing industry and the terms of trade as predetermined factors. However, under the economic situation in Japan at that time, the world manufacturing industry was unable to explain the movement of Japan's domestic economy adequately, and the terms of trade are not regarded as the predetermined factor. In the middle of the world-wide depression, Japan attempted to overcome her own domestic slump by driving export strongly, and at the same time, enduring the rapid decline of terms of trade. Defying the world-wide depression, she tried to recover her economic situation from its depression. The weapon on the occasion was the export drive. To express these circumstances, export is regarded as the exogeneous variable in the sense of the political factor. As the production of the world manufacturing industry is no longer the powerful variable to explain Japan's economic movement, but is certainly the exogenous variable from Japan's economic point of view, it is also regarded as the predetermined factor.

In the model "B", the Japan's export and the production of the world manufacturing industry are regarded exogenous variables, while the terms of trade, the import, national income and production of the export industry in Japan are regarded as endogenous variables. The structure of the model "B" is as follows:

[the terms of trade] $\log t = -a \log X + b \log Z_f + h_1$ (3. 8)

[the export industry] $\log Z_d = c \log t + d \log X + h_2$ (3. 9)

[the balance of payments] $\log M = e \log t + f \log X + h_3$ (3. 10)

[the trade multiplier] $\log Y_d = g \log X + h_4$ (3. 11)

Ther reduced fom are as follows:

$$\log t = -a \log X + b \log Z_f + h_1 \quad (3.\ 8)$$

$$\log Z_d = (d - ac) \log X + bc \log Z_f + (ch_1 + h_2) \quad (3.\ 12)$$

$$\log M = (f - ae) \log X + be \log Z_f + (eh_1 + h_3) \quad (3.\ 13)$$

$$\log Y_d = g \log X + h_4 \quad (3.\ 11)$$

By applying these to data in the period between 1928 and 1937:

$$\log t = -0.7801 \log X + 0.1107 \log Z_f + 3.3438 \quad (3.\ 8,\ 1)$$

$R^2 = 0.9326$

$$\log Z_d = 0.7857 \log X + 0.0441 \log Z_f + 0.3575 \quad (3.\ 12,\ 1)$$

$R^2 = 0.8944$

$$\log M = 0.4239 \log X + 0.1388 \log Z_f + 0.8626 \quad (3.\ 13,\ 1)$$

$R^2 = 0.9261$

$$\log Y_d = 0.4481 \log X + 1.1549 \quad (3.\ 11,\ 1)$$

$r^2 = 0.6530$

From these, the model is derived as follows:

$$\log t = -0.7801 \log X + 0.1107 \log Z + 3.3438 \qquad (3.\ 8,\ 1)$$
$$\log Z_d = 0.3983 \log t + 1.0964 \log X - 0.9743 \qquad (3.\ 9,\ 1)$$
$$\log M = 1.2538 \log t + 1.4119 \log X - 4.3079 \qquad (3.\ 10,\ 1)$$
$$\log Y_d = 0.4481 \log X + 1.1549 \qquad (3.\ 11,\ 1)$$

The model gives sufficient information as to the circumstances mentiond below:

(1) Japanese economy is less influenced by the world economic trend.
(2) Export drives caused the heavy decline of terms of trade.
(3) Expansion of export increased the production of the export industry at almost the same pace, and expanded national income at the rate of growth nearly half that of manufacturing production.
(4) As a result, an unequal development inside the national economy took place.

By applying this model to the period from 1920 to 1929, the equation (3. 8) which is supposed to be the most important support of this model becomes as follows:

$$\log t = -0.2402 \log X + 0.0935 Z_f + 2.3147$$
$$R^2 = 0.2090$$

The correlation in the equation is weak, and it makes the application of the model difficult.

Applied to the period between 1950 and 1956 in post-war years:

$$t = -0.5070 \log X + 2.4478 \log Z_f - 2.8417 \qquad (3.\ 8,\ 2)$$
$$R^2 = 0.7549$$
$$\log Z_d = -0.3043 \log X + 4.0567 \log Z_f - 5.5150 \qquad (3.\ 12,\ 2)$$
$$R^2 = 0.9564$$
$$\log M = -0.7042 \log X + 5.5887 \log Z_f - 8.7495 \qquad (3.\ 13,\ 2)$$
$$R^2 = 0.9852$$
$$\log Y_d = 0.4079 \log X + 1.1648 \qquad (3.\ 11,\ 2)$$
$$r^2 = 0.9261$$

The model becomes:

$$t = -0.5070 \log X + 2.4478 \log Z_f - 2.8417 \qquad (3.\ 8,\ 2)$$
$$\log Z_d = 1.6572 t + 0.5359 \log X - 0.8058 \qquad (3.\ 9,\ 2)$$
$$\log M = 2.2831 t + 0.4533 \log X - 2.2617 \qquad (3.\ 10,\ 2)$$
$$\log Y_d = 0.4079 \log X + 1.1648 \qquad (3.\ 11,\ 2)$$

Compared with the analysis done with model "A", (1) the correlation of the basic equation (3. 8) of the model "B" is weak, and (2) in the two equations (3. 9) and (3. 10) which have the same functional forms, estimated errors are great. Therefore, it seems that model "B" is inferior to the former. Except for such periods with special policy as the one form 1928 and 1937, model "B" is not always the proper hypothesis analyze the relation between foreign trade and national economy in Japan.