The New Theory of International Values: An Overview

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Division I. Introductory Part

After a short introduction, a brief history of international trade follows (section 2). This peculiar section is was necessary, because the new theory emerged from the very thin strand that remained undercurrent for a long time. Whole history requires much more pages. I focused here on two points: (1) to situate the new theory in a long history of trade theory. The crucial bifurcation point went back to John Stuart Mill when he believed to have solved the unsettled problem left by Ricardo. (2) Special attention was paid why intermediates (or input) goods were not implemented in theory despite of awareness of their importance.

§ 1. Introduction

The theory of international values that will be presented in this chapter lies in a strand that remained undercurrent for a long time and differs much from any of trade theories except a few. The theory resurrects and belongs to the classical tradition that production plays the major role in the determination of wages and prices[1].

The new theory gives a value theory for a most wide class of Ricardo-Sraffa trade economies (RS economy in short). The model includes many-country, many-commodity trade economy in which inputs goods are traded and choice of techniques are explicitly incorporated. There are no comparable general theory in trade theory except for general equilibrium theory (GET) à la Arrow and Debreu. Heckscher-Ohlin-Samuelson theory and its generalization Heckscher-Ohlin-Vanek theory totally depend on GET. Krugman's trade theory (or new trade theory) gives an explanation why intra-industry trade occurs only on an extremely symmetrical situation and thus depends implicitly on a generalized GET that permits increasing returns. Melitz's new new trade theory is originally formulated in GET, but can be easily incorporated into the new theory, because each firm can have different production techniques for its own. However, trade theories based on GET have common weakness. GET generally excludes corner solutions and is not well suited analyze those cases, while the specialization is but a typical case of corner solutions. The new theory, developed specifically to analyze international specialization, does not have this weakness.

The merits of the new theory do not remain in its generality. One of its fundamental innovations is general treatments of input goods (or intermediate goods). The world

[1] As for its connection to the classical theory of value, see Shiozawa (2016).

economy is increasing more and more its global character with the reduction of information and transportation costs. Trade in input goods is rapidly increasing in volumes and proportions. Firms are obliged to adopt global optimal procurement policy and engineers are designing best fragmentation of production process. A great unbundling is now proceeding and trade in task is now common everywhere. The trade theory for RS economies provides a good tool of analysis because it assumes many different and separated production techniques and production process can be fragmented into a series of different production techniques.

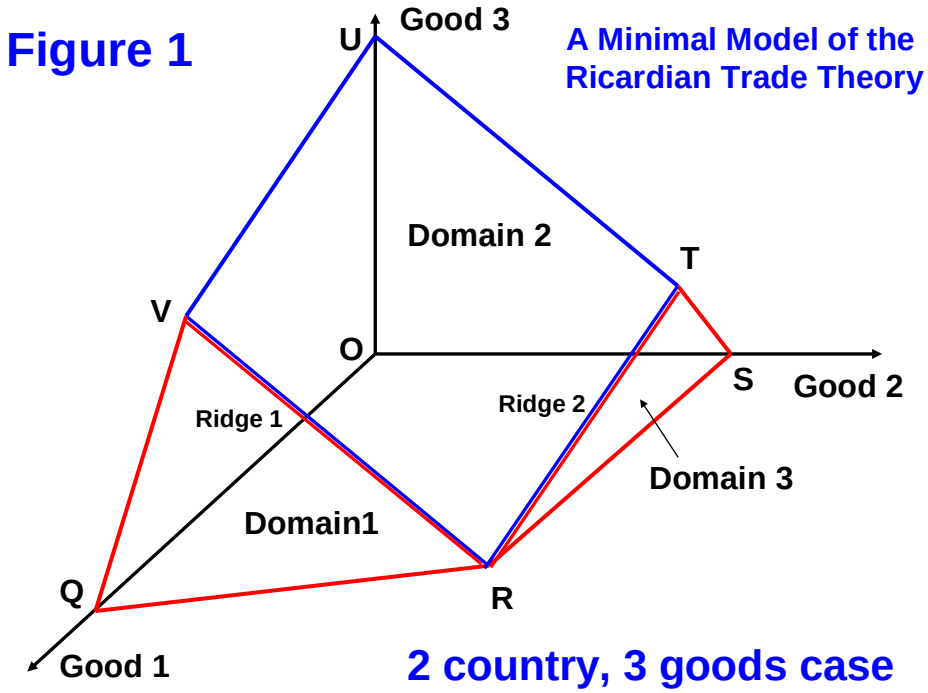
A result of trade and production globalization is that the trade is no more trades in (final) goods but a complex network of value-adding processes (trade in value added). The new theory of international values provides a basic framework for the analysis of this complexity. The new theory typically assumes that each firm's production and procurements are based on global optimal procurement policy.

One of biggest merits of the new theory is that RS economy has a good representation in International Input-Output Tables (IIOT). Although there are some differences of points of view, RS economy and IIOT have a similar vision on the working of economies. As a workable statistical table, IIOT has various restrictions in information collections and is obliged to condense information in a more or less aggregate level. RS economy is an ideal virtual entity which is constructed abductively from preceding economic theories and observations. However, it is rather easy to transcribe ideas in RS economy into IIOT and argue complex processes which are taking place in the present globalized economy.

We can easily compare with this regard the new theory and some other trade theories such as HOV model. The latter sees trade as exchange of factor contents and considers that factor endowments among countries are the main driving force of international trade. This vision may have been true in the time when the transportation costs are considerable. The location of primary resources may have played a major role in determining the pattern of production and trade. Decrease of transportation costs undermined the raison-d'être of this kind of division of labor. Trades in globalized economy work with different principles other than locations and proportions of primary resources. RS economy and IIOT have a common vision that production of commodities is a production by means of commodities. Driving force of globalization and trade in input goods and tasks is now the differences of production techniques. They are different by country and even by firms. This is the common starting point of RS

economy and IIOT. We can expect that the new theory will provide some theoretical basis for analysis based on IIOT and will profit in turn by developments of the latter. Such a trial has already started[2]

Although the formal formulation is highly mathematical and the theorems require knowledge of non-elementary mathematics, the essence of the new theory is quite simple. The world production possibility set forms a polytope. In N-commodity case, the production possibility set is a polytope of dimension N. It is covered by facets of dimension $N-1$. The simplest example (minimal model) is given by Figure 1. The production possibility set is a 3-dimenional body whose positive boundary is composed of 2 triangles and 1 parallelogram as facets. These three polygons are facets ($3-1$ dimensional faces) we are concerned of and the interior of these facets are called regular domains. At any point of a regular domain, a unique value exists (up to scalar multiplication) whose price component is perpendicular to the domain.[3] As far as the demand remains in the same domain, the international value remains constant.



At an intersection of two facets, i.e. at a ridge in 3-dimensional case, the values are not

[2] An example is Escaith and Miroudot (2016).

[3] An international value $\mathbf{v} = (\mathbf{w}, \mathbf{p})$ is composed of two parts: wage vector $\mathbf{w}$ and price vector $\mathbf{p}$. A wage vector expresses the set of wages w_i in country i, which may differ from country to country. The core of the fundamental theorem (theorem 4.4) is to prove the existence of a wage vector $\mathbf{w}$ that forms admissible value together with price vector $\mathbf{p}$.

uniquely determined but we can exclude those points as cases of low probability. It is important to note that in the interior of a facet price adjustment fails to work. Inside of such a domain, the main mechanism that adjusts demand and production is the change of production levels of each product. This is the reason why new theory of international value is basically conformal to classical theory of value.[4]

A major limit of the present paper is that it assumes that the set of production techniques is given and fixed. In this sense, the new theory is still strictly static in its nature, but it does not mean that we cannot develop a more dynamic theory in the future. In fact, the new theory has already a possibility to deal with change of production techniques. Suppose we are given a set of production techniques $\mathcal{S}_0$ and some new techniques are added. We have now two sets of production techniques $\mathcal{S}_0$ and $\mathcal{S}_1$. Normally we can suppose $\mathcal{S}_0 \subset \mathcal{S}_1$.[5] Then, transition from state of technology $\mathcal{S}_0$ to $\mathcal{S}_1$ raises question of choice of production techniques.[6] This logic is incorporated in the new theory of international values. Now two questions arise. (1) How do production techniques evolve? (2) What are the effects of technological changes? These are underdeveloped questions even in neoclassical micro and macro economics. Various notions of neutral technical change (Solow, Harrod and Hicks among others) are introduced only to facilitate macroeconomic analysis. More frequently used labor and capital saving technical changes are rough notions which may loosely indicate a long term trend but with no firm reasons, as we will see in Section 13. To analyze effects of technological change is more difficult task. In principle we can analyze the change of specialization patterns. If production techniques in use change, the values change. We know yet very little on these changes and mutual relations. They are tasks for the next step of the new theory.

If the world set of production technique is fixed, there is no big difficulty in developing growth theory where quantities increase proportionally. Analysis of a closed economy can easily generalized to international trade case. However, every sincere economist knows that real economic development is very different from this proportional growth. Prices, wage rates, consumption, people's life and technology change through time. We

[4] As for the characterization and understanding of classical theory of value, see Shiozawa (2016).
[5] This relation occurs as far as old production techniques remain possible and socially permissible ones. On the other hand some old techniques become inadmissible by ecological reasons and others.
[6] Another important choice of techniques is adoption of new articles and abandon of old ones. However, I do not enter in this important but difficult problem. .

are not yet ready to analyze all these changes. Despite of all these difficulties and challenges we face, I believe that the new theory of international values gives a firm basis for further studies of the interconnected world economy. The new theory will also contribute to studies of any country's economic development which should be considered in the global context.

§ 2. A short history of international trade theory

The new theory of international values resurrects an old tradition that goes back to Ricardo. Many people may think that it is too trivial to mention it. Although the first form of trade theory really started from Ricardo, the history of international trade theory is disoriented and quite sinuous. I have no intention to cover all currents. This section mainly covers the point why the new theory of international values was so late to appear. It is true that a general theory could not appear before 1950's because the new theory required some level of mathematics. The general theory of linear inequality, the essential tool for the new theory, was mainly developed around 1950's in connection to the arrival of linear programming. However, this was not the major obstruction. Much graver obstacle was the mode of thinking in economics.

The first turning point came when John Stuart Mill tried to solve the problem that Ricardo left unsettled. His "solution", now named theory of reciprocal demand. It is important to note that Mill's theory is based totally on supply and demand relations. Mill wanted to be a Ricardo's loyal disciple but when he posed himself to solve the unsettled problem in international trade, he was obliged to abandon the cost-of-production theory of value and returned to the "antecedent law," i.e. law of demand and supply (Mill, 1848, III. 18.4)), which is "more fundamental" and "anterior to cost of production" (Mill, 1848, III.16.5). After a discussion on the logical status of cost of production and law of demand and supply, Mill concludes that

> This law of International Values is but an extension of the more general law of Value, which we called the Equation of Supply and Demand. (Mill, 1848, III.18.24)

I have argued how and why John Stuart Mill was guided to this conclusion in another chapter of mine in this volume, I will not argue that point here. However, it is inevitable to emphasize that a change of the *problématique* occurred in economics.

Classical economics was an economics of production (*plutology* after Hicks). In trying to examine the situation where both countries enjoy gains from trade, Mill was guided to consider the complete specialization. In that case, each country produces one commodity. In this situation, productions of each country are completely determined: the commodity that a country produces and the quantity that the country produces, because labor force and the labor input coefficient are given. Nominally there are productions but the commodity and the quantity that a country can supply is uniquely determined. This is equivalent to a pure exchange economy. When countries set out to trade, each country has its own commodity in hand and tries to obtain a bundle of commodities that maximizes its satisfaction. The "solution" Mill obtained is but an economics of exchange (*catallactics* after Hicks). Thus Mill inaugurated the long tradition of catallactics in international trade. This was the real change of the *problématique* in economics and triggered the explosion of neoclassical economics.

The problem set by John Mill was refined and formulated in a more mathematical way by Alfred Marshall and Francis Ysidro Edgeworth by the end of the 19th century. They paved the basis of international trade theory. The core logic of their analysis was that of pure exchange economy. [7] After Marshall and Edgeworth, there were many contributions in this field but a few economists deserve special mention for the emergence of Ricardian theory of international values.

In 1930's, works such as Haberler (1933), Ohlin (1933) and Viner (1937) appeared. There were a tripartite dispute between them but they all belonged to the Mill's tradition. Among them, Bertil Ohlin deserves a special note. He started in his book Ohlin (1933) a formulation which later became Heckscher-Ohlin theory of international trade. It was young Samuelson who transformed Ohlin's observation into more precise formulations and produced series of theorems, among which factor price equalization theorem was included. Chipman (1965-66) distinguished "neoclassical" and "modern" approaches by the appearance of Heckscher-Ohlin-Samueslon theory. While reference to

[7] I also explained this history in some detail in my chapter "An Origin of Neoclassical Economics / Mill retreat and his followers" (Chapter 6) in this volume.

the factor endowments was a new orientation and more modern tools were employed, the "modern approach" intensified its neoclassical character and it was absorbed to a general equilibrium theory by the appearance of Arrow-Debreu (1954). International trade theory became a part of standard micro economics and it was interpreted that special feature of the theory lies only in the special situation setting and assumptions such as trade between nations and immobility of factors. It is not accidental that Krugman's new trade theory supposed an extremely high symmetry for its situation setting. His basic presumptions must be that the general case is supported by general equilibrium theory.

At the side of the mainstream of international trade theory, there was a thin under current that paid attention to the special features of Ricardian theory. The most remarkable proponent was Frank Dunstone Graham (1890-1949). He endeavored to correct the misdirected orientation started by John S. Mill and redress Ricardian theory on a right path. However, after publishing a book full of numerical examples, he was dead by an unexpected accident. Lionel W. McKenzie was one of Graham's students in Princeton and partly succeeded Graham's research program and developed it into a more modern style. McKenzie founded a new graduate course in Rochester and recruited Ronald Jones.[8] They produced a series of papers that can be called Ricardian trade theory in a wide sense. Its culmination was Jones (1961).

Praising 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 is right in conveying the general atmosphere in Rochester and elsewhere but was wrong in two critical points.

First, Jones indicated that his theory was extended to include trade of intermediate

[8] The two raised many Japanese economists. The majority of them were specialists in international trade theory. This helped to make a strong tradition of Ricardian trade theory in Japan.

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, because all questions from importation of primary materials, processing trade (Kakō Bōeki in Japanese) to outsourcing and fragmentations are concerned with trade in intermediate products.[9] 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 [of the theory] 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. Just after Ethier (1999), Paul Samuelson (2001) gave an example which shows that gains from trade is multiplied when two countries has strongly asymmetric production techniques. Symmetric assumption is not a naïve condition that has no influence to the reality. It is the condition that must be removed when we really want to understand gains from input trade.

Real difficulty for value theory to introduce input trade lies in the fact that the cost of production of a country depends on the price and wages of other countries through importation of input goods, if we ignore many other cost factors comprising tariffs and transportation costs. The cost of imported inputs depends on its turn on the price and wages of other counties, because material input has a kind of fractal structure. If a product comprises a part, that part comprises other parts.[10] Simply stated, the cost of a product depends on wages of all countries. Here is the essential difference between value theory without input trade and that with input trade. The fact that two trade theories have different mathematical structures will be explained in the end of this section.

Second, Jones (1961) was more interested to the situation when the prices can move

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[9] 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.

[10] As an illustration of fractal structure of international division of labor, see Figure 5.1 of Escaith and Inomata (2013).

freely (even within a certain range). In the world where neoclassical thinking dominated, it is natural that Jones was interested in this situation. Ricardian framework had opened another possibility but he could not find that possibility. Sraffa's seminal book (Sraffa, 1960) had just appeared before Jones's paper and Jones cannot have time to read the book and consider its consequences. After all, Jones remained in the tradition or the problématique that J. S. Mill opened. As I have argued in chapter XX? [of this book], Mill concentrated his analysis to the case where two countries enjoy gains from trade and was conducted to examine the economy that corresponds to the extreme point of the production frontier (point C in Figure 1, Chapter XX?).[11] Jones studied many-commodity case. He had no necessity to confine himself to the examination of an extreme point. He must have paid much effort in the characterization of extreme points of the world production frontier. He was rewarded by his beautiful theorem. Jones's formula gave a complete characterization of the extreme points. He proved that extreme points on the frontier are in fact unique if they exist and gave the way to know the possible specialization pattern.[12] However, to know the complete specialization is not the end of international trade theory. A price vector may be determined in the similar way as Mill, Marshall and Edgeworth, but the production specified by a complete specialization pattern is uniquely determined as it was the case of Mill's case. What happens if world final demand is not proportional to its net production? What prices emerge out side of the extreme point and how do they change when demand changes? A deficiency of the theory is manifest but Jones and his followers did not pursue these questions.

More conspicuous fact is that Jones and McKenzie's neglect to examine the case where the number of commodities exceeds the number of countries. This is exorbitant because if we observe the real world the number of commodities far exceeds the number of countries and economics areas. The first is at the order of 10 to 100 million, while the latter counts at most two hundreds. To examine this situation was quite inconvenient for them, because in these cases there is no extreme point on the frontier. This fact is

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[11] Extreme point of a convex set is defined to be the point that cannot be the middle point of a segment contained in the set. Normal vectors at a boundary point of a convex polytope can have full dimensional freedom (i.e. $N-1$ dimension) only when the point is an extreme point.

[12] Jones gave a necessary and sufficient condition for the existence of an extreme point. He gave a proof of necessary part but did not prove them to be sufficient. See Shiozawa (2015), Section 10.

easily understandable. An extreme point on a frontier means complete specialization. All country produces only one product. If the number of products is more than the number of countries, how can this complete specialization be possible?[13] If Jones ever examined the case where number of products exceeds the number of countries, they must have noticed that their research program based on the existence of extreme point cannot be justified because no such point exists.

Curiously, McKenzie (1954 a) examine cases where the number of countries is greater than that of products. It is possible that he was also predominated by the preoccupation that prices must move freely. When I started to study McKenzie and Jones in 1980's, I was already a Sraffian and had an idea to separate price determination and quantity determination. I was critical to the general equilibrium framework. In spite of this, I pursued for a long time to characterize the Mill-Jones points, i.e. extreme points of the world production possibility set. Major part of my struggle was to escape from the preoccupation to the case where the prices move freely.

My first paper Shiozawa (1985) in international trade was published in 1985. Main content was a generalization of the minimal price theory for a two-country case. I assumed the relative wage rate was given. In the two-country case, it was sufficient to move the relative wages from very low wage rate for a country to that of another country to a very high wage rate. By the intermediates value theorem, I can easily prove the existence of a wage ratio on which each country can have at least one competitive good. This result was so obvious and I did not make an English version. It was, I believe, in a post Keynesian tradition. I discussed proportional growth path and others.

When I published Shiozawa (1985), I was planning to generalize this paper to many-country (i.e. three-or- more-country) cases and I was thinking that this could be done soon. However, the general argument in many-country case was much harder than I imagined. I tried many methods, e.g. theory of linear inequalities, various forms of fixed point theorem, combinatorial geometry, matroid theory, convex cones, and others. No one worked and time passed by. Research was interrupted many times. At some time, I was almost giving up. The main difficulty was to characterize Mill-Jones point. I wanted to prove at least its existence. I was also trapped in the idea that the first task was to find the characterization of Mill-Jones point. I had pursued in vain more than 20 years before I found a sufficient condition for the existence of a Mill-Jones point, or an

[13] I omit formal proof here. A simple example for the non-existence is Figure 1.

open cone where the relative prices can freely move.[14] It was not a very satisfactory result, because the sufficient condition required too much and in a sense tautological. Half satisfied and half dissatisfied, I wrote two papers, one in Japanese and another in English. The latter became Shiozawa (2007).

By writing these papers, I came to know that there is a beautiful one-to-one correspondence between the modal decomposition of the wage or price simplex and the modal decomposition of the production possibility set frontier. This result was more important than the existence of Mill-Jones point. It was evident that Mill-Jones point is only a point on a frontier. If the net world demand was not on that point, what happens? I came to know that the situation was very different from that of Mill-Jones point. If we consider an economy of *N*-commodities, the production frontier is a set of faces of less than or equal to N-1 dimension. The faces of the greatest dimension are specially called facets. The other faces are the common set of several facets. Then, what happens in (the interior of) a facet must represent more general situation. With this acknowledgement, all became clear and simple. It was even obvious. I had to have emphasized that the prices remain constant while the demand moves in the interior of a facet.

With Shiozawa (2007) in hand, I tried to find chances to discuss these new interpretations and succeeded to talk in 16 seminars and workshops, including Ricardo Society's 14th Seminar on January 12, 2008 at Meiji University, Tokyo. This experience gave me the confidence that my idea is running a good way. Summarizing my idea I formulated a fundamental theorem. A rough result was reported in the International Conference on Structural Economic Dynamics on September 3, 2012 at Meiji University. A young economist Yasuaki Tsukamoto taught me that history of doctrines can be a good weapon to persuade people to a new idea. I compiled what I came to know from the long pursuit of the international theory of values. Those became the essential parts of chapter 3 and chapter 4 of the book Shiozawa (2014). Hiroshi Takahashi, the editor of the book, recommended me to newly write down the major part of the book and I reformulated the plan. In chapter 3, I only gave the core concept and mathematical parts were concentrated in chapter 5. This reformulation gave a good result as chapter 5 became more rigorously reconstructed.[15]

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[14] Theorem 4.3 in Shiozawa (2007). It proves the existence in the wage simplex of an open face in which all country have at least one competitive products (strongly shared pattern of specialization). By the duality theorem (Shiozawa, 2007, Theorem 5.7), it corresponds to an extreme points of the production frontier.

[15] Section 3 is a digest of the chapters 3 and 5 of Shiozawa (2014). Major content of my

The theoretical situation after Jones (1961) can be summarized by Ethier's two misunderstandings. While the general preoccupation in price adjustment was more epistemological in the sense that it is more concerned with focus of interest, the construction of a general theory of international trade with input trade was more substantial, because the omission of input trade changes the world trade effectively and tremendously. As McKenzie put it, input trade was the vital condition that made cotton industry revolution possible in Lancashire. In the age of globalization, trade in tasks (or fragmentation of production process) and global optimal procuring or global supply chain management are more and more omnipresent. Any analysis of value added trade is theoretically impossible if we do not have a theory of input trade. However, generalization to input trade raises a mathematical problem that is structurally different from the theory that excludes input trade. In the case where there is no input trade, the prices at the closed economy can give explicit reference for a possible specialization pattern. In two-country case, for example, price ratios p_i(A)/p_i(B) for the two countries A and B determine which country can specialize in which products. The dividing ratio is given by conditions that comprise the demand and the ratio of labor forces. If it is *d,* then country A is competitive in product *i,* when

$$p_i(\mathrm{A})/p_i(\mathrm{B}) < \mathrm{d}.$$

If the inequality holds in the opposite direction, country B is competitive for product *i*. This property holds because price vectors p(A) and p(B) are both proportional to the wage of each country. However, if input goods are traded, these simple relations do not hold, because the cost price of a product of a country is dependent now on the relative prices of input goods and thus on the wage level of another country. In fact, the trade economy with input trade has a mathematically different structure[16]. In comparison to this fact, two extended forms of Ricardian trade economy are structurally identical to the pure labor input economy.

Simple evidence that RS economy is mathematically different from other Ricardian economies is given by the Jones's formula that I mentioned above (p.8). It tells that *N*-country, *N*-commodity pure labor input economy in a general position¥footnote{Those who are not accustomed in this terminology, please simply ignore it.} has at most one internal extreme point, because it is characterized by the fact that the complete

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preceding chapter come from chapter 4 of the same book. Parts IV and V are not contained in Shiozawa (2014).

[16] From a different angle, Samuelson(2001) emphasized that input trade comprises a new logic of gains from trade.

specialization pattern of the point attains the strict minimum among all permutation products:

$$\Pi_{\sigma \in P(N)} \quad a_{1\sigma(1)} \cdot a_{2\sigma(2)} \cdot \quad \ldots \quad \cdot a_{N\sigma(N)} .$$

However, as Higashida (2005) has shown, 3-country, 3-commodity RS economy can have three internal extreme points. This cannot occur if RS economy has the same mathematical structure as Ricardian economies. If we define more concretely, there is no isomorphism that converts an RS economy into a Ricardian economy by a suitable transformation. It is not difficult to find such counter-examples by computer. I have found a case that possesses 7 extreme points in a 7 by 7 RS economy.

Although I have no intension to enter into the details of these mathematical questions, let me distinguish four different types of Ricardian trade models and add some remarks on their mutual relations. R0 is the pure labor input economy. In this model, all products are produced purely by the labor and no goods are input for the production. As there are no input goods, there is no input trade. When production is made by labor with the aid of material input, we can distinguish R Ⅰ and R Ⅱ. In R Ⅰ, final demand goods (or consumer goods) are only permitted to export. In R Ⅱ, input goods are internationally traded but it is supposed that all countries have the same material input coefficient matrices. The fourth type is RS (Ricardo-Sraffa trade economy). In this model, input matrices can be different by country by country and input products are traded freely (at the same title as other final demand goods).

It is already noted by McKenzie (1954, p.166) that R Ⅰ is structurally identical (or can be reduced) to R. Jones (1961, Section 4) gave the way to reduce R Ⅱ to R0. In this sense, all three Ricardian economies have the same mathematical structure, because they can be identified by a suitable transformation.[17] However, RS cannot be reduced to R0 or any of RI and RII.

The structural difference between R0, R Ⅰ, and R Ⅱ for one part and RS for another is the fact that we should keep mind in the examination of RS economies, because theorems found for R0 or others cannot necessarily be generalized for RS economies. With these structural relations in mind, we can group R0, R Ⅰ and R Ⅱ in a single group of Ricardian economies, whereas RS economy must make an independent class. The formulations and results in Division Ⅱ is always concerned with RS economy.

[17] Shiozawa (2014) gives the concrete procedure to convert RII model (called Ricardo-Jones trade economy there) to R0 in Chapter 4, Subsection 8.2 (pp.286-287).

As a mathematical entity, Ricardian trade economy (either R0, R Ⅰ and R Ⅱ) has an interesting mathematical structure. The theory of Ricardian trade economy can be interpreted as subtropical convex geometry based on min-times algebra (Shiozawa, 2015). Whether this interpretation can be generalized to RS economy or not is an open problem. The following exposition is totally independent from this interpretation.

Division Ⅱ. The Theory

In this Division (sections 3 to 6) the new theory of international values is presented. In section 3, the basic assumptions is defined and a fundamental result (fundamental theorem) is given. Section 4 shows light and shadow of international trade. Section 5 explains how to incorporate markup pricing in the theory. Section 6 deals with a delicate question that we cannot bypass when we want to implement the theory in an actual economy.

§3. A short summery of the new theory of international values[18]

The new theory of international values is constructed on a model which is highly general and permits trade of intermediate goods. The word "general" here means that theory does not depend on special hypothesis on numbers of countries and commodities and must be free from various kinds of symmetric assumptions. Such a model is named Ricardo-Sraffa economy, or more shortly RS economy. The new theory redresses the theory of international values before John Stuart Mill. It is a theory of value that Ricardo would have imagined to construct but could not even give a rough design. It contains an account on how the wage disparity occurs between countries. Discussions on types of specializations are omitted below but implicitly contained in the Fundamental theorem.

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

We assume the following situation:

(a) There are M countries.

[18] 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.

(b) There are N goods which are traded freely between countries.

(c) Labor of each country is assumed to be homogeneous.

(d) Production is a transformation of inputs into outputs. Input comprises labor and produced goods and output is a set of produced goods.

(e) A possible production is a positive combination of productions each of which is belonging to a production technique.

(f) Productions that belong to a production technique are simple and proportional with each other. "Simple" here means that the out put of a production has only one positive net output.

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

(h) Any production technique belongs to a country. Labor used by a single technique must be that of the single country to which the production technique belongs.

(i) Goods are transported without cost within a country and from one country to another.

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

Although we assume finite number of production techniques, there are in general many production techniques that produce the same good. Some techniques are in operation and some others are not. Thus we naturally consider a choice of techniques and input substitutions are built in as internal logic of the theory. We will see later that a production technique is expressed by a set of input-output coefficients. These are expressed by physical units and not the same ones in input-output tables. In Section 15, we will examine how these two different coefficients are related.

The above settings (a) to (j) are chosen to give the core framework of the theory. Various generalizations are possible. Condition (f) implies that joint productions are excluded. This excludes to incorporate durable capital goods. Extensions to include durable capital goods (or fixed capital) are explained in Section 8. Condition (g) excludes the production process that requires many production periods such as wine production. This condition can be eliminated by assuming that labor is directly or indirectly necessary. This is to assume that a production technique can be divided into series of production techniques and at least one production technique requires labor input. As this is rather a classical treatment, we do not explain this process explicitly.

Condition (h) is the crucial property that permits us to construct the whole theory. By condition (i), there is no necessity to distinguish the place of existence of commodities.

Of course, this is a strong assumption. Generalization to the case of positive transportation costs is given in section 9. Condition (i) is equivalent to assume that products are freely traded and thus intermediate or input trade is incorporated in the new theory. Precise definition of productive system is given in Definition 3.1.

Condition (j) excludes the case that some country cannot produce some products such as petrol or rare earth. This may seem too restrictive as a model of the real world, because there are many countries that cannot produce petrol of rare earths. However, condition (j) is not as strong as it seems. We may suppose that each country has a productive system but some of its production techniques are extremely inefficient. For example, it is possible to synthesize petrol but at a cost which is not economically effective. Another method is to weaken condition (j) to (j'): the world as a whole contains at least one productive system of production techniques. In this case, it is sufficient that some countries can produce petrol or rare earths. In the following, however, this generalization is avoided, because expositions become too long and complicated.

Labor mobility between countries is not normally considered. Condition (c) means in effect that labor is freely movable within a country. In some cases, we can consider a migration of labor force from one country to another. As we will see in Section 11, this is possible if migrated labor force can be assimilated to the labor force of the host country. Condition (c) also excludes the case where a country has different categories of labor forces, for example skilled and unskilled labor. Even in this case, most of the results in this paper can be generalized if we can assume that relative wage rates of different classes are fixed. However, new theory of international values cannot treat the variation of wage discrepancies between labor classes.

We use following notations: A set of different goods is denoted by an N-row vector $\mathbf{x}$ and is called commodity vector. As goods can be transported freely without cost (condition g), we can treat goods of the same kind as the same one independent of which country it lies in. In the same way, price of a good is treated as the same anywhere in the world. A price vector will be denoted by a N-column vector $\mathbf{p} = (p(\mathrm{i}))$, where $p(i)$ is the price a good i. The wage rate of a country i will be noted by $w(i)$. A set of wage rates for all countries is denoted by a M-column vector $\mathbf{w} = (w(i))$. 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 the wage of a country or the price of a good.

Industry is a set of activities that produces a product i and called by the same index i.[19] As we assume that production techniques are simple (condition d), each technique belongs by definition to an industry that produces the single positive product. Country is the place where the production takes place (condition h). 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 imagine.[20] 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 h is expressed by a net production vector $\mathbf{a}(h)$ 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 $\mathbf{a}(h)$. The set of all labor input is expressed by a $H \times M$ matrix J whose entries are either 0 or 1. The (h, i) entry of matrix J takes the value 1 if and only if h is the production technique of the country i. Note that labor is assumed to be different when it belong to a different country. This is only because labor in country A cannot be used as input in the production of any other country B. Each row vector of J contains only one entry with value 1 which indicates in which country the production takes place.

Each country has a certain quantity of labor force $q(\mathrm{i})$. The set of labor forces of the world is denoted by M-row vector $\mathbf{q}$. A demand vector $\mathbf{d}$ is a set of demand for each product. It is an N-dimensional row vector. Activity vector $\mathbf{s} = (s(h))$ is given by a set of the activities $s(h)$ for each production technique h. It is a H-dimensional row vector. Then the net material production of the world is $\mathbf{s}A$ and the total labor input of the world is $\mathbf{s}\,J$. When $s(h)$ is positive, we say that production technique h is operating.

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[19] This implies that industry and product corresponds one-to-one. Another possible treatment is to suppose industry includes a group of products. Here, we treat as if industry can be divided to product levels. The same explanations apply to relations between firms and products. A firm can produce a variety of products. In the following, we suppose that a firm produces only one product.

[20] It is sometimes criticized that Ricardian framework ignores input substitutions. This is a misunderstanding because substitution occurs between different production techniques that produce the same products. What is excluded is the differentiability of the "production function." Note that this last property is too strong to assume except the cases such as agriculture in which one can choose any input ratio.

A production technique has two affiliations: its country of production and the good it produces. In the following they will be denoted $c(h)$ and $g(h)$ respectively.

The production possibility set $P(\Gamma, \mathbf{q})$ for a set of techniques Γ is defined as set of vectors $\{ \mathbf{s}\ A \mid \mathbf{s}\ J \leqq \mathbf{q}, \mathbf{s} \geqq \mathbf{0} \}$. To examine the production possibility set, we need some basic concepts of the theory of (convex) polytopes. A polytope P is a set of a vector space $\mathbb{R}^N$ that is spanned by a finite set of points of vector space $\mathbb{R}^N$. A face of a polytope P is a subset of P that is the common set of P and the hyperplane of a half space that contains P. A facets of polytope P is a face of codimension 1. In our case, a facet has the dimension $N-1$. A point $\mathbf{x}$ of a set P is maximal when there is no points z in P that satisfies $\mathbf{z} \geqq \mathbf{x}$ and $\mathbf{z} \neq \mathbf{x}$. By these terminology, $P(\Gamma, \mathbf{q})$ is a polytope in $\mathbb{R}^N$. We are normally concerned with a non-negative subset of $P(\Gamma, \mathbf{q})$, because such a point can only represent an economy which reproduces itself materially. The frontier of the production possibility set $P(\Gamma, \mathbf{q})$, or the maximal boundary of $P(\Gamma, \mathbf{q})$, is a set of maximal points of $P(\Gamma, \mathbf{q})$. The boundary points of $P(\Gamma, \mathbf{q})$ are covered by finite number of facets.

Definition 3.1 (Productive system)

A system of production techniques is productive by definition when there exists a non-negative vector $\mathbf{s}$ such that $\mathbf{s}\ A > 0$. □

Definition 3.2 (Ricardo-Sraffa Trade Economy, or RS economy)

An economy which satisfies conditions (a) to (h) is named Ricardo-Sraffa trade economy. □

As we have noted above, condition (h) can be weakened to (h') but we assume condition (h) to avoid making propositions too complicated.

Definition 3.3 (Regular Domain)

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

Theorem 3.4 (Fundamental Theorem for Ricardo-Sraffa Trade Economy)

Let E be a Ricardo-Sraffa trade economy with A, J and $\mathbf{q}$ as denominated above. For any final demand vector $\mathbf{d}$ which belongs to the production possibility set, there are a production activity vector $\mathbf{s}$ and an international value vector $\mathbf{v} = (\mathbf{w}, \mathbf{p})$ that satisfy the

following conditions:

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

(ii) $\mathbf{s}\,J \leqq \mathbf{q}$.

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

(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 if the final demand $\mathbf{d}$ is in a regular domain of the production possibility set and it remains constant as long as $\mathbf{d}$ stays in the regular domain. □

The proof of the Fundamental Theorem requires a short preparation. As it is purely mathematical in its nature, the proof will be given in the Appendix to this section.

Remark 3.5 (uniqueness in out of full employment)

When demand is not sufficient and the state of the economy is not in full employment, the uniqueness of value does not hold in general. However, if the net production is sufficiently close to a point in the interior of a facet of the frontier, the international value that satisfies conditions (iii) and (iv) is unique up to scalar multiplication. □

Remark 3.6 (trade flows)

Even if the gross production y and demand vector of each country $\mathbf{d}(i)$ satisfying the condition

$$\mathbf{d}(1) + \mathbf{d}(2) + \cdots + \mathbf{d}(M) = \mathbf{d},$$

the trade flows from one countries to another are not determined. Suppose that a product is produced in two countries $i = 1, 2$ and another countries $i = 3$ consume the product together with producing countries. Suppose also country j consumes the product by the amount of z_i. Then in order that the allocation problem has a solution, it is necessary that production y_i (i=1,2) satisfies the equation:

$$y_1 + y_2 = z_1 + z_2 + z_3.$$

Let x_{ij} (i=1,2, j = 1,2, 3,) be the quantity of product that is transported from country i to country j, then x_{ij} must satisfy the conditions:

$$x_{11} + x_{21} = y^1$$

$$x_{21} + x_{22} = y_2$$

$$x_{11} + x_{12} + x_{13} = z_1$$

$$x_{12} + x_{22} + x_{13} = z_2$$

$$x_{13} + x_{23} + x_{33} = z3$$

$$x11,\ x_{12},\ x_{13},\ x_{21},\ x_{22},\ x_{23} \geqq 0.$$

This is a simple example of classical *transportation problem* and has solutions that form the *transportation polytope*. In the above case, the polytope has the dimension 2 (is of degree of freedom 2). In the case of m producer countries and n consumer countries (the same country can be producer and consumer at the same time), the transportation problem has a polytope whose dimension is $(m-1)(n-1)$.

□

Let us give suitable names for international values that theorem 3.4 shows the existence of.

Definition 3.7 (admissible and regular values)

The international value $\mathbf{v} = (\mathbf{w}, \mathbf{p})$ that satisfies conditions (i) to (iv) for some couple of positive $\mathbf{d}$ and $\mathbf{q}$ is called *admissible value* and one that corresponds to a final demand on a regular domain when $\mathbf{q}$ is fixed called *regular value*.[21]

Definition 3.8 (competitive technique)

A production technique h is called competitive when

$$w(\,c(h)\,) = \langle \mathbf{a}(h), \mathbf{p} \rangle$$

for an intentional value $\mathbf{v} = (\mathbf{w}, \mathbf{p})$ that satisfies condition (iii).

If international value $\mathbf{v} = (\mathbf{w}, \mathbf{p})$ is admissible, any country has at least one competitive production technique and any commodity has at least one competitive production technique that produces it. This is equivalent to say that competitive type associated to the international value $\mathbf{v} = (\mathbf{w}, \mathbf{p})$ is spanning. Regular value has maximal spanning competitive type.[22]

Number of regular values is always finite as they correspond one-to-one with facets of the frontier. The price part p of the regular value is perpendicular to the facet that includes the final demand. The proof of the theorem is given in Chapter 5, Shiozawa

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[21] Japanese readers are requested to note that I changed definitions of these two notions. I gave different notions in Definitions 18 and 19 in Chapter 3 and Definitions 38 and 39 in Chapter 5 in Shiozawa (2014).

[22] I don not enter in the details of competitive types that gives possible specialization pattern for the set of techniques. Competitive pattern is spanning when it has a link that is connected to any given vertex. We can define an international value as one that has spanning competitive pattern. It is expected that this definition make it possible to define admissible and regular values completely independent from demand.

(2014) for Theorem 44.[23] See also Shiozawa (2007) Theorems 5.2. and Theorem 5.7. Shiozawa (2007) uses more geometric intuition whereas Shiozawa (2014) gives a strait and algebraic proof.

Conditions of Theorem 3.4 have concrete economic meanings. Suppose that an economy is in a self replacing state. Then each of four conditions stands for the following propositions:

(i) The supply is equal to the demand.

(ii) The labor force of each country is fully employed.

(iii) No production technique is running with excess profit.

(iv) The value of the net product is equal to the total sum of wages.

The term "excess profit" in (iii) may require an explanation. As I will discuss in Section 5, we normally assume a normal markup rate for each industry and input coefficients are modified into equivalent ones. Excess profit here means the profit margin that exceeds this markup rate. We are here following Ricardo who contended that cost of production should be understood to include (normal) profits (Ricardo, 1951, p.47, footnote for the 3rd edition). Note that competitive production technique operates with normal profit margins even if it is not producing excess profit.

Condition (iv) combined with condition (iii) implies that those production techniques with positive activities are all competitive, that is they satisfies condition (iii) with equality. More precisely, we say that technique h of a country i is competitive if it satisfies the equality

$$w(\mathrm{c}(h)) = \langle \mathbf{a}(\mathrm{h}), \mathbf{p} \rangle \ .$$

The proof of this property is not difficult. Indeed, suppose that there is a production technique with positive $y(h)$ with $w(h) > \langle \mathbf{a}(h), \mathbf{p} \rangle$, then

$$\langle \mathbf{q}, \mathbf{w} \rangle - \langle \mathbf{y}, \mathbf{p} \rangle = \langle \mathbf{y}J, \mathbf{w} \rangle - \langle \mathbf{y}A, \mathbf{p} \rangle = \langle \mathbf{y}, J\mathbf{w} - A\mathbf{p} \rangle$$
$$= \Sigma_h \, \mathrm{y}(h) \cdot \{ w(\mathrm{c}(h)) - \langle \mathbf{a}(h), \mathbf{p} \rangle \} > 0.$$

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 excess profit is operating.

[23] Theorem 17, Chapter 3, Shiozawa (2014) gives an equivalent theorem in different expressions.

In the above formulation, we have omitted referring to markups. In other words, we have assumed that all markup rates are 0. In such a case, no profit is produced by production. Cases of positive markup rates are dealt in section 5. The definitions of net output matrix and final demand require some modifications. With these modifications, we can re-interpret theorem 3.4 as proving the existence of a proportionally growing economy.

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. Although we did not explicitly mentioned on firms, it can also comprise the cases where a firm holds several production techniques that produce the same products. Questions of choice of techniques and input substitutions are incorporated and solved in this framework.

Another important characteristic is that the new theory is a natural generalization of the classical value theory. We have stated above (section 3, p.13) that the new theory of international values "is a theory of value that Ricardo would have imagined to construct but could not even give a rough design of." To contend this, the new theory must satisfy the essential characteristics of classical theory of value, or cost-of-production theory of value. The most important point is that regular value remains constant whenever the final demand changes within the same regular domain. Although it is necessary to add supplementary condition "within the same regular domain," the international value defined in this way conserves the basic property of the classical theory that value is primarily independent of the demand. This is in sharp contrast to the neoclassical theory of value, in which small variations of the demand crucially determines the prices. In the new theory, there are no needs to appeal to the concepts such as marginal product or marginal cost.[24]

In the classical theory of value, including the new theory of international values, the values and quantities are primarily separated. Thus, quantity variables such as production scale and amount of employment moves (within a certain range) independently from value variables. The most conspicuous effect of this independence is that we can examine the situation where unemployment exists. We will discuss this point in the next section.

It is also important to note that the classical theory is not constructed on the general

[24] This is in accordance to Sraffa's opinion expressed in the Preface of Sraffa (1960).

equilibrium framework. For example, theorem 3.4 describes the existence of self-replacing state but it does not assume or affirm that the economy converges to such a state. On the contrary, the theorem can be interpreted as showing how difficult it is that a full employment state is realized.

In the next section we will see first gains from trade and then the possibility of trade conflicts including unemployment problems.

§4. Gains from trade and possibility of trade conflicts

Suppose a Ricardo-Sraffa trade economy $\mathcal{E}$ with A, J and $\mathbf{q}$ defined in section 3. We can imagine each country's closed economy $\mathcal{E}(i)$ with production techniques and labor force belonging to country i. Suppose each country has at least a productive system of techniques. The economy $\mathcal{E}(i)$ with matrix $A(i)$, $I(i)$ and $\mathbf{q}(i)$ composes country i's closed economy. In a closed economy, or an economy in one country, we have the minimal price theory. It can be expressed in various forms.[25] The next lemma is one of them:

Lemma 4.1 (Minimal price theorem)

Let $\mathcal{E}$ be a one-country economy which satisfies conditions (c), (d), (e), (h) in the definition of Ricardo-Sraffa trade economy. Then, there exists a system of production techniques that gives the minimal price for all goods when the wage rate is fixed at w.

Lemma 4.1 can be paraphrased as follows. A system of production techniques is a set of production techniques that includes exactly one production technique that produces each of all goods. If a system of production techniques γ is productive, its associated input coefficient matrix $A(\gamma)$ is a square matrix and non-negatively convertible, that is $A(\gamma)^{-1}$ exists and non-negative. Thus, a price vector p associated to system γ with wage w can be expressed by the formula:

$$\mathbf{p} = w \cdot A(\gamma)^{-1} 1,$$

where 1 is a N-dimensional column vector whose entries are all 1. Lemma 4.1 tells that there exists a system of production techniques γ^* such that

$$\mathbf{p}^* = w \cdot A(\gamma)^{-1} 1, \leqq \mathbf{p} = w \cdot A(\gamma)^{-1} 1.$$

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[25] This lemma was first discovered by P. Samuelson and named non-substitution theorem. Samuelson proved the two-good case and Koopmans the three-good case. General case of N-good was proved by Arrow. See …

As a corollary to Lemma 4.1, we obtain the next theorem.

Theorem 4.2 (Gains from trade)

Let $\mathcal{E}$ be a Ricardo-Sraffa economy with A, J, $\mathbf{q}$. Let $\mathbf{v} = (\mathbf{w}, \mathbf{p})$ be an admissible value and $\mathbf{p}^*(i)$ be the minimal price vector with wage w_i. Then we have

$$\mathbf{p} \leqq \mathbf{p}^*(i). \qquad (4\text{-}1)$$

If $\mathbf{p}$ is not proportional to $\mathbf{p}^*(i)$ for a country index i, an inequality of (4-1) is strict for some product j.

□

The proof of theorem 4.2 is easy. If $\mathbf{v} = (\mathbf{w}, \mathbf{p})$ is admissible, we have condition (iii) of the theorem 3.5. Then

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

Taking production techniques that belong to country i, (4-2) can be expressed as

$$w_i \mathbb{1}(i) \geqq A(h)\mathbf{p} \qquad (4\text{-}3)$$

for all h belonging to i, where $\mathbb{1}(i)$ is the $H(i)$-column vector composing of only 1 and $H(i)$ is the number of production techniques belonging to country i. Now let γ be the system of techniques that gives the minimal price of the country i. Restricting inequalities (4-3) to the production techniques that belong to γ, we get

$$w_i \mathbb{1} \geqq A(\gamma)\mathbf{p}.$$

Applying to this inequality the non-negative matrix $A(\gamma)^{-1}$ from left, we obtain

$$\mathbf{p}^*(i) = w_i A(\gamma)^{-1}\mathbb{1} \geqq A(\gamma)^{-1}A(\gamma)\mathbf{p} = \mathbf{p}.$$

This proves the theorem.

Inequality (4-1) means that real wage level for workers in country i higher under international values than that possible in closed economy. It is strictly higher when $\mathbf{p}^*$ is not proportional to $\mathbf{p}$. It is important to note that the conclusion of Theorem 4.2 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 by the opening of international trade. 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 4.3 (Existence of Unemployment)

Let $\mathcal{E}$ be a Ricardo-Sraffa trade economy with A, J 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 $\mathbf{y}$ satisfy for a suitable $\mathbf{t}$ the following four conditions:

(a) $\mathbf{y}\, A = \mathbf{d} \leqq \mathbf{x}$,

(b) $\mathbf{y}\, J = \mathbf{t} \leqq \mathbf{q}$,

(c) $J\mathbf{w} \geqq A\,\mathbf{p}$, and

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

The system $\mathbf{y}$, $\mathbf{d}$, $\mathbf{w}$, and $\mathbf{p}$ 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

$$\mathbf{p} \leqq \mathbf{p}^*(i) \text{ and } \mathbf{p} \neq \mathbf{p}^*(i). \qquad (4\text{-}4)$$

Theorem 4.3 follows from a simple calculation:

$$\langle \mathbf{t}, \mathbf{w} \rangle = \langle \mathbf{d}, \mathbf{p} \rangle \leqq \langle \mathbf{x}, \mathbf{p} \rangle = \langle \Sigma_i \mathbf{x}(i), \mathbf{p} \rangle$$
$$< \Sigma_i \langle \mathbf{x}(i), \mathbf{p}^*(i) \rangle \leqq \Sigma_i \mathbf{q}(i)\, w_i = \langle \mathbf{q}, \mathbf{w} \rangle .$$

First equality holds from (d), the second inequality from (a), third equality by definition, the fourth from the first part of (4-4) 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. The fourth inequality holds strictly, because $\mathbf{p} \neq \mathbf{p}^*(i)$ for some i. As a conclusion, we obtain a strict inequality

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

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

Note that in the formulation of Theorem 4.10 vector $\mathbf{t}$ in condition (b) needs not be assumed it is less than vector $\mathbf{q}$. This means unemployment is inevitable even if workers move across country borders. Also note that the value v = (w, p) is only used in this proof as weights of aggregation and it need not be an actual wages and prices of the economy.

If we combine Theorem 3.4 and Theorem 4.3, we can say followings. Theorem 3.4 tells that there is a self-replacing state with an international value in which full employment is attained. But Theorem 4.3 also says that with the same wage price system, unemployment necessarily occurs if the world demand stays the same as before trade. Neoclassical economists have a custom to assume that price adjustment is always sufficient for full employment but Theorem 4.3 tells it is not true.

We know that Mill and his followers assumed that each commodity has elasticity -1. The same assumption is adopted in Dorbusch, Fischer, and Samuelson (1977). This is equivalent to assume Cob-Douglas demand functions. If demand changes in this way, each country's demand for a competitive goods increases in such a way that the total employment remains unchanged. However, if this assumption fails to hold, some countries' demand for their competitive products become too big that the total necessary employment exceeds their labor forces. In this case also, production and employment of a country are restricted below or equal to the country's labor force and this implies that other countries must suffer by the lack of effective demand.

§ 5. Questions related to markup rates

In sections 3 and 4, we have supposed that markup rates were 0, but this was grossest negligence. I consciously did this in order to avoid unnecessary complication as a first construction. Now it is time to observe explicitly the effects of positive markup rates.

Markup is a common practice which is widely employed by small and large firms in the determination of product or service price. If the cost is known, the sale price is the original cost plus the amount of markups. This amount of markups is usually calculated by a percentage markup. If the markup rate is m and the unit cost is c, then the price is set by the formula

$$p = (1+m)\, c.$$

In actual practice, many complications intervene. What is the unit cost and how can we calculate it? If we are concerned with a single product, we can estimate the unit direct cost by observing accounting data set. If we are concerned with many items as it is the case of supermarkets or multi-product makers, it may be out of question to calculate the exact cost for each of the items. Most often, costs are classified between variable (proportional) costs and fixed costs. The unit cost is the sum of all proportional costs per

unit of products.[26] The total cost is the sum of the fixed costs and the unit costs times the number of units of the production. One of practical objectives of markup rates is to cover the fixed costs by the cost times the units of production part. However it is necessary to note that markup rate is not equal to profit rate if fixed costs exist. Indeed, the total profit depends on the sold volume. If the product is sold by quantity y at the fixed markup price, i.e. at $p = (1+m)\, c$, the total profit is

$$m\, c\, y.$$

If the total fixed cost is F, the profit may be negative if

$$y < \mathrm{F} / (m\, c).$$

This is the breakeven point. If the sales volume exceeds this level, the profit is positive and becomes bigger if y increases further.

Markup rates are often determined by conventions.[27] There is certain standard level of markup rates for each industry. It may change by countries. However, the level of markup rates is not arbitrarily determined. Roughly speaking, markup rates are determined by the state of market competition for each product[28]. This partly justifies well known *pricing-to-market* practice. The key point is to assume that the market share of the firm's own product among competitors' products is a function of relative prices of those products. If the price is set, the firm sells the product as much as purchase offer comes. Then, with some auxiliary assumptions, a markup rate is calculated as the best policy for a firm. When the firm adopts this markup rate, the firm gets the maximal profit. The market share function may not be exactly known, but if market competitive condition does not change much, the firm may fixed the most profitable markup rate by trial and error. Demand changes by various reasons, if the prices are all fixed. For example, we may enumerate weather, temperature, special events, and topics on TV or net.[29] In this sense, it is the market which determines

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[26] In the designing process of the car of a new mark, for example, the unit cost is not a fixed constant but a variable. It is a target which is to be determined in order to produce a good sales price by markup pricing. This practice is well known as *target costing*. However, we are mainly concerned with the pricing practice when the manufacturing process is already going on.

[27] At the backside of this convention, standard level of sales volume is often assumed. If, at this volume, profit remains negative, the firm is obliged to exit from the market and the state of competition changes. By this long term adjustment the markup rate determined by the market most often produces a positive profit at the supposed standard level of sales volume. See also the next paragraph.

[28] Market competitive condition may change by the change of currency exchange rates, as we will observe in next Section 6.

[29] Markup rate is often explained by kinked demand curves. However, it is not a good explanation of markup rate, because a markup price is determined without clear

markup rate. However, it is also necessary to note that market competition is not independent from markup rates. As I have indicated in Shiozawa (2016), if the markup rate determined by the market is too low, the firm cannot cover the depreciation of the fixed capitals. In such a case, some firms will be obliged to exit from the market and the competition changes. This explains partly why the markup rate differs by industry. See Shiozawa (2016) for a fuller explanation.

If markup rates are positive, we need to modify the input coefficient matrix. Let us suppose that a markup $m(i,j)$ rate is fixed for each pair of country i and product j. Suppose that a production technique h is competitive, the market price must be equal to the markup price. This means that an equation

$$\{1+m(i,j)\} \cdot \{w(c(h)) + \langle \mathbf{a}(h), \mathbf{p} \rangle \} = p_{g(h)}$$

must hold. Remind that the expression $\mathbf{a}(h)$ is taken to be the net output of the production that requires a unit of labor input. This can be expressed also as

$$w(c(h)) \cdot a_0(h) = (1/\{1+m(i,j)\}) \cdot p_{g(h)} - \langle \mathbf{a}(h), \mathbf{p} \rangle .$$

Let us now define a new net output coefficient vector $\mathbf{a}_e(h)$ by the vector

$$(1/\{1+m(i,j)\}) \, \mathbf{e}(g(h)) - \mathbf{a}(h).$$

This net output coefficients vector corresponds to a virtual production that requires unit labor input. If we interpret this vector as a coefficient vector that represents a virtual production technique, we get a new system of production techniques. The matrix A_e composed of vectors $\mathbf{a}_e(h)$ satisfies the same value relations as (iii) of the theorem 3.4, that is

$$J\mathbf{w} \geqq A_e\mathbf{p}.$$

We can now define the equivalent RS economy. An RS economy with A_e, J, $\mathbf{q}$ is called equivalent RS economy. By taking the equivalent RS economy, all stories developed in sections 3 and 4 hold without modification as far as value relations are concerned. However, notions and analyses concerning quantities require more cautious treatments. For example, $\mathbf{d}$ in (i) and (iv) of theorem 3.4 needs to be re-interpreted. If you replace A by A_e, you can have the same relations (i) to (iv) for the equivalent RS-economy $\mathcal{E}_e$., but $\mathbf{d}$ (or perhaps $\mathbf{d}_e$) should be interpreted as a different bundle of goods that appears in the original expression of theorem 3.4. Let me explain.

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reference to the sales volume. Markup price is an offer price that expresses the supplier's attitude that it is ready to sell any amount of the product at the fixed set price (of course within certain common sense range).

For simplicity of discussion, let us suppose that all markup rates are the same and equal to m ($m > 0$). Generally speaking, the production possibility set of an equivalent economy $\mathcal{E}_e = \{A_e, J, \mathbf{q}\}$ for $m > 0$ "shrinks" in comparison to the original $\mathcal{E} = \{A, J, \mathbf{q}\}$ for $m = 0$. The commodity vector $\mathbf{d}$ is a world final demand in $\mathcal{E}$. It is a sufficient demand to gives full employment through condition (ii) in Theorem 3.4. If we compare two production possibility sets of $\mathcal{E}$ and $\mathcal{E}_e$, that of $\mathcal{E}_e$ is smaller than that of $\mathcal{E}$. Then vector $\mathbf{d}$ is outside of the production possibility set P_e of $\mathcal{E}_e$. Does this mean that, in an equivalent economy, the world demand for full employment can be smaller than that demanded in the original economy? How does this singular situation happen?

All these peculiarities occur by the ambiguity of two concepts: the final demand and the production possibility set. We normally assume that these concepts have well defined meaning without any explicit reference to growth rate or others. In fact, we naturally think that these two concepts correspond to some objective entities and have an invariant meaning that does not change whether we think of a self-replacing state or of a proportionally growing path. However, this is a misunderstanding. These concepts implicitly depend on the economic state we imagine. To be more precise, let us suppose that we are interested to investigate a proportionally growing path. Let the growth rate be g. For simplicity, consider a closed economy of a single country. Let $\mathbf{a}_0$ be labor input coefficient vector, A material input coefficient matrix and I output coefficient matrix. Again for simplicity, we assume that, in our virtual economy, there is only one production technique for each of products. Then A is a square matrix and we can assume I is an identity matrix. Let us assume we have a series of productions

$$\mathbf{y}(0), \mathbf{y}(1), \dots, \mathbf{y}(t), \dots .$$

If this series is growing proportionally at constant rate g, the following equations hold:

$$(1+g)\,\mathbf{y}(0) = \mathbf{y}(1),\ (1+g)\,\mathbf{y}(1) = \mathbf{y}(2),\ \dots,\ (1+g)\,\mathbf{y}(t) = \mathbf{y}(t+1),\ \dots . \qquad (5\text{-}1)$$

In this series, what are the net products? To produce $\mathbf{y}(1), \mathbf{y}(2) \dots, \mathbf{y}(t+1), \dots$, we need material inputs in addition to labor inputs. They are

$$\mathbf{y}(1)\,A,\ \mathbf{y}(2)\,A,\ \dots,\ \mathbf{y}(t+1)\,A,\ \dots .$$

A natural definition of net output for this series would be the following:

$$\mathbf{y}(0) - \mathbf{y}(1)\,A,\ \mathbf{y}(1) - \mathbf{y}(2)\,A,\ \dots,\ \mathbf{y}(t) - \mathbf{y}(t+1)\,A,\ \dots . \qquad (5\text{-}2)$$

These are what we can extract from the economy with constant growth. If we substitute equalities (5-1) into (5-2), we get

$$\mathbf{y}(0)\,\{I-(1+g)A\},\ \mathbf{y}(1)\{I-(1+g)A\},\ \dots,\ \mathbf{y}(t)\{I-(1+g)A\},\ \dots . \qquad (5\text{-}3)$$

It would be natural to define (5-3) as the net out put for each period. In this formula, it is evident that the concept of net output depends on the growth rate.

Now let us return to the international trade economy. If the net output depends on the growth rate, the concept of production possibility set depends on the growth rate of the underlying economy. When the uniform markup rate m and the underlying growth rate g are equal, there is no problem to simply examine the equivalent economy. The value obtained for equivalent economy gives a value (i.e. systems of wages and prices) that determines competitive production techniques with markup rate m. The demand vector $\mathbf{d}$ gives a bundle of commodities which can grow with constant rate g. However, if $m \neq g$, we need an appropriate conversion of the final demand vector.

Let us consider the case where $g < m$. The opposite case ($g > m$) is a bit more complicated, because firms cannot accumulate sufficient fund for growth from their internal reserves and must get money from workers savings. We can consider two equivalent economies $\mathcal{E}_e(m_0)$ and $\mathcal{E}_e(m_1)$ where $m_0 = m$ and $m_1 = g$. Each of two economies $\mathcal{E}_e(m_0)$ and $\mathcal{E}_e(m_1)$ has a set of regular values and a set of corresponding systems of competitive techniques. It may happen that two sets of competitive techniques differ with each other. Let them be $\mathcal{S}(m_0)$ and $\mathrm{S}(m_1)$. The production possibility set $P(m_1)$ associated to $\mathcal{E}_e(m_1)$ with growth rate $g = m_1$ is of course convex. However, if competitive techniques are chosen by the system $\mathcal{E}_e(m_0)$, the production possibility set $P(m_1, \mathcal{S}(m_0))$ with growth rate $g = m_1$ by means of competitive techniques $\mathcal{S}(m_0)$ set is included in the possibility set $P(m_1)$ and may not be even convex. Takamasu' (1986) gave an example of concave production possibility frontier in the case of a closed economy when land intervenes as constraints for productions. Similar situation occurs in the case of international trade even if there are no other constraints than labor. There is no inconvenience in this, because we are treating different trajectory with the same growth rate and there is no need that those net outputs form a convex set.

Further analyses are requested for quantity relations but these are the targets of the coming research.

§ 6. Problems of exchange rates

Foreign exchange market poses a delicate problem to the new theory of international values. All that the new theory can say is included in theorem 3.4. The theorem implies that there is at least one but in general a plural number of international values that make it possible to realize full employment for all countries by their competitive

production techniques. Different from the general equilibrium theories, the new theory does not contend that the actual international values (the actual system of wages and prices) will converge to one of those regular values and full employment will be attained. On the contrary, the new theory emphasizes the difficulty in finding one of such a set of international values. However, if any system of international values has some practical meanings, we have to deal with problems on how to interpret daily fluctuation of exchange rates, or rather on how to harmonize highly volatile exchange rates and the requirement of price stability that the new theory presupposes as criterion for firms in choosing more competitive production techniques.

The biggest trouble is that foreign exchange rates shift drastically and extensively. High volatility itself is not a big problem if its moving average shifts slowly. In the latter case, we may interpret the moving average as reflecting the slow but long term change of economic conditions, mainly as effects of differential technological progresses. However, an actual exchange rate sometimes jumps up or down in a few days and stays around the new rate level for many months. For example, during the first quarter of 2103 the JPN Yen/US Dollar rate went down from around 80 Yen/Dollar to 100 Yen/Dollar and stayed around that level for one and half years after that and then in the fourth quarter 2014 the rate jumped down to around 120 Yen/Dollar. At the first change Yen went down 20 percent and at the second change another 17%. During the two years period, Yen depreciated to two third of the original value. The 120 Yen/Dollar level continued for about one year throughout 2015 and in 2016 the rate is now going down (Yen is appreciating) motivated by various reasons including the British vote to leave the EU.

What was more curious in this depreciation was that Japanese export in real terms did not increase much. Many explanations are possible, but it is not our topic of this paper. Our problem lies in the fact that this depreciation was the change of relative wage rates by the extent of 33% down seen from Japanese side and 50% up from the U.S.A. side. In the new theory of international values wage rates are expressed by a given (real or imaginary) international currency. The exchange rate change of the extent of 33% or 50% signifies depreciation or appreciation of wage rate viewed from Japanese or American side. Large changes of this extent must produce substantial effects on the competitiveness of production techniques of both sides. In reality, there was no big change in Japanese export. Here arise two problems. The first problem is the speed of firms' reaction. The second problem is the relation between exchange rates and the relative wages assumed in the new theory.

As for the first problem, firms have to take into consideration various factors and conditions. Even if a big change of exchange rate happens, it may not be wise to react to the new situation too promptly. The exchange rate is extensively volatile and it is possible that it may swing back to opposite direction in a near future. A change of exchange rate changes competitive conditions in the exporting or importing markets. If the change is considerable, firms are obliged to reconsider their markup rates. They have to observe how their competitors behave at the big change of conditions. They also have to think about preserving their clients' loyalty, be it consumers or industrial purchasers.

In the case of recent Yen depreciation (2012-2016), many consumer good makers did not raise their product prices in spite of the price rise of imported materials for about a year. This reaction may have been conditioned by the long deflation (or rather the price stabilization) of the Japanese economy. On the other hand, this reaction was possible because many firms held a big amount of internal reserves. Exporters did not change their selling price in the importing currency despite the fact that it was a good chance to bring down the product price and to extend the market share. If the depreciation occurred in 1960's, Japanese firms must have taken a very different behavior. These brief observations show that firms do not react promptly and wait and see for about a year when the big change of exchange rate occurs.

Reactions of firms to the exchange rate change are being studied extensively under the topic of exchange rate pass-through to prices. Gopinath and Rigobon (2008) report that median price duration in the currency of pricing is 10.6 months for U.S. imports and 12.8 months for U.S. export. Nakamura and Zerom (2009) report that coffee industry changes wholesale price 1.3 times per year and retail price 1.5 times per year. Lewis (2016) uncovered that pass-through is strongly non-linear in exchange rates. The pass-through of larger bilateral exchange rate movements (i.e. more than 5%) is around four times larger than that of smaller changes. Frankel, Parsley and Wei (2012) report that pass-through rates and delays may change in time and by stages of development[30].

The second problem is much more difficult to answer. High volatility of the exchange

[30] We do not enter into the details of measurements. We can argue for example that log linear regression is adequate or not if we consider the additive character of costs. I here simply report the raw numbers only to get rough estimation of the price adjusting behavior of firms.

rate market itself is not astonishing. It is a proper characteristic that we observe in many of financial markets. The problem we face is the following: do the relative wage rates supposed in the new theory have something to do with the level of exchange rates? Evidently there is no clear tendency for the exchange rate to converge to a certain level. Exchange rates are always fluctuating and do not show any apparent tendency of convergence. What kind of long term characteristics does an exchange rate exhibits? In the decade following 1996 a closely related question was discussed under the title of the purchasing power parity puzzle (Rogoff 1996). The question that was discussed at this time is not the validity of classical purchasing power parity (PPP) hypothesis. The classical PPP hypothesis assumed the equality of price indices (when they were converted by exchange rate to a single currency expression). It was obvious that this hypothesis does not hold, if the price index included non-tradable goods and services. Because of the Balassa-Samuelson effect, the consumer price index of a high income country has the tendency to be higher than that of a low income country. Even between comparable high income countries, absolute levels of price indices have no clear tendency to converge to equality. Therefore the question discussed after 1996 concerned the convergence of relative PPP indices.

PPP puzzle, or Rogoff puzzle as some economists dabbed it, is a complicated question that requires deep knowledge of time series statistics (Taylor 2001; Yabu 2007). If I introduce some conclusions from the long debates, the central question was the evaluation of half-life of the exchange rate time series. At the time of Taylor (2001), it was believed that the half-life was "of the order of five years at best, and infinity at worst." (Taylor 2001). The discussion continued on the nature of half-life estimation and a new consensus emerged until 2005. The half-life of the relative PPP divergence from limiting average was estimated to lie between 3 to 5 years (Yabu, 2007). It was also made clear why the unit root test behaved so badly for about 20 years after the shift to floating exchange rate system. It required around 100 year data to distinguish of the series has a unit root or not, if one worked in quarterly time series. After 30 to 40 years after the shift to floating system, the estimation became sufficiently accurate to discern 4 year half-life series and the unit root series.

If we believe the recent estimation, the convergence speed of the relative PPP rate is very slow and requires 3 to 5 years until an accidental deviation from the trend halves. This fact, together with the delayed price response to cost changes of the scale of one year, teaches us the time span of the new theory of international values. This is in

accord with the recent observation in Japan. During the period of Yen depreciation, firms endured 25 to 50% cost up of imported goods without raising their product prices. We have to think that adjustment of wage levels works in this time scale.

A third question arises in relation to Rogoff puzzle. It is the validity of law of one price. This question is more directly related to the new theory, because law of one price lies at the basis of the new theory of international values (especially when transportation cost is negligible). Studies on law of one price should be done not on aggregated price indices but on product-wise price movement across countries. To get a good estimate on the effectiveness of the law, studies should be better done in a situation where trade barriers are minimal. EU's great experimentation of unified currency provides us a good occasion to evaluate the actual effectiveness of the law[31]. We can hope that these empirical studies will give us a chance to refine the theory of international values.

Division Ⅲ. Extensions and generalizations

In this Division (from section 7 to section 11), we treat the question how to interpret or generalize the theory and its components to adapt them to the situation which are not included in its typical formulations. The questions related to markup rates are already explained in section 5. Our first point of discussion is how to interpret production techniques.

§ 7. Primary resources

The question of primary resources is not a problem of extension or generalization. It is simply a question of interpretation.

In the formulation in section 3, each country has its own set of production techniques. Thus, if we take the case of agriculture, the production technique that produces wheat may be different because of differences of the climate. In a temperate zone, we may cultivate wheat easily, whereas in arctic or tropical zones, wheat cultivation may not produce a good result. These differences of efficiency caused by climates can be easily incorporated into the differences of production techniques. Our basic assumption on

[31] Although there is no specialized examination on cross-country price differences, Dhyne et al. (2006) and Vermeulen (2012) are the fist attempts.

production techniques is that input-output relations are proportional to scales of productions. As far as this relations hold, there is no problem in reflecting climate conditions and other environmental effects onto production techniques.

Classical question of decreasing returns arises when cultivation extends to less fertile or badly irrigated lands. It is the question of rents. In this paper, we do not treat this question. It requires a proper theory of value that is different from domestic or international theory of value.[32] Christian Bidard in his series of papers is studying this question energetically. For our theory of international values, the different efficiency of production does not pose a problem, because they can be treated as different production techniques. If no limits in the scale of production are effective, the question of which peace of land we choose is the question of the choice of production techniques.

In the same vein, underground resources do not pose any problem as far as extraction can be continued at the same efficiency and at the required volume per time. If the production volume in a better condition is limited, we have to appeal to the theory of rents.

The existence of primary resources itself does not necessarily imply that the production with primary resources needs to be treated by the theory of rents. For example, Sweden produces iron core of high quality. As the possible capacity of extraction is gigantic and the actual demand for this quality of iron core is far smaller than the capacity, we can treat iron core extraction as an ordinary production process. In this sense, even in the case of productions that presupposes the existence of primary resources, we can treat them as normal production techniques and the new theory of international values holds without explicit consideration to the amount of primary resource reserves. Just like a dissipative structure is self-regulating its flow of energy, the activity levels of an economy are normally limited by the internal logics of the economy itself (e.g. effective demand, profitability and others).[33] Quite often the capacity of a production exceeds the required volume of the production. Thus the theory of international values holds in quite a wide situation independent of theory of rents.

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[32] The classical theory of value probably comprises 5 fields: (1) domestic theory of value, (2) international theory of values, (3) theory of rents (land and primary resources), (4) theory of wages (inside of a country), and (5) price theory of financial markets. The first three fields have relatively firm theories of value while the last two need completely new approaches.

[33] See for example, Shiozawa (1996).

§ 8. Durable or fixed capital goods

Capital goods such as machines and installations can formally be treated as producing old machines and installations together with the main product. The existence of durable capital goods thus means that we have to assume that two or more products are produced at the same time by a single production technique. In other words, the existence of these durable capital goods violates condition (d) in section 3.

When two or more products are produced (i.e. if the net products are positive for more than two goods) in a single production technique, the production technique is called joint production. John Stuart Mill (1848, III, 16) discussed joint production under the term of "joint cost of production." It is the case where two commodities are produced by the same "operation." His favorite example was the production of coke and coal-gas by the same process (carbonization of raw coal). In such a case, costs of coke or coal-gas are not determined. Mill argued that cost-of-production theory of value fails in this case and "we must revert to a law of value anterior to cost of production, and more fundamental, the law of demand and supply." (Mill, III. 16. 5) John von Neumann (1944) introduced the idea to treat durable capital goods as joint production. Morishima (1973) highly praised this event and called it von Neumann revolution. However, von Neumann-Morishima type treatment of joint production is too general and does not permit detailed analysis except for balanced growth and others. It is necessary to introduce some good properties that are general enough and easily tractable. One of such properties is to assume constant efficiency during the life span of the machines and be freely destroyed at the end of life span. This is the solution given in Chapter 10 in Sraffa (1960). More general treatment which includes choice of production technique is done in Shiozawa (1975). In this case, if a markup rate is given for the production, the value contribution of the machine is calculable and joint production problem is easily reduced to simple production case. The same thing is possible for international trade case.

§ 9. Transportation and transaction costs and non-traded goods

In recent years, transportation and communication costs decreased drastically. This, together with decrease of transportation time, changed the feature of world economy and international trade enormously. In order to analyze the effects of transportation

and transaction cost decrease, we have to reformulate space of commodities in such a way that we can distinguish the same products situated in different countries. This is the purpose of this section. When we say transportation cost, we includes in it transaction costs related to the transportation of goods.

When we introduce transportation costs, we must distinguish the location of products. Any goods are labeled by the pair (j, i) of product index j and the country index i. We call this location specified goods. Then any commodity can be labeled by a couple of indices (j, i). Note that in this expression good index j precedes country index i. When two commodities have the same good index j with two different country indices, we are considering the same good that is situated in different countries. In a transportation economy, therefore, there are $N \times M$ different commodities when N is the number of products (abstract of locations) and M is the number of different countries.

Transportation is a production technique which produces product (j, i_2) with an input that comprises the same quantity (or more) of product (j, i_1). In other word, transportation is the activity to change product j situated in country i_1 into product j situated in country i_2. Other inputs represent labor and materials (packaging materials, fuels, and transportation equipments) necessary for the transportation. In order to conserve the fundamental properties of production technique in section 3, the transportation must be simple (Property f). This means that output must consist of only one product, except for transportation equipments, which can be treated as durable capital goods with constant efficiency. Transportation as a production technique must satisfy another property, i.e. labor used for the production must be composed of labor of a single country (Property h). So the employment of a crew of mixed nationality is excluded. It would be normal to assume that material inputs are also located in the same country as the labor, but for the theory construction, we do not need this condition. In our setting, a good in country i_1 can be transported to country i_2 by a crew member of country i3. In this case, this transportation is a production activity of country i_3.

This treatment of transportation costs may seem complicated. This complication is inevitable in order that the theorems in Section 3 can be extended automatically. However, this treatment has some merits of its own. Often assumed transportation costs are *iceberg model*. It treats transportation costs as an evaporation of a part of the transported goods. With this convention, we have no necessity to distinguish products by its locations. This simplicity is the main reason why iceberg model was widely

accepted despite of its apparent irrelevance to reality. Iceberg is a convenient parable in modeling transportation costs but carries some deficiencies as a model. One example is the vanishing of Alchian-Allen effect. Hummels and Skiba (2004, p.1400) point it, "iceberg hypothesis is neither correct nor innocuous."

Transportation equipments require special treatment, because in a standard interpretation transportation changes a ship in the country of expedition to a ship in the country of destination. This is another form of joint production. However, what is necessary is the cost of employing transportation equipment. They can be calculated by the standard method (Sraffa, 1960, chapter 10; Shiozawa 1975) if we assume constant efficiency.

We suppose there is at least a system of production techniques (including transportation techniques) which is productive in the sense that any positive vector of commodities are producible with a net consumption of labors of various countries. By operating transportation techniques no products are increased. Then if the transportation economy is productive, the underlying Ricardo-Sraffa economy is also productive.

Competitiveness of a production technique is defined in a similar way as in section 3. Let h is a production technique that produces commodity (j, i). It is competitive when it satisfies the following two conditions with regards to international value $\mathbf{v} = (\mathbf{w}, \mathbf{p})$:

$$\text{(i)} \quad a_0(c(h))\, w_{c(h)} + \langle \mathbf{a}(h), \mathbf{p} \rangle \leqq a_0(c(h'))\, w_{c(h')} + \langle \mathbf{a}(h'), \mathbf{p} \rangle$$

for all production technique h' which produces product j in country i, and

$$\text{(ii)} \quad a_0(c(h))\, w_{c(h)} + \langle \mathbf{a}(h), \mathbf{p} \rangle \leqq \{ a_0(c(h''))\, w_{c(h')} + \langle \mathbf{a}(h''), \mathbf{p} \rangle \} + \{ a_0(c(t)\, w_{c(t)} + \langle \mathbf{a}(t), \mathbf{p} \rangle \}$$

for all production technique h'' which produces product j in country i' and all transportation technique t which transport product j from country i' to country i. Here, the value $\mathbf{v}$ is a couple of wage vector $\mathbf{w}$ and price vector $\mathbf{p}$, but $\mathbf{p}$ represents prices for all $M \times N$ commodities (j, i). Note also that $\mathbf{a}_0(h)$ and others express here material *input* coefficients, while $\mathbf{a}(t)$ represented material *net output* coefficients in the formulation of theorems 3.4 and 4.3.

The first condition means that *h* is competitive among production techniques that produces *j* in the same country *i*. The second condition means that production cost by *h* is less than the cost of producing product *j* in other country *i'* and bringing it to country *i*. In the latter case, the transportation cost should be added onto the production costs in country *i'*.

When the transportation is costly, each country has more competitive techniques than when the transportation cost is negligible, because condition (ii) is more relaxed. If the transportation cost decreases uniformly, each product will be competitively produced in smaller number of countries and the rest of countries will begin to import the product. This explains why the general decrease of transportation cost increases specialization and the total volume of international trade. By the same reason, a production process may be divided among many different processes in different countries. This phenomenon will be examined in more detail in section 11 under the title of fragmentation.[34]

In arguments like Balassa-Samuelson effects, the distinction between tradable and non-tradable goods is important. However, there are no intrinsic properties which divide tradable and non-tradable goods. It is the transportation cost that makes some goods tradable and some others non-tradable. Indeed, if the transportation costs for a good between countries are always above the minimal difference of production costs, such a good will not traded. On the contrary end, if the transportation costs (including transaction costs and tariffs) are negligible, the good will be traded between countries if there are small differences of costs. Therefore, if the transportation costs decrease to a small fraction of the original costs, many formerly non-tradable goods become tradable and would be traded in effect.

Some services require face-to-face communications or proximity and simultaneity of production and consumption. It is difficult to trade such services across countries. Even in these cases as well, the condition that divides tradable and non-tradable is the transportation cost. For example, food preparation of a specially talented cook can be exported if the demander of the service is a king or billionare and is willing to pay the travel cost and the wage of his or her binding time.

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[34] Using formulation given here, Escaith and Miroudot (2017, Section 2) has examined implications of transportation cost.

§ 10. Tariffs

To examine the effects of import and export tariffs has been one of the major subjects of international trade theory. If the tariffs are proportional to the value of imported goods (or exported goods), there is no new problem in introducing tariffs in the theory. They can be treated as a kind of additional markup rate. In fact, in the definition of competitiveness of a production technique, it is sufficient to modify the above condition (ii) in the following form:

(ii') $a_0(c(h))\ w_{c(h)} + \langle \mathbf{a}(h), \mathbf{p} \rangle \leqq (1+\tau)\ [\{\ a_0(c(h''))\ w_{c(h')} + \langle \mathbf{a}(h''), \mathbf{p} \rangle\ \} +$
$\{a_0(c(t)\ w_{c(t)} + \langle \mathbf{a}(t), \mathbf{p} \rangle\ \})$

Note that the markup rates required by firms are incorporated in the input coefficients.

§ 11. International migration of labor

Some people think that wages are not equal between countries because there is no free labor migration between countries. Although we read often this kind of explanations in textbooks, this understanding is not exact.

Suppose that a non-negligible portion of labor force of a country B migrates to country A. We may consider several situations. A possible situation is that new labor force is quickly assimilated to the labor force of country A. In this case, the effects of migration are only the increase of labor force for country A and the decrease of labor force for country B. If the competitive patterns of countries A and B do not change by this migration, there would be no change of international values and wages of both countries remain constant. If wage ratio between A and B changes by the migration, one of two mechanism must work: (1) Country B suffers lack of labor force, is obliged to raise the wage rate, and abandons some parts of competitive industries. (2) Country A, by the increase of unemployment, cut down the wage rate and acquires new competitive industries. However, migration is usually not as big as it changes patterns of trade.

Of course, we can imagine a situation that migrated workers exhibit less productivity than the workers who continue to live in country A. However, in our assumption, labor force is assumed to be uniform, we cannot treat this case. A theory of wage differentials between industries and between categories of workers is to be constructed (See footnote 32. Five fields of value theory). It will complement the theory of international values. If

relative wage rates of each category of workers are determined, by institutional or other reasons, the theory of international values works as the case of uniform labor force assumption.

Related to the topic of this section, it would be useful to note that money transfers by any reasons do not change the international values if the world total demand does not change by this transfer. For example, migrated workers in country B may transfer some part of their wage to their family in country A. This may change the balance of payments, but it is possible that the volume and composition of the consumption do not change by this transfer. In such a case, the international values would not be affected by this transfer. The change of consumption locations may change the volume and direction of the trade but the competitive pattern and the international values do not change if the world demand remains unchanged.

Major reasons of big wage differentials between nations are to be searched in the differences of technologies, i.e. the sets of production techniques that each country possesses. Labor productivity is one of differences of production techniques but it is conditioned by the working customs and incentive systems. Labor force migration changes these basic conditions and it is not easy to tell how labor productivity changes after migrations.

Division IV. Applications

In this Division (sections 12 to 15) three examples of applications are given. The first two show how the new theory can be used in the analysis of dynamical changes as a co-evolution of international values and the sets of production techniques. Section 15 shows that the new theory of international values has the advantage of being well matched to international input-output analysis.

§ 12. Flying geese

Vernon's product cycle theory and Akamatsu's flying geese theory are famous as mid-range theories of industrial development in the field of international trade. 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, while Vernon is observing the transfer of technology and

production from advanced countries to less advanced countries. When Akamatsu started his research in 1930's, Japan was still a "backward country", at least in the conscience of Japanese scholars.

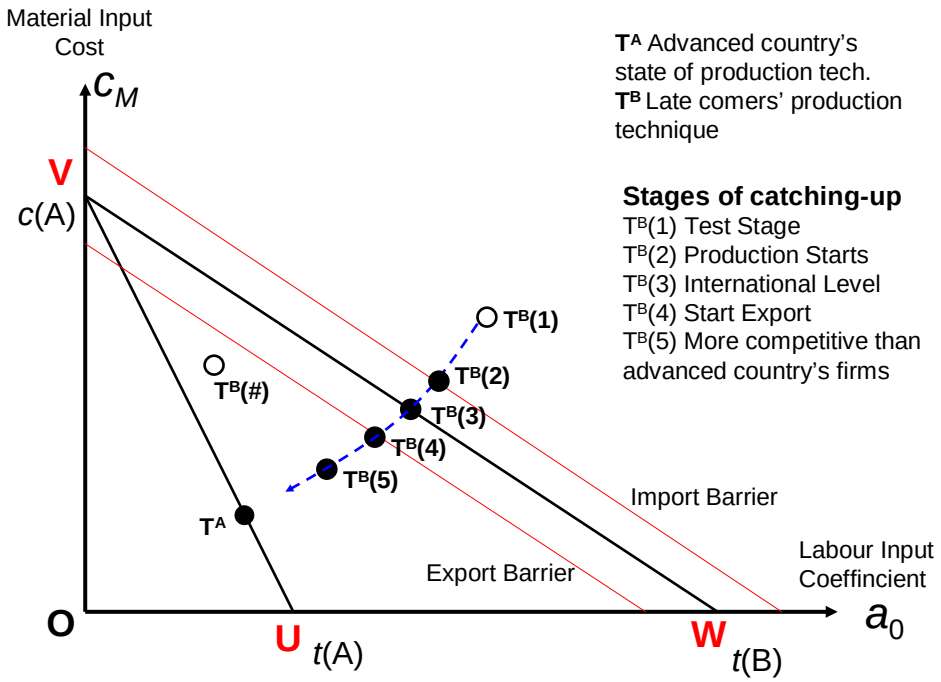

Figure 2. The Flying Geese: Technology Path of Late Comers

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 papers mention 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 explain why Japan first imported cotton thread (mainly for warp use) from abroad, then started to produce it for the internal consumption (for making textile), and finally arrived to export it. It was observed that many commodities traced the same pattern and Akamatsu wanted to explain why these patterns are common. Akamatsu's logic was based on a kind of Hegelian dialectics. But it is not difficult to explain by the new theory the basic mechanism of the fundamental flying geese pattern.

The new theory of international values explains how the wage disparity emerges between countries as standard situation. This is one of crucial difference between factor

proportion theory (which assumes Factor Price Equalization theorem as standard case) 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 the wage of a worker in an advanced country can ranges from 5 to 30 times of the wage of less developed countries. 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 2. In the following analysis, we assume that prices of goods and wage rates of two countries remain constant. In other words, we assume that international values remain constant. Readers can weaken this assumption in various ways if once they know how to argue with this assumption. The crucial assumption is the great disparity of wage rates between two countries A and B.

A point of the figure represents a state of production technique of a product. The production technique of the product is given by input vector (a_0, a_1, ... , a_N). The unit labor cost is $w \cdot a_0$, where w is wage rate either of A or B. The unit material cost c_M is $a_1 p_1 + a_2 p_2 + ... + a_N p_N$, Then we can express the production techniques as a point (a_0, c_M) of a plane.

In this representation, horizontal axis is measured in real terms (e.g. units of work hours) and vertical axis is measured in money terms[35]. In other words, the abscissa represents a labor input coefficient a_0 in real terms and the ordinate expresses the total material input cost c_M. Because two countries have different wage rates, the same work day has different labor cost. Let $a_0(A)$ and $a_0(B)$ be labor input coefficients for countries A and B. If $w(A)$ and $w(B)$ are wage rates of two countries respectively, then the unit wage costs for two countries become equal when

$$w(A)\,a_0(A) = w(B)\,a_0(B) \quad \text{or} \quad a_0(B) = \{w(A)/w(B)\} \cdot a_0(A).$$

This means that the two countries have the same unit wage cost when $a_0(B)$ is $w(A)/w(B)$ times as big as $a_0(A)$. Suppose (more advanced) country A has a higher wage than that of country B (less advanced). For example, if w_A is 3 times higher than w_B, then a point $a_0(B)$ can be 3 times as big as $a_0(A)$.

[35] We can use mixed axes in money and real terms, because prices and wages do not change during our argument by assumption. We take vertical axis in money terms in order to express multi-dimensional point by a single real value. As for the horizontal axis, we have to take axis in real terms to express the change of production technique while wage rates of two countries are different.

We assume that production technique of country A remains invariable. Let $c(A)$ be the total unit cost and $c_0(A)$ the labor input coefficient for country A. The two bold lines UV and WV are drawn as follows. First, plot the coordinate ($a_0(A)$, $c_M(A)$) and mark it T^A. This represents production technique for country A. By assumption, this point remains immobile. Point V is plotted at coordinate (0, $c(A)$). The line UV passes through point T^A and point V. All points on this line express production techniques that have the same total unit cost for country A. The line of the same unit cost for country B is expressed by bold line VW. It passes the point V(0, $c(A)$) but has a different slope. Points on the abscissa U($t(A)$, 0) and W($t(B)$, 0) have the same unit labor cost. Then abscissa $t(B)$ is three times bigger than abscissa $t(A)$ if w_A is three times higher than w_B..

In the following we assume that production technique of country A does not vary but production techniques of country B changes through time. In reality the input coefficients of A may also change. Readers can easily adjust the story to that case. Because point T^A moves in this case, the story becomes a kind of chasing.

Now come back to the simple case where the production technique T^A stays invariant. We follow what happens when country B learns and improves its production technique. In Figure 2, five such points are plotted. At first, the production technique is at the point $T^B(1)$. It lies out of triangle OWV. This means that total unit cost is greater than that of country A. At this stage country B cannot produce the product competitively because the same product can be imported cheaper than to produce in country B. If country B arrives at the stage where it can produce at point $T^B(2)$, production in B becomes competitive if the government imposes a certain tariff. If the production starts, country B accumulates knowhow by learning by doing and improves its production technique. When it arrives at point $T^B(3)$, country B can rival country A in the production cost provided that wage rate in B is one third of that in A. If production technique come to point $T^B(4)$, the product becomes competitive even if other country imposes a tariff. The width of the barrier lines depends on the rate of tariff for the product. Finally, when production technique in country B comes to point $T^B(5)$, production in country A is no more competitive. At this eventual case, the specialization pattern changes and international values may change accordingly. This may not happen easily, because country A improves its production technique in contradiction to our assumption.

Now the flying geese story starts like this. We will simply repeat the story above. 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 2 the state of input coefficients is indicated by a small circle $T^B(1)$.

Figure 2 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 where they are. 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 import 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*.[36]

[36] Jane Jacobs (1969, Chapter 2) tells the similar story for Japanese bicycle manufacturing.

No one knows the limit of rationalization (the lower bound of input coefficients) but producers of country B have an advantage since they 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. Until recently there was no established English name for this concept except that some are using the term "processing trade."[37] This strange fact can be partly explained by the lack of trade theory which incorporated input trade.

If the catching up process occurs in many other industries, it may pull up the wage rate of the catching up country. Chasing will then occur between the productivity increase and the wage hike.

§ 13. Fragmentations and unbundling

Production processes or parts of them 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, offshoring, fragmentations, processing trade, trade in tasks (or task trade), and vertical specialization. These transformations 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 (2006, 2014) 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

[37] 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 center of this movement. The opposite side of great unbundling is the decreased cost of transport and communication. 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.[38]

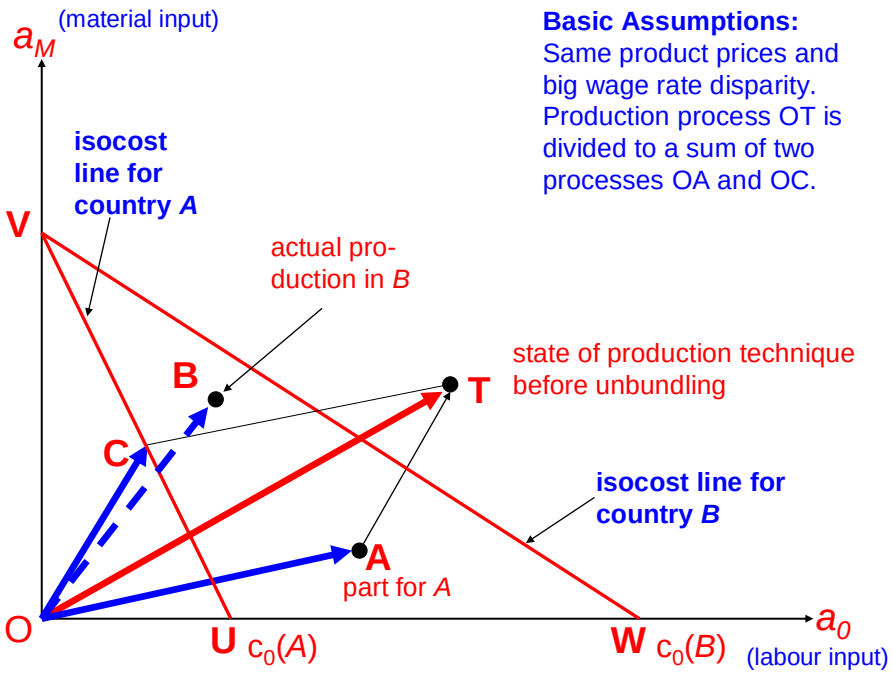

Figure 3. Fragmentation of production process

The logic of fragmentation can be illustrated by Figure 3. Coordinates have the same meanings as Figure 2. The starting point of the construction is point **T**. This represents the state of production technique of a firm in high wage country *A*.[39] The abscissa and ordinate represents labor and material input coefficients (to be more precise, labor in real terms and material input in money terms if we want to express in a 2-dimensional plae). 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 that the firm wants to keep secret. **OC** is the part of the production process that the firm wants to transfer from country *A* to low wage country *B*. This transfer may induce a loss of

[38] Grossman and Rossi-Hansberg (2008) emphasized the necessity of paradigm change. As RS economy includes input or intermediate goods, we need no new particular formulations.

[39] In this section production techniques and points in the plane are denoted by bold characters to distinguish country names which is denoted by italic letters.

efficiency because of low experience of production and additional costs such as transport cost of intermediate products, communication cost between the main office in *A* 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 represents points of the same production cost. Let the line intercepts at points **U**($c_0(A)$, 0) and **V**(0, c(**C**)), where c(**C**) is the total unit cost.in country *A* for the process **C**. Line **VW** is the set of points where production in **B** has the same total cost as the process **C** when it is operated in country *A*. Then the point **W** on the abscissa has coordinate (c_0(**B**), 0). 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 or 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 **OVW**. 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.

It is easy to see that the above logic of fragmentation can be applied to almost all process of productions. This explains the universal character of fragmentation when there is a big difference of wage rates and transportation and transaction costs are reduced.

The logic of flying geese catch-ups and fragmentations teaches us how the main message of the factor proportion theory (FPT) is flawed. Heckscher-Ohlin theorem tells that labor intensive products have a propensity to be exported from labor abundant countries. However, if we look Figure 2 and Figure 3, factor intensity does not matter much. Normally catching-up country will have labor intensive exports but this is the question of chance and probability. It may happen as in Figure 2 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* [40]. 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 3, 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 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 can be 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. Factor proportion theory does not refer to the potential cost advantage and only indicates a rough criterion on not-well-defined comparative advantage.

Global supply or value chain attracts managers' attention as it includes new aspects. Crossing national borders is not the same as crossing state or department borders. We have to gain special skill to manage additional procedures and control problem. Baldwin distinguished the *first great unbundling* (FGU) and the *second great unbundling* (SGU). The first unbundling occurred in the late 19th century within a country. The second unbundling started to spreads from the end of the 20th century and across countries. However, it is important to see that the same logic continues to work both in the first and second unbundling. From the view point of supply chain optimization, the same logic applies in both first and second unbundling. 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

[40] 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.

tried always to find a best organization of production process. Information and communication technology revolution and trade liberalization widened the range of options. Top managers are now required to consider world-wide logistics. As for procurement policy, they have to adopt global optimal procurement. This is the cause of ever increasing input trade. Ricardo-Sraffa trade theory provides a general theory that incorporates all these features, because it supposes that mangers adopt the global optimal procurement policy.

§ 14. Trade and international wage inequality

One of most important features of the new theory of international values is that it has a theory that explains the wage differences between countries. This contrasts with many of Marxian explanations. They assume a minimal level of wages that makes possible socially and culturally the reproduction of the labor force. The new theory reverses the causality of things. It is the change of general level of wages that pulls up or down the level of life of common workers. The new theory implies that wage differences normally occur as far as country differences of levels of technology continue. This is in sharp contrast with HO theory or factor proportion theory which predicts as a standard case the equality of wages (factor price equalization theorem). The new theory makes clear how differentiated wages emerge between countries.

Message is plain. It is the set of production techniques which determines the (real) wage of a country. Markups may intervene in it but the margins of variance are not very great. Production techniques can differ enormously and this is the main reason which makes rich country rich and poor country poor.

Let us illustrate how the principle works by a simple example. Suppose there are two countries. We ignore the transportation costs and others and assume that prices of products are unique determined in two countries and markup rates of both countries are the same for each industry. Suppose for the simplicity that production techniques of a product have the same material input coefficients. This is the assumption that Ronald Jones (1961) made in his paper but not necessary for the new theory. Labor efficiency can differ substantially. Imagine two production teams of the same number of persons that work with the same machines and equipment and produce a complex machine, say a car. The necessary time to produce a car for an experienced team can be one fifth of that for the less experienced team. In this case, the labor efficiency of the experienced

team is 5 times as high as compared to the less experienced team. In terms of labor input coefficient, this means that the coefficient of one team is one fifth of the other. This kind of difference can happen between countries. If labor efficiency of all teams of country *A* is 5 times higher than that of corresponding teams in country *B*, then the real wage rate of country *A* turns out to be 5 times as high as that of country *B*.

In a more realistic situation, Jones's assumption does not apply and the labor efficiency ratios between two countries are not uniform among industries. Even in such a complex case, the new theory of international values affirms that the wages between countries are determined by the same principle. It is the productivity of a country as a whole that determines the level of wage rate of the country.

If this is the truth, what we can do to raise the real wage level is only two: (1) to improve the set of production techniques and (2) to reduce markup rates. Let us ignore the second possibility for the moment and concentrate in the first possibility.

All efforts to make production technique more productive contribute to the improvement of the real wage rate of a country. However, we often come to a tradeoff situation. If we want to reduce input coefficient of one input, then the coefficient of some other inputs may increase. This is the case of choice of techniques. In general, we may have several production techniques which produce the same product. If we are given wage rate and prices, we can find which of the techniques has the least cost. This is a simple question of calculation. When all firms choose anew and renew their product prices, prices change. In a closed economy of one country, the minimal price theorem (Lemma 4.1) implies that a system of prices and a system of production techniques exist such that the full cost of a production technique belonging to the latter system gives the minimal cost and is equal to the price of the product. In the case of international trade also, there exists a pair of an international value vector $\mathbf{v} = (\mathbf{w}, \mathbf{p})$ and a set of production techniques Γ such that (1) the full cost of a production technique of Γ is equal to the price of the product, (2) and the full cost of production techniques not belonging to Γ exceeds (or equals to) the price of the product, and (3) Γ forms a spanning tree as a competitive type. A finite number of such pairs may exist but for each of them a steady state economy exists. Even if final demand changes, wage rates and prices remain constant as far as there is no constraint by the shortage of labor force in one or more countries. This weak version of minimal price theorem indicates that each firm's judgment by production costs leads the whole system of production techniques Γ

to a more efficient one. Thus, the market system has a general tendency to lead the production system more efficient.

It is now evident that the prime mover in improving the real wage rate of a country is firms' efforts to reduce the production costs of their products. Do not confuse this reduction of production costs with the cost cut by reducing the wage rate. The first cost down is realized at constant values. This is possible only by changing input coefficients, in other words, only by the improvement of production technique. It is also important to note that the real wage rate depends on the concerted improvements in all industries.

There are two circuits which lead the real wage rate to rise. The first circuit is the (relative) reduction of the price of consumer goods. The price reduction of a consumer good contributes to the improvement through the reduction of prices relative to the wage rate. The second, but sometimes more important, circuit is the price reduction of input goods. If the good is a material that is used widely in productions, the effects of the price reduction propagate through the input cost reduction of many products and contribute to raise the real wage level.

The possibility of the second circuit suggests why the industrialization is generally preferred than agricultural and raw material improvements. In the case of agricultural products, as they are near to the final consumption, the effects of production improvements are confined to the first circuits. In the case of raw materials, the effects of the improvements will contribute to the general reduction of costs. However, if the domestic industry is not well developed, the effects of cost down of raw materials will only contribute to reduce the production costs of foreign industries. If a country succeeds to construct a cycle of basic input goods, productivity increase of an industry contributes to the productivity improvement of other industries. Then, a causal accumulative cycle emerges and gives impetus for a wider economic development.

Improvements of production process may contribute also to the rapid increase of the market for the product (or *débouché* in French). In particular, if the cost reduction of formerly imported goods makes the production of these goods competitive in the world market, this may contribute to gain the internal and world market for the goods. The increase of production volume generally contributes to the cost improvements, mainly through learning by producing, but also due to increasing returns to scale. This may produce a virtuous circle between the cost improvement and the growth of the

production volume. And this virtuous circle may spread through the industrial input-output relation network.

The productivity of a production mainly depends on the production process inside of the firm. It is most often the result of team work of workers and production site managers. On the other hand, however, if we consider transportation and transaction costs, social infrastructure and institutions influence the productivity of a country. In fact, in each time when the intermediate goods move from one production site to another, transportation costs are incurred and add up to the total cost. Information and communication network helps to reduce information and communication costs and increase the chance of successful trades and better deals. This business chance creation is not often counted as value creation, but plays the crucial role for firms' growth and by consequence for the economic growth of a country. It is evident that a good network of roads and ports contributes to the reduction of total productivity of the country.

At the side of infrastructures, institutions are also important factors which generate visible and invisible costs. If production and transfer require permits and approvals of administrative authorities, transaction cost in these processes will be substantial. Good social and economic institutions also contribute to pull down the markup rates, because they will generally help to increase competition within local markets. Anti-monopoly legislation and its effectiveness evidently promote competitive markets and help to reduce the general level of markup rates. Fair and just governments are also important, because corruption and bribery cost private firms enormously. Papers hint that the bribes may amount as high as 30 to 50% of the total costs in some corrupted countries.

The big discrepancies of wages between developed and developing countries come from the differences of set of production techniques, but they reflect social infrastructures both material and institutional. The best policy to raise the real wage rate is to enhance the productivity of production techniques. As the wage workers occupy the majority of working people in any capitalist economy, the policy to enhance real wage rate is the policy to bring up nation's per capita income. Topics mentioned above are familiar to all those people who have worked for economic development of developing countries. This suggests the effectiveness of the new theory of international values.

The difference with other trade theories is apparent. In fact, the policies that new theory indicates are very different from those indicated by the standard

Heckscher-Ohlin theory or other factor proportion theories including Heckscher-Ohlin-Vanek theory. Factor proportion theories focus on the capital/labor ratio, but not much on production techniques. In the worst case, they simply assume that production techniques are all the same across countries. It is quite natural that they do not inquire how to increase productivity or reduce production costs. Their main concern is the capital/labor ratio. The new theory mentions nothing on this ratio. For the new theory, capital/labor ratio is simply irrelevant for the improvement of real wage rate. As we have seen in Section 13 on Fragmentation, it is not the capital/labor ratio which should be the guide of business decision making. If the product (specification) is given, it is the unit production cost that determines which process is better.

Although the new theory of international values seems far better than factor proportion theories, it has still a weak point as a theory of wages. In section 3, we have assumed that labor force is homogeneous in any country. As this assumption is imperative to the theory construction, it cannot deal with problems of wage inequality inside of a country. This is because the classical value theory has yet no good theory of labor market.[41] The measure to bypass this lack of theory is to assume a constant wage ratio between different kinds of work forces. Then we can reduce different kinds of labor to a single labor force by giving weights to each labor by wages.

Here we also meet a sharp contrast between the new theory and factor proportion theory. Factor proportion theory rightly assumes two kinds of labor, for example, unskilled and skilled labor. With the aid of Stolper-Samuelson theorem, the standard theory can argue if the increased inequality of wages in some developed countries, including the U.S.A, by the deeper trade liberalization. This may be a strong point of factor proportion theory.

These two decades have seen an appearance of plenty of empirical and theoretical studies on the increased wage inequality (See for example Kurokawa, 2014). Many of them argued if this increase of wage inequality is related to trade liberalization and trade with low waged countries. Whether they argue for the trade influence or against it, they all refer to Stolper-Samuelson theorem, because this is only the established theory which permits to argue wage differences as effects of international trade. However, I feel a problem there. All argue wage differences but focus uniquely on internal wage disparity. It may be an important and polemical question. What about the wage

[41] See footnote 32 in section 6 (*the last in section 6*).

inequality between nations? These are as important questions as internal wage inequality. However, I could find only a few exceptions. Two manifest exceptions were Ruffin (2009) and Waugh (2010). He discussed how the globalization affects income inequality, both between countries and within countries. What does this state of economics stand for? This strongly indicates the absence, among mainstream economics, of a trade theory that can analyze international wage inequality. This proves at least the strength and uniqueness of the new theory, without asking truthfulness of the theory.

§ 15. International input-output table

World trade in intermediates goods rose in volume and in ratio in these two decades. The increasing global fragmentation of production process or trade in tasks engendered among international economists and policy makers a keen interest on the state and structure of global value chains. The interest has produced and is producing various stimulating studies. The investigation required a new approach of measuring trade such as Trade in Value Added (TiVA). This measurement became possible by the aid of international Input-Output Tables (IIOTs) and they stimulated in its turn compilations of worldwide IO tables.

The first attempt to compile multinational IO table was Leontief and his collaborators' United Nations' World Input-Output Model 1976.[42] In 1981 Institute of Development Economies (IDE, now IDE-JETRO) succeeded in compiling ASEAN International Input-Output Table 1975 and from 1992 started to publish Asia IO Tables covering each five years from 1985. Now there are a number of initiatives that are compiling large-scale global IOTs: GTAP (Global Trade Analysis Project), ICIOT (Inter Country Input output Tables) by OECD-WTO, WIOT (World Input Output Tables) by WIOD, MRIO (Multi Regional Input-Output database) by EORA and others.[43] They differ by their purpose, coverage, period, and openness.[44] In the following when I refer to international IO table, I take WIOT as the standard model because it is most open,

[42] The table covered 15 regions and 45 sectors of economic activity. See Cole 1977[2014], pp.20-21.
[43] Jones, Li and Degain (2014) gives comparison of first three global IOTs.
[44] GTAP is more oriented to build applied general equilibrium models, while ICIOT and WIOD provide data based on official public data and consistent with them. EXTIPOL and EORA aim to contribute to ecological policy. OECD and WTO now release the ICIOT as well as TiVA data that preceded the publication of the ICIOT.

richly documented and seems conceptually plausible (Timmer et al, 2015, Dietzenbacher et al. 2013, Timmer 2012).

It is almost evident that the new theory of international values is closely related to international input-output table. Let us remind the treatment when the transportation costs are positive (Section 9). In this case, it was necessary to distinguish goods by its location (in which country the product is located). In the M-country, N-good economy, we must distinguish $M\times N$ commodities. A production in a country consists of labor input and material inputs of goods coming from various countries. An input coefficient vector is then a set of an input coefficient of the labor of the country of production and $M\times N$ coefficients, each representing an input of good j in country i. If we are permitted to suppose that each good or product corresponds to an industry, we have exactly $M\times N$ vectors that express material inputs for any production technique. In the same way, World IO Table has the endogenous sector of the equal size: a square matrix of $M\times N$ rows and $M\times N$ columns.

We have here some minor difference between the new theory and IO tables. First, in IO tables, input means the value of inputted goods evaluated by the prices, i.e. the sum of corresponding quantity times price. In the theory of values, input stands for material quantity expressed by some physical units. Second, in IO tables, input vectors are expressed by column vectors while, in the new theory, we customarily expressed input coefficients by a row vector. The second difference is only a question of convention. We could start our discussion by putting input coefficient vectors to be columns. We only preferred them to be rows, because in the cost comparison it is more natural to compare the cost and the price of each product row by row. As a consequence of this difference of conventions, material inputs and value-added in an industry are expressed by columns in IO tables. A row vector in IO tables expresses how a product is divided in different uses. In section 3, the final demand vector is expressed by a row of different goods and difference of uses was not discussed there. To avoid these inconveniences, it is sufficient to take transposed expressions for all vectors and matrices in the formulation of RS economy.

Transportation requires a more cautious treatment. In section 9, we have argued that transportation can be interpreted as a production technique. As such it must satisfy the requirement that labor used for the transportation must be composed of labor of a single country (condition h). In the IO table, national or international, transportation is

tabulated with a special treatment. Let us imagine a transportation of a product P in China to Japan by a crew of Thai workers. As a production technique in the new theory, this is a production in Thailand that produces commodity P in Japan by inputting product P in China. In international IO tables, this is not interpreted as a production of commodity P in Japan, but as a combination of transportation service production in Thailand and a use by Japan of product P made in China. Thus, a single operation of transportation is divided into a couple of use and transportation service. This special treatment is made to avoid that all products passes through transportation industry. If we tabulate like this, we will loose from sight the material relationship between inputs and outputs. Then, main merit of IO tables will be lost. Similar treatment is done for the works of whole sale agents.

A commodity (i, j) requires a special interpretation. In international IO tables, a commodity with an index (i, j) does not designates the product j which is **located in** country i. It means a product j **made in** country i. Thus, a commodity in IIOTs is marked by country and industry, not of the location, but of the origin. When the product is used in a country k, transportation is required but this activity is tabulated as a production of transportation service (possibly by a third country) and used by the country of consumption k. This interpretation is in accordance with the convention that all trade flows are expressed in FOB (free on board) prices.

Some other conceptual differences between international IO tables and the new theory of international values come from the fact that an IO table has a fixed accounting period. For example, investment in fixed capital and its depreciation is not tabulated as inputs and outputs in the endogenous sectors. Investments are compiled in a column of final use and depreciation is included among rows of value added. The new theory of international value has more flexible point view and can argue, as I have done in section 8, formation and cost imputation of fixed capital goods as something like outputs and inputs. They are actual questions to be treated theoretically but they cannot conveniently be treated in a year by year base statistics. There are methods of imputation but it may introduce arbitrariness in figures and it is custom to avoid this kind of imputations.

In spite of some of these conceptual differences, the new theory has an advantage of being well matched with the accounting framework of the IIOTs. The IIOTs give the new theory a possibility to get empirical basis in developing concrete analysis based on

statistical figures. IIOTs will be the best possible “experiments” for the new theory to judge if it can be employed usefully in analyzing and understanding the actual economy. On the other hand, IIOTs can use the new theory as a background theory. It may contribute to know the deep basis of facts that an IIOT represents.

The key consideration concerns the fixedness of input coefficients of a IIOT. In the case of national IOTs, in which we can plausibly assume the labor homogeneity, we had the minimal price theorem (Lemma 4.1). In this case, the theorem proves that there is a set of production techniques that gives the minimal price if the wage rate w is given. When this theorem holds, there are no known production techniques which can replace (or undersell) actually competitive techniques. Thus the theorem assures the price stability and no input substitution. If we neglect those cases where two production techniques have the same cost, we can safely suppose that input coefficients remain constant even if the demand composition changes. This theorem gives theoretical basis to distinguish the change of input coefficients and the change of volumes of inputs. If input coefficients remain constant, we may estimate various quantities and values based on constant coefficient hypothesis when the production volume changes. This is worth noting, because many concepts such as Trade in Value-Added are implicitly constructed on this assumption.

In the case of international economy, we have no simple version of minimal price theorem. Instead, we have theorem 3.4. Interpretation of this theorem is more subtle than the minimal price theorem, but the theorem assures the existence of a system of competitive production techniques. If the production is possible with this system within the given labor forces, there is no necessity for international values and production techniques to change when the production volume changes provided that productions remain within the capacity of capital installment and labor. No such assertion is provided by factor proportion theories such as HOV theory.

The transportation flow may illustrate the present question. We can consider as an ideal limit of globalization an economy in which transportation is all free. In such an idealized (but of course unrealistic) M-country, N-good economy, the most probable state has $M+N-1$ competitive production techniques. We can imbed this economy in the IIOT framework. If productions and final demands are determined, trade flows can have various solutions as I have noted in Remark 3.6. In this idealized but fictitious economy, trade flows may change freely within a certain transportation polytope. Within this

degree of freedom, even the trade pattern may change. The existence of (or the possibility of compiling) an IIOT does not automatically signify the constancy of its input coefficients. It needs theoretical background to suppose it. If transportation cost is positive, the transportation will be more stable, because the cost differs with a route and a method of transportation.

WIOT as well as other IIOT distinguish commodities by countries and industry of origin. Thus it has $M\times N$ entries as inputs and outputs. The endogenous part of the table is a square matrix of $M\times N$ rows and columns. Dividing each row by the total production of the row, we get input coefficient matrix A. Let I be identity matrix of order $M\times N$. Then by the famous Hawkins-Simon theorem, the matrix $I-A$ is non-negatively invertible.[45] The inverse matrix is $(I-A)^{-1}$ is called Leontief inverse matrix.

The existence of Leontief inverse matrix is a great merit to treat commodity as distinguished by country and product of origin. It gives a simple device of calculating the total outputs that produces a given net output vector. Using this tool, we can define various important concepts.

Let $\mathbf{f}$ be the final use vector. We do not distinguish varieties of use class. All use of a commodity is summed up to a single total. Let $\mathbf{y}$ be the total activity vector that produces vector $\mathbf{f}$.[46] Then we have an equality:

$$\mathbf{f} = \mathbf{y} - A\mathbf{y} = (I - A)\mathbf{y}.$$

Multiplying $(I - A)^{-1}$ from left, we get

$$\mathbf{y} = (I - A)^{-1}\mathbf{f}.$$

Let $\mathbf{u}$ be the row vector that corresponds to unit productions. Then

$$\langle \mathbf{u}, \mathbf{y} \rangle = \Sigma_{(i,k)}\, u(i,j)\, y(i,j)$$

gives total value-added that is necessary to produce net output $\mathbf{f}$. This total can be divided to value-added in different countries. If $VA(k)$ is the part of country k,

$$\langle \mathbf{u}, \mathbf{y} \rangle = \Sigma_{(i,j)}\, u(i,j)\, y(i,j) = \Sigma_i \Sigma_k\, u(i,j)\, y(i,j) = VA(\mathbf{f}, 1) + VA(\mathbf{f}, 2) + \ldots + VA(\mathbf{f}, M).$$

On the other hand, let $\mathbf{p}$ be the price vector (row vector). Then

$$\mathbf{u} + \mathbf{p}A = \mathbf{p},$$

because each production technique must be competitive. We can write this as follows:

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[45] This follows from the fact that each column has a positive value added. Final use may be 0 for all entries in a row if the commodity is purely intermediate goods.

[46] Here, $\mathbf{f}$ and $\mathbf{y}$ are column vectors to make them consistent with the IO-table expression of matrix A. Consequently, matrix A corresponds to the transposed of the input coefficients matrix in the new theory.

$$\mathbf{p} = \mathbf{u}\,(I - A)^{-1}.$$

This means that

$$\langle \mathbf{u}, \mathbf{y} \rangle = \langle \mathbf{u}, (I - A)^{-1}\mathbf{f} \rangle = \langle \mathbf{u}\,(I - A)^{-1}, \mathbf{f} \rangle = \langle \mathbf{p}, \mathbf{f} \rangle .$$

Thus, the total value $TV(\mathbf{f})$of vector $\mathbf{f}$ can be divided to each country's total value-added, or

$$TV(\mathbf{f}) = VA(\mathbf{f}, 1) + VA(\mathbf{f}, 2) + \ldots + VA(\mathbf{f}, M). \qquad (15\text{-}1)$$

If $\mathbf{f}$ is the export from country i, then (15-1) expresses how the total export value is composed of each country's value-added. Each term of the right member of (15-1) is non-negative, because $\mathbf{f}$, $(I - A)^{-1}$ and $\mathbf{u}$ are all non-negative. Country i's value added divided by the total export is called *value added export ratio* (Timmer et al. 2015,). It is expressed by

$$VA(\mathbf{f}, i) \,/\, TV(\mathbf{f}).$$

Evidently the value added export ratio is less than 1 (except the case that all export products are made without using any imported inputs).

If $\mathbf{f}$ expresses the total production of a product, e.g. automotives, (15-1) expresses the each country's income in the world production of the product. *Value added share* in the world production is given by dividing each term of the right member by the total production i.e. the left member.

An import of a country may include some portion of value added of the importing country. When $\mathbf{f}_M$ is the import vector of country i and $\mathbf{f}_X$ is the export vector, let $TV(\mathbf{f}_M, i)$ and $TV(\mathbf{f}_X, i)$ be the part of value added for country i included respectively in the import and the export. The net export value added of the country is

$$TV(\mathbf{f}_X, i) - TV(\mathbf{f}_M, i).$$

Other useful concepts can be derived in the similar way.

When value added can be classified into several different categories such as low skilled workers, medium skilled workers, high skilled workers, and capital services (comprising profit and depreciation), the value added in the global value chain can be divided into the sum of value added for each category. Indeed, let $\mathbf{u}(\mathrm{l})$, $\mathbf{u}(\mathrm{m})$, $\mathbf{u}(\mathrm{h})$ and $\mathbf{u}(\mathrm{c})$ be the corresponding value added for the unit production of commodity (i, j), we have

$$\mathbf{u} = \mathbf{u}(\mathrm{l}) + \mathbf{u}(\mathrm{m}) + \mathbf{u}(\mathrm{h}) + \mathbf{u}(\mathrm{c}).$$

It is evident that we can define each country's contribution of each category to the total production. We can interpret this decomposition as value-added in trade. Value-added in trade is conserved for each category. What is interpreted as factor content of a

commodity in Hechscher-Ohlin-Vanek theory has a good chance to have misinterpreted these relations. This theory often assumes that factor proportions of all countries can determine the international trade flows. However, it is evident that they have no such causalities if we observe that there are far more number of commodities than the number of different production factors.

Division Ⅴ Some implications to other fields

The impact of the new theory does not stay inside of international trade theory. In sections 16 and 18, we discuss implications to two fields of economics theory. The theory was developed on a new vision on how market economy works. Although it is new and extremely different from the dominant equilibrium framework, the idea can go back to classical economics. Section 16 argues the rational core of classical value theory and the common base between two theories. Section 18 is in part a continuation of section 14. The question of international wage inequality was always in the core of development economics but the traditional theory of international trade has not provided a suitable theory to discus it. The new theory has a strong message on this question and development economics must have something to inspire it. Section 17 picks up international political economy. This new science emerged by the inability of traditional trade theory to analyze the cause of trade conflicts and others. The new theory may provide an economic basis to this science, which is hitherto principally a political science in spite of its name..

§ 16. Classical theory of value

Classical theory of value has a close relationship with the new theory of international values.[47] There are many theories of value in the classical political economy period. A single economist held two different versions of value. For example, Adam Smith held two ideas: labor theory of value and labor command theory of value. Other political economists, such as Jean B. Say had his version of utility theory of value. Law of demand and supply existed before Smith and persisted throughout the classical era of economics. Ricardo was often interpreted as preaching labor theory of value but his core theory was what we can now call *cost-of-production theory of value* (Takenaga 2004). By

[47] As I have written an independent paper on this theme (Shiozawa, 2016), I will be brief in this section.

the expression classical theory of value I will mean Ricardo's cost-of-production theory of value.

Classical theory of value and the neoclassical theory of value stand in opposition. The most important transition from classical political economy to neoclassical economics is, as Hicks put it, the change of attention from production to exchange. Value theory was at the center of this change. Classical theory of value viewed that the value of a commodity is determined by the conditions of production. Neoclassical theory of value viewed that the value is determined by demand and supply and demand by psychological factors. The shift from classical to neoclassical economics was the shift from objective to subjective theory of values.

Classical theory of value had many good points but the neoclassical theory of value replaced it. Why was classical theory of value defeated? What were the defects of the classical theory? In my opinion, the most important defect was that it lacked a theory of international values. As I have argued in section 2, John Stuart Mill intending to solve the problem that Ricardo left unsolved opened the way to the reversion to law of demand and supply, that is, the old common wisdom. However, classical theory of value has a good chance to revive.

Under the influence of Keynesian ideas, economics of the 20 century discovered fix-price economy, markup pricing, quantity adjustment and input-output table. By the construction of the new theory of international values, intellectual power balance has changed. In these one and a half centuries classical economics was on the defensive. It is now time to counterattack. After Lehman Brothers collapsed, many people, economists and non-economists, are starting to doubt if the economics is running toward a right direction. Students are asking more pluralistic education and a substantial number of established economists are now reconsidering economics.[48] The new theory of international values may play an important part in this rethinking of economics.

[48] *International Student Initiative for Pluralism in Economics* is a network of students grouped in various groups having names like *Rethinking Economics* and others and spreading over more than 30 countries. They are aiming to "demystify, diversify and invigorate economics." *Institute for New Economic Thinking* is an open forum composed of more professional economists.

§ 17. International political economy

International political economy (IPE) treats wide variety of topics concerning international relations. I here confine myself on the discussion concerning international trade conflicts. IPE pick up problems which we can call trade conflicts. It is natural if IPE is a part of political science, because political science is always concerned with conflicts. However, IPE is also a part of economics. The problem comes from the fact that standard international economics does not in principle admit trade conflicts.

Economists in the neoclassical traditions, or those who think in the framework of general equilibrium, do not admit the existence of trade conflicts. If they admit, they say that those are only a transitory events and all goes well in the end. Paul Krugman, one of most prestigious trade theorists and a famous polemicist in New York Times, once wrote a paper with the title The Illusion of Conflict in International Trade (Krugman 1997, chapter 5). This means that IPE has no support from the part of international economics. We can even say that IPE emerged because no economists argue or analyze trade conflicts. However, the intellectual situation changed much by the emergence of the new theory of international values. The new theory stands on a different strand from neoclassical economics. It is a theory that positively affirms unemployment. Theorem 4.3 is an example. The new theory of international values may provide a powerful economic tool to IPE.

As an illustration of above contention, let us cite Thomas Oatley (2004). This is a book compiled by a successful textbook writer in IPE. It intends to give students chances to reflect on the crucial questions in IPE. Topics in IPE are always polemic, because it focuses on issues in which opinions are divided widely and deeply. The book presents two opposing stands and asks students to reflect on this divergence. The sample chapter is illustrating.[49] It opposes Robert E. Scott and Douglas A. Irwin. The former argues that trade deficits indicate job loss and the latter defends that there is no job loss caused by free trade agreement. This reveals the strength and weakness of IPE. In the mainstream economics textbook does not treat this problem in this symmetric way. There are occasional mentions on the popular opinions but passes by emphasizing that they are misconceived.

[49] The chapter is titled Trade and Job in the United States (Part II Chapter 1). You can download it from ResearchGate. Short introduction by Oately is followed by Robert E. Scott's paper Manufacturing Decline are the Legacies of NAFTA and the WTO and Douglas A. Irwin's The Employment Rationale for Trade Protection.

In Thomas Oatley (2004), Irwin contends that

> the overall impact of trade on the number of jobs in an economy is best approximated as zero. Total employment is not a function of international trade, but the number of people in the labor force. (OatleyIrwin, 2004, p.27)

Here Irwin simply repeats the claim he made in his book *Free Trade under Fire*, (2002, p.115. All his arguments are constructed on the framework of general equilibrium (GE). In this framework, there is no unemployment. One of fundamental assumptions in GE model is the efficient use of all resources, which includes labor force as one of them. This is what Irwin supposes and what he deduces as a conclusion. This is but a petitio principii.

Scott's arguments and analysis follow the IPE tradition and are based on real or supposed conflicts of interests. It is less dogmatic and reflects the existing psychology of the society. This is the strength of the IPE. It is more close to the actually existing conflicts. It reveals also the weakness of the IPE, because, although it raises the question rightly, it cannot go deep in the economics arguments and criticize it. It is necessary that IPE produces or provides a theory that is alternative to the existing economic explanations. The new theory of international values may provide such a necessary framework for IPE.

§ 18. Development economics

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 were 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 (1998) showed, based on a 1992 cross-country study 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, South East Asia, China and India revealed that unexpected process was happening in these countries and areas and it helped much to bypass the classical dilemma: causally circular conditionals of economic development. Before that era, industrialization required that a whole set of industries are developed. When such nexus of products and techniques is lacking, it was difficult for an industry to develop alone. In the case of above cited Asian countries, foreign trade made it possible to separate one 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 and speeds.[50] 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.

[50] We have treated the logic of unbundling in section 12.

In spite of this important absence 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.

Although there were various evidences that refute factor proportion theory (or HOS and HOV theories) and few people believe their economic relevance, economists continue to recommend policies that rely on factor proportion arguments. Even those economists who are critical of mainstream economics sometime argue on this line.

Take an example of high technology industries in India. Is it not good to develop these industries as possible export industries, because India is still labor abundant country? India is a big country which has a biggest army of skilled engineers and proportionally small capital/labor ratio. If we follow what the factor proportion theory recommends, it would be advisable to concentrate to industries that have lesser capital labor ratios. The new theory of international value shows another possibility. It would be wise to develop any industries which can produce a product (of a given quality) with a competitive cost given the actual wage disparity between India and other more developed countries. For example, a cutting-edge industry that employs a relatively high rate of capitals and requires substantial number skilled engineers can be highly competitive, if labor cost of skilled engineers is one third of that of the United States of America. In this case, factor proportion theory gives completely wrong recommendation. The new theory of international values is a theory that analyses the competiveness on the firm level. It gives a more plausible policy recommendation than the factor proportion theory that only considers country wise differences of factors.

The lack of appropriate theory of trade once oriented development economics in a wrong direction. Typical case was the dependency theory. People in this theory worried that the terms of trade for developing countries are worsening. They recommended import substitution industrialization policy.[51] Emmanuel (1969)'s theory of unequal exchange gave a raison for their orientations. Dependency theorists argued that high wage of developed countries worsens the terms of trade for less developed countries. It is evident

[51] I do not deny that import substitution industrialization policy had some plausibility. Given the economic structure that is totally dependent on the former colonial powers, it was necessary to change it into more independent and internally self-supporting and circulating economy. For that purpose some measures to exclude foreign commodities were justifiable. I am here questioning their implicit theory of international values.

that they were thinking just like John Stuart Mill. For Mill the terms of trade are not determined by production relations but by law of demand and supply. Dependency theorists thought that this terms of trade is determined in final account by power relations between developed and developing 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 each country possesses. This is not to claim that institutions or knowledge do not matter. They are important factors which determine the present set of production techniques. There are many other factors which influence the state of technologies of each country. For example, the infrastructure of the society helps to reduce transport cost and make production techniques more efficient. 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. We cannot change them by trade policy. Terms of trade reflect wage disparity between countries and not vice versa as Emmanuel imagined. To improve them, we should improve production techniques. This is the direct lesson from the new theory of international values.

Low wage rate itself is a bad thing but it can serve as powerful arm for exportation. Using these arms make the export oriented industrialization possible. Even in this case, initial production experience is crucial. Japan, four little tigers, China, India and Southeast Asian countries accumulated this social ability in very different ways. In the prewar Japanese case, it was the flying geese pattern. Korea followed similar path like Japan. Taiwan accumulated experience by contract manufacturing. Southeast countries gained it by manufacturing connected with foreign direct investment. China and India kept their economy rather closed for a long time. They have accumulated their potential and in 1990's they have opened their countries. In all cases, processing trade in the wide sense (in the Japanese sense of kakō bōeki, see footnote 37 *the last of Section 12) has been a key-concept in trade policy. It is astonishing that trade theory lacked this concept until 1990's. An easy explanation is the influence of trade theory. Input trade (or trade of intermediate goods) was excluded in the trade theory. It may have retarded the recognition of input trade and strategic importance of processing trade.

Development economics requires a good trade theory. The new theory of international values may provide such a new theory that it needs, because it is the unique general

theory which can treat input trade. Exceptions may be those trade theories based on general equilibrium framework, but we may contend with reasons that general equilibrium theory is not a good framework for development economics.

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