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The Economics of the Great Unbundling

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Abstract

Unbundling is the name of the recent conspicuous phenomenon in which manufacturing process is fragmented between firms and is now straddling countries. Permeating unbundling has changed the fundamental conditions and policies of developing countries for the economic development. This paper gives a basic framework to analyze unbundling and examines how it opens a new possibility for development strategies.

☆This is an incomplete version of the paper. Sections 7, 8 and 9 are lacking.
☆Any suggestions to this paper are welcome. My e-mail address: yATshiozawa.net
Replace "AT" with @.

§ 1. Introduction / Three generations of development policies

Development economics immerged after the World War II. It experienced a big change of leading ideas (Lindauer and Prochett 2002). We can detect three generations. In 1950s and 1960s, the era of the first generation, the Big Idea was to attain economic independence. State should play a leading role in accumulations and industrializations. Import substitution was targeted and foreign direct investment was to be avoided. There was a big swing between the first and the second generations. A neoclassical counterrevolution took place in 1970's and many of Big Ideas were reversed. Policies most advocated in 1980's and 1990's was dubbed Washington Consensus. General orientation was "let market go." State interventions were interpreted as the main obstacle to development. Investment emphasis was switched from public to private ones. Trade and foreign direct investment were welcomed. Deregulations were recommended and market economy should be re-enforced. Export became the strategic target of development policies. However, the liberalization of trade and finance brought a series of financial crisis. The economic performance of 1990's differed much from country to country and the effectiveness of the second set of Big Ideas seemed blurred. The East

Asian Miracle and China presented much more confused facts than clear-cut images that two generations of development theories could produce. Krugman (1992) called for a counter-counterrevolution and argued that high development theory of the first generation of development theory looks more sensible if we take in account new development of theories which incorporated increasing returns to scale. But the situation was not as simple as he imagined. Stiglitz (1992) argued in his comment to Krugman (1992) that Krugman's vison is too narrow and ignores equally important factors. Rodrik (1997) showed, based on a cross-countr1992) that the usual rules of thumb on what makes for good policy (uniformity, transparency, non-selectivity, etc.) are quite useless in predicting which policy regimes perform better in practice. Lindauer and Prochett (2002) talked about the End of Big Ideas.

Economic success of East Asia, Soth East Asia, China and India reveals unexpected process is happening in these countries and it helps much to bypass the classical dilemma: circular nature of economic development. Industrialization of a country requires the whole set of industries are organized. When such nexus of products and techniques is lacking, an industry cannot develop alone. In the case of Asian countries above cited foreign trade made it possible to separate an industry from others. This phenomenon is named Second Great Unbundling by R. Baldwin (2006; 2011).

Why did this phenomenon immerge in the end of the 20th century? It is a result of drastic deduction of transportation and communication costs. Former connected manufacturing process was unbundled and divided into chains of fragmented processes and a part of a chain was transferred to a country with lower wages. But here occurs a peculiar problem. We lacked general theory of international trade in which input goods are traded. The deficiency of this part of theory was noticed as early as late 1950's but the theory of input trade was not developed mainly by the mathematical difficulty in the formulation of price theories.

In spite of this important lack of a theory, trade theory continued to play an important role in formulating industrial and trade policies. This state of the art produced a series of wrong policies and became one of the reasons why the first and second generations of development policies failed.

The present paper shows how the difficulty was relieved and then explain why the second unbundling offered a practical pass to economic development.

The paper is organized as follows. In section 2, a short history of international trade theory is given. This is to give an overview on how the trade theories developed and what kind of deficiency they had. Section 3 explains how the traditional mainstream trade theory gave a flawed policy recommendation. Confusion continues up to today even among economists who are opposed to neoclassical economics. Section 4 gives a short summery of a new international trade theory or a new theory of international values which replaces neoclassical trade theory. It is important to note that the new theory of international values is coherent with classical value theory. Another important feature of the new theory is that it gives the wage of workers for each nation. Based on the big wage differences of nations Section 5 illustrates on figures the old Flying Geese Formation theory and the relatively new fragmentation. This section prepares the analysis of Section 6 where the second great unbundling is examined in relation to technological revolutions. Section 7 comes back again to the high development theory and examines why two generations of Big Ideas failed. Section 8 draws some lessons on institution oriented economics. Section 9 close this paper by indicating further research topics to be developed.

§ 2. A short history of international trade theory

It is well known that economic science developed in close relation with foreign trade policy. Smith became the founder of the Political Economy distinguishing gains from trade from accumulations. Ricardo gave a numerical example that Samuelson called "four magic numbers". The principle of comparative advantage survived neoclassical revolution and continues to be the source of inspirations of various concepts of comparative advantage. Textbooks continue to illustrate Ricardo's two-country two-goods case, producing a table of four numbers if they are not his original four numbers. However Ricardo has been misunderstood in two points. First, his gains from trade explanation were not based on the comparison of two ratios.[1] Second, his illustration on two commodity exchange did not mean that he excluded the third tradable commodity. In fact, he noted that many and articles enter into the list of exports and imports (Ricardo 1951, p.141). I will explain later how this makes big difference (See p.xx).

[1] See Maneschi (2004). Ruffin's discovery has been made more than a quarter century before him by K. Yukizawa in 1974. See Fujimoto and Shiozawa (2011-12) note 23 (p.29). For detailed information see Tabuchi (2014).

Even if the four magic numbers were an ingenious and persuasive illustration, Ricardo left a serious problem, i.e. building a theory of international values. If I use Marshall's terminology, Ricardo succeeded to build a theory of domestic values but left the task of building a theory of international values. An unfortunate accident occurred when John Stuart Mill started to tackle this problem. He examined the Ricardo's four numbers situation, i.e. two-country two-commodity trade situation. The production possibility set forms a convex quadrilateral with two sides coincident with two axis (For the details see Shiozawa, 2014a, Section 7). It has two "efficient" sides and the common point is an extreme point of the convex quadrilateral. This point is sometime called Ricardo Limbo but I here prefer to call it Mill-Jones point.

John S. Mill knew well that when a world production take place on a (relative) interior point of one of two sides, one country has no gains from trade. As he wanted to examine the case where both countries enjoy gains from trade, he was enforced to examine the Mill-Jones point. A change of the problematic occurred. Classical economics was an economics of production (Plutology after Hicks). Mill examined Mill-Jones point and he started an economics of exchange (Catallactics). Of course, we know that the demand for an ecoomics of exchange existed before Mill. The word "catallactics" was coined by Richard Whately in 1831 around the time when Mill was writing his first essay in Mill (1844).[2] Although Mill was a loyal disciple of Ricardo and had no intention to make a change, he was enforced to create economics of exchange because the Mill-Jones point situation forced it.

The point is that each country has only one competitive commodity at a Mill-Jones point. This situation is often named complete specialization. In that situation, productions of both countries are completely determined: what a country produces and at what amount. It is equivalent to a pure exchange situation where country A has a particular amount of commodity 1 and country B has commodity 2 of predetermined amount. The only thing to determine is the exchange ratio. Mill solved this terms of exchange problem with what is named later reciprocal demand approach.

The problem set by John Mill was further refined by Alfred Marshall and Francis Ysidro Edgeworth in their ways and their theory became the tradition named neoclassical theory of international trade. In 1930's works such as Haberler (1933), Ohlin (1933) and Viner (1937) appeared. Among them, Ohlin's book deserves a note. In this book Ohlin

[2] L. on Mises (1949) names Richard Whateley as the first propoponet of the term "catallactics."

started a formulation which becomes later Heckscher-Ohlin theory of international trade. It was young Samuelson who transformed Ohlin's observation into a series of theorems, among which Factor Price Equalization theorem is included. Heckscher-Ohlin-Samueslon theory (HOS theory hereafter) has three conspicuous characteristics. First, it assumes existence of at least two kind of primary factors. Second, the trading countries have different proportion of factor endowments. Third, the production functions or technologies of trading countries are all identical. With these assumptions, it is assumed that finished products are traded. Factor Price Equalization theorem (FPE theorem) claims that all factor prices are equal if trading countries continues to produce all products. When factor proportions of countries are very different from those of other countries, this "if" clause is not satisfied. It is widely believed that if clause holds as a standard situation. What is astonishing in FPE theorem is that wages of all countries are equal as a standard situation.

Exceptional stations were studied as multi-cone problems but FPE theorem was normally interpreted as if two clauses (i.e. conditional and conclusive clauses) hold. This factor proportion theory was later reformulated as factor content trade theory (Vanek, 1968). Heckscher-Ohlin-Vanek model was tested by many economists, generally with strongly negative results. But the factor proportion theory (HOS theory as well as HOV model) stayed to be a major trade theory even today.

There were another strand of trade theory, which we may call Ricardian theory. The most remarkable proponent in the first half of the 20 century was Frank D. Graham. He endeavored to correct the deformed orientation started by John S. Mill and redress Ricardian theory in a right path. After publishing a book full of numerical examples, he was dead by an unexpected accident. Lionel W. McKenzie, a Graham's student in Princeton succeeded his research program and developed it into a more modern style. McKenzie and Ronald W. Jones, in Rochester, produced a spring of Ricardian trade theory but it practically ended by Jones (1961). Praizing this work, Ethier (1999, p.764) commented in this way:

The contribution was so definitive that the Ricardian model has since been used almost entirely as a tool of other purposes and not as a subject of research in its own right. The main exception is the extension, by Samuelson (1964) and by Dornbusch, Fischer, and Samuelson (1977) to the model of a continuum of commodities.

Ethier was wrong in a critical point. Jones (1961) found a beautiful theory which characterizes Mill-Jones point in *N*-country *N*-Commodity case. He indicated that his theory was extended to include trade of intermediates products, but what he did was the study of the symmetric case. In other words, he only succeeded to give a general theory when all countries have an identical matrix of material input coefficients. The extension to a wider situation (asymmetric case) was not pursued except some sporadic studies in Japan and elsewhere. However, to build a trade theory by which we can analyze the trade of intermediate (or input) products was a crucial problem for Ricardian and factor proportion theories, for all questions from importation of primary materials, processing trade (Kakō Bōeki in Japanese) to outsourcing and fragmentations concerned with trade in intermediate products.[3] As McKenzie (1954, p.179) put it, "Lancashire would be unlikely to produce cotton cloth if the cotton has to be grown in England." McKenzie (1954, p.180) concluded his paper with this warning: "we have found that this simplicity is bought at the expense of prohibiting all trade in intermediate products (with a slight exception), which is indeed a heavy price." Ethier should have known this fact. He should not cover the existence of real problem to solve.

It will be useful to compare two strands of trade theories. One is factor proportion theory and the other Ricardian trade theory. Strangely factor proportion theory is widely believed to be a modern form of Ricardo's trade theory. The confusion of two theories (or identification of the two) spreads even among confessed anti-neoclassical economists. For example, see Boyer, Uemura and Isogai (2012, p.332). They confuse Ricardo's theory and apparently factor proportion theory.[4] Another example appears in Rowthorn (2006, p.8) in a more vague way. Under the title of "comparative advantage" he talks about a shift based on factor proportion theory. But two theories differ in its construction at the depth of theory construction.

Factor proportion theory is a typical neoclassical theory, as it assumes smooth

[3] All primary materials are intermediate products, because they are extracted ant processed. The difference between primary material and intermediate product does not matter. What makes analysis difficult is that the cost of a product is dependent of other country's product prices if imported products are used as inputs. See also note 7.

[4] They write: The field was effectively coined by David Ricardo, whose theory of comparative advantage is based upon natural endowments of each national territory; this framework is still the reference in modern international trade theory.

production functions with substitutive factor inputs. A simplest example is the production function $Y = f(K, L)$ where f is differentiable along both variables. The unique common point between two theories is that both theories take account of comparative advantage. In the case of factor proportion theory, comparative advantage lies in which factor is proportionally more abundant. In the case of Ricardo, comparative advantage lies in differences of labor input coefficients.

Two new trends appeared after 1980's. One is Krugman and others' New Trade Theory. Krugman (1979) succeeded in explaining the raison-d'-être of intra-industry trade. He assumed increased returns to scale (and thus monopolistic competition) and showed that countries will specialize in different products in an industry. Krugman's parable depended on the assumption that producers and products are symmetric. In other words, he assumed that producers' cost functions are all identical and consumers have a Dixit-Stiglitz type symmetric preference. As a parable in explaining the raison-d'-être of intra-industry trade, this was sufficient. But as a theory of intra-industry trade, it had a crucial defect. Krugman and others could not produce any general theory without symmetricity assumptions.

Another trend is Melitz's New New Trade Theory (Melitz, 2003). He initiated firms' level analysis. This was really a revolutionary act, as trade theories before him always treated industries but not firms. Despite of this tremendous contribution, New New trade theory is also defective as a trade theory, because it assumes different kind of simplifying symmetry assumptions on countries and products (Section 6, in particular). Another remarkable paper at the beginning of the 21st century was Eaton and Korthum (2002). In a Ricardian framework Eaton and Korthum treated input trade. Unfortunately they assumed that the cost of a bundle of inputs is the same across commodities within a country (p.1745) and used Frechet's type II extreme value distribution (p.1746). It was an ingenious mathematical technique but they were obliged with this trick to exclude the very mechanism of how the gains from input trade appears and what Samuelson (2001) named Sraffian bonus. The result is obvious. They estimated "the cost of moving to autarchy" was one quarter of a percent for Japan (p.1768). This is unbelievable if Japan returns to autarchy and prohibited to import crude oil.

It is worthy to note that new theories from Krugman to Melitz and to Eaton and Korthum all assume a different kind of symmetries. As far as these models are used to

show what kind of trade situation can occur, they are giving good examples. However, serious problems arise when asymmetricity is the source of gains from trade. As Samuelson (2001) illustrated beautifully, the big gains from input trade are obtained when trading countries have strongly asymmetric production processes. What is lacking is the truly general theory of trade which includes asymmetric cases. We shall see such a theory already exists in Section 4.

Before we set about on a new theory of trade, let us overview in the next section how Heckscher-Ohlin theory worked in trade and development policies.

§ 3. The theory that led ISI to an impasse.

Heckscher-Ohlin theory and more general Heckscher-Ohlin-Vanek theory can be called Factor Proportion Theory. In this section we use the abbreviation FPT.

In a most simple 2-country, 2-products and 2-factor case, the most important variables which determine the trade pattern are two countries' factor proportions. Suppose 2 factors are labor and let (K_A , L_A) and (K_B , L_B) be pairs of capital and labor endowment for countries A and B respectively. If $K_A / L_A > K_B / L_A$ and two countries has the same preference function, then country A exports capital intensive product say product 1 and country B exports product B. If the world production lies in the factor price equalization cone, factor prices and product price are the same for two countries (Factor Price Equalization theorem). The trade occurs because country A produces capital intensive product 1 proportionally more than product 2 and country B produces labor intensive product 2 proportionally more than product 1. As two countries have the same preference and prices are equal for two countries both countries consume two products with the same proportion. Then product 1 should be exported from country A and product B should be exported from country B.

This account of trade seems similar to the Ricardo's trade example, but in reality a deep difference lies in the logic of why trade occurs. In the Ricardo's case, it is the difference of costs which determines which product is exported. If England exports cloth, it has cost advantage in cloth than Portugal. At the international exchange ratio, England can produce the cloth with less labor than to produce the same quantity of wine that can be exchanged by trade. The same is true for Portugal. It can produce wine with less labor than to produce the same quantity of cloth that can be exchanged by trade (Yukizawa's

original interpretation). This situation happens only when the wages for two countries w_E and w_P satisfy the condition

$$100/90 < w_P / w_E < 120/80, \qquad (3\text{-}1)$$

in other words, when the Portuguese workers' wage is 11.1% higher than English workers' wage and the first is less than 150% of the latter. Note that the condition (3-1) is equal to the condition for the existence of positive w_E and w_P such that

$$100\ w_E < 90\ w_P \quad \text{and} \quad 120\ w_E > 80\ w_P. \qquad (3\text{-}2)$$

In N-country N-product case, this relation can be generalized to Jones's theorem (Jones, 1961).

In the Ricardian trade theory, it is the wage differentials which induce trade patterns. In general, exporter country has lower cost in the production of its exports and has higher cost in the production of its imports. The exception is the case when the two countries have the equal cost. In this case, we cannot tell by the cost comparison which country exports and which country imports.

Heckscher-Ohlin theory typically deals with the above exceptional case, i.e. the case when the two countries have the same cost of production. In Ricardian theory, the cost comparison works as indicators of trade pattern. The country with lower cost exports to higher cost country. Trade pattern is regulated by the relative wage change. If nominal wage rates (denominated by each country's currency) for both country are fixed, it is the exchange rate that regulates the relative wage rate. In Heckscher-Ohlin theory, a firm cannot tell if their products can be profitably exported. In its standard case (where factor price equalization theorem holds), it is not the difference of costs but relative volumes of production and consumption of a good for each country. The logic is quite similar to Adam Smith's vent-for-surplus argument (of course, less productivity argument).[5]

This "subtlety" in the FPT produced a flawed argument even in the framework of the theory. A typical argument using the FPT is something like this. The USA was thought

[5] See for a short review on the vent-for-surplus and productivity arguments Kurtz (1992, Introduction and Section I).

to be relatively more abundant in capital than any other countries. Then it was argued that the USA export capital intensive products because they has comparative advantage in it. This was the origin of Leontief paradox. Take another example, say India. Low skilled labor is relatively more abundant in India than in the USA. Then typical argument is India should concentrate in low skilled labor intensive products. Is this argument correct? No.

India has a very large army of highly skilled engineers in the ICT or other edge technologies. But, as Indian population is huge (1.3 trillion people), the proportion of skilled engineers may be smaller than say the USA. Given this, is it right that India has comparative advantage in low skilled industries? Do firms in India have less chance of succeeding in the ICT or any other edge technology based industries?

The FPT tells yes. This conclusion is, however, a total error. Competitiveness first operate on firms, not on nations. If a firm can produce a unique product that no other firms can produce, that product may conquer the world. If several firms are competing to sell similar products of the same quality, it is the price (then the production cost) which determines which firm's product can take the dominant position.

In the case of India, a firm in the ICT or any other edge technology has a special advantage than those in the USA, because they have large enough number of excellent and talented engineers (for a firm) and they work voluntarily with relatively cheap wages. The only thing they lack may be experience, but the lack of experience will be compensated if they start to work in a business. Thus it is more correct to say that India has a comparative advantage in edge-technology industries, even though the meaning of "comparative advantage" is clearly different from the normally accepted one.

The FPT put its focus of examination on tow capital/labor ratios. One is capital/labor ratio in inputs of a production. The other is capital/labor ratio of endowments. A country with higher capital/labor ratio has tendency to export capital intensive products whereas a country with lower capital/labor ratio has a tendency to export labor intensive products. But, it is important to note that these tendencies do not ensure any competitive edge for firms which produce labor intensive products in a country endowed with proportionally higher labor endowment. The same is true for firms which produce capital intensive products in a country with higher capital/labor ratio. Firms of both countries have the same cost of production, as factor prices (i.e. wage and profit rate)

are equal for both countries and production functions are the same. The trade pattern which the FTP tells is irrelevant to firm's competitiveness in the market.

To study firm's competitiveness, we have to exmain the quality and the price of the firm's product. If the quality is the same for all firms, it is the price competition which determines whether a firm can expand its production or not. If we are permitted to ignore the quality, the delivery and other services, the competition occurs on the cost level. This is a natural argument but the internal logic of the FPT does not permit this kind of examination. The FPT has a serious defect in examining the situation and working out a strategy of a firm.

In Section 1, we overviewed three generations of development policies. The typical industrialization policy for the first generation was import substitution. The first generation policy set was a general failure. The second generation of development theory aimed at export-lead economic growth. The second policy set was also a general failure except for four little tigers. What difference divided the East Asian Miracle and the general failure of many other countries? The FPT did not provide any plausible accounts of these experiences and continued constantly to produce erroneous policy recommendations or perspectives both for government officials and for entrepreneurs.

In view of cost competition, low wage of a country is a point of strength for firms in the country. This simple truth has been concealed for a long time, because the FPT does not admit wage disparity as a standard situation. The FPT is ill-adapted to examine trade policies and we need another trade theory. It will be the Ricardo-Sraffa trade theory which we give a short account in the next section.

§ 4. A short summery of the new theory of international values[6]

The above discussion revealed the necessity of a new theory. The theory must satisfy two conditions. First, the new theory must be a one which is general enough and permits trade of intermediate goods. The word "general" here means that theory does not depend on various kinds of symmetricities as have been assumed from Krugman to Eaton and Korthum. Second, the new theory must contain an account how the wage disparity occurs between countries. Such a theory has been obtained as a Ricardo-Sraffa

[6] This section is highly mathematical and can be skipped if you understand that a new theory international values determines a wage price system $(\mathbf{w}, \mathbf{p})$ where $\mathbf{w} = (w_i)$ gives wages of countries and $\mathbf{p} = (p_i)$ gives prices of goods.

trade theory.

As it is explained in various papers (Shiozawa, 2007; 2014a; 2014b; 2015) and in Shiozawa (2014) in detail, only an essential minimum is given here.

We assume the following situation:

(a) There are M countries.

(b) There are N goods which are traded freely between countries and transported without cost.

(c) Labor of each country is assumed to be homogeneous. There is no international labor force movement across countries.

(d) Production techniques are simple. Joint productions are excluded. This means that only one product is produced by one production technique.

(e) To produce a good requires a positive amount of labor.

(f) Each country has at least one productive system of techniques.

Production technique represents a fixed coefficient input-output relationship. As we permit for a product many production techniques and consider choice of techniques, input substitutions are built in as internal logic of the theory. Transport cost can be incorporated in the theory (Shiozawa, 2014, Chapter 3 Section 8; 2014b, Section5) but explicit formulations are omitted here.

We use following notations: A set of different goods is denoted by an N-row vector x and called commodity vector. As goods can be transported freely without cost, we can treat them abstract of locations. Prices of any good are equal anywhere in the world. A price vector will be denoted by a N-column vector $\mathbf{p} = (p(\mathrm{i}))$, where $p(\mathrm{i})$ is the price a good i. The wage rate of a country i will be noted by $w(\mathrm{i})$. A set of wage rates for all countries is denoted by a M-column vector $\mathbf{w} = (w(\mathrm{i}))$. A value vector $\mathbf{v}$ is a couple $(\mathbf{w}, \mathbf{p})$ which is also deemed as a column vector of $M+N$ entries. Each entry indicates either a wage of a country or a price of a good.

Industry is a set of activities a product i and called by i, the same name of the product. As we assumed that production techniques are simple, each technique belongs to an industry. Country is the place where the production takes place. Each country has at least one producing process or a production technique for any good. Producing processes which produce the same product but belong to (or are operating in) different countries

are treated as different techniques. We suppose there are in total H different techniques in the world (H must be greater than $M \times N$). H is finite if it can be as big as we suppose. Techniques are numbered in a certain order but there is no need to enter in this detail. It is sufficient to suppose that this order is preserved for all expressions.

A production technique is expressed by a net production vector which requires one unit of labor input. The set of all production techniques is expressed by an $H \times N$ matrix A composed of vectors of net output vectors which corresponds to a production with unit labor input. The set of all labor input is expressed by a $H \times M$ matrix I whose entries are 0 or 1. The i-th component of this vector expresses the labor input for the country i. Note that labor is assumed to be different when it belong to a different country. Each row vector of I contains only one entry with value 1 which indicates in which country the production takes place.

Each country has a certain quantity of labor power q(i). The set of labor powers of the world is denoted by M-row vector $\mathbf{q}$. Activity vector $\mathbf{y} = (y_k)$ is given by a set of the activities y_k for each production technique k. Then the net material production of the world is $\mathbf{y}A$ and the total labor input of the world is $\mathbf{y}\,I$. When y_k is positive, we say that technique k is operating.

The production possibility set $P(\Gamma, \mathbf{q})$ for a set of techniques Γ is defined as set of vectors $\{\mathbf{y} \mid \mathbf{y}\,I \leqq \mathbf{q}, \mathbf{y} \geqq \mathbf{0}\}$. $P(\Gamma, \mathbf{q})$ is a polytope of the vector space of dimension N. We are normally concerned with a non-negative subset of $P(\Gamma, \mathbf{q})$, as such a point can only represent an economy which reproduces itself materially. Facets of a polytope is a set in the boundary of codimension 1. This means in our case, a facet has the dimension $N-1$. The boundary points of $P(\Gamma, \mathbf{q})$ are covered by finite number of facets.

Definition 4.1 (Productive system)
A system of production techniques is productive by definition when there exists a non-negative vector y such that $\mathbf{y}\,A > 0$. □

Definition 4.2 (Ricardo-Sraffa Trading Economy)
An economy which satisfies conditions (a) to (f) is named Ricardo-Sraffa trading economy. □

Condition (f) can be removed if the world is provided a productive system of production

techniques. We assume condition (f) to avoid unnecessary complications in descriptions.

Definition 4.3 (Regular Domain)

The frontier or the non-negative boundary of production possibility set $P(\Gamma, q)$ is composed of a finite number of facets. The interior of any such facet is called regular domain. □

Theorem 4.4 (Fundamental Theorem for Ricardo-Sraffa Trading Economy)

Let E be a Ricardo-Sraffa trading economy with A, I and $\mathbf{q}$ as denominated above. For any final demand vector $\mathbf{d}$ which belongs to a regular domain, there is a production activity vector $\mathbf{y}$ and a value $\mathbf{v} = (\mathbf{w}, \mathbf{p})$ which satisfy the following conditions:

(i) $\mathbf{y}A = \mathbf{d}$.

(ii) $\mathbf{y}I = \mathbf{q}$.

(iii) $I\mathbf{w} \geqq A\mathbf{p}$.

(iv) $\langle \mathbf{q}, \mathbf{w} \rangle = \langle \mathbf{d}, \mathbf{p} \rangle$.

The value vector $\mathbf{v} = (\mathbf{w}, \mathbf{p})$ is unique up to scale and remains constant whenever demand vector $\mathbf{d}$ remains in the same regular domain. □

The proof is given Shiozawa (2014) Chapter 2, Theorem 17 and Chapter 5 Theorem 44. See also Shiozawa (2007) Theorems 5.2. and Theorem 5.7. Shiozawa (2014) gives a strait and algebraic proof. An international value which is unique up to scale is associated to a final demand d on a regular domain. This international value is often called regular value. Number of regular values is always finite.

Conditions of Theorem 4.4 have concrete economic meanings. In a word, they stand for
(i) supply and demand equality,
(ii) labor is fully utilized,
(iii) no excess profitability,
(iv) income circulation.

The condition (i) confirms that the net production for consumption is equal to a given world final demand d. The condition (ii) confirms that full employment is achieved. The condition (iii) indicates that no production techniques are operating with positive profit. Each entry of the left hand is labor cost whereas each entry of the right hand is the net value-added of the production. The condition (iv) implies that the value of the net product is equal to the total sum of wages. This permits the economy to stay at a

self-replacing state when workers can buy all the net products with their wages. Firms may have profit when mark-ups are introduced. See Remark 4.5 in the following.

Conditions (iii) and (iv) implies that no production technique with negative profit is operating. Indeed, suppose that there is a production technique with positive $y(\mathrm{k})$ with $w(\mathrm{k}) > \langle\, \mathbf{a}(\mathrm{k}) , \mathbf{p}\rangle$, then

$$\langle \mathbf{q}, \mathbf{w}\rangle - \langle \mathbf{y}, \mathbf{p}\rangle = \langle \mathbf{y}\, I, \mathbf{w}\rangle - \langle \mathbf{y}\, A, \mathbf{p}\rangle = \langle \mathbf{y}, I\,\mathbf{w} - A\,\mathbf{p}\rangle = \mathrm{y}(\mathrm{k}) \cdot \{w(\mathrm{k}) - \langle\, \mathbf{a}(\mathrm{k}) , \mathbf{p}\rangle\} > 0.$$

This is a contradiction, because the left member of the equations is 0 from condition (iv). By consequence, it follows that no technique with negative profit is operating. When a production technique k of a country i satisfies the equality

$w(\mathrm{i}) = \langle \mathbf{a}(\mathrm{k}), \mathbf{p}\rangle$,

we say that technique k is operating competitively instead of saying it is profitable. When we say all techniques are operating competitively, it means all operating techniques are competitive. This expression is adopted in order to make our expression usable when we adopt full cost principle with mark-ups. See Remark 4.6.

The following two remarks are important.

Remark 4.5 (Mark-ups)

When each industry of each country has a fixed mark-up rate, it is easy to modify the Theorem 4.4 for a unique existence of value vector with production prices. It suffices to multiply (both labor and material) input coefficients by 1 plus the corresponding mark-up rate. But formulae become a bit complicated and explanations become longer. Except for the case when we discuss the effects of change of mark-ups, we suppose mark-up rate is 0 in order to keep expressions simple. □

Remark 4.6 (No equilibrium interpretation)

Theorem 4.4 assures only the existence of a self-replacing state. It does not affirm in any sense that the economy converges to such a state. On the contrary, the theorem can be interpreted as showing how difficult it is that an full employment state is realized. □

To illustrate Remark 4.6, we will show in Theorem 4.9 that Ricardo-Sraffa trade theory can take in consideration the situation where unemployment exists. We need some

preparations before that.

To make later descriptions short, we make here one technical definition.

Definition 4.7 (covering)
A positive international value (**w**, **p**) is said be "covering" when (w, p) satisfies conditions (iii) and each good has at least one technique which satisfies (iii) with equality. A vector (**w**, **p**) is covering if and only if there is a positive d and a nonnegative y which satisfy conditions from (i) to (iv). This concept is applicable to a wage price system (**w**, **p**) in a country too. □

Suppose a Ricardo-Sraffa trading economy E with A, I and **q**. We can imagine each country's closed economy E(i) with production techniques and labor belonging to country i. As we have supposed it in condition (f), each country has a productive system of techniques. The economy E(i) with matrix A(i), I(i) and **q**(i) compose a country i's closed economy. In a one-country closed economy, we have the minimal price theory. It can be expressed in various forms. The next lemma is one of them.

Lemma 4.8 (Minimal price theorem)
Let E be a one-country economy which satisfies conditions (d), (e), (f) in the definition of Ricardo-Sraffa trade economy. There exists a covering system of techniques and its normalized price vector is minimal among all normalized price vectors associated to covering systems.

The above lemma can be paraphrased as follows. Any covering system of techniques which satisfies wage price system w, p contains a productive system of techniques composed of techniques each belonging to different industry. Let the system be expressed by a $N \times N$ square matrix A of net output vectors and the N-column vector J all composed of 1. Then A and J satisfies the equation $J\mathbf{w} = A\mathbf{p}$. Given a covering system γ, this wage price system with a given w is uniquely determined. When $w=1$, we call p the normalized price system associated to a system of techniques γ. Among covering systems of techniques there is a special system γ* which satisfies the inequality

$$\mathbf{p}(\gamma^*) \leqq \mathbf{p}(\gamma)$$

for all covering system γ, if **p*** and p are normalized price vectors associated to γ* and γ.

Take any covering system γ in country i. Let $A(\gamma)$ be the square matrix associated to a productive subsystem of γ. Then the wage price system $w(i)$, $\mathbf{p}(i)$ associated to γ satisfies the equation

$$w(i)\, J = A(\gamma)\, \mathbf{p}(i) \qquad (4\text{-}1)$$

and inequality

$$w(i)\, I(i) \geqq A(i)\, \mathbf{p}(i). \qquad (4\text{-}2)$$

Matrix $A(\gamma)$ is square and non-negatively invertible. It means that (4-1) can be expressed as

$$\mathbf{p}(i) = w(i)\, A(\gamma)^{-1}\, J. \qquad (4\text{-}3)$$

Theorem 4.9 (Gains from trade)

Let E be a Ricardo-Sraffa trading economy with A, I, $\mathbf{q}$. Let a couple of vectors ($\mathbf{w}$, $\mathbf{p}$) satisfy the condition

$$I\,\mathbf{w} \geqq A\,\mathbf{p}, \qquad (4\text{-}4)$$

then any covering wage price system $w(i)$, $\mathbf{p}(i)$ of a country i satisfies the equation

$$(1/w_i)\,\mathbf{p} \leqq (1/w(i))\,\mathbf{p}(i). \qquad (4\text{-}5)$$

□

Inequality (4-5) means that the international value which satisfies condition (4-4) gives for country i a better real wage level than any covering wage price system ($w(i)$, $\mathbf{p}(i)$). Note that expressions like $w_i/\mathbf{p}$ or $w(i)/\mathbf{p}(i)$ do not have any meaning as $\mathbf{p}$ and $\mathbf{p}(i)$ are vectors. Real wage is better when the price vector divided by the wage rate is smaller.

The proof is easy. Taking country i part of (4-4),

$$w_i\, I(i) - A(i)\,\mathbf{p} \geqq 0.$$

In a closed economy, we have the minimal price theory. Let $A(\gamma)$ be the square matrix of the system of techniques γ which gives minimal price. Then we have

$$w_i J - A(\gamma)\,\mathbf{p} \geqq 0,$$

because any production technique of γ make a part of $A(i)$. Multiply this inequality by non-negative matrix $A(\gamma)^{-1}$ and we get

$$w_i A(\gamma)^{-1} J - A(\gamma)^{-1} A(\gamma)\,\mathbf{p} \geqq \mathbf{0}.$$

Using (4-3) this is equivalent to

$$w_i / w(i)\,\mathbf{p}(i) - \mathbf{p} \geqq \mathbf{0}.$$

Therefore (4-5) holds.

Combined with Lemma 4-8, Theorem 4-9 implies that we have series of inequalities

$$(1/w_i)\,\mathbf{p} \leqq (1/w^*(i))\,\mathbf{p}^*(i) \leqq (1/w(i))\,\mathbf{p}(i),$$

where $w^*(i)$, $\mathbf{p}^*(i)$ is the wage price system which give the minimal no≦rmalized price vector.

It is important to note that the conclusion of Theorem 4.9 (amelioration of real wage level) applies only for workers who continue to be employed. These gains from trade do not apply for workers who are fired or for entrepreneurs who are obliged to close the business. Neoclassical economics usually assume that full employment is achieved soon if not immediately and ignores these losses from trade. However, as the next theorem shows it is possible that unemployment continues if no measures are taken.

Theorem 4.10 (Existence of Unemployment)

Let E be a Ricardo-Sraffa trading economy with A, I and $\mathbf{q}$. Suppose there exists at least a pair of countries of which the minimal price vectors are not proportional with each other. Let positive vector $\mathbf{x}(i)$ be the net product of a self replacing state of the closed economies and $\mathbf{x} = \Sigma_i\, \mathbf{x}(i)$ be the sum of those vectors. Finally suppose that an international value ($\mathbf{w}$, $\mathbf{p}$) and an activity vector y satisfy the following four conditions:

(a) $\mathbf{y}\,A = \mathbf{d} \leqq \mathbf{x}$,
(b) $\mathbf{y}\,I = \mathbf{t}$,
(c) $I\,\mathbf{w} \geqq A\,\mathbf{p}$, and
(d) $\langle \mathbf{t}, \mathbf{w} \rangle = \langle \mathbf{d}, \mathbf{p} \rangle$.
The system y, d, w, and p forms a self-replacing state and all operating techniques are competitive. In this self-replacing state at least one country suffers from unemployment.
□

As we have assumed there are two countries in which minimal price vectors are not proportional. Then, there must be at least one country i where price vector $\mathbf{p}$ is not proportional to its minimal price vector. It means that

$$\mathbf{p} \lneqq (w_i / w(\mathrm{i}))\, \mathbf{p}(\mathrm{i}). \qquad (4\text{-}6)$$

Here $\lneqq$ means that inequality $\leqq$ holds for all components whereas inequality < holds for at least one component. Theorem 4.10 follows from a simple calculation:

$$\langle \mathbf{t}, \mathbf{w} \rangle = \langle \mathbf{d}, \mathbf{p} \rangle \leqq \langle \mathbf{x}, \mathbf{p} \rangle = \langle \Sigma_{\mathrm{i}}\, \mathbf{x}(\mathrm{i}), \mathbf{p} \rangle$$

$$< w_i / w^*(\mathrm{i}) \;\; \Sigma_{\mathrm{i}} \langle\, \mathbf{x}(\mathrm{i}), \mathbf{p}^*(\mathrm{i}) \rangle \leqq \Sigma_{\mathrm{i}}\, \mathbf{q}(\mathrm{i})\; w_i = \langle \mathbf{q}, \mathbf{w} \rangle \;.$$

First equality holds from (d), the second inequality from (a), third equality by definition, the fourth from (4-6) for positive $\mathbf{x}$(i), fifth by the fact that $\mathbf{x}$(i) can be purchased by the wage of all workers, and seventh from definition. As a conclusion, we obtain a strict inequality

$$\langle \mathbf{t}, \mathbf{w} \rangle < \langle \mathbf{q}, \mathbf{w} \rangle \;.$$

As this means that the weighted sum of all countries' employment with weights w_i is smaller of the weighted sum of world's labor power, there is at least one country where some workers are unemployed. Q.E.D.

It is noted that in the formulation of Theorem 4.10 vector $\mathbf{t}$ in condition (b) is not assumed less than vector $\mathbf{q}$. This means unemployment is inevitable even if workers move across country borders.

If we combine Theorem 4.4 and Theorem 4.10, we can say followings. Theorem 4.4 tells

that there is a self-replacing state with an international value in which full employment is attained. But Theorem 4.10 also says that with the same wage price system, unemployment necessarily occurs if the world demand stays as same as before trade. Neoclassical economists have a custom to assume that price adjustment is always sufficient for full employment but Theorem 4.10 tells it is not true.

On the other hand, we have next the theorem which clarifies some properties of the international value whose existence was assured by Theorem 4.4.

Proposition 4.11 (A Property of a Regular International Value)
Let E be a Ricardo-Sraffa trading economy with A, I and $\mathbf{q}$ and assume that final demand vector $\mathbf{d}$ belongs to a regular domain. There exists an international value $(\mathbf{w}, \mathbf{p})$ and a production activity vector $\mathbf{y}$ which satisfy four conditions of Theorem 4.4.Take any world production whose activity vector $\mathbf{s} = (s_h)$ contains positive activity levels which are not competitive with regards to $(\mathbf{w}, \mathbf{p})$. Then it is impossible to produce $\mathbf{d}$ as net product by the world production $\mathbf{s}$. □

The proposition can be demonstrated by the following calculation. Let C be the set of competitive production techniques with regards to $(\mathbf{w}, \mathbf{p})$. We note $i = i(h)$ when a production technique h belongs to country i. If $i = i(h)$, then by definition

$$\langle \mathbf{a}_h, \mathbf{p} \rangle = w_i \quad \text{if and only if } h \in C .$$

If h belongs to country i and is not competitive,

$$\langle \mathbf{a}_h, \mathbf{p} \rangle < w_i.$$

If we define $w(h) = \langle \mathbf{a}_h, \mathbf{p} \rangle$, then

$$w(h) < w_i$$

for any production technique h not belonging to C.

Let nonnegative vector $\mathbf{s} = (s_h)$ a production activity vector which satisfies $\mathbf{s} I \leqq \mathbf{q}$. The net product of this world production is

$$\mathbf{u} = \Sigma_h s_h \mathbf{a}_h.$$

Then

$$\langle \mathbf{u}, \mathbf{p} \rangle = \langle \Sigma_h \, s_h \mathbf{a}_h, \mathbf{p} \rangle = \Sigma_h \, s_h \langle \mathbf{a}_h, \mathbf{p} \rangle$$

$$= \Sigma_h \, s_h \, w(h) < \Sigma_h \, s_h \, w_{i(h)} = \Sigma i \, (\Sigma_{i(h)=i} \, s_h) \, w_i .$$

Here, the strict inequality holds when s_h has positive sh for non-compeitive production techniques. As we have assumed that $\mathbf{s}\, I \leqq \mathbf{q}$ or $\Sigma_{i(h)=i} \, s_h \leqq q_i$, the above relation means that

$$\langle \mathbf{u}, \mathbf{p} \rangle < \Sigma_i \, (\Sigma_{i(h)=i} \, s_h) \, w_{i(h)} \leqq \Sigma_i \, (\Sigma_{i(h)=i} \, s_h) \, w_{i(h)} = \langle \mathbf{q}, \mathbf{w} \rangle .$$

As we have condition (iv) of the Theorem 4.4, we have

$$\langle \mathbf{u}, \mathbf{p} \rangle < \langle \mathbf{d}, \mathbf{p} \rangle .$$

This means that the net product $\mathbf{u}$ cannot attain $\mathbf{d}$ as far as production $\mathbf{s}$ contains positive non-competitive production techniques with regards to $(\mathbf{w}, \mathbf{p})$.

Q.E.D.

The above demonstration clarifies how international values are related. It shows that non-competitive production techniques hold bigger weights, $\mathbf{u}$ becomes farther from $\mathbf{d}$. More precisely, if the value

$$\Sigma_{h \notin C} \, s_h \, (w_i - w(h)) \qquad (4\text{-}7)$$

is bigger, so is the difference $\langle \mathbf{d}, \mathbf{p} \rangle - \langle \mathbf{u}, \mathbf{p} \rangle$. The value (4-7) may be called loss value.

Let an international value $(\mathbf{w}^{\#}, \mathbf{p}^{\#})$ satisfy condition (iii) of Theorem 4.4. Then the loss value (4-7) attains a minimum when the production stays competitive with regards to $(\mathbf{w}^{\#}, \mathbf{p}^{\#})$ and satisfies the condition $\mathbf{s}\, I = \mathbf{q}$. This minimum is positive if the value $(\mathbf{w}^{\#}, \mathbf{p}^{\#})$ is not proportional to $(\mathbf{w}, \mathbf{p})$, because $(\mathbf{w}^{\#}, \mathbf{p}^{\#})$ together with s satisfies four conditions of Theorem 4.4 and becomes proportional to $(\mathbf{w}, \mathbf{p})$ by the uniqueness of international values. Define this minimal the quasi-distance δ of value $(\mathbf{w}^{\#}, \mathbf{p}^{\#})$ from

$(\mathbf{w}, \mathbf{p})$ [7]. Then we get

Theorem 4.12 (Qausi-distance of International Values)

Let E be a Ricardo-Sraffa trading economy with A, I and $\mathbf{q}$ and let $(\mathbf{w}, \mathbf{p})$ and production $\mathbf{y}$ satisfy four conditions of Theorem 4.4. Let an international value $(\mathbf{w}^{\#}, \mathbf{p}^{\#})$ satisfy condition (iii) of Theorem 4.4. A quasi-distance δ can be defined for international value $(\mathbf{w}^{\#}, \mathbf{p}^{\#})$ by

$$\min \sum_{h \notin C} s_h (w_1 - w(h))$$

with the constraint

$$\mathbf{s}\, I = \mathbf{q} \text{ and } w_h = \langle \mathbf{a}_h, \mathbf{p}^{\#} \rangle \ \forall \text{all } h \in C^{\#},$$

where $C^{\#}$ is the set of all competitive production technique with regards to $(\mathbf{w}^{\#}, \mathbf{p}^{\#})$. It is positive when $(\mathbf{w}^{\#}, \mathbf{p}^{\#})$ is not proportional to $(\mathbf{w}, \mathbf{p})$ and u cannot be close to $\mathbf{d}$, if δ is big. More precisely,

$$\langle \mathbf{u}, \mathbf{p} \rangle = \langle \mathbf{d}, \mathbf{p} \rangle - \delta .$$

□

Theorem 4.12 tells that an international value cannot be very different from $(\mathbf{w}, \mathbf{p})$ if the world economy is close to produce d as net product. We can say that international value is determined in this loose sense.

Let us remind that the new theory of international values is constructed on a wide situation where each country has its own set of production techniques. It can hold many techniques which produce the same products. The question of choice of techniques and input substitutions are solved in this framework. As products are freely traded, intermediate or input trade is incorporated in the new theory.

Another important characteristic is that the new theory is a natural generalization of the classical value theory (Shiozawa, 2014c; 2015). The most important fact of the new theory is that relative values are determined in the same loose sense as it has been stated above.

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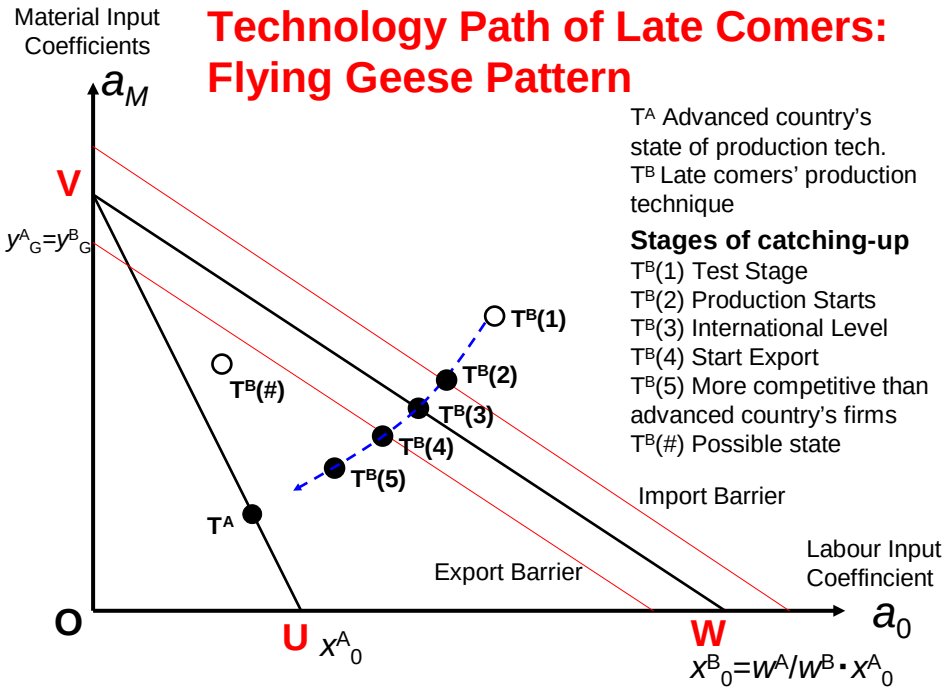
[7] It is not a distance in mathematical sense. For example, it does not satisfy the symmetric law. But δ is positive if $(\mathbf{w}^{\#}, \mathbf{p}^{\#})$ is not proportional to $(\mathbf{w}, \mathbf{p})$.

Emmanuel (1969) and other some dependency theory economists argued that high wage of developed countries worsens the terms of trade between for less developed countries. The new theory does not think in the same way. If we assume a predetermined demand, wage disparity is more or less determined by differences of technologies that countries possess. This is not to claim that institutions or knowledge do not matter. They are important factors which determine the present set of technologies. There are many other factors which influence state of technologies of each country. For example, the infrastructure of the society helps to reduce transport cost and make production techniques more efficient. For example, good ports, roads and railways reduce real transport costs and contribute to make almost all production techniques more efficient. The important thing to know here is that wage disparities are determined through the set of production techniques. The direct lesson from this theory is that you should improve production techniques' efficiency. This improvement of efficiency includes gaining new production techniques which were impossible earlier. This is equivalent to reduce infinitely high cost to finite.

The factor proportion theories including HOS theory are customarily satisfied to see that trade occurs when factor endowment ratios are different despite the equal factor prices. If this is one way to explain international trade, factor proportion theory ignores a preponderate condition which determines the cost advantage. Low wage is bad but provides powerful arms to get cost advantage and by consequence a competitiveness in the world market. Next section illustrates how the wage disparity works in catching up process as well as in the recent great unbundling.

§ 5. Flying geese and fragmentations

As mid-range theories of industrial development in relation to international trade, Vernon's product cycle theory and Akamatsu's flying geese theory are famous. Akamatsu and Vernon have a similar viewpoint but they were seeing the same mechanism from the opposite sides. Akamatsu set his observational eye on the catching up process of Japan, whereas Vernon is observing the transfer of technology and production from advanced countries to less advanced countries. When he started his research in 1930's, Japan was still a "backward country", at least in the conscience of Japanese scholars.



In the recent discussions on the East Asian economic development, it is custom to mention Akamatsu's flying geese pattern. Many of those discussions are concentrated on the question if the flying geese pattern in Asian countries has changed or not (Boyer, Uemura, and Isogai, 2012, Conclusion). But few paper mentions that this "flying geese pattern" is what Akamatsu named "the third type" (Akamatsu, 1962, p.17). The original fundamental pattern of "flying geese formation" was to analyze why Japan first imported cotton thread from abroad, then started to produce for the internal consumption, and finally arrived to export it. It was observed that many commodities traced the same pattern and Akamatsu wanted to explain why this happened.

Akamatsu's logic was based on Hegelian dialectics. But it is not difficult to explain by the new theory the basic mechanism of the fundamental flying geese pattern.

Ricardo-Sraffa trade theory assumes different technology among countries as standard trade situation. The new theory of international values explains wage disparity between countries as standard situation. This is one of crucial difference between factor proportion theory and Ricardo-Sraffa trade theory. The pure theory cannot tell how wide this disparity can be but a simple observation of the real world tells us that wage per hour can easily change more than 10 times. Although China is catching up Japan very rapidly, there still remain wage differences around 5 times or so.

The basic logic of transition from importation to exportation can be illustrated by Figure 5.1. In the following analysis, we assume that goods of two countries have the same prices and they remain constant. We may easily omit this assumption but we adopt this assumption to avoid longer descriptions. The crucial assumption is the great disparity of wage rates between A and B.

A point of the figure represents a state of production technique. A production technique is given here by input vector $(a_0, a_1, \ldots, a_N)$ which is necessary to produce a unit of product, where a_0 is labor input coefficient and $a_M = (a_1, \ldots, a_N)$ are material input coefficients. For simplicity, we represent vector $(a_1, \ldots, a_N)$ by a single ordinate. Thus we assume that vertical axis represents in reality an N-dimensional vector. An easier method of interpretation is to assume ordinate to be equal to total material cost $a_1 p_1 + a_2 p_2 + \ldots + a_N p_N$. It is sufficient for the analysis to know the unit material cost and the unit labor cost. Indeed, the unit cost of production is the sum of them.

Absissa represents a labor input coefficient. The unit of horizontal axis cannot be taken as that of a currency. It must be real unit like work day or work hour. Because two countries have different wage rates, the same work day has different labor cost. If x^A_0, x^B_0 and w_A and w_B are labor input coefficients and wage rates, the unit labor costs is $w_A x^A_0$ and $w_B x^B_0$ for countries A and B respectively. Suppose country A (more advanced) has a higher wage than country B (less advanced). For example, if w_A is 3 times higher than w_B, then a point x^B_0 which is 3 times bigger than x^A_0 represents the same unit labor cost.

The two bold lines are drawn as follows. First, plot the coordinate (a^A_0, a^A_M) and mark it T^A. We suppose this input coefficients remain constant throughout our analysis. In reality it changes but readers can easily adjust the story to that case. Draw a hyperplane through point T^A such that the hyperplane is normal (or perpendicular) to value vector $(w_A, p_1, \ldots, p_N)$. In the figure on a plane, a hyperplane is drawn as a line. This gives the first bold line. Any production technique at a point of this line has the same cost as production technique T^A for firms in country A.

Let the first line intercepts at $U(x^A, 0)$ and $V(0, y^A)$ with horizontal and vertical axes. The second bold line is drawn as hyperplane passing through $V(0, y^A)$ and normal to $(w_B, p_1, \ldots, p_N)$. Let $W(x_B, 0)$ be the intercept of this line with horizontal axis. Any point on

the line VW has the same cost as V(0, y^A) and then as T^A. Consequently, any production technique of country B at a point in the second bold lines has the same cost for firms in country B as the production technique T^A. In particular, points U(x_A, 0) and V(x_B, 0) have the same cost. Therefore, if w_A/w_B is 3, x_B must be 3 x_A. In general $x_B = (w_A/w_B)\ x_A$.

Note that a firm in country B has lower cost than firms in country A as far as point of production technique lies in the interior of triangle OWV.

Imagine a country like Japan not far from Meiji revolution. People come to acknowledge that many convenient goods are used in advanced countries, for example in Unites States and Europe. They start to import them as a part of new life style. Some business owners try to produce the same products but the lack of experience and technology gap would prevent them to produce them competitively against imported products.

It was not the shortage of capital that prevents them to be competitive producers. If their prospectus is good and people believe it will pay, future entrepreneurs could raise enough capital funds to buy necessary machines, installations and materials. This is the trial phase or test stage of product nationalization. In the Figure 5.1, the state of input coefficients is indicated by a small circle $T^B(1)$.

Figure 5.1 shows different stages of technology development of a firm in country B. When the state of production technique lies at $T^B(1)$, the production cost for firms in B is much higher than that of firms in A and entrepreneurs cannot compete with the imported products. But they don't remain inutile. By trials and errors, they arrive to a new stage where the input coefficients are decreased sufficiently and their production cost becomes comparable to advanced country's production cost. The exact cost of country B can be a little higher than the production cost of A. The producers of country B may be protected by duty, transport cost and transaction cost. A parallel line above the second bold line indicates the import barrier. If B's state of production technique comes down to this line, a commercial production can start. Point $T^B(2)$ indicate this stage.

Once the production starts, learning by doing starts. Inputs coefficients continue to decrease to $T^B(3)$ where the country B's production cost really becomes comparative with that of country A. A parallel line below the second bold line indicates the export barrier. If the leaning by doing continues further, the coefficients decrease further and

arrive to point $T^B(4)$ when country B can start to export the product competitively. Country B can still continue to decrease input coefficients to arrive eventually to point $T^B(5)$. Now producers of country A would be obliged to decrease their production cost in order to compete with firms of B. Even at this stage, the producers of country B are still technologically backward. The production efficiency (measured by the input coefficients) is lower than the producers of country A.

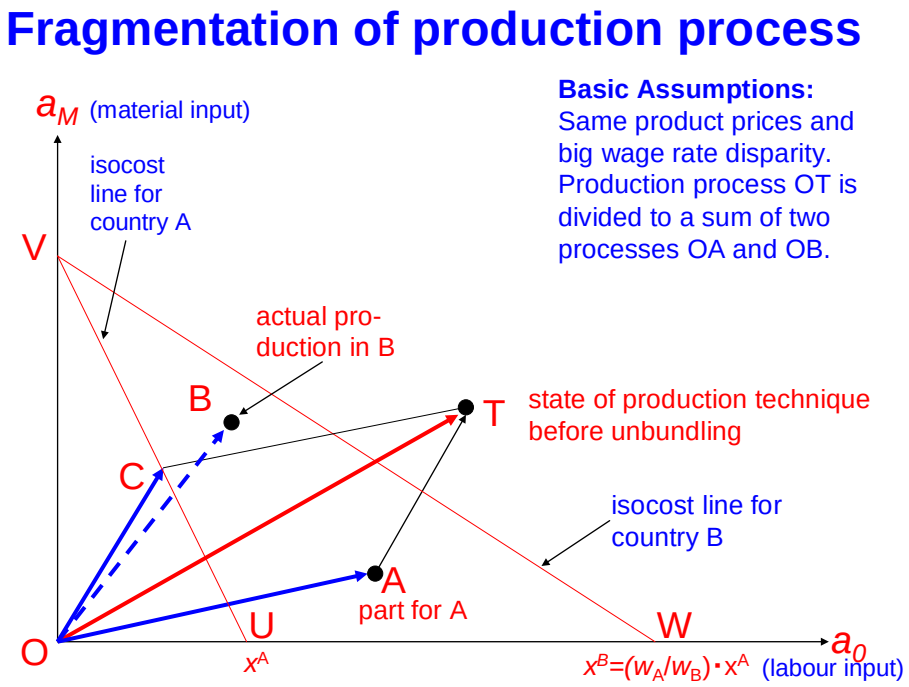
No one knows the limit of rationalization (the lower bound of input coefficients) but producers of country B have an advantage for they can know that they can still go further because country A has achieved a better productivity. This is another advantage of late comers.

Gerschenkron (1962) has pointed several merits of "backwardness". To know the existence of advanced products and technologies is one of most important factors which help backward countries to catch up advanced countries. Akamatsu's fundamental or first pattern of flying geese shows a mechanism how these caching-ups are achieved. Note that flying gees pattern presupposes import of raw materials. In the case of cotton industry, Japan imported cotton flowers. In later stage it exported cotton thread and cotton cloth made by this imported cotton. This pattern of trade has been called "Kakō Bōeki" in Japanese and it has been important concept in the trade and industry policy discussions. There was no established English name for this concept except that some are using the term "processing trade." [8] This strange fact can bee partly explained by the lack of trade theory which incorporated input trade.

Production processes were and are being transferred from advanced or high wage countries to low wage countries. It occurs by various reasons and forms. Recent names for these phenomena are outsourcing and fragmentations. These transfers are not isolated or sporadic. It is a uniform and pervasive movement. We are observing a tremendous shift of production sites in the globalized world. Baldwin (2011) named this recent movement the second great unbundling. The basic logic of unbundling is similar to flying geese. The big wage rate disparity lies in the center of this movement. The opposite side of great unbundling is the decreased cost of transport and communication.

[8] Many countries including EU stipulate "processing trade" as a special trade regime whereby some parts of imports of intermediates and exports of finished products can be traded duty free. Processing trade represents almost half of the recent Chinese export. Kakō Bōeki (加工貿易) does not stand for such a specific legal regime. It means whole business flow from raw materials importation to products exportation with no reference to duties. To promote Kakō Bōeki was a national credo for Meiji Japan.

The difference between flying geese and fragmentation lies in the degree of unbundling production process. Flying geese supposed a whole production process from the input of raw materials to the output of final products. Fragmentation divides this process into two or more processes.



The logic of fragmentation can be illustrated by Figure 5.2. Coordinates have the same meanings as Figure 5.1. The starting point of the construction is point T. This represents the state of production technique of a firm in high wage country A. The abssisa and ordinate represents labor and material input coefficients. Suppose this process (vector OT) can be divided into the sum of two parts OA and OC. OA is the part which requires high technology or includes knowhow the firm wants to keep secret. OC is the part the firm wants to transfer from country A to low wage country B. This transfer may induce a loss of efficiency because of low experience of production and additional costs such as transport cost of intermediate products, communication cost between the main office and the factory in B, and so on. In order to know the admissible range of loss, we construct two lines as follows. Draw a line through point C which is perpendicular to the value vector (w_A, **p**). The line intercepts at points U(x_A, 0) and V(0, y_A). Then draw a line from V which is perpendicular to value vector (w_B, p) and let the line intercepts horizontal axis at W. Production in country A on line UV and production in country B on line VW have the same cost.

When production OT is divided to the sum of OA and OC, there is no loss nor gain. However, if the process part OC is transferred to country B, we can reduce at least wage cost. This must compensate the additional cost that should be incurred by unbundling. Suppose process part OC is realized by the state of production technique OB. We assume OB includes the loss of efficiency and additional cost incurred by unbundling. By the construction, the total cost of the fragmented process is lower than the original integrated production in country A, as far as point B remains in the interior of triangle OWV. Similar situation happens as in the case of flying geese pattern. Because of low wage rate of country B, production technique OB can move in a wider range of efficiency states. In this case also, it is the low wage that makes the major advantage for the cost competition. If transport cost and transaction cost were reduced, B can be close to C and the chance to achieve cost reduction by unbundling becomes higher.

Note that OB part can be exploited by the original firm in country A but it can also be outsourced to a different firm or firms in country B.

It is easy to see the above logic of fragmentation can be applied to almost all process of productions. In the next section, we will see that this concerted process of unbundling is actually making a great change in the world economy. We will also see why the second unbundling was not perceived as technological revolution.

The logic of flying geese catch-ups and fragmentations teaches us how the main message of standard factor proportion theory (FPT) is flawed. Heckscher-Ohlin theorem tells that labor intensive products have a propensity to be exported from low wage countries. However, if we look Figure 5.1 and Figure 5.2, factor intensity does not matter much. Normally catching-up country will have labor intensive exports but this is the question of chances. It may happen in Figure 5.1 that a firm of country B has production technique $T^{B}(\#)$ with less unit cost but with higher capital intensity than firms in country A [9]. As it was already explained, any production technique at a point in the interior of triangle OWV has the unit cost lower than firms in country A. In the case of Figure 5.2, the original production process was divided in two tasks such that country A retains labor intensive OA and less labor intensive OC was outsourced and realized as OB. The logic of unbundling is not based on factor intensities of divided processes or

[9] Capital and labor intensities are usually measured by the ratio of capital and labor costs among the total unit cost. Capital cost may indicate cost of fixed capital (i.e. depreciation cost), material input cost, and the sum of the two. The slope of line OT represents the labor and capital but we cannot compare visually, because wage rates are different in two countries.

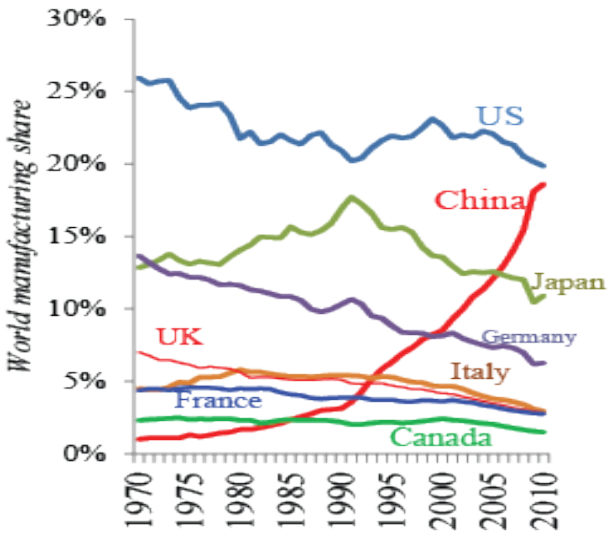
tasks but is based on the strategic decision of the firm. If there is no reason to retain OA part in country A, the whole process OT can be transferred to country B. In fact, the firm of country A faces a risk that its product is produced as a whole by some firms in country B. The logic of unbundling itself presupposes that there is a reason to retain some part of the total process in country A.

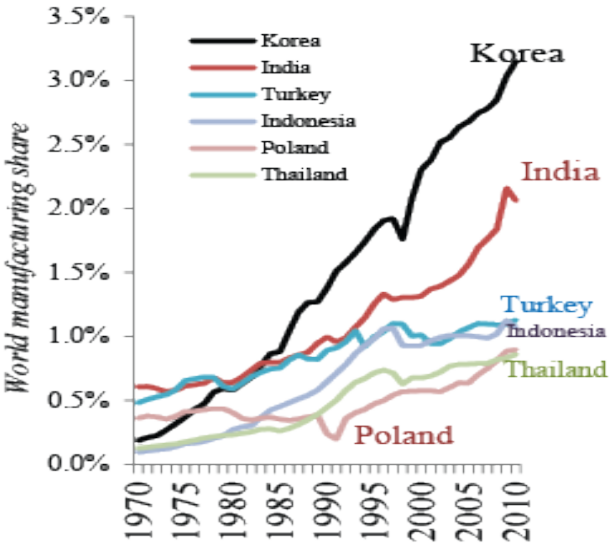
The factor intensity is an indicator for general tendency but is not a good criterion to judge competitiveness. Unit cost is a much more direct indicator than factor intensities. When two indicators contradict, it is the cost which prevails. FPT does not refer to the potential cost advantage and only indicates a rough criterion on not-well-defined comparative advantage.

§ 6. The second unbundling and conformal innovations

See two figures adopted from Baldwin (2011). Figure 6.1 shows there are seven winners and seven losers by the share in the recent world shares in manufacturing. After 1970, China, Korea, India, Turkey, Indonesia, Thailand and Poland are increasing their manufacturing share in the world. On the other hand, USA, Japan, Germany, UK, Italy, France and Canada are decreasing their share. Figure 6.2 is more impressive. G7 countries cited above are rapidly decreasing their share in the world export and in the world GDP from around 1990. This is the effects that Balding calls the Second Great Unbundling.

Baldwin (2006) distinguishes two great unbundlings: the First Great Unbundling (FGU) and the Second Great Unbundling (SGU). The FGU occurred in two waves: the first wave from 1850 to 1914 and the second wave from 1960's to present. Between two waves, unbundling stagnated during the period form 1914 to 1950 because of continued turmoil. Baldwin considers that the SGU started around the decade 1985-1995. The transport cost did not changed much before and after this period. ICT revolution must have played a major role in the SGU. It lowered not only the communication costs but also increased transmitted information volume per second (often wrongly expressed as communication speed). Even if communication costs are reduced near to zero level, unbundling was impossible when "communication speed" remained constant.





The Industrial Revolution in Britain coevolved with steam power, although it did not replaced water power until after the Industrial Revolution. Steam engine was first used for pumping out mines. It liberated factories from the yoke of locations. Water powered factories were forced to locate at a running water side. With the spread of steam engines, they became more efficient, light and powerful. Richard Trevithick's high pressure engine was light enough to be use on railways. Steam boats and ships on canal, river, lake and ocean followed locomotives on railways. And finally came automobile cars powered by combustion engines. Powered locomotion covered world surface. Telegraph,

telephone and radio reduced information transmission time to almost instantaneous level. Railways, highways and airplanes made travelling easier, cheaper and faster. ICT revolution was only a go a step further in the long historical trend. However, the effects of the SGU were very different from those of the FGU.

As two figures shows, we observe a big reversal of trends. Top developed countries are loosing world shares in GDP, manufacturing, and trade. Newly industrializing countries are increasing their world shares. Baldwin emphasizes that this is the change of historical trends. After World War II, many countries obtained political independence. But economic independence and growth were a difficult problem. Developing countries stagnated while developed countries developed further. Two generations of Big Ideas in development policy saw severe failures. But around 1990, trend changed. Now developed countries are de-industrializing and stagnating whereas some developing countries are rapidly industrializing and growing. For Baldwin, this is the clear mark of difference of two unbundlings. Is this correct?

Baldwin's classification of winners and losers depends on how many countries we take for comparison. If we take one most developed country as "winner," this kind of trend reverses took place already several times. Holland has been top country in GDP per capita in the 17th century. The UK overtook Holland by the end of the 18th century. Then the USA overtook UK by the turn of 20th century. New countries repeatedly overtook then top countries. We can think the present state as something similar to catching up and overtaking process.

Another criterion is range of agglomeration. The FGU created supply network within a country whereas the SGU created a global supply chain crossing national borders. As a trade phenomenon this must be new. But, if we consider the logic of supply chain formation, the logic of making supply network is not changing from the time of FGU to SGU. Firms pursue lower unit cost by outsourcing, getting new suppliers, and dividing production process. Baldwin cites Klier and Rubensteins (2008). "During 1950s, 3/4 of all auto parts were made in or near Michigan, whereas the state is now responsible for only one-quarter." A continued trend of distant supply existed. The SGU can be interpreted as continuation of this trend. It is possible that the range of economical supply distance became wider and came to stride over the national border.

Global supply or value chain attracts managers' attention as it includes a new aspects.

Crossing national borders is different from crossing state or department borders. We have to gain special skill to manage additional procedures and control problem. But it is also important to see that the same logic continues to work both in the FGU and SGU. From the view point of supply chain optimization, the same logic applies in both unbundlings. The difference lies whether chain stays within a country or strides over national borders.

This explains partly why the SGU is not perceived as a major industrial revolution in spite of its enormous economic consequences. Unbundling is a common technique usable to every industry. Production process of each product differs in depth and width. A process may contain many stages of operations. It may require large number of parts and materials. A process can be divided in infinitely many ways. Production engineers tried always to find a best organization of production process. ICT revolution and trade liberalization widened the range of options. Top managers are now required to consider world-wide logistics. As it was demonstrated, the logic of fragmentation is simple. As simple as it is, it makes fragmentation pervasive. This technique is applicable for every industry. Each fragmentation is no special innovation. Most of successful fragmentations are imitations of other industries' experience. And yet its successful realization is an innovation. We may call this kid of innovation "conformal innovation."

Schumpeter defined innovation as realization of new combination. Fragmentation is a new combination of an idea and production process. The idea is common one, but each firm has different process and successful fragmentation requires a solution to each process. Perez (2008) refers to dynamic industries which work as leading industry in technological revolutions. The SGU is not such technological revolution but the consequence is as great as any technological revolutions, because fragmentation or unbundling is a pervasive technique.

§ 7. Reflections on high development theory

- What did high theory economists really lack?

- How can we explain the failure of ISI and the some countries success in industrialization under the SGU?.

- Industrial complimentarity and lessons from the SGU.

§ 8. Why did the second unbundling work as a solution?

Complementarity and escape from dilemma
Myrdal's circular causation

-Krugman's counter counter-revolution strategy is flawed.
Real problem did not lie in the increasing returns to scale (See Stiglitz, 1992). Industrialization requires building complex network of industries.

-Interconnected conditionals were the origin of development difficulties for many nations.

-The first generation of catching up development: Germany, USA, Japan.

-Korea's economic success is a mixture of first and second unbundlings.

§ 9. Conclusions

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