Labor Value and Exploitation in the Global Economy

Hagiwara, Taiji

(Citation)
Return of Marxian Macro-Dynamics in East Asia (Research in Political Economy, Volume 32):15-37

(Issue Date)
2017-08

(Resource Type)
book part

(Version)
Accepted Manuscript

(URL)
https://hdl.handle.net/20.500.14094/90004720

Labour Value and Exploitation in the Global Economy

Taiji Hagiwara
Graduate School of Economics
Kobe University, Japan
hagiwara@econ.kobe-u.ac.jp

Abstract

This paper discusses labour value and the rate of exploitation in the global economy using international input-output tables. Labour value is defined as the multiplication of the labour coefficient and Leontief inverse. Exploitation means that the amount of labour embodied in the received wage commodity is less than the amount of the labour actually sold. Therefore, the Fundamental Marxian Theorem, which states that the conditions for the existence of profit and those for the existence of exploitation are the same, should be modified to stipulate that the existence of profit requires exploitation in at least one country. In other words, exploitation may not exist in some countries (non-exploitation). In the context of international input-output tables, we introduce the concept of global labour value, which is the vector of embodied labour in various countries. In the empirical study using an international input-output table, we find that (1) there are non-exploitation cases in several countries. (2) During the time period 1995–2009, the rate of exploitation increased in Asian countries, namely China, Japan, Korea and Taiwan, whereas the advanced countries other than Asia faced a decreased rate of exploitation.

1. Introduction

In classical economics, including Marx, labour *value* was considered as a good proxy for price. Since the marginal revolution, economists have explained prices as being determined by demand and supply, and the concept of labour value was thought to be obsolete. But Marx found a more important role for labour value as a good tool to explain the existence of exploitation. He insisted that the existence of profit is conditioned by the existence of exploitation.

According to Marx, labour value is the sum of *living labour* and *dead labour*. While the notion of *living labour* is obvious, that of *dead labour* is arguable. *Dead labour* is the value of *constant capital* which is *circulation capital* (intermediate input) and *fixed capital*. However, measuring the value of a commodity requires a value for *constant capital*. Okishio (1955) formulated this as labour value in his system of equations, using the input-output framework developed by Leontief (1941) which he then proved mathematically. Later, Morishima (1973) named this the *Fundamental Marxian Theorem*.

Among numerous discussions on the Theorem, two points receive the maximum attention. The first point is joint production which means that multiple outputs are produced in single production activity. However, many cases of joint production except fixed capital seem to have less importance in the real economy. Fixed capital, in turn, can be treated in a more simplified way.

The second point is heterogeneity of labour. There are various kinds of jobs, whose skill levels vary. However, if not unified as simple labour, the Theorem may not hold. Okishio (1965) showed how various labour types can be unified by incorporating training labour. Bowles and Gintis (1978) took another approach and proved that although some types of labour may not be exploited, at least one kind of labour must be exploited in order for profit to exist under a heterogeneous labour situation. This paper aims to expand on this approach by using international input-output (IO) tables to determine the existence of non-exploited labour in several Asian countries.

Various empirical studies have used input-output tables, for example, Okishio (1958), Gupta and Steedman (1971), Nakatani (1984), Ochoa (1984), Nakajima and Izumi(1995), Fröhlich (2012) and so on. Some compromises are required when using these tables in an empirical study. One important compromise is international trade. Until the 1980s, only single-country IO tables existed. In a single-country IO table, economic transactions are not closed within the country. The labour value of import commodities must be defined. Okishio (1958) assumed that this equals the labour value of export commodities, for which the monetary value is the same as that of imports.

When international input-output tables were first planned, Katano (1984) tried to formulate labour value in the international IO framework but this attempt was incomplete. Nakatani-Hagiwara (1984) defined global labour value and expanded the Marxian Fundamental Theorem as heterogeneous labour value (Bowles and Gintis 1977) Hagiwara (2004) examined global labour using Japan-USA-Asia-Europe international IO tables 1985–1990 and found that the labour value of Japan’s labourers’ wage commodity basket is larger than their working hours. Following this approach of using international IO tables to measure labour value across countries, this paper uses IO tables to investigate the presence of non-exploited labour in several Asian countries.

2. Labour value and exploitation in a single economy

labour value is defined as the labour embodied in one commodity. In the commodity's production process, labour is incorporated as direct labour. In addition, the commodity is used as intermediate input or fixed capital. Intermediate input and fixed capital are also, in turn, products of labour, intermediate input and fixed capital, and so on. Although such calculations may seem to go back indefinitely, labour value is solved in a system of equations.

2-1. Labour Value in a single economy

Suppose there are *N* commodities. Each commodity needs some commodity and labour inputs. That is, a_{ij} units of commodity[1] i and τ_j units of labour are required to produce one unit commodity j

$$1 \leftarrow \left(a_{1j}, a_{2j}, \ldots, a_{Nj}, \tau_j\right), \quad 0 \le a_{ij}, 0 < \tau_j$$

Labour value, t, is defined as

$$t_j = \sum_i t_i a_{ij} + \tau_j$$

Labour value t_j represents the total labour inputs needed to produce commodity j and may therefore be considered the labour embodied in commodity j. In the matrix form,

$$\mathbf{t} = \mathbf{tA} + \boldsymbol{\tau} \tag{1}$$

where

$$\mathbf{A} \equiv \begin{pmatrix} a_{11} & \cdots & a_{1N} \\ \vdots & \ddots & \vdots \\ a_{N1} & \cdots & a_{NN} \end{pmatrix}, \quad \boldsymbol{\tau} \equiv \left(\tau_1, \ldots, \tau_N\right), \quad \mathbf{t} \equiv \left(t_1, \ldots, t_N\right)$$

Its solution is

---

[1] The input coefficient generally used in input-output analysis is an intermediate input coefficient. In this paper, the input coefficient is defined as intermediate input coefficient plus fixed capital consumption per output. Consumption of fixed capital of the *i*th commodity in the *j*th sector is defined as the *i*th share of capital formation multiplied by the rate of depreciation.

$$\mathbf{t} = \boldsymbol{\tau}(\mathbf{I_N} - \mathbf{A})^{-1} \tag{2}$$

where $\boldsymbol{I_N}$ represents an N × N identity matrix. Since the reciprocal of labour value shows the amount of product produced by a unit of labour either directly or indirectly, $1/t_j$ can be called labour productivity. In the context of input-output analysis, labour value can be called an employment multiplier. Labour value t is positive if the matrix $(\mathbf{I_N} - \mathbf{A})$ satisfies the Hawkins- Simon condition.[2]

2-2 Conditions for profit's existence in a single economy

Profit in each sector should be positive.

$$0 < \pi_j = p_j - \sum_i p_i a_{ij} - w\tau_j$$

where p_j is the output price of sector j, and w is the nominal wage rate. In matrix form,

$$0 < \boldsymbol{\pi} = \mathbf{p} - \mathbf{pA} - w\boldsymbol{\tau} \tag{3}$$

where $\mathbf{p} \equiv (p_1, \ldots, p_N)$.

Wage labourers purchase certain amounts of consumption commodities (wage basket)

$$\mathbf{b} \equiv (b_1, \ldots, b_N)'$$

$$w = \mathbf{pb} \tag{4}$$

Substituting (4) for (3), we get

$$0 < \mathbf{p}(\mathbf{I_N} - \mathbf{A} - \mathbf{b}\boldsymbol{\tau}) \tag{5}$$

Prices must satisfy inequality (5). Therefore, the matrix $(\mathbf{I_N} - \mathbf{A} - \mathbf{b}\boldsymbol{\tau})$ must satisfy the Hawkins-Simon condition.

2-3 Exploitation in a single economy

---

[2] Assuming a square matrix **H** with a positive diagonal and non-positive off-diagonal and vector **b**, the Hawkins-Simon theorem states following four conditions are equivalent:
(1) $\mathbf{Hx} = \mathbf{b}$ has a non-negative solution $\mathbf{x} \geq \mathbf{0}$ for some $\mathbf{b} > \mathbf{0}$,
(2) $\mathbf{Hx} = \mathbf{b}$ has a non-negative solution $\mathbf{x} \geq \mathbf{0}$ for any $\mathbf{b} \geq \mathbf{0}$,
(3) Any principal minor of **H** is positive (Hawkins-Simon Condition) and
(4) The inverse of **H** is non-negative.

From the viewpoint of demand and supply, it is possible to choose some positive output vector (*x*) such that surplus product (*z*) is positive in all sectors.

$$0 < z = x - \mathbf{A}x - \mathbf{b\tau}x = (\mathbf{I_N} - \mathbf{A} - \mathbf{b\tau})x \quad (6)$$

The condition for a positive output (*x*) in all sectors to produce surplus product (*z*) is that the matrix $(\mathbf{I_N} - \mathbf{A} - \mathbf{b\tau})$ satisfies the Hawkins-Simon condition, which is equivalent to the condition for positive prices to exist as positive profit in all sectors.

Multiplying (6) with labour value (*t*) from the left, we get

$$0 < \mathbf{tz} = \mathbf{t}(\mathbf{I_N} - \mathbf{A} - \mathbf{b\tau})x = \mathbf{t}(\mathbf{I_N} - \mathbf{A})x - \mathbf{tb\tau}x = \boldsymbol{\tau}x - \mathbf{tb\tau}x = (1 - \mathbf{tb})\boldsymbol{\tau}x \quad (7)$$

Since total employment (τx) is positive, *tb* must be less than unity:

$$0 < 1 - \mathbf{tb} \quad (8)$$

Here, $\mathbf{tb} = \sum_i t_i b_i$ is the sum of labour value embodied in wage basket (*b*). Unity means one unit of labour is sold. Since *b* is the wage basket a labourer received by selling one unit of his/her own labour and *t* is amount of labour embodied in each commodity, *tb* means the amount of labour embodied in the wage basket. Therefore, (8) means the amount of the worker's labour embodied in the wage basket by selling his/her labour is smaller than amount of labour that he/she sold. That is, exploitation, i.e. the worker not receiving the full value created by his or her labour, exists. The rate of exploitation is defined as a fraction of surplus value (*1-tb*) and variable capital (*tb*)

$$e = (1 - \mathbf{tb})/\mathbf{tb} \quad (9)$$

The so-called *Fundamental Marxian Theorem* states the condition of profit's existence is equivalent with the condition of exploitation's existence.

2-4 Measuring labour value in single economy

Several researches have addressed the estimation of labour value in the context described above. First was Okishio (1958), followed by Okishio and Nakatani (1985), and Nakajima and Izumi (1995). Another stream is Gupta and Steedman (1971), Ochoa (1984), Fröhlich (2012) and so on. When applying input-output tables to labour value measurement, Okishio (1958) noted three points.

First, he noted that the difference between the physical term and monetary term. Input-output tables are measured in terms of money, whereas labour value is measured in physical terms, because labour value should be independent from price. Monetary input-output tables from the cost side are

$$p_j x_j = \sum_i p_i a_{ij} x_j + w\tau_j x_j$$

Dividing by the monetary amount of output, $p_j x_j$, we get

$$1 = \sum_i \frac{p_i a_{ij}}{p_j} + \frac{w\tau_j}{p_j}$$

The input coefficient used in input-output analysis is the product of a physical input coefficient (a_{ij}) and relative price (p_i/p_j), and the labour coefficient is the quotient of the physical labour coefficient (τ_j) divided by price (p_j)

$$a_{ij}^* = p_i a_{ij} / p_j \quad \tau_j^* = \tau_j / p_j \qquad A^* = \hat{p} A \hat{p}^{-1}, \quad \tau^* = \tau\hat{p}^{-1}$$

where the symbol ^ indicates a diagonal matrix. The solution of (1) with monetary coefficient A^* and τ^* is

$$t^* = t^* A^* + \tau^* \tag{10}$$

$$t^* = t^* \hat{p} A \hat{p}^{-1} + \tau\hat{p}^{-1}$$

Multiplying with diagonal p from the right yields

$$t^* \hat{p} = At^* \hat{p} + \tau \tag{11}$$

Comparing (11) with (1), we get

$$t^* \hat{p} = t$$

This means that the solution to (10) is t_j/p_j, that is, the rate of unequal exchange. In the following analysis, the symbols A, τ and t are used as monetary terms, instead of A^*, τ^* and t^*.

The second point addresses the treatment of fixed capital. Input coefficients a_{ij} include only intermediate inputs. Using depreciation per output (d_j) as an approximation of the unit cost of fixed capital and sectoral share of investment (s^I_i) as the composition of capital, the cost of fixed capital is endogenized as follows:

$$t_j = \sum_i \left(a_{ij} + d_j s^I{}_i\right) t_i + \tau_j \tag{12}$$

The third point is the treatment of imports.[3] The labour value of domestic commodities is endogenously determined by (1), whereas the value of imported commodities is not. Okishio (1958) used the labour value of an exported commodity as the labour value of an imported commodity, that is, one monetary unit of imports is earned by one monetary unit of exports. Let m_j be the import coefficient of sector j and s^E_i be the share of exports. The labour value of the imported commodity is

[3] Researches in line with Sraffa(1960), like Gupta and Steedman (1971), Ochoa (1984) and Fröhlich (2012), neglected the labour value of imports. Steedman (2008) commented that the labour value of imports can be incorporated by using exports, an idea similar to that of Okishio (1958).

$$t_m = \sum_i s^E{}_i t_i \qquad\qquad t_m = s^E t$$

The labour value equation is modified as

$$\begin{aligned} t_j &= \sum_i a_{ij} t_i + a_{mj} t_m + \tau_j \\ &= \sum_i a_{ij} t_i + a_{mj} \sum_i s_i^E t_i + \tau_j \end{aligned}$$

In the matrix form, it reads

$$\begin{aligned} \mathbf{t} &= \mathbf{tA} + a_{\mathbf{m}} t_m + \boldsymbol{\tau} = \mathbf{tA} + a_{\mathbf{m}} \mathbf{s}^{\mathbf{E}} \mathbf{t} + \boldsymbol{\tau} \\ &= \mathbf{t}\left(\mathbf{A} + a_{\mathbf{m}} \mathbf{s}^{\mathbf{E}}\right) + \boldsymbol{\tau} \end{aligned} \tag{13}$$

Since export share, s^E, and import inputs, a_m, are measured in monetary terms, they reflect both export and import prices. That is, terms of trade will influence the value of imports. This treatment of imports was unavoidable when only single-country input-output tables were available.

Recently, in a reflection of the globalised economy, several international input-output tables have been compiled.[4] Labour value can be applied to the new situation described in the next section.

3 Global Economy

In this section, we discuss how the *Fundamental Marxian Theorem* should be modified in the international input-output framework. In short, we will treat labour as heterogeneous among countries due to substantial wage differences among countries.

3-1 Labour value in a global economy

We extend the concept of labour value in a global economy. There are *R* countries with *N* sectors in each country. Therefore, there are *RN* sectors in the world. Complete specialization is assumed. For example, the agricultural product produced in country *r* is different from that produced in country *s*.

One unit of production in sector *j* of country *s* requires a_{ij}^{rs} units of the commodity from sector *i* in country *r* and l_j^s units of labour from country *s*. In the matrix form, the input coefficient matrix is

[4] For example, the Institute of Development Economics (Japan) complied an Asia table covering China, Indonesia, Japan, Korea, Malaysia, Taiwan, the Philippines, Singapore, Thailand and the U.S.A. for 1985, 1990, 1995, 2000 and 2005 (Asian International Input-Output Project (2013). Groningen University compiled tables covering 40 countries during 1995 and 2009, WIOD, which we use in this research. Other data are GTAP (Hertel 1997) and EORA (Lenzen 2013).

$$\mathbf{A}^{rs} \equiv \begin{pmatrix} a_{11}^{rs} & \cdots & a_{1N}^{rs} \\ \vdots & \ddots & \vdots \\ a_{N1}^{rs} & \cdots & a_{NN}^{rs} \end{pmatrix}, \qquad \mathbf{A} \equiv \begin{pmatrix} \mathbf{A}^{11} & \cdots & \mathbf{A}^{1R} \\ \vdots & \ddots & \vdots \\ \mathbf{A}^{R1} & \cdots & \mathbf{A}^{RR} \end{pmatrix}$$

The direct labour coefficient vector of country *s* is

$$\boldsymbol{\tau}^{s} \equiv \left(\tau_1^s, \ldots, \tau_N^s\right)$$

Although it is possible to combine each country's labour coefficient in the same row, we locate each country's labour in a different row in order to treat them as different kind of labour, namely, heterogeneous labour.[5] Because each economy's wage level differs,[6]

$$\boldsymbol{\tau} \equiv \begin{pmatrix} \boldsymbol{\tau}^{1} & \cdots & \mathbf{0} \\ \vdots & \ddots & \vdots \\ \mathbf{0} & \cdots & \boldsymbol{\tau}^{R} \end{pmatrix}$$

Labour value is defined in the same way as (1).

$$\mathbf{T} \equiv \mathbf{TA} + \boldsymbol{\tau} \qquad (14)$$

where

$$\mathbf{t}^{rs} \equiv \left(t_1^{rs}, \ldots, t_N^{rs}\right) \qquad \mathbf{t}^{r} \equiv \left(\mathbf{t}^{r1}, \ldots, \mathbf{t}^{rR}\right) \qquad \mathbf{T} \equiv \begin{pmatrix} \mathbf{t}^{1} \\ \vdots \\ \mathbf{t}^{R} \end{pmatrix} = \begin{pmatrix} \mathbf{t}^{11} & \cdots & \mathbf{t}^{1R} \\ \vdots & \ddots & \vdots \\ \mathbf{t}^{R1} & \cdots & \mathbf{t}^{RR} \end{pmatrix}$$

Labour value is an R × RN matrix. t_j^{rs} represents one unit of the commodity of sector *j* in country *s* which embodies labour from country *r*. A commodity is a bundle of labour from various countries (t_j^{rs}, r=1, …R). We call the matrix **T** as global labour matrix.

3-2 Condition for profit's existence in global economy

The profit of industry *j* in country *s* (π_j^s) is determined by own output price (p_j^s), input prices (p_i^r, i=1,..,N, r=1,…,R) and wages (w^s) in addition to input coefficient (a_{ij}^{rs}) and labour coefficient (τ_j^s). The condition for positive profit to exist is

$$0 < \pi_j{}^s = p_j{}^s - \sum_r \sum_i p_i{}^r a_{ij}{}^{rs} - w^s \tau_j{}^s \qquad (15)$$

Using matrix notation, it is expressed as

---

5 Bowles and Gintis (1978)

6 Wage differences exist among labourers in a single economy, which are justified as the reflection of differences in labour quality. Although labour quality differences, like sklill level, between economies exist, it is not a major reason of international wage difference.

$$0 < \mathbf{p} - \mathbf{pA} - \mathbf{w\tau}$$

$$\mathbf{p}^s \equiv \left(p_1^s, \ldots, p_N^s\right), \qquad \mathbf{p} \equiv \left(\mathbf{p}^1, \ldots, \mathbf{p}^R\right), \quad \mathbf{w} \equiv \left(w^1, \ldots, w^R\right)$$

Labourers in country *s* purchase various countries' consumption commodities (b_i^{rs}, i=1,…,N, r=1,…,R) and the total cost for purchasing wage commodities equals the wage in country *s*:

$$w^s = \sum_r \sum_i p_i^r b_j^{rs}$$

In matrix notation, the wage basket is expressed as

$$\mathbf{b}^{rs} \equiv \begin{pmatrix} b_1^{rs} \\ \vdots \\ b_N^{rs} \end{pmatrix} \qquad \mathbf{b}^s \equiv \begin{pmatrix} \mathbf{b}^{1s} \\ \vdots \\ \mathbf{b}^{Rs} \end{pmatrix}$$

$$\mathbf{B} \equiv \left(\mathbf{b}^1 \quad \cdots \quad \mathbf{b}^R\right) = \begin{pmatrix} \mathbf{b}^{1s} & \cdots & \mathbf{b}^{1R} \\ \vdots & \ddots & \vdots \\ \mathbf{b}^{R1} & \cdots & \mathbf{b}^{RR} \end{pmatrix} \tag{16}$$

$$\mathbf{w} = \mathbf{pB} \tag{17}$$

The condition for profit's existence can be rewritten as

$$\mathbf{p}\left(\mathbf{I}_{RN} - \mathbf{A} - \mathbf{B\tau}\right) > \mathbf{0} \tag{18}$$

The condition for the existence of a positive price assuring a positive profit in all sectors is that the matrix $\left(\mathbf{I}_{RN} - \mathbf{A} - \mathbf{B\tau}\right)$ satisfies the Hawkins-Simon condition.

3-3 Exploitation in the global economy

Since matrix (18) satisfies the Hawkins-Simon condition, there exists a positive column vector of output (x) for any positive vector of surplus product (z):

$$\left(\mathbf{I}_{RN} - \mathbf{A} - \mathbf{B\tau}\right)x = \mathbf{z} > \mathbf{0}$$

Multiplying the global labour value matrix (**T**) from the left, we get

$$\begin{aligned} \mathbf{0} < \mathbf{Tz} &= \mathbf{T}\left(\mathbf{I}_{RN} - \mathbf{A} - \mathbf{B\tau}\right)x \\ &= \mathbf{T}\left(\mathbf{I}_{RN} - \mathbf{A}\right)x - \mathbf{TB\tau}x \\ &= \mathbf{\tau}x - \mathbf{TB\tau}x \\ &= \left(\mathbf{I}_R - \mathbf{TB}\right)\mathbf{\tau}x \end{aligned} \tag{19}$$

Although (19) looks similar to (8) in the previous section, $\mathbf{TB}$ is an R × R matrix and $\boldsymbol{\tau}\mathbf{x}$ is an R-dimensional column vector of each country's employment:

$$\mathbf{TB} = \left[\mathbf{t}^r\mathbf{b}^s\right] = \begin{pmatrix} \mathbf{t}^{11} & \cdots & \mathbf{t}^{1R} \\ \vdots & \ddots & \vdots \\ \mathbf{t}^{R1} & \cdots & \mathbf{t}^{RR} \end{pmatrix} \begin{pmatrix} \mathbf{b}^{11} & \cdots & \mathbf{b}^{1R} \\ \vdots & \ddots & \vdots \\ \mathbf{b}^{R1} & \cdots & \mathbf{b}^{RR} \end{pmatrix} \tag{20}$$

where the (r,s) factor of TB is $\boldsymbol{t}^r\boldsymbol{b}^s$. Since the vector of employment ($\boldsymbol{\tau}x$) is positive, the matrix

$$\left(\mathbf{I}_R - \mathbf{TB}\right) \tag{21}$$

satisfies the Hawkins-Simon condition.

What is the implication of (21) satisfying Hawkins-Simon condition? Consider its dual problem. Multiplying the positive row vector μ from the left, we get

$$\boldsymbol{\omega} \equiv \boldsymbol{\mu}\left(\mathbf{I}_R - \mathbf{TB}\right) \qquad \text{in scalar terms,} \quad \omega^s \equiv \mu^s - \sum_r \mu^s \mathbf{t}^r \mathbf{b}^s \tag{22}$$

where ω^s reflects the surplus value in country s evaluated by the conversion rate of labour (μ). If (21) satisfies the Hawkins-Simon condition, some conversion rate of labour (μ) exists, which generates a positive surplus value in all countries ($\omega^s > 0$ for all s). That is,

$$0 < \boldsymbol{\omega} = \boldsymbol{\mu}\left(\mathbf{I}_R - \mathbf{TB}\right) \qquad \text{In scalar terms,} \quad 0 < \omega^s = \mu^s - \sum_r \mu^s \mathbf{t}^r \mathbf{b}^s$$

It can be rewritten as

$$1 > \sum_r \frac{\mu^r}{\mu^s} \mathbf{t}^r \mathbf{b}^s \qquad \text{for all } s \tag{23}$$

Proposition

The condition for the existence of positive profit in global economy (18) is equivalent to the condition that there exists some conversion rate of labour (*μ*) in (23) such that labour is exploited in all countries.

To illustrate the proposition, we consider a two-country case:

$$\begin{cases} \omega^1 = \mu^1 - \left(\mu^1\mathbf{t}^1\mathbf{b}^1 + \mu^2\mathbf{t}^2\mathbf{b}^1\right) \\ \omega^2 = \mu^2 - \left(\mu^1\mathbf{t}^1\mathbf{b}^2 + \mu^2\mathbf{t}^2\mathbf{b}^2\right) \end{cases}$$

For a positive surplus of labour to exist in both the countries ($0 < \omega^1$ and $0 < \omega^2$), the conversion rate of labour (μ) must satisfy

$$\frac{\mathbf{t}^1\mathbf{b}^2}{1-\mathbf{t}^2\mathbf{b}^2} < \frac{\mu^2}{\mu^1} < \frac{1-\mathbf{t}^1\mathbf{b}^1}{\mathbf{t}^2\mathbf{b}^1} \tag{24}$$

If the conversion rate of labour (μ^2/μ^1) is lower than the lower bound $\frac{\mathbf{t}^1\mathbf{b}^2}{1-\mathbf{t}^2\mathbf{b}^2}$, surplus labour in country 2 is negative, whereas that in country 1 is positive ($\omega^2 < 0 < \omega^1$). If the conversion rate (μ^2/μ^1) is higher than the upper bound $\frac{1-\mathbf{t}^1\mathbf{b}^1}{\mathbf{t}^2\mathbf{b}^1}$, surplus labour in country 1 is negative, whereas that in country 2 is positive ($\omega^1 < 0 < \omega^2$). If the conversion rate of labour (μ^2/μ^1) is between the lower and upper bounds, surplus labour is positive in both countries ($0 < \omega^1$ and $0 < \omega^2$).

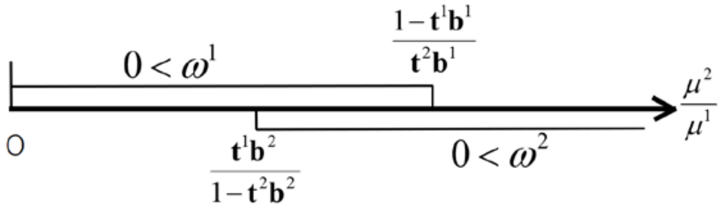

Figure 1 Conversion rate of labour and surplus value

The existence condition of the conversion rate of labour (μ^2/μ^1) needed to assure (23) is

$$\frac{\mathbf{t}^1\mathbf{b}^2}{1-\mathbf{t}^2\mathbf{b}^2} < \frac{1-\mathbf{t}^1\mathbf{b}^1}{\mathbf{t}^2\mathbf{b}^1}$$

That is,

$$0 < \left(1-\mathbf{t}^1\mathbf{b}^1\right)\left(1-\mathbf{t}^2\mathbf{b}^2\right) - \left(\mathbf{t}^1\mathbf{b}^2\right)\left(\mathbf{t}^2\mathbf{b}^1\right)$$

The right-hand side of inequality is a second-order principle minor of (21). Since the Hawkins-Simon condition requires any principal minor of (21) is positive, there exists some range of the conversion rate of labour (μ^2/μ^1) to assure the existence of (23).

The lower bound of the conversion rate of labour (μ^2/μ^1) in (24) increases as the wage basket in country 2 (***b²***) increases, and the upper bound decreases as the wage basket of country 1 (***b¹***) increases. If the wage basket (***b¹*** and/or ***b²***) increases enough, the Hawkins-Simon condition is violated and the range of the conversion rate of labour (μ^2/μ^1) satisfying the positive surplus labour conditions ($0 < \omega^1$ and $0 < \omega^2$) will diminish. Positive surplus labour exists exclusively in two countries. If the surplus value in country 1 is positive, that in country 2 is negative, and *vice versa*.

The important point is that the conversion rate of labour satisfying (23) is not always plausible. The possibility exists that some country's labourers enjoy a rich wage basket which embodies more labour than those labourers sold:

$$1 < \sum_r \frac{\mu^r}{\mu^s} \mathbf{t}^r \mathbf{b}^s \quad \text{for some s}$$

Even in this case, there exists at least one country in which labour is exploited:

$$1 > \sum_r \frac{\mu^r}{\mu^s} \mathbf{t}^r \mathbf{b}^s$$

If labourer is not exploited in all countries, the inequality $0 > \boldsymbol{\omega} = \boldsymbol{\mu}(\mathbf{I} - \mathbf{TB})$ holds, which contradicts (23)

Corollary 1

There exists some conversion rate of labour (*μ*) such that labour is not exploited in some countries. Nonetheless, there exists at least one country in which labour is exploited.

The rate of exploitation in country *s* (e^s) is

$$e^s \equiv \frac{\left(1 - \sum_r \sum_i (\mu^r / \mu^s) \mathbf{t}^r \mathbf{b}^s\right)}{\sum_r \sum_i (\mu^r / \mu^s) \mathbf{t}^r \mathbf{b}^s} = \frac{\left(\mu^s - \sum_r \sum_i \mu^r \, \mathbf{t}^r \mathbf{b}^s\right)}{\sum_r \sum_i \mu^r \mathbf{t}^r \mathbf{b}^s} = \frac{\omega^s}{1 - \omega^s} \qquad (25)$$

If the conversion rate of labour (μ) satisfies (23), the exploitation rate in all countries is positive. Conversely, there is a possibility that a plausible conversion rate of labour (μ) may not satisfy (23) and rate of exploitation is negative in some countries.

Another point is that the own-country's labour embodied in a worker's labour basket is less than unity independent from the choice of conversion rate of labour (μ):

$$0 < 1 - \mathbf{t}^s \mathbf{b}^s$$

The right-hand side of inequality is a first-order principle minor of (21). The Hawkins-Simon condition requires any principal minor of (21) to be positive. Therefore, the inequality holds.

Corollary 2

Whatever the conversion rate of labour (μ) is chosen, the own-country labour embodied in wage basket $t^s b^s$ is less than unity.

Since the total labour embodied in a wage basket is a country's own labour plus foreign labour, the own-country labour is its lower bound. The case of non-exploitation occurs when foreign labour is large due to the conversion rate of labour.

4. Empirical Study

In this section, we examine exploitation in the context of global labour using international input-output tables.

First, we need to specify the conversion rate of labour (μ). It is natural to assume that labour is the same across countries even if serious wage gaps exist; that is, the essential nature and value of labour in a rich country and that in poor country are the same. We employ a simple weight wherein the conversion rate for any country's labour equals unity.[7]

$$\mu = \iota_R \equiv (1,1,\ldots,1) \tag{26}$$

Then surplus value (22) is specified as

$$\boldsymbol{\omega} = \iota_R(\mathbf{I}_R - \mathbf{TB}) \qquad \text{in scalar term} \qquad \omega^s = 1 - \sum_r \mathbf{t}^r \mathbf{b}^s \tag{27}$$

It should be noted that (27) does not guarantee a positive surplus value in all countries ($\omega^s > 0$ for all s). As shown later, there are countries where the surplus value is negative.

Exploitation is the gap between the labour sold and the amount of labour purchased as wage commodity by selling his/her own labour. The amount of labour purchased by selling unit labour is expressed as the sum of the value of labour in the wage basket ($\sum_r \mathbf{t}^r \mathbf{b}^s$) in (27). If it is less than unity, exploitation prevails; otherwise labourers in the country enjoy being paid for more labour than he/she provides (non-exploitation).

4-1 Data

We use the World Input Output Database (WIOD)[8] which covers 40 countries and the rest of the world (RoW). It includes 27 EU countries (except Croatia), three NAFTA countries, four East Asian countries and six resource-rich countries. The 40 WIOD countries cover nearly 90% of global GDP and include major rich and large countries.

We aggregate countries into four separate countries and two regions: China, Japan, Korea,

---

[7] An alternative conversion rate of labour is a weight-reflecting skill level. The database explained later supplies hours worked by high-skilled, medium skilled and low-skilled persons, as classified by attained education. To apply this alternative, we need to determine the weight among these three skill levels.

[8] Timmer *et al.* (2015). Calculation based on WIOD release 2013.

Taiwan, Advanced Countries (ADCs hereafter) and Developing Countries (DVCs hereafter). The list of regions is given in Table 1. A total of 35 industry sectors are aggregated into nine sectors, namely, (1) agriculture, hunting, forestry and fishing; (2) mining and quarrying; (3) manufacturing; (4) electricity, gas and water Supply; (5) construction; (6) commerce; (7) transport and communication; (8) financial intermediation, real estate, renting and other business services and (9) other service. Using the previous year's price table, we constructed an input-output table with fixed prices (1995 prices).

Table 1 Definitions of countries and regions

Country and Region	Description
China	People's Republic of China
Japan	Japan
Korea	Republic of Korea
Taiwan	Republic of China
Advanced Countries (ADCs)	USA, Australia, Canada, EU15 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, UK)
Developing Countries (DVCs)	Brazil, India, Indonesia, Mexico, Russia, Turkey, EU12 (Bulgaria, Cyprus, Czech, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia)

WIOD does not serve consumption of fixed capital (CFC) by industry. We used statistics of United Nations and World Development Indicators (WDI) of the World Bank. UN statistics were used first; then, a cross-country average ratio of CFC to value added and the WDI macro ratio are used to fill in the missing data. Since those statistics are not disaggregated as in the WIOD, we assume that the WIOD ratio of depreciation to value added is common to UN statistics. WIOD has no data on labour and value added for Rest of the World. We therefore ignored labour of the Rest of the World. Therefore, the result shown below underestimates the real labour value.

Table 2 shows wage and labour hour differences among countries in 1995 and 2009. The top wage group was Japan and ADCs. Korea and Taiwan were the second group. The third group was China and DVCs. The wage level in the second group was around 40% of that of top group, whereas that in the third group was around 5% of that in the first group. Wages in China increased rapidly, whereas those in Japan stagnated in both nominal and real terms.

As for labour hour engaged, China and DVCs were the largest, followed by ADCs. Korea and Taiwan are the smallest group. While labour hour of China and DVCs increased more than 20%, that of Japan decreased.

Table 2 Wages and labour hours

		China	Japan	Korea	Taiwan	ADCs	DVCs
Nominal wage	1995	0.33	24.71	8.10	8.21	19.59	0.89
	2009	1.35	26.12	10.98	9.64	32.75	2.03
	Change rate	310%	6%	36%	17%	67%	129%
Real Wage	Change rate	137%	11%	42%	40%	26%	47%
Labor hour engaged	1995	1,215	128	51	22	541	1,512
	2009	1,556	106	54	22	592	1,821
	Change rate	28%	-17%	5%	0%	9%	20%

Source: Author's calculation using WIOD database

Unit: Nominal wage: US$ per hour. Labour hours engaged: trillion hours.

4-2 Composition of wage basket in terms of global labour value

The labour embodied in the wage basket ($\boldsymbol{t^r b^s}$) in 1995 and 2009 is shown in Table 3. The sum of labour embodied ($\boldsymbol{\Sigma_r t^r b^s}$) is less than unity in China, Taiwan and DVCs, whereas Japan, Korea and ADCs exceed unity (non-exploitation case). Labourers in the latter countries purchase wage commodities which embody more labour than they sold their labour. The rate of exploitation is negative. Labour embodied in the wage basket of Asian countries decreased during the period 1995–2009, whereas that of ADCs and DVCs increased. In other words, the rate of exploitation increased in the four Asian countries, whereas it decreased in ADCs and DVCs.

Own-country labour embodied in the wage basket ($\boldsymbol{t^s b^s}$) diagonal factor in Table 3 is the largest among column countries. It is less than unity, between 0.47–0.80, which is consistent with the *Fundamental Marxian Theorem* in a global economy. Own-country labour increased in ADCs and DVCs but decreased in Asian countries during the period 1995–2009.

Regarding the foreign labour in a country's wage basket, the sum of the off-diagonal factors ($\boldsymbol{\Sigma_{r \neq s} t^r b^s}$) for labour in China and the DVCs are largely embodied in these countries' wage baskets. Since China (top row) and DVCs (bottom row) have large labour forces and low wages, more advanced countries take advantage. The share of Chinese labour embodied in the Japanese wage basket ($\boldsymbol{t^{China} b^{Japan}}$) is around 0.287 and 0.268. In Korea and ADCs, the share of Chinese labour was 0.18 in 1995, increasing to 0.235 and 0.302, respectively. In DVCs, the share of Chinese labour is small. The amount of DVCs labour embodied in ADCs, 0.237 and 0.365, is larger than that in Japan, Taiwan and Korea, between 0.077 and 0.133. In China, the share of DVCs labour is quite low.

Table 3 Composition of labour embodied in countries' wage baskets

	Country r	Year	Wage basket of Country s: China	Japan	Korea	Taiwan	ADCs	DVCs
Labor *r* embodied in wage basket of *s* ($t^r b^s$)	China	1995	0.565	0.287	0.180	0.116	0.184	0.006
		2009	0.489	0.268	0.235	0.148	0.302	0.021
	Japan	1995	0.000	0.679	0.010	0.020	0.008	0.000
		2009	0.001	0.618	0.011	0.018	0.009	0.001
	Korea	1995	0.000	0.014	0.796	0.010	0.007	0.000
		2009	0.001	0.008	0.691	0.007	0.009	0.001
	Taiwan	1995	0.000	0.008	0.002	0.543	0.005	0.000
		2009	0.001	0.006	0.004	0.470	0.005	0.000
	ADCs	1995	0.001	0.039	0.031	0.049	0.656	0.003
		2009	0.003	0.032	0.030	0.030	0.724	0.006
	DVCs	1995	0.002	0.133	0.085	0.080	0.237	0.542
		2009	0.009	0.106	0.097	0.077	0.365	0.551
	Sum of Labor $\Sigma_r t^r b^s$	1995	0.569	1.160	1.105	0.818	1.098	0.552
		2009	0.504	1.038	1.067	0.751	1.415	0.579
Surplus Value: $\omega^s = 1 - \Sigma_r t^r b^s$		1995	0.431	-0.160	-0.105	0.182	-0.098	0.448
		2009	0.496	-0.038	-0.067	0.249	-0.415	0.421
Rate of exploitation: $e^s = \omega^s / (1 - \omega^s)$		1995	0.757	-0.138	-0.095	0.223	-0.089	0.810
		2009	0.986	-0.037	-0.063	0.332	-0.293	0.727

Source: Author's calculation using WIOD database

The time series of labour embodied in wage baskets are shown in Figures 2.a–f. Labour embodied in the wage basket of China (Fig.2.a) decreased during the period 1998–2007, then slightly recovered. Own-country labour is almost all labour embodied the wage basket, with negligible labour coming from other countries. In Japan (Fig.2.b), the sum of embodied labour was 1.2 then moved between 1.08 and 0.97. The embodied Japanese own-country labour decreased until 2007 and then slightly increased. Embodied Chinese labour decreased until 2002 and then increased. Other7 decreased. In Korea (Fig.2.c), there are two sudden decreases, in 1998 and 2008, respectively. In Taiwan (Fig.2.d), a decreasing trend can be seen in the sum of embodied labour, whereas Chinese embodied labour increased. ADCs (Fig.2.e) show an increasing trend, especially for embodied Chinese labour. DVCs (Fig.2.f) share decreased until 2000 and then gradually increased.

Figure 2.a China

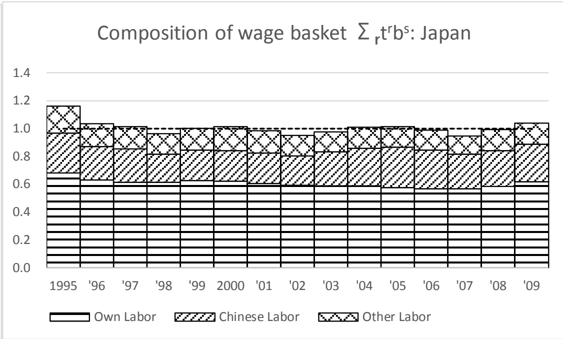

Figure 2.b Japan

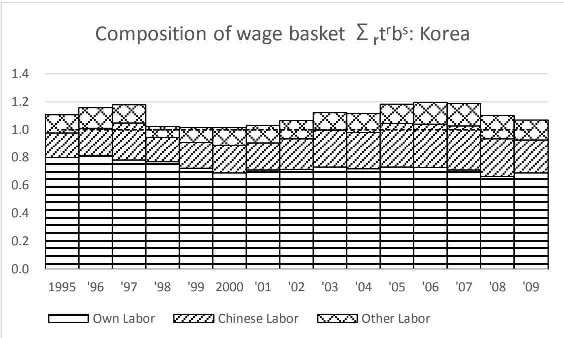

Figure 2.c Korea

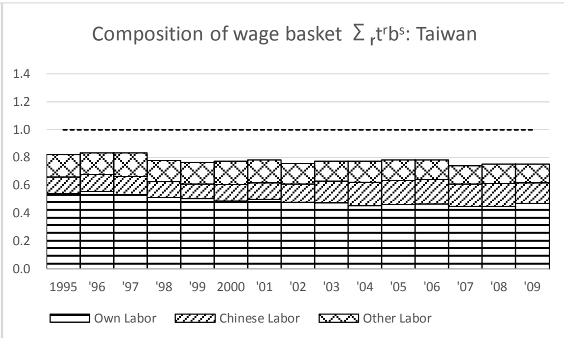

Figure 2.d Taiwan

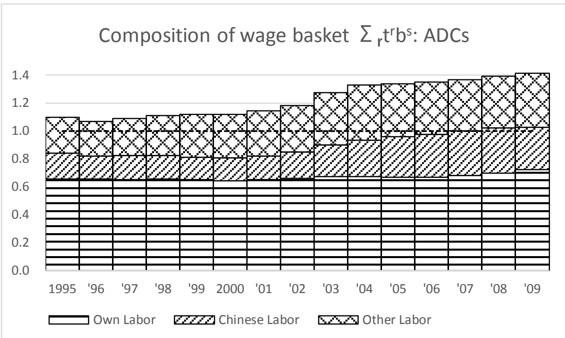

Figure 2.e ADCs

Figure 2.f DVCs

4-3 Contribution Analysis

From Figures 2.a–f, we see that labour embodied in the wage baskets ($\boldsymbol{t^r b^s}$) of the four examined Asian countries decreased, whereas that in ADCs increased. We explore the factors that contributed to these changes in labour embodied in wage baskets. The studied factors are wage basket b, input coefficient A and labour coefficient τ. The sum of the effects of A and τ is the effects of labour value. Taking the time difference of (22), we get the following formula for contribution analysis[9]:

$$\Delta(\iota\mathbf{TB}) = \iota\mathbf{T}\Delta\mathbf{B} + \iota\Delta\mathbf{TB} = \iota\mathbf{T}\Delta\mathbf{B} + \iota(\mathbf{T}\Delta\mathbf{A} + \Delta\boldsymbol{\tau})(\mathbf{I}_{RN} - \mathbf{A})^{-1}\mathbf{B}$$
$$= \iota\mathbf{T}\Delta\mathbf{B} + \iota\mathbf{T}\Delta\mathbf{A}(\mathbf{I}_{RN} - \mathbf{A})^{-1}\mathbf{B} + \iota\Delta\boldsymbol{\tau}(\mathbf{I}_{RN} - \mathbf{A})^{-1}\mathbf{B}$$

$$\Delta\left(\sum_r \mathbf{t}^r\mathbf{b}^s\right) = \left(\sum_r \mathbf{t}^r\Delta\mathbf{b}^s\right) + \left(\sum_r \mathbf{t}^r\Delta\mathbf{A}(\mathbf{I}_{RN} - \mathbf{A})^{-1}\mathbf{b}^s\right) + \left(\sum_r \Delta\boldsymbol{\tau}^r(\mathbf{I}_{RN} - \mathbf{A})^{-1}\mathbf{b}^s\right)$$

The first term on the right-hand side is the effect of a wage basket change (Δb^s). The second term is the effect of an input coefficient change (ΔA). The third term is the effect of a labour coefficient change (**$\Delta\tau$**).

We compare ADCs and four Asian countries during the period 1995–2009. The sum of labour embodied in the wage baskets (line 1) of ADCs increased, whereas that in the four Asian countries decreased. From Table 4.a, it can be seen that the contribution of wage basket changes (line 2) is positive and high except in Japan. The contribution of labour value (line 3) is negative and large in China, Korea and Taiwan, but negative and small in ADCs. The contribution of direct labour coefficient (line 4) is large negative for every country. The difference between ADCs and the four Asian countries lies in the input coefficient (line 5). In ADCs, the effects of wage basket, *b*, and input coefficient, *A*, overcome the negative effect of the direct labour coefficient. In contrast, the effect of the input coefficient is not so large and the sum of *tb* decreases in the four studied Asian countries.

Table 4.a Contribution to change in the sum of labour embodied in wage basket: $\Delta(\Sigma_r t^r b^s)$

		Wage basket of Country s					
		China	Japan	Korea	Taiwan	ADCs	DVCs
(1) $\Delta(\Sigma_r t^r b^s)$	=(2)+(3)	-0.066	-0.121	-0.038	-0.067	0.316	0.027
(2) $\Sigma_r t^r \Delta b^s$		0.450	0.173	0.431	0.346	0.427	0.184
(3) $\Sigma_r \Delta t^r b^s$	=(4)+(5)	-0.515	-0.294	-0.469	-0.413	-0.111	-0.158
(4) $\Sigma_r \Delta\tau^r (I-A)^{-1} b^s$		-0.595	-0.547	-0.700	-0.521	-0.625	-0.178
(5) $\Sigma_r \tau^r \Delta A (I-A)^{-1} b^s$		0.080	0.253	0.231	0.108	0.514	0.021

Source: Author's calculation from WIOD database

The sum of labour embodied in the wage basket ($\Sigma_r t^r b^s$) is divided into the own country's labour (Table 3.b) and foreign labour (Table 3.c).

---

9 Applying a time difference on the product, there are several alternatives for timing:

$$\Delta(xy) = x_1y_1 - x_0y_0 = \Delta xy_0 + x_1\Delta y = \Delta xy_1 + x_0\Delta y = \Delta x(y_0 + y_1)/2 + (x_0 + x_1)\Delta y/2$$

We adopt the third formulation.

$$\Delta\left(\mathbf{t}^s\mathbf{b}^s\right)=\left(\mathbf{t}^s\Delta\mathbf{b}^s\right)+\left(\mathbf{t}^s\Delta\mathbf{A}\left(\mathbf{I}_{RN}-\mathbf{A}\right)^{-1}\mathbf{b}^s\right)+\left(\Delta\boldsymbol{\tau}^s\left(\mathbf{I}_{RN}-\mathbf{A}\right)^{-1}\mathbf{b}^s\right)$$

$$\Delta\left(\sum_{r\neq s}\mathbf{t}^r\mathbf{b}^s\right)=\left(\sum_{r\neq s}\mathbf{t}^r\Delta\mathbf{b}^s\right)+\left(\sum_{r\neq s}\mathbf{t}^r\Delta\mathbf{A}\left(\mathbf{I}_{RN}-\mathbf{A}\right)^{-1}\mathbf{b}^s\right)+\left(\sum_{r\neq s}\Delta\boldsymbol{\tau}\left(\mathbf{I}_{RN}-\mathbf{A}\right)^{-1}\mathbf{b}^s\right)$$

In ADCs, the large contribution of *b* and *A* comes from foreign labour. In the four Asian countries, it is not so large. Therefore, differences between ADCs and the four Asian countries arise from the extent of the shift from domestic purchases to international purchases, especially in low-wage countries. The contribution of this factor to changes in Chinese labour (Table 3.d) does not show a significant difference between ADCs and the three Asian countries of Japan, Korea and Taiwan. Tables 3.c and 3.d are similar in terms of these three Asian countries, which means that the shift to global purchases is limited to China. In ADCs, the share of labour from China is large but other foreign labour is also significant, which is obvious from Figure 5.

In case of China and DVCs, the effect of foreign labour is negligible; own-country labour dominates (Tables 3.b and 3.c), as can be seen in these countries' own labour value far exceeding other countries' labour values.

Table 4.b Contribution to change in own-country labour embodied in wage basket: $\Delta\,(t^s b^s)$

		Wage basket of Country s					
		China	Japan	Korea	Taiwan	ADCs	DVCs
(1) $\Delta\,(t^s b^s)$	=(2)+(3)	-0.076	-0.061	-0.106	-0.073	0.068	0.009
(2) $t^s \Delta b^s$		0.442	0.055	0.228	0.205	0.155	0.166
(3) $\Delta t^s b^s$	=(4)+(5)	-0.518	-0.116	-0.334	-0.278	-0.087	-0.157
(4) $\Delta\tau^s (I\text{-}A)^{-1} b^s$		-0.592	-0.123	-0.382	-0.282	-0.167	-0.155
(5) $\tau^s \Delta A\,(I\text{-}A)^{-1} b^s$		0.073	0.006	0.048	0.004	0.080	-0.002

Source: Author's calculation from WIOD database

Table 4.c Contribution to change in foreign labour embodied in wage basket: $\Delta\,(\Sigma_{r\neq s} t^r b^s)$

		Wage basket of Country s					
		China	Japan	Korea	Taiwan	ADCs	DVCs
(1) $\Delta\,(\Sigma_{r\neq s} t^r b^s)$	=(2)+(3)	0.011	-0.060	0.068	0.006	0.248	0.018
(2) $\Sigma_{r\neq s} t^r \Delta b^s$		0.008	0.118	0.203	0.141	0.272	0.018
(3) $\Sigma_{r\neq s} \Delta t^r b^s$	=(4)+(5)	0.003	-0.178	-0.135	-0.135	-0.024	0.000
(4) $\Sigma_{r\neq s} \Delta\tau^r (I\text{-}A)^{-1} b^s$		-0.004	-0.424	-0.318	-0.239	-0.458	-0.023
(5) $\Sigma_{r\neq s} \tau^r \Delta A\,(I\text{-}A)^{-1} b^s$		0.006	0.246	0.183	0.104	0.434	0.023

Source: Author's calculation from WIOD database

Table 4.d Contribution to change in Chinese labour embodied in wage basket: $\Delta(t^{China}b^s)$

	Wage basket of Country s					
	China	Japan	Korea	Taiwan	ADCs	DVCs
(1) $\Delta(t^{China}b^s)$ =(2)+(3)		-0.018	0.055	0.032	0.118	0.015
(2) $t^{China}\Delta b^s$		0.120	0.163	0.113	0.172	0.015
(3) $\Delta t^{China}b^s$ =(4)+(5)		-0.138	-0.109	-0.080	-0.054	0.000
(4) $\Delta\tau^{China}(I-A)^{-1}b^s$		-0.363	-0.276	-0.190	-0.348	-0.021
(5) $\tau^{China}\Delta A(I-A)^{-1}b^s$		0.225	0.167	0.109	0.294	0.020

Source: Author's calculation from WIOD database

China in Table 4.d is omitted because it is the same as Chinese own-country labour in Table 4.b.

5. Conclusion

In this paper, we discussed labour value and exploitation in the context of international input-output analysis. Each country's labour is treated as heterogeneous. Evaluation of exploitation needs a conversion rate for labour. There exists a conversion rate for labour such that each country's labourers are exploited, whereas the non-exploitation case may happen in some countries.

From international input-output analysis, we found (1) non-exploitation in Japan, Korea and advanced countries (ADCs); (2) during 1995 and 2009, the rate of exploitation declined in Asian countries, whereas it increased in ADCs. There is a tendency that increases in the effect of wage baskets and decreases in the effect of labour value coexist; and (3) the labour embodied in ADCs' wage basket increased, whereas that in the four Asian countries decreased. This difference can be traced back to the spread of globalization.

Reference

Asian International Input-Output Project (ed.) (2013) *Asian International Input-Output Table 2005*, IDE-JETRO

Bowles, S. and H. Gintis (1977) "The Marxian theory of value and heterogeneous labor: a critique and reformulation," *Cambridge Journal of Economics*, Vol.1, No.2, pp.173-192.

Gupta, S. and I. Steedman (1971) "An Input-Output Study of Labor Productivity in the British Economy," *Bulletin of the Institute of Economics and Statistics*, Vol.33, No.1, pp.21-34

Fröhlich, N. (2012), "Labour values, prices of production and the missing equalisation tendency of profit rates: evidence from the German economy", *Cambridge Journal of Economics*, Vol.37, No.5, pp.1107-1126.

Hagiwara, T. (2004) “Measurement of Global Labor Value,” *Kokumin Keizai Zasshi,,*, Vol.189, No.2, pp.17-31 (in Japanese)

Hertel, T. (1997) *Global Trade Analysis: Modeling and Applications*, Cambridge U.P.

Katano, H. (1984) "Basics of International Input-Output Relations," *Kokumin Keizai Zasshi,,* Vol.151, No.4, pp.1-14 (in Japanese).

Leontief, W. (1941) *The Structure of American Economy, 1919–1929*, Harvard UP.

Lenzen, M., D.Moran, K.Kanemoto, A.Geschke,(2013) "Building Eora: A Global Multi-regional Input-Output Database at High Country and Sector Resolution", *Economic Systems Research*, Vol.25,No.1, pp.20-49

Morishima, M. (1973) *Marx's Economics*, Cambridge UP.

Nakajima, A. and H. Izumi (1995) "Economic Development and unequal Exchange among Nations: Analysis of the U.S., Japan and South Korea," *Review of Radical Political Economics*, Vol.27, No.3, pp.86-94.

Nakatani, T., (1994) *Economics of Value, Price and Value*, Keiso Shobo (in Japanese)

Ochoa, E.M. (1989),"Values, prices, and wage-profit curves in the US economy", *Cambridge Journal of Economics*, vol. 13 pp.413–29

Okishio, N. (1955) "Value and Price - Labor Value Theory and Equilibrium Price Theory," *Annals of Economics Research (Kobe University)*, No.1, (in Okishio (1977), in Japanese)

Okishio, N. (1958) "Empirical Study of Unequal Exchange," *Shogaku ronshu (Fukushima University)*, Vol.27, No.3 (in Okishio (1977), in Japanese)

Okishio, N. (1965) *Fundamental Theory of Capitalist Economy*, Sobunsha, (in Japanese)

Okishio, N. (1977) *Marxian Economics*, Chikuma Publishers (in Japanese).

Okishio, N. and T. Nakatani, "A Measurement of the Rate of Surplus Value in Japan: The 1980 Case," *Kobe University Economic Review*, No.31, pp.1-13

Sraffa, P. (1960) *Production of Commodities by Means of Commodities - Prelude to a Critique of Economic Theory*, Cambridge University Press

Steedman, I. (2008) "Marx after Sraffa and the Open Economy," *Bulletin of Political Economy*, Vol.2, No.2, pp.165-74.

Timmer, M. P., E. Dietzenbacher, B. Los, R. Stehrer and G.J. de Vries (2015), "An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production", *Review of International Economics*., Vol. 23, pp. 575–605