The purpose of this paper is to test empirically economies of scale, defined by technology in Intra-Industry Trade (IIT). B. Balassa found first the existence of IIT. Grubel and Lloyd, Linder, Dreze, and others treated IIT as consisting of final goods. But P. Rayment found that IIT consists mostly of intermediate goods and he tried to explain IIT by economies of scale and specialization. However, to test the relationship between economies of scale and IIT, I will use I. Ozaki's definition on economies of scale, defined by technology. I. Ozaki sees technology, measured in plant scale, as the basis of economies of scale. In order to connect the relation between the economies of scale and IIT, Ozaki's technology types, classified by statistically estimated parameters values must be first introduced. I converted this into Standard International Trade Classification (SITC) data, then calculated Balassa index for each of these sectors and see if economies of scale and IIT can be related. Through this empirical test, I confirmed the assumption that IIT is based on economies of scale, defined by technology. Also, I found that this relation did not exist in East-West trade. The outline of my paper is as follows: First, representative theories and measurements of IIT of industrial countries are shown. Second, considering that IIT is made up mostly of intermediate goods, Rayment, trying to explain IIT by specialization and economies of scale, will be introduced. In order to empirically test this relationship, I introduce Ozaki's definition on economies of scale, based on technology. Third, empirical results, using Ozaki's technology types, on IIT with economies of scale and specialization is stated. France, Germany, EC, Austria, and Hungary are taken as example. Fourth, explanation of the whole process is summarized and last but very important, further research is mentioned. As a further research, an empirical analysis of IIT explained by the economies of scale and specialization, has to be pursued. I will provide an example by analyzing the automobile's components within EC countries and between eastern and western countries. I will follow my analysis by taking General Motors (GM) in Europe as an example and try to see GM's export and import of components of automobiles to and from Austria, Countries which I will be handling with are: Austrian trade with Germany, France, United Kingdom, Spain, Belgium, and finally to see East-West trade, Hungary-Austria will be taken as an example.
Economies of Scale, Technology, and Intra-Industry Trade

by

Nobuko Inagawa
Economies of Scale, Technology, and Intra-Industry Trade

by

Nobuko Inagawa*

*Keio University doctorate course, Special researcher at the Vienna Institute for Comparative Economic Studies. I am grateful to Professors of Keio University, Professor Iwao Ozaki, Professor Keiichiro Obi, and the staffs of the Keio Economic Observatory. This paper is preliminary and comments and discussions are welcome.
Title: Economies of Scale, Technology, and Intra-Industry Trade.

0. Introduction

1.1 Intra-Industry Trade of Industrial Countries

   Theory and measurement of Intra-Industry Trade

2.1 Specialization and Economies of Scale

2.2 Empirical Result on Intra-Industry Trade with Economies of Scale and Specialization

   1) Trade between France and West Germany
   2) Trade between West Germany and European Communities (EC)
   3) Trade between France and EC
   4) Trade between Austria and Hungary

3.0 Summary

4.0 Further Research
0. Introduction

The purpose of this paper is to test empirically economies of scale, defined by technology in Intra-Industry Trade (IIT). B. Balassa found first the existence of IIT. Grubel and Lloyd, Linder, Dreze, and others treated IIT as consisting of final goods. But P. Rayment found that IIT consists mostly of intermediate goods and he tried to explain IIT by economies of scale and specialization. However, to test the relationship between economies of scale and IIT, I will use I. Ozaki's definition on economies of scale, defined by technology. I. Ozaki sees technology, measured in plant scale, as the basis of economies of scale. In order to connect the relation between the economies of scale and IIT, Ozaki's technology types, classified by statistically estimated parameters values must be first introduced. I converted this into Standard International Trade Classification (SITC) data, then calculated Balassa index for each of these sectors and see if economies of scale and IIT can be related. Through this empirical test, I confirmed the assumption that IIT is based on economies of scale, defined by technology. Also, I found that this relation did not exist in East-West trade.

According to traditional international trade theory, international unit cost differences arise from national differences in factor endowments. But in this theory, only the final goods trade is treated and not the intermediate goods trade. Because in this theory all the production process is assumed to be done within the country, so that the concept of the industrial structure is completely ignored.

This traditional approach has two weaknesses in explaining the situation of today's world trade. First, it cannot explain why trade developed so rapidly between countries whose factor endowments are so similar as in European Communities (EC). Second, it cannot explain why industries operate in terms of the intermediate goods so that a high proportion of trade can be characterized as the Intra-Industry Trade (IIT) where the same good is both imported and exported. If we consider today's world trade, it is necessary that we have a new approach which can answer these two points.

Traditional trade theory sees international trade as originating from comparative advantage differences of economic development. Countries with relatively more capital tend to be industrialized countries and countries with relatively more labour tend to be developing countries, so that the Heckscher-Ohlin theory means international trade will grow where the differences of development are large. Also, there was a traditional view that the relative importance of manufactured goods in world trade will decline, for the developing countries will soon acquire modern technology and economic growth. But according to Economic Survey of Europe's (1987-88), 'empirical analysis, the features of the international trade after World War II can be seen in the increase of manufactures trade and the increase of that trade among the industrialized countries. Therefore, manufactures international trade after World War II did not move the way as the traditional theorists have imagined. Instead, the ratio of manufactures in the world trade has increased and world manufactures trade is dominated by the industrialized countries, which is made up mostly from IIT, the same good imported and exported simultaneously.
The outline of my paper is as follows: First, representative theories and measurements of IIT of industrial countries are shown. Second, considering that IIT is made up mostly of intermediate goods, Rayment, trying to explain IIT by specialization and economies of scale, will be introduced. In order to empirically test this relationship, I introduce Ozaki's definition on economies of scale, based on technology. Third, empirical results, using Ozaki's technology types, on IIT with economies of scale and specialization is stated. France, Germany, EC, Austria, and Hungary are taken as example. Fourth, explanation of the whole process is summarized and last but very important, further research is mentioned.

As a further research, an empirical analysis of IIT, explained by the economies of scale and specialization, has to be pursued. I will provide an example by analyzing the automobile's components within EC countries and between eastern and western countries. I will follow my analysis by taking General Motors (GM) in Europe as an example and try to see GW's export and import of components of automobiles to and from Austria. Countries which I will be handling with are: Austrian trade with Germany, France, United Kingdom, Spain, Belgium and finally to see East-West trade, Hungary-Austria will be taken as an example.

1.1 Intra-Industry Trade of Industrial Countries

Theory and Measurement of Intra-Industry Trade (IIT)

The existence of IIT was first found by Balassa. He explained this phenomenon, using Balassa index, as the result of IIT development.

\[
\frac{1}{n} \sum_{i=1}^{n} \frac{X_i^e - X_i^i}{X_i^e + X_i^i}
\]

\[
1/n \sum_{i=1}^{n} \frac{X_i^e - X_i^i}{X_i^e + X_i^i}
\]

n: number of commodities, 
i: commodity 
X: export 
N: import

Important theoretical explanations on IIT are: Grubel (1967) explained IIT by monopolistic competition theory model. Grubel and Lloyd (1971) explained IIT by oligopolistic production differentiation. Linder (1961) explained IIT by demand side's product differentiation. He said that factor endowment theory can explain the primary product trade's division of labour but when manufactured good trade's division of labour exists, domestic demand condition must be considered. Manufactured good trade occurs more among nations where per income level is similar than countries with different factor endowment. His conclusion was that in order to export manufactured good, domestic demand must exist first.

Dreze (1951) also considered the relations between trade and domestic demand important, but he thinks that according to the size of domestic market, one can specialize in standardized production run good and the other in longer production run good. One nation will
import standardized intermediate components and the other exports for example, more
differentiated finished good. This must definitely increase IIT and manufactured trade.

But Grubel, Grubel and Lloyd, Linder, and Dreze models cannot explain manufactured good
trade, consisting of intermediate and capital goods among the industrialized countries.
So we need a new approach, focusing on intermediate goods trade, explaining IIT by special-
ization and economies of scale.

2.1 Specialization and Economies of Scale

International division of labour can be normally divided into two groups: vertical
division of labour and horizontal division of labour. Vertical division of labour means
primary products and manufactured good traded between industrialized countries and develop-
ment countries. This trade occurs between countries of different stages of development.
Horizontal division of labour, on the other hand, means manufactured good traded within indus-
trialized countries.

This horizontal division of labour can be further divided into three groups: (A), (B),
(C). (A): exchange of differentiated product (exchange of labour-intensive consumer goods
with capital-intensive goods). (B): exchange of different production stages of the same industry product (exchange of machine components with assemblying pro-
cess). (C): exchange of differentiated goods of the same industry (exchange of differenti-
ated consumer goods). (A) and (B) types, which can be explained by traditional trade
theory, take place between industrialized countries and developing countries. (C) cannot
be explained by the traditional trade theory, so we need the theory by Linder, Dreze, and
others mentioned earlier. But we know now that IIT consists mostly of intermediate goods.
So the above-mentioned theories, explaining IIT by final consumer goods, are not suitable.
Rayment (1983), focusing on intermediate trade, tries to explain IIT by specialization and
economies of scale. IIT is explained by the increased specialization of industrial
activities, which increase intermediate goods trade. With the market spreading, division of
labour will develop, dividing the production stage into smaller units. This "disintegra-
tion of industrial activities increases the intermediate goods trade. This type of trade
develops among countries with a similar production structure. Therefore, one can say that
the division of labour process increases as the differences of national economic develop-
ment decreases. This phenomenon is shown in the trade statistics as the increase of IIT
and in the production statistics as the increase of the intermediate consumption import.
The European Economic Survey (1987-1988) has provided us with some data. They investigated
if manufactures trade consists of narrowly differentiated consumer goods or if it consists
of highly specialized intermediate goods. They statistically examined by using Western
Europe's trade data. According to this empirical evidence, IIT consists mostly of parts
and components. Therefore, we must separate final goods market and intermediate goods
market when considering IIT. Rayment states that IIT can be explained by vertical spe-
cialization process. It is the same thing as saying that he explained IIT by fragmenta-
tion of industrial activities, pursuing longer production run.
Trying to explain IIT by differentiated final goods, has been done by several authors I mentioned before: Linder, Dreze, etc. It is true that differentiated final good is traded among industrialized countries, but we have found out that large percentage of IIT is made up of intermediate goods. As we all know that if there are many differentiated final goods traded, there will be even more intermediate goods needed to produce final goods. Final good shows only the demand side, so here I will take the demand side as given and handle the supply side only, concerning intermediate goods.

Next, the assumption that IIT can be explained by economies of scale and specialization, has to be empirically tested. I will pursue with the following method. First of all, economies of scale must be defined. Economies of scale is a compound of two conceptions. One is an economic meaning of the tendency of decreasing input factors as scale increases. Another is an engineering approach. In a traditional trade theory engineering meaning of an economies of scale has been ignored. Here, this engineering relations is taken as an estimation of the technology production function of capital plant.

In order to prepare for the empirical research, I have to explain how to connect the economies of scale and specialization with IIT. For this, Ozaki's technology type must first be explained.

From his earlier statistical test, Ozaki confirms the assumption of constant returns to scale for an intermediate input function, but rejects the assumption of constant returns to scale for the labour and capital input functions in the Leontief-type approach. Therefore, he develops a more generalized production function which excludes substitutability as in Leontief-type approach, but allows variable returns to scale for labour and capital. He calls this production function, plant base factor-limitational production function.

Since capital embodied technical change plays the most important role in our modern technology system, he introduces the concept of a plant as a production unit in which fixed capital is embodied. He assumes that the different technical characteristics of plants can be described by different vectors composed of plant capacity and all input variables required to operate each plant. This means that a vector, consisting of plant capacity, labour input, material inputs, represents the technical character of the plant, and various vectors would represent the various types of technology. Then, technical indivisibility of each plant is assumed. This means that each of the plant with a different technology has a definite plant capacity. Next, a fixed technological coefficient is assumed for a given plant capacity that is, physical inputs are uniquely determined by the plant scale alone, meaning there is no substitutability.

The whole thing can be explained by an example. There are many plants, each with different technology, to produce one good, machinery. There is a plant to make engine, gears, and other parts, from which one machinery is produced. This plant has crossed over the border, thereby increasing IIT. He defines economies of scale as the plant capacity increases, there is decreasing tendency in input variables required to operate the plant. So he estimated this plant base factor-limitational production function and Cobb-Douglas production function for each fifty-two sectors of the Japanese Input-Output table, using time-series data of labour and capital inputs and gross output. His classification result is shown on page 14, table 1.
Now I will quote the results of Ozaki's estimation of the parameters of the production function for all 52 sectors of Input-Output tables of Japan.

Experimental equations are as follows:

Factor-Limitational Type

\[ L = a_L X^{\beta_L} \quad K = a_K X^{\beta_K} \]  
(1)

Linear Homogeneous Cobb-Douglas Type

\[ X = a_0 L^{1-\beta_0} K^{\beta_0} \]  
(2)

Generalized Cobb-Douglas Type

\[ X = a_L^{-\gamma} L^{1-\gamma} K^{\gamma} \]  
(3)

where \( X \) = gross output, \( K \) = capital stock, \( L \) = labor, \( a, \beta, \gamma \) = parameters

On the basis of the result obtained in the estimation, he divided 52 sectors into two large groups, i.e., groups which are characterized by capital-intensive type technology, where plant base factor-limitational production function is a measuring formula and labour-intensive type technology, where Cobb-Douglas production function is a measuring formula. Then he groups together the sectors which are of the similar parameters into six different groups of technologies: \( K(I-B), K(I-M), K(II), (L-K), L(I), \) and \( L(II) \).

1) Type \( K(I-B) \) technology

It is the case of \( \beta_L < 1 \) and \( \beta_K < 1 \) in equation (1), meaning that economies of scale prevail tremendously in both labour and capital input. If the demand side is enough, this industry production will keep on growing indefinitely by expanding of the plant size with this type of technology. This characteristic is common to \( K(I-M) \) technology also. The differences between the two types of technologies are \( K(I-B) \) technology's value of elasticity of the labour input is extremely small and the value of capital intensity \( (K/L) \) is large. This is because massive investment is required and large size equipment allows drastic labour saving. (examples: petrochemical, iron and steel industries).

2) Type \( K(I-M) \) technology

It is the same as the first type technology, but compared to the first one, the value of the parameter for labour input is a little more than \( K(I-B) \) type technology while the value of capital intensity \( (K/L) \) is not as large as the first one. (examples: machinery sectors)

3) Type \( K(II) \) technology

This is the case if \( \beta_L < 1 \) and \( \beta_K > 1 \) in equation (1). This means that while economies of scale have a strong effect in the labour input process, in the capital inputs the diseconomies of scale prevails and the value of capital intensity is comparatively large. (examples: intermediate goods sectors, pulp, cement, inorganic chemical, chemical fertilizer, and coal product industries)

We can include all above 3 types of technology as capital-intensive type.
4) Type (L-K) technology

This is the case \( \beta_1 < 1 \) in equation (2). (examples: small-scale industries that have divisible technology and factor substitution implied by \( \beta_1 < 1 \) and a low capital-labour ratio)

5) Type L(I) technology

This is the case \( 0 < \gamma_L < 1, 0 < \gamma_K < 1, \) and \( \gamma_L + \gamma_K > 1 \) in equation (3). This is the ordinary type of generalized Cobb-Douglas production function with increasing returns to scale and factor substitutability.

6) Type L(II) technology

This is the special case of type L(I) with \( \gamma_L > 1 \). In both type L(I) and L(II), the degree of capital intensity is low, while labour absorption ability is high. Type (L-K), L(I), L(II) can be named as labour-intensive technology.

In table 1(7), Ozaki states that which sectors are associated to which technology. One can see from this table that the economies of scale is working in type K. So he grouped all sectors into 6 technology types according to the evaluation of the estimated parameter's values. They are: 1) Type K(I-B) technology (large-quantity production technology), 2) Type K(I-M) technology (large-scale assembly production technology), 3) Type K(II) technology (capital-intensive technology), 4) Type (L-K) technology (Cobb-Douglas constant earnings type), 5) Type L(I) technology (Labour-intensive technology), 6) Type L(II) technology (Labour-intensive technology).

According to this classification by Ozaki, I now explain what I did to test the relation between economies of scale and IIT. I shall explain on my data first. Following examples were taken. France and Germany to see the bilateral relations. France and European Community and also Germany and European Community were taken to see multilateral relations. Finally Austria and Hungary were taken to see East-West trade relations. The year 1980 is taken for my data. I assume here that the phase of industrialization between Japan, Germany, and France is at the same level, so that I can use Ozaki's classification using Japanese Input-Output table into these countries. I assume that production function's parameters \( \beta_1 \) and \( \beta_2 \) are almost the same in these countries. This is because engineering design law for producing a commodity should be in common among these countries, which is approximated by labour and capital input functions in Ozaki's approach. Ozaki has earlier estimated the parameters of capital-intensive technology type, and made the comparison of the parameter among Japan, Germany, and USA. The result was that parameters are very similar. So I can assume that in countries, as in Japan, Germany, and France above mentioned is valid.

As for the case between Austria and Hungary, if IIT is low, reason for this can be explained by the different phases of industrialization among these countries or by different economic systems among these countries. So I converted Standard International Trade Classification (SITC) of 2-digits into Ozaki's 52 sectors of the Japanese Input-Output table. This result is shown on page 17.

Then on the basis of this data, for each 90 sectors of the SITC, aggregated into 52 sectors, a Balassa index is calculated. If the result is such that in capital-intensive technology type where economies of scale plays a great role, IIT was high, we can conclude that division of labour is caused by the economies of scale, resulting in IIT's increase.
2.2 Empirical Results on IIT with Economies of Scale and Specialization

The empirical results is shown in table 2 on page 16.

Standard International Trade Classification's exports are valued by free on board (f.o.b.) and imports are valued by cost, insurance, and freight (c.i.f.). That is why there are two columns for each case. For example, IIT between Germany and France, first column is seen from German side and second column is seen from French side.

Empirical Results: (9)

(1) IIT between Germany and France

Corresponding to Type K(I-B) technology, except electric current and gas, natural and manufactured, there are the connection between the scale merit and IIT. Especially in organic chemicals, non-ferrous metals, iron and steel, and petroleum refining products, are IIT increasing. In Type K(I-M) technology, except beverages, IIT is large. Motor vehicles, machinery, electrical machinery, precision instruments, and fiber spinning have large IIT. In Type K(II) technology, except chemical manure and miscellaneous coal products, IIT is large. Basic inorganic chemicals and paper have large IIT. In Type (L-K) technology, IIT is not large, meaning that with the linear-homogeneous classical Cobb-Douglas production function, which is observed in small-scale industries, IIT is not large. So I confirmed that IIT can be explained by the economies of scale and specialization. In Type L(I) and L(II) technology, even though they are labor-intensive, IIT is not small. But this does not contradict the above-mentioned result. The reason for this result can be explained, I think, by the special close trade relations in these particular sectors between France and Germany.

(2) IIT between Germany and EC

In type K(I-B) technology, IIT is large, meaning the existence of economies of scale in explaining IIT. In type K(I-M) technology, IIT is also large. In type K(II), IIT is rather large. In type (L-K), IIT is small. In type L(I) and L(II), IIT is rather large. We can conclude that IIT can be explained by economies of scale. Next, if we compare the bilateral trade between West Germany and France and multilateral trade between Germany and EC countries, we can conclude the following interesting points. In K(I-B) technology, gas and water supply (2), artificial fiber materials (5), in K(I-M) technology, machinery (10), fiber spinning (13), beverages and alcoholic drinks (14), in K(II) technology, pulp (16), cement (17), chemical manure (19), and miscellaneous coal products (20), Germany's IIT with EC is larger than bilateral trade with France. This can be interpreted that in these sectors, multilateral relations exist between Germany and EC. For example, machinery is not only traded bilaterally, but also multilaterally within EC countries.
(3) IIT between France and EC

In type K(I-B), K(I-M), and K(II), except in electric power supply(1), gas and water supply(2), Precision instruments(12), chemical manure(19), miscellaneous coal products(20), and Tobacco(21), IIT was high. Therefore, we can also conclude that IIT can be explained by economies of scale. Next, we compare the bilateral trade between France and Germany and multilateral trade between France and EC countries. In K(I-B) technology petroleum refining products(3), iron and steel(6), in K(I-M) technology, motor vehicles(9), machinery(10), electrical machinery(11), in K(II), paper(15), pulp(16), cement(17), chemical manure(19), miscellaneous coal products(20), France's IIT with EC is larger than bilateral trade with Germany. Especially in motor vehicles(9), machinery(10), and electrical machinery(11), existence of multilateral relations between France with other EC countries, is interesting to observe. We can interpret this result that many of the components of these sectors are traded among EC countries multilaterally rather than only bilaterally.

(4) IIT between Austria and Hungary

There is almost no IIT found in the East-West trade between Austria and Hungary. Exceptions are other wood product(40), wood milling(27) and beverages and alcoholic drinks. In type K(I-M) technology, motor vehicles(9), machinery(10), electrical machinery(11), precision instruments(12), one can say that IIT is quite low in these sectors. So one can conclude that there is almost no relation between economies of scale and IIT in capital-intensive technology type in East-West trade yet.

Therefore, one must increase IIT in these sectors, where economies of scale prevails, in East-West trade. The reason is because for the economic reform which Hungary is now pursuing, the main target of economic policy should be the promotion of structural change. In order to promote structural change, first, Hungary should be directed more to international market competition. Second, a more integral participation in the world-wide division of labour, meaning increase in IIT, especially in capital-intensive technology type is needed. As I have pointed out in my empirical results, for example in motor vehicles, machinery, electrical machinery, precision instruments where IIT is yet low, should increase.

In order to do so, Hungary must not promote large scale production of these sectors from above or from the Central Planning Bureau. Because then, economies of scale can work only in final assembling stage, for example, but not at the level of producing these sectors. I have shown in this paper that there is a relation between economies of scale, defined by technology and IIT, consisting mostly from intermediate goods. In order to be integrated in the world-wide division of labour with EFTA (European Free Trade Association) and EC (European Community) countries, Hungary must give the sectors where intermediate goods are produced to compete in market mechanism, not to be given orders from the Central Planning Bureau, so that economies of scale merit will work within these sectors, thereby increasing IIT in East-West trade.
3.0 Summary

Here in this article, I wanted to convey the following procedure of the line in explaining IIT.

1. disintegration ---> economies ---> international ---> increase ---> integration
2. of the process of scale division of IIT of EC (large labour market)

(1) When disintegration of the process has been done, the technological scale merit will work on the particular sector.
(2) We have seen that which sectors are easily connected to the international division of labour, instead of just saying, IIT consists mostly from intermediate goods. This is to say that which sectors were affected and increased IIT by the expansion of the market.
(3) The fact that IIT increased if the division of labour exists, can be taken as the problem of the aggregation to a certain extent. But there is an empirical study from Grubel and Lloyd (1971), stating that IIT persisted even with 7-digit level. Another example is given by Raymond, stating that for most countries, the growth of IIT at 4-digits level has been growing faster than at 3-digits level, meaning that impact of disaggregation on IIT has been declining over the year 1962 to 1973. So when sectors are aggregated there will surely be an increase in IIT, but it certainly does not mean that disaggregation will wipe out IIT.
(4) When parts and semi-finished products trade increase among countries within EC, complementary relationship occurs within them increasing IIT, thereby increasing the intermediate goods within EC as a whole. This will lead to the integration of EC, supplying larger market and increasing the demand.

Here, I have confirmed that because of the enlargement of the market, IIT increases in Type K technology, where economies of scale works. This result supports the assumption that EC integration is based on economies of scale, defined by technology. One can say that compound goods like motor vehicle and machinery, where economies of scale exists, are traded not only bilaterally but also multilaterally within EC countries.

In East-West trade also, this type of technological relation must increase especially in capital-intensive type technology.

4.0 Further Research

On the empirical analysis of IIT, very little has been done of a case study type. Industry specific studies can provide with rich information, but very few studies exists. Therefore, I like to take up automobile's trade of components as an example of IIT and to see the relationship between economies of scale and IIT. I will provide an example by analyzing the automobile's trade of components within EC countries and between East and West countries. I will follow my analysis by taking General Motors (GM) in Europe as an
example and try to see GM’s export and import of components of automobile’s to and from Austria. Countries which I will be handling with are: Austrian trade of components of cars with Germany, France, United Kingdom, Spain, Belgium and finally to see East-West trade Austria-Hungary will be taken as an example.

We have found that within EC countries, IIT, made up mostly of intermediate goods, occurs by pursuing economies of scale, decreasing unit cost. Therefore, we can conclude that economies of scale, defined by technology is the main cause of IIT in EC. On the other hand, within CMEA countries, specialization is very low in general. Therefore, I conclude that Eastern countries can increase IIT only through promoting East-West trade in intermediate goods.

I think study on EC and CMEA give a good example for our future world in three points.

1. If integration like EC shall be realized in Asia (Japan, China and other Asean countries) or in USA (USA, Canada, and South America)? If so, what will the effects of these block sectors to the world trade be?
2. If IIT will increase by introducing market mechanism in countries like USSR and China?
3. East-West trade between EC country and CMEA country can give an example model to the future relationship between Japan and China.

From this point of view, I like to make my further research.
Footnotes

(1) Economic Survey of Europe in 1987-88. Comtrade data bank (United Nations) was used to calculate trade share, trade intensity coefficients, and IIT ratio.

(2) Ozaki's technology types are K(I-B), K(I-M), K(II), L-K, L(I), and L(II). This will be explained in section 2.1 Specialization and Economies of Scale in this paper.

(3) SITC 2-digits converted to Ozaki's 56 sectors are given in table 1.


(7) Ozaki's table 1 is given in the appendix.

(8) Ozaki's classification converted into SITC 2-digits is shown in table 3.

(9) Empirical results are shown in table 2.

References


-13-
## TABLE I

### PRODUCTION TECHNOLOGY TYPES

<table>
<thead>
<tr>
<th>Technology Type</th>
<th>Sector</th>
<th>(1) Production Function Parameters</th>
<th>(2) $\left(\frac{K}{L}\right)$</th>
<th>Technological Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>($L=\alpha X^{\mu}$, $K=\alpha X^{\nu}$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\alpha$, $\mu$, $\nu$</td>
<td>$\beta$, $\gamma$</td>
<td>1951-68 Average</td>
</tr>
<tr>
<td>(A) Large-Quantity Processing Technology: K(I-B) Type</td>
<td>Electric power supply</td>
<td>0.11</td>
<td>0.80</td>
<td>17.43</td>
</tr>
<tr>
<td>(A) Large-Quantity Processing Technology: K(I-B) Type</td>
<td>Gas &amp; water supply</td>
<td>0.68</td>
<td>0.72</td>
<td>2.59</td>
</tr>
<tr>
<td>(A) Large-Quantity Processing Technology: K(I-B) Type</td>
<td>Petroleum refining products</td>
<td>0.37</td>
<td>0.63</td>
<td>14.76</td>
</tr>
<tr>
<td>(A) Large-Quantity Processing Technology: K(I-B) Type</td>
<td>Basic organic chemicals</td>
<td>0.33</td>
<td>0.72</td>
<td>5.20</td>
</tr>
<tr>
<td>(A) Large-Quantity Processing Technology: K(I-B) Type</td>
<td>Artificial fiber materials</td>
<td>0.10</td>
<td>0.84</td>
<td>3.89</td>
</tr>
<tr>
<td>(A) Large-Quantity Processing Technology: K(I-B) Type</td>
<td>Iron and steel</td>
<td>0.38</td>
<td>0.73</td>
<td>3.84</td>
</tr>
<tr>
<td>(A) Large-Quantity Processing Technology: K(I-B) Type</td>
<td>Nonferrous primary products</td>
<td>0.80</td>
<td>0.73</td>
<td>3.84</td>
</tr>
<tr>
<td>(B) Large-Scale Assembly Production Technology: K(I-M) Type</td>
<td>Electric power supply</td>
<td>0.07</td>
<td>0.80</td>
<td>1.19</td>
</tr>
<tr>
<td>(B) Large-Scale Assembly Production Technology: K(I-M) Type</td>
<td>Motor vehicles</td>
<td>0.46</td>
<td>0.70</td>
<td>2.12</td>
</tr>
<tr>
<td>(B) Large-Scale Assembly Production Technology: K(I-M) Type</td>
<td>Machinery</td>
<td>0.32</td>
<td>0.83</td>
<td>0.62</td>
</tr>
<tr>
<td>(B) Large-Scale Assembly Production Technology: K(I-M) Type</td>
<td>Electrical machinery</td>
<td>0.35</td>
<td>0.91</td>
<td>1.00</td>
</tr>
<tr>
<td>(B) Large-Scale Assembly Production Technology: K(I-M) Type</td>
<td>Precision instruments</td>
<td>0.33</td>
<td>0.97</td>
<td>0.29</td>
</tr>
<tr>
<td>(B) Large-Scale Assembly Production Technology: K(I-M) Type</td>
<td>Fiber spinning</td>
<td>0.36</td>
<td>0.79</td>
<td>2.07</td>
</tr>
<tr>
<td>(B) Large-Scale Assembly Production Technology: K(I-M) Type</td>
<td>Beverages &amp; alcoholic drinks</td>
<td>0.27</td>
<td>0.79</td>
<td>2.16</td>
</tr>
<tr>
<td>(C) Capital-Intensive Technology: K(II) Type</td>
<td>Paper</td>
<td>0.13</td>
<td>1.03</td>
<td>3.07</td>
</tr>
<tr>
<td>(C) Capital-Intensive Technology: K(II) Type</td>
<td>Pulp</td>
<td>-0.29</td>
<td>1.23</td>
<td>3.94</td>
</tr>
<tr>
<td>(C) Capital-Intensive Technology: K(II) Type</td>
<td>Cement</td>
<td>0.23</td>
<td>1.03</td>
<td>9.07</td>
</tr>
<tr>
<td>(C) Capital-Intensive Technology: K(II) Type</td>
<td>Basic inorganic chemicals</td>
<td>0.04</td>
<td>1.01</td>
<td>2.71</td>
</tr>
<tr>
<td>(C) Capital-Intensive Technology: K(II) Type</td>
<td>Chemical maunsre</td>
<td>-0.71</td>
<td>1.71</td>
<td>4.97</td>
</tr>
<tr>
<td>(C) Capital-Intensive Technology: K(II) Type</td>
<td>Miscellaneous coal products</td>
<td>-0.09</td>
<td>1.67</td>
<td>1.50</td>
</tr>
<tr>
<td>(C) Capital-Intensive Technology: K(II) Type</td>
<td>Tobacco</td>
<td>0.18</td>
<td>2.30</td>
<td>1.83</td>
</tr>
<tr>
<td>(D) Cobb-Douglas Constant Earnings Type: (L-K) Type</td>
<td>Agriculture, forestry, and fisheries</td>
<td>0.57</td>
<td>0.46</td>
<td>4.61</td>
</tr>
<tr>
<td>(D) Cobb-Douglas Constant Earnings Type: (L-K) Type</td>
<td>Coal &amp; lignite</td>
<td>0.56</td>
<td>0.90</td>
<td>0.90</td>
</tr>
<tr>
<td>(D) Cobb-Douglas Constant Earnings Type: (L-K) Type</td>
<td>Mining</td>
<td>0.64</td>
<td>0.56</td>
<td>0.56</td>
</tr>
<tr>
<td>(D) Cobb-Douglas Constant Earnings Type: (L-K) Type</td>
<td>Silk reeling &amp; spinning</td>
<td>0.70</td>
<td>0.59</td>
<td>0.59</td>
</tr>
<tr>
<td>(D) Cobb-Douglas Constant Earnings Type: (L-K) Type</td>
<td>Vegetable &amp; animal oil &amp; fat</td>
<td>0.69</td>
<td>1.91</td>
<td>1.91</td>
</tr>
<tr>
<td>(D) Cobb-Douglas Constant Earnings Type: (L-K) Type</td>
<td>Wood milling</td>
<td>0.78</td>
<td>0.68</td>
<td>0.68</td>
</tr>
</tbody>
</table>
(E) Labor-Intensive Technology (Increasing Returns to Scale): Types L(I) and L(II)

<table>
<thead>
<tr>
<th>Technology Type</th>
<th>Sector</th>
<th>( X = aL + bL^2 )</th>
<th>( \frac{L^2}{E} )</th>
<th>Technological Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>L(I)</td>
<td>Building &amp; construction</td>
<td>0.75</td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>L(I)</td>
<td>Meat</td>
<td>0.64</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>L(I)</td>
<td>Seafood, preserved</td>
<td>0.90</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>L(I)</td>
<td>Transport services</td>
<td>0.70</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>L(I)</td>
<td>Paints</td>
<td>0.58</td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td>L(I)</td>
<td>Rubber products</td>
<td>0.99</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>L(I)</td>
<td>Glass products</td>
<td>0.44</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>L(I)</td>
<td>Miscellaneous industrial</td>
<td>0.83</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Other transport equipment</td>
<td>1.21</td>
<td>0.54</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Metal products</td>
<td>1.35</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Leather products</td>
<td>2.21</td>
<td>-0.07</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Furniture &amp; fixtures</td>
<td>1.82</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Other wood products</td>
<td>2.33</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Paper articles</td>
<td>1.29</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Pottery, china &amp; earthenware</td>
<td>1.29</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Structural clay products</td>
<td>1.59</td>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Other nonmetallic mineral products</td>
<td>1.87</td>
<td>0.19</td>
<td>1.15</td>
</tr>
<tr>
<td>L(II)</td>
<td>Medicine</td>
<td>1.20</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Weaving &amp; other fiber products</td>
<td>1.75</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Footwear &amp; wearing apparel</td>
<td>1.93</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Printing and publishing</td>
<td>1.43</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Other food, prepared</td>
<td>1.26</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Trading</td>
<td>1.95</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Finance &amp; insurance</td>
<td>1.60</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>L(II)</td>
<td>Communication services</td>
<td>3.38</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>1. Electric power supply</td>
<td>0.4448</td>
<td>0.3212</td>
<td>0.5234</td>
<td>0.6415</td>
</tr>
<tr>
<td>2. Gas and water supply</td>
<td>0.6869</td>
<td>0.6751</td>
<td>0.0319</td>
<td>0.6106</td>
</tr>
<tr>
<td>3. Petroleum refining products</td>
<td>0.3242</td>
<td>0.3512</td>
<td>0.0114</td>
<td>0.6101</td>
</tr>
<tr>
<td>4. Basic organic chemicals</td>
<td>0.0516</td>
<td>0.0656</td>
<td>0.0041</td>
<td>0.41</td>
</tr>
<tr>
<td>5. Artificial fiber materials</td>
<td>0.3415</td>
<td>0.0221</td>
<td>0.0177</td>
<td>0.0641</td>
</tr>
<tr>
<td>6. Iron and steel</td>
<td>0.1419</td>
<td>0.1354</td>
<td>0.1079</td>
<td>0.116</td>
</tr>
<tr>
<td>7. Nonferrous primary products</td>
<td>0.0423</td>
<td>0.0243</td>
<td>0.1024</td>
<td>0.00621</td>
</tr>
<tr>
<td>8. Ships and ship repairing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Motor vehicles</td>
<td>0.1889</td>
<td>0.209</td>
<td>0.368</td>
<td>0.3422</td>
</tr>
<tr>
<td>10. Machinery</td>
<td>0.3713</td>
<td>0.3397</td>
<td>0.334</td>
<td>0.318</td>
</tr>
<tr>
<td>11. Electrical machinery</td>
<td>0.2023</td>
<td>0.2047</td>
<td>0.28</td>
<td>0.265</td>
</tr>
<tr>
<td>12. Precision instruments</td>
<td>0.258</td>
<td>0.2002</td>
<td>0.221</td>
<td>0.201</td>
</tr>
<tr>
<td>13. Footwear and clothing</td>
<td>0.1543</td>
<td>0.1542</td>
<td>0.006</td>
<td>0.052</td>
</tr>
<tr>
<td>14. Beverages and alcoholic drinks</td>
<td>0.8339</td>
<td>0.832</td>
<td>0.499</td>
<td>0.4968</td>
</tr>
<tr>
<td>15. Paper</td>
<td>0.132</td>
<td>0.1347</td>
<td>0.1368</td>
<td>0.1722</td>
</tr>
<tr>
<td>16. Pulp</td>
<td>0.5576</td>
<td>0.4706</td>
<td>0.1069</td>
<td>0.047</td>
</tr>
<tr>
<td>17. Cement</td>
<td>0.4827</td>
<td>0.427</td>
<td>0.0023</td>
<td>0.0188</td>
</tr>
<tr>
<td>18. Basic inorganic chemicals</td>
<td>0.1418</td>
<td>0.0954</td>
<td>0.1835</td>
<td>0.2486</td>
</tr>
<tr>
<td>19. Chemical manure</td>
<td>0.7773</td>
<td>0.7402</td>
<td>0.0269</td>
<td>0.0187</td>
</tr>
<tr>
<td>20. Miscellaneous coal products</td>
<td>0.8518</td>
<td>0.8284</td>
<td>0.1008</td>
<td>0.0242</td>
</tr>
<tr>
<td>21. Tobacco</td>
<td>0.4398</td>
<td>0.3699</td>
<td>0.3773</td>
<td>0.2762</td>
</tr>
<tr>
<td>22. Agriculture, forestry, and fisheries</td>
<td>0.7043</td>
<td>0.7517</td>
<td>0.642</td>
<td>0.685</td>
</tr>
<tr>
<td>23. Coal and lignite</td>
<td>0.8884</td>
<td>0.8561</td>
<td>0.044</td>
<td>0.0549</td>
</tr>
<tr>
<td>24. Mining</td>
<td>0.3249</td>
<td>0.28</td>
<td>0.538</td>
<td>0.65</td>
</tr>
<tr>
<td>25. Silk selling and spinning</td>
<td>0.7991</td>
<td>0.8747</td>
<td>0.0753</td>
<td>0.425</td>
</tr>
<tr>
<td>26. Vegetable and animal oil and fat</td>
<td>0.0208</td>
<td>0.1023</td>
<td>0.387</td>
<td>0.369</td>
</tr>
<tr>
<td>27. Wool milling</td>
<td>0.5576</td>
<td>0.469</td>
<td>0.0263</td>
<td>0.0116</td>
</tr>
<tr>
<td>28. Building and construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. Meat</td>
<td>0.1694</td>
<td>0.1466</td>
<td>0.4092</td>
<td>0.4082</td>
</tr>
<tr>
<td>30. Seafood preserved</td>
<td>0.1042</td>
<td>0.0678</td>
<td>0.3711</td>
<td>0.6457</td>
</tr>
<tr>
<td>31. Transport services</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. Paints</td>
<td>0.388</td>
<td>0.459</td>
<td>0.4058</td>
<td>0.3796</td>
</tr>
<tr>
<td>33. Rubber products</td>
<td>0.1763</td>
<td>0.1913</td>
<td>0.0548</td>
<td>0.0671</td>
</tr>
<tr>
<td>34. Glass products</td>
<td>0.0028</td>
<td>0.0145</td>
<td>0.021</td>
<td>0.022</td>
</tr>
<tr>
<td>35. Miscellaneous industrial products</td>
<td>0.2012</td>
<td>0.1903</td>
<td>0.021</td>
<td>0.014</td>
</tr>
<tr>
<td>36. Other transport equipment</td>
<td>0.0918</td>
<td>0.1591</td>
<td>0.0446</td>
<td>0.0235</td>
</tr>
<tr>
<td>37. Metal products</td>
<td>0.2755</td>
<td>0.2146</td>
<td>0.2646</td>
<td>0.2498</td>
</tr>
<tr>
<td>38. Leather products</td>
<td>0.1124</td>
<td>0.2204</td>
<td>0.305</td>
<td>0.437</td>
</tr>
<tr>
<td>39. Furniture and fixtures</td>
<td>0.8212</td>
<td>0.1809</td>
<td>0.1006</td>
<td>0.0824</td>
</tr>
<tr>
<td>40. Other wood products</td>
<td>0.2622</td>
<td>0.293</td>
<td>0.1408</td>
<td>0.1573</td>
</tr>
<tr>
<td>41. Paper articles</td>
<td>0.132</td>
<td>0.1347</td>
<td>0.1368</td>
<td>0.1722</td>
</tr>
<tr>
<td>42. Pottery, china and earthenware</td>
<td>0.3499</td>
<td>0.3544</td>
<td>0.0066</td>
<td>0.0308</td>
</tr>
<tr>
<td>43. Structural clay products</td>
<td>0.5743</td>
<td>0.4634</td>
<td>0.0029</td>
<td>0.0129</td>
</tr>
<tr>
<td>44. Other nonmetallic mineral products</td>
<td>0.2116</td>
<td>0.2477</td>
<td>0.039</td>
<td>0.025</td>
</tr>
<tr>
<td>45. Medicine</td>
<td>0.8253</td>
<td>0.9507</td>
<td>0.011</td>
<td>0.0043</td>
</tr>
<tr>
<td>46. Weaving and other fibre products</td>
<td>0.0157</td>
<td>0.0101</td>
<td>0.0876</td>
<td>0.1</td>
</tr>
<tr>
<td>47. Footwear and wearing apparel</td>
<td>0.4511</td>
<td>0.5982</td>
<td>0.305</td>
<td>0.406</td>
</tr>
<tr>
<td>48. Printing and publishing</td>
<td>0.5882</td>
<td>0.1553</td>
<td>0.0154</td>
<td>0.0095</td>
</tr>
<tr>
<td>49. Other food, prepared</td>
<td>0.1917</td>
<td>0.1914</td>
<td>0.063</td>
<td>0.028</td>
</tr>
</tbody>
</table>

Table 2: IIT between: Germany & France, Germany & EC, France & EC, Austria & Hungary
Ozaki's classification

1. Electric power supply
2. Gas and water supply
3. Petroleum refining products
4. Basic organic chemicals
5. Artificial fiber materials
6. Iron and steel
7. Nonferrous primary products
8. Ships and ship repairing
9. Motor vehicles
10. Machinery
11. Electrical machinery
12. Precision instruments

SITC 2-digits classification

35. Electric current
34. Gas, natural and manufactured
33. Petroleum, petroleum products and related materials
51. Organic chemicals
582. Condensation, poly condensation and poly addition products, whether or not modified
583. Polymerization and copolymerization products
584. Regenerated cellulose; cellulose intrate, cellulose acetate and other cellulose esters, cellulose ethers
585. Other artificial resins and plastic materials
67. Iron and steel
68. Nonferrous metals
78. Road vehicles (including air cushion vehicles)
71. Power generating machinery and equipment
72. Machinery specialized for particular industries
73. Metalworking machinery
74. General industrial machinery and equipment, N.E.S. and machine parts, N.E.S.
75. Office machines and automatic data processing equipment
76. Telecommunications and sound recording apparatus and equipment
77. Electrical machinery, apparatus and appliances, N.E.S., and electrical parts thereof
87. Professional, scientific and controlling
88. Photographic apparatus, equipment
13. Fiber spinning

14. Beverages and alcoholic drinks

15. Paper

16. Pulp

17. Cement

18. Basic inorganic chemicals

19. Chemical manure

20. Miscellaneous coal products

21. Tobacco

22. Agriculture, forestry, and fisheries

23. Coal and lignits

24. Mining

ment and supplies and optical goods, N.E.S.; watches and clocks.

263. Cotton

264. Jute and other textile bast fibers, N.E.S., raw or processed but not spun: two and waste thereof

265. Vegetable textile fibers (other than cotton and jute) and waste of such fibers

266. Synthetic fibers suitable for spinning

267. Other man-made fibers suitable for spinning and waste of man-made fibers

268. Wool and other animal hair (excluding wool tops)

269. Old clothing and other old textile articles: rags

11. Beverages

64. Paper, paperboard, and articles of paper pulp, of paper or paperboard

25. Pulp and waste paper

661. Lime, cement, and fabricated construction materials (except glass and clay materials)

52. Inorganic chemicals

56. Fertilizers, manufactured

323. Briquettes: coke and semi-coke of coal, lignite or peat; retort carbon

12. Tobacco and tobacco manufactures

04. Cereals and cereal preparation

05. Vegetables and fruit

23. Crude rubber (including synthetic and reclaimed)

322. Coal, lignite and peat

27. Crude fertilizers and crude minerals (excluding coal petroleum and precious stones)

28. Metallic ferrous ores and metal scrap
25. Silk selling and spinning
26. Vegetable and animal oil and fat products
27. Wood milling
28. Building and construction
29. Meat
30. Seafood preserved
31. Transport services
32. Paints
33. Rubber products
34. Glass products
35. Miscellaneous industrial products
36. Other transport equipment
37. Metal products
38. Leather products
39. Furniture and fixtures
40. Other wood products
41. Paper articles
42. Pottery, china and earthenware
43. Structural clay products
44. Other nonmetallic mineral products

33. Petroleum, petroleum products and related materials
261. Silk
22. Oil seeds and oleaginous fruit
29. Crude animal and vegetable materials, N.E.S.
41. Animal oils and fats
42. Fixed vegetable oils and fats
43. Animal and vegetable oils and fats, processed, and waxes of animal or vegetable origin
24. Cork and wood
01. Meat and meat preparations
03. Fish, crustaceans and molluscs, and preparations thereof
53. Dyeing, tanning and colouring materials
62. Rubber manufactures, N.E.S.
664. Glass
665. Glassware
81. Sanitary, plumbing, heating and lighting fixtures and fittings
893.
899.
79. Other transport equipment
69. Manufactures of metal, N.E.S.
21. Hides, skins and furskins, raw
61. Leather, leather manufactures, and dressed furskins
82. Furniture and parts thereof
63. Cork and wood manufactures (excluding furniture)
64. Paper, paperboard, and articles of paper pulp, of paper or of paperboard
666. Pottery
662. Clay construction materials and refractory construction materials
663. Mineral manufactures
667. Pearls, precious and semi-precious stones, unworked or worked
45. Medicine
46. Weaving and other fibre products
47. Footwear and wearing apparel
48. Printing and publishing
49. Other food, prepared

50. Trading
51. Finance and insurance
52. Communication services

54. Medicinal pharmaceutical products
55. Textile yarn, fabrics, made up articles, and related products
83. Travel goods, handbags and similar containers
84. Articles of apparel and clothing accessories
85. Footwear
86. Printed matter
02. Dairy products and bird’s eggs
06. Sugar, sugar preparations and honey
07. Coffee, tea, cocoa, spices, and manufactures thereof
08. Feeding stuff for animals (not including unmilled cereals)
09. Miscellaneous edible products and preparations

06. Dairy, sugar, coffee, tea, cocoa, spices, and manufactures thereof
08. Feeding stuff for animals (not including unmilled cereals)