emeraldinsight

Return of Marxian Macro-Dynamics in East Asia

Labor Value and Exploitation in the Global Economy

Taiji Hagiwara,

Article information:

To cite this document: Taiji Hagiwara, "Labor Value and Exploitation in the Global Economy" *In* Return of Marxian Macro-Dynamics in East Asia. Published online: 14 Aug 2017; 15-37.
Permanent link to this document:
https://doi.org/10.1108/S0161-723020170000032003

Downloaded on: 20 August 2017, At: 04:28 (PT)
References: this document contains references to 0 other documents.
To copy this document: permissions@emeraldinsight.com
The fulltext of this document has been downloaded 1 times since 2017*



Access to this document was granted through an Emerald subscription provided by emerald-srm:425905 []

For Authors

If you would like to write for this, or any other Emerald publication, then please use our Emerald for Authors service information about how to choose which publication to write for and submission guidelines are available for all. Please visit www.emeraldinsight.com/authors for more information.

About Emerald www.emeraldinsight.com

Emerald is a global publisher linking research and practice to the benefit of society. The company manages a portfolio of more than 290 journals and over 2,350 books and book series volumes, as well as providing an extensive range of online products and additional customer resources and services.

Emerald is both COUNTER 4 and TRANSFER compliant. The organization is a partner of the Committee on Publication Ethics (COPE) and also works with Portico and the LOCKSS initiative for digital archive preservation.

*Related content and download information correct at time of download.

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

LABOR VALUE AND EXPLOITATION IN THE GLOBAL ECONOMY

Taiji Hagiwara

ABSTRACT

This paper discusses labor value and the rate of exploitation in the global economy using international input–output tables. Labor value is defined as the multiplication of the labor coefficient and Leontief inverse. Exploitation means that the amount of labor embodied in the received wage commodity is less than the amount of the labor 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 labor value, which is the vector of embodied labor 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.

Keywords: Exploitation; global economy; input–output tables; Fundamental Marxian Theorem; labor value

Return of Marxian Macro-dynamics in East Asia
Research in Political Economy, Volume 32, 15–37
Copyright © 2017 by Emerald Publishing Limited
All rights of reproduction in any form reserved
ISSN: 0161-7230/doi:10.1108/S0161-723020170000032003

INTRODUCTION

In classical economics, including Marx, labor *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 labor value was thought to be obsolete. But Marx found a more important role for labor 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, labor value is the sum of *living labor* and *dead labor*. While the notion of *living labor* is obvious, that of *dead labor* is arguable. *Dead labor* 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 labor 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 labor. There are various kinds of jobs, whose skill levels vary. However, if not unified as simple labor, the Theorem may not hold. Okishio (1965) showed how various labor types can be unified by incorporating training labor. Bowles and Gintis (1977) took another approach and proved that although some types of labor may not be exploited, at least one kind of labor must be exploited in order for profit to exist under a heterogeneous labor situation. This paper aims to expand on this approach by using international input–output (IO) tables to determine the existence of non-exploited labor in several Asian countries.

Various empirical studies have used input–output tables, for example, Okishio (1958), Gupta and Steedman (1971), Nakatani (1976), Ochoa (1989), 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 labor value of import commodities must be defined. Okishio (1958) assumed that this equals the labor 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 labor value in the international IO framework but

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

this attempt was incomplete. Nakatani and Hagiwara (in Nakatani, 1994) defined global labor value and expanded the Fundamental Marxian Theorem as heterogeneous labor value (Bowles & Gintis, 1977). Hagiwara (2004) examined global labor using Japan-USA-Asia-Europe international IO tables 1985−1990 and found that the labor value of Japan's laborers' wage commodity basket is larger than their working hours. Following this approach of using international IO tables to measure labor value across countries, this paper uses IO tables to investigate the presence of non-exploited labor in several Asian countries.

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

LABOR VALUE AND EXPLOITATION IN A SINGLE ECONOMY

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

Labor Value in a Single Economy

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

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

Labor value, t, is defined as

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

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

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

where

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

Its solution is

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

where $\mathbf{I_N}$ represents an $N \times N$ identity matrix. Since the reciprocal of labor value shows the amount of product produced by a unit of labor either directly or indirectly, $1/t_j$ can be called labor productivity. In the context of input–output analysis, labor value can be called an employment multiplier. Labor value t is positive if the matrix $(\mathbf{I_N} - \mathbf{A})$ satisfies the Hawkins–Simon condition.[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 laborers purchase certain amounts of consumption commodities (wage basket)

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

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

Substituting Eq. (4) for Eq. (3), we get

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

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

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

Exploitation in a Single Economy

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

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

The condition for a positive output ($\mathbf{x}$) in all sectors to produce surplus product ($\mathbf{z}$) 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 Eq. (6) with labor value ($\mathbf{t}$) from the left, we get

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

Since total employment ($\boldsymbol{\tau}\mathbf{x}$) is positive, $\mathbf{tb}$ must be less than unity:

$$0 < 1 - \mathbf{tb} \tag{8}$$

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

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

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

Measuring Labor Value in Single Economy

Several researches have addressed the estimation of labor 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

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

Steedman (1971), Ochoa (1989), Fröhlich (2012), and so on. When applying input–output tables to labor 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 labor value is measured in physical terms, because labor 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 labor coefficient is the quotient of the physical labor coefficient (τ_j) divided by price (p_j)

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

where the symbol ˆ indicates a diagonal matrix. The solution of Eq. (1) with monetary coefficient $\mathbf{A^*}$ and $\boldsymbol{\tau}^*$ is

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

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

Multiplying with diagonal p from the right yields

$$\mathbf{t}^*\hat{\mathbf{p}} = \mathbf{A}\mathbf{t}^*\hat{\mathbf{p}} + \boldsymbol{\tau} \tag{11}$$

Comparing Eq. (11) with Eq. (1), we get

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

This means that the solution to Eq. (10) is t_j/p_j, that is, the rate of unequal exchange. In the following analysis, the symbols $\mathbf{A}$, $\boldsymbol{\tau}$, and t are used as monetary terms, instead of $\mathbf{A^*}$, $\boldsymbol{\tau}^*$, and $\mathbf{t^*}$.

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

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

(s_i^I) as the composition of capital, the cost of fixed capital is endogenized as follows:

$$t_j = \sum\nolimits_i (a_{ij} + d_j s_i^I) t_i + \tau_j \tag{12}$$

The third point is the treatment of imports.[3] The labor value of domestic commodities is endogenously determined by Eq. (1), whereas the value of imported commodities is not. Okishio (1958) used the labor value of an exported commodity as the labor 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_i^E be the share of exports. The labor value of the imported commodity is

$$t_m = \sum\nolimits_i s_i^E t_i \quad t_m = \mathbf{s^E t}$$

The labor 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

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

Since export share, $\mathbf{s^E}$, and import inputs, $\mathbf{a_m}$, 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 globalized economy, several international input–output tables have been compiled.[4] Labor value can be applied to the new situation described in the next section.

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 labor as heterogeneous among countries due to substantial wage differences among countries.

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

Labor Value in a Global Economy

We extend the concept of labor 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 labor from country s. In the matrix form, the input coefficient matrix is

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

The direct labor coefficient vector of country s is

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

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

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

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

$$\mathbf{T} \equiv \mathbf{TA} + \boldsymbol{\tau} \tag{14}$$

where

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

Labor value is an R × RN matrix. t_j^{rs} represents one unit of the commodity of sector j in country s which embodies labor from country r. A commodity is a

bundle of labor from various countries (t_j^{rs}, $r=1, \ldots, R$). We call the matrix **T** as global labor matrix.

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, $i=1,\ldots, N$, $r=1, \ldots, R$) and wages (w^s) in addition to input coefficient (a_{ij}^{rs}) and labor coefficient (τ_j^s). The condition for positive profit to exist is

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

Using matrix notation, it is expressed as

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

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

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

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

In matrix notation, the wage basket is expressed as

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

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

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

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

The condition for profit's existence can be rewritten as

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

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

Exploitation in the Global Economy

Since matrix (18) satisfies the Hawkins–Simon condition, there exists a positive column vector of output ($\mathbf{x}$) for any positive vector of surplus product ($\mathbf{z}$):

$$\mathbf{0} < \mathbf{z} = (\mathbf{I}_{RN} - \mathbf{A} - \mathbf{B}\boldsymbol{\tau})\mathbf{x}$$

Multiplying the global labor value matrix ($\mathbf{T}$) from the left, we get

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

Although Eq. (19) looks similar to Eq. (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:

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

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

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

satisfies the Hawkins–Simon condition.

What is the implication of Eq. (21) satisfying Hawkins-Simon condition? Consider its dual problem. Multiplying the positive row vector $\boldsymbol{\mu}$ from the left, we get

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

$$\boldsymbol{\omega} \equiv \boldsymbol{\mu}(\mathbf{I}_R - \mathbf{TB}) \text{ in scalar terms, } \omega^s \equiv \mu^s - \sum\nolimits_r \mu^s \mathbf{t}^r \mathbf{b}^s \tag{22}$$

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

$$0 < \boldsymbol{\omega} = \boldsymbol{\mu}(\mathbf{I}_R - \mathbf{TB})$$

In scalar terms,

$$0 < \omega^s = \mu^s - \sum\nolimits_r \mu^s \mathbf{t}^r \mathbf{b}^s$$

It can be rewritten as

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

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 labor ($\boldsymbol{\mu}$) in Eq. (23) such that labor is exploited in all countries.

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

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

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

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

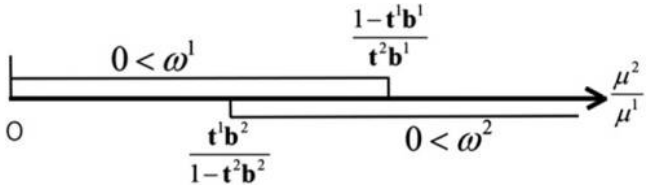


Fig. 1. Conversion Rate of Labor and Surplus Value.

The existence condition of the conversion rate of labor (μ^2/μ^1) needed to assure Eq. (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,

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

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

The lower bound of the conversion rate of labor (μ^2/μ^1) in Eq. (24) increases as the wage basket in country 2 ($\mathbf{b}^2$) increases, and the upper bound decreases as the wage basket of country 1 ($\mathbf{b}^1$) increases. If the wage basket ($\mathbf{b}^1$ and/or $\mathbf{b}^2$) increases enough, the Hawkins–Simon condition is violated and the range of the conversion rate of labor (μ^2/μ^1) satisfying the positive surplus labor conditions ($0<\omega^1$ and $0<\omega^2$) will diminish. Positive surplus labor 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 labor satisfying Eq. (23) is not always plausible. The possibility exists that some country's laborers enjoy a rich wage basket which embodies more labor than those laborers sold:

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

for some s

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

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

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

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

> **Corollary 1:** There exists some conversion rate of labor (μ) such that labor is not exploited in some countries. Nonetheless, there exists at least one country in which labor is exploited.

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

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

If the conversion rate of labor ($\boldsymbol{\mu}$) satisfies Eq. (23), the exploitation rate in all countries is positive. Conversely, there is a possibility that a plausible conversion rate of labor ($\boldsymbol{\mu}$) may not satisfy Eq. (23) and rate of exploitation is negative in some countries.

Another point is that the own-country's labor embodied in a worker's labor basket is less than unity independent from the choice of conversion rate of labor ($\boldsymbol{\mu}$):

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

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

> **Corollary 2:** Whatever the conversion rate of labor ($\boldsymbol{\mu}$) is chosen, the own-country labor embodied in wage basket $\mathbf{t}^s\mathbf{b}^s$ is less than unity.

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

EMPIRICAL STUDY

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

First, we need to specify the conversion rate of labor (μ). It is natural to assume that labor is the same across countries even if serious wage gaps exist; that is, the essential nature and value of labor in a rich country and that in

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

poor country are the same. We employ a simple weight wherein the conversion rate for any country's labor equals unity.[7]

$$\boldsymbol{\mu} = \boldsymbol{\iota}_{\mathbf{R}} \equiv (1, 1, \ldots, 1) \tag{26}$$

Then surplus value (22) is specified as

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

It should be noted that Eq. (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 labor sold and the amount of labor purchased as wage commodity by selling his/her own labor. The amount of labor purchased by selling unit labor is expressed as the sum of the value of labor in the wage basket $\left(\sum_r \mathbf{t}^r\mathbf{b}^s\right)$ in Eq. (27). If it is less than unity, exploitation prevails; otherwise laborers in the country enjoy being paid for more labor than he/she provides (non-exploitation).

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, Taiwan, Advanced Countries (ADCs hereafter) and Developing Countries (DVCs hereafter). The list of regions is given in Table 1. A total of

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
*Ad*vanced *C*ountrie*s* (ADCs)	USA, Australia, Canada, EU15 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, UK)
*De*veloping *C*ountrie*s* (DVCs)	Brazil, India, Indonesia, Mexico, Russia, Turkey, EU12 (Bulgaria, Cyprus, Czech, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia)

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

Table 2. Wages and Labor 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. Labor hours engaged: trillion hours.

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

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).

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 labor and value added for Rest of the World. We therefore ignored labor of the Rest of the World. Therefore, the result shown below underestimates the real labor value.

Table 2 shows wage and labor 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 labor hour engaged, China and DVCs were the largest, followed by ADCs. Korea and Taiwan are the smallest group. While labor hour of China and DVCs increased more than 20%, that of Japan decreased.

Composition of Wage Basket in Terms of Global Labor Value

The labor embodied in the wage basket ($\mathbf{t}^r\mathbf{b}^s$) in 1995 and 2009 is shown in Table 3. The sum of labor embodied ($\mathbf{\Sigma}_r\mathbf{t}^r\mathbf{b}^s$) is less than unity in China,

Table 3. Composition of Labor Embodied in Countries' Wage Baskets.

	Country r		Wage Basket of Country s					
		Year	China	Japan	Korea	Taiwan	ADCs	DVCs
Labor r embodied in wage basket of s ($\mathbf{t^r b^s}$)	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 $\Sigma_r \mathbf{t^r b^s}$	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:		1995	0.431	−0.160	−0.105	0.182	−0.098	0.448
$\omega^s = 1 - \Sigma_r t^r b^s$		2009	0.496	−0.038	−0.067	0.249	−0.415	0.421
Rate of exploitation:		1995	0.757	−0.138	−0.095	0.223	−0.089	0.810
$e^s = \omega^s / (1 - \omega^s)$		2009	0.986	−0.037	−0.063	0.332	−0.293	0.727

Source: Author's calculation using WIOD database.

Taiwan, and DVCs, whereas Japan, Korea, and ADCs exceed unity (non-exploitation case). Laborers in the latter countries purchase wage commodities which embody more labor than they sold their labor. The rate of exploitation is negative. Labor 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 labor embodied in the wage basket ($\mathbf{t^s b^s}$) diagonal factor in Table 3 is the largest among column countries. It is less than unity, between 0.47 and 0.80, which is consistent with the *Fundamental Marxian Theorem* in a global economy. Own-country labor increased in ADCs and DVCs but decreased in Asian countries during the period 1995−2009.

Regarding the foreign labor in a country's wage basket, the sum of the off-diagonal factors ($\mathbf{\Sigma_{r \neq s} t^r b^s}$) for labor in China and the DVCs are largely embodied in these countries' wage baskets. Since China (top row) and DVCs (bottom row) have large labor forces and low wages, more advanced countries take

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

advantage. The share of Chinese labor embodied in the Japanese wage basket ($\mathbf{t}^{\mathbf{China}}\mathbf{b}^{\mathbf{Japan}}$) is around 0.287 and 0.268. In Korea and ADCs, the share of Chinese labor was 0.18 in 1995, increasing to 0.235 and 0.302, respectively. In DVCs, the share of Chinese labor is small. The amount of DVCs labor 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 labor is quite low.

The time series of labor embodied in wage baskets are shown in Figs. 2(a)–(f). Labor embodied in the wage basket of China (Fig. 2(a)) decreased during the period 1998–2007, then slightly recovered. Own-country labor is almost all labor embodied the wage basket, with negligible labor coming from other countries. In Japan (Fig. 2(b)), the sum of embodied labor was 1.2 then moved between 1.08 and 0.97. The embodied Japanese own-country labor decreased

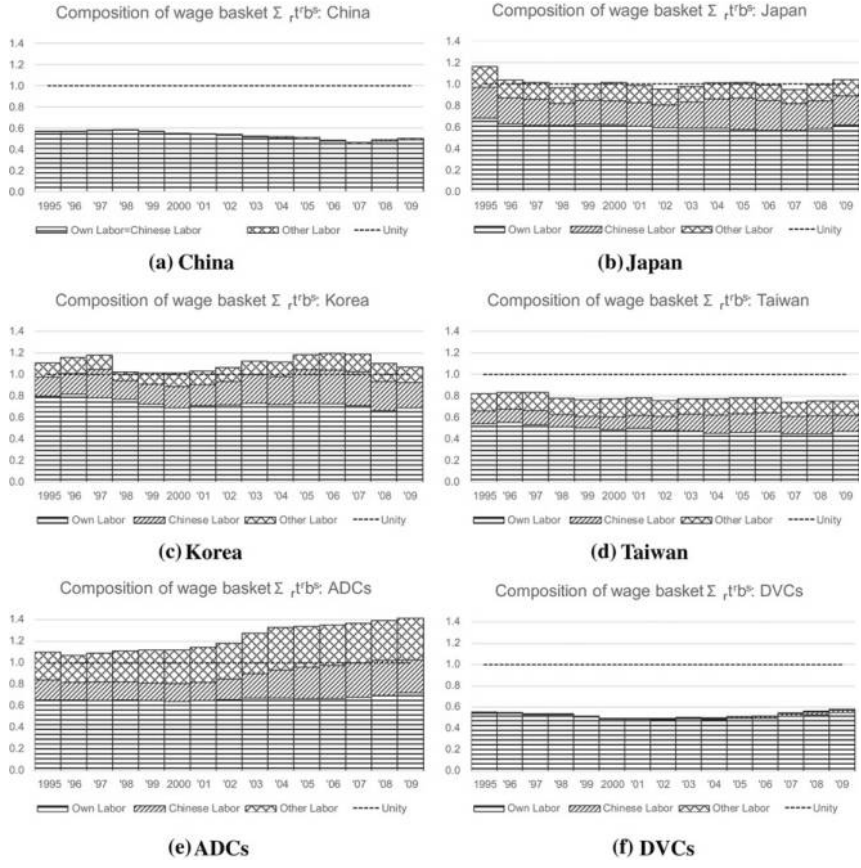


Fig. 2. (a) China, (b) Japan, (c) Korea, (d) Taiwan, (e) ADCs, (f) DVCs.

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

until 2007 and then slightly increased. Embodied Chinese labor decreased until 2002 and then increased. Other 7 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 labor, whereas Chinese embodied labor increased. ADCs (Fig. 2(e)) show an increasing trend, especially for embodied Chinese labor. DVCs (Fig. 2(f)) share decreased until 2000 and then gradually increased.

Contribution Analysis

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

$$\begin{aligned}\Delta(\imath\mathbf{TB}) &= \imath\mathbf{T}\Delta\mathbf{B} + \imath\Delta\mathbf{TB} = \imath\mathbf{T}\Delta\mathbf{B} + \imath(\mathbf{T}\Delta\mathbf{A} + \Delta\boldsymbol{\tau})(\mathbf{I}_{RN} - \mathbf{A})^{-1}\mathbf{B} \\ &= \imath\mathbf{T}\Delta\mathbf{B} + \imath\mathbf{T}\Delta\mathbf{A}(\mathbf{I}_{RN} - \mathbf{A})^{-1}\mathbf{B} + \imath\Delta\boldsymbol{\tau}(\mathbf{I}_{RN} - \mathbf{A})^{-1}\mathbf{B}\end{aligned}$$

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

The first term on the right-hand side is the effect of a wage basket change ($\boldsymbol{\Delta b}^s$). The second term is the effect of an input coefficient change (ΔA). The third term is the effect of a labor coefficient change ($\boldsymbol{\Delta\tau}$).

We compare ADCs and four Asian countries during the period 1995–2009. The sum of labor embodied in the wage baskets (line 1) of ADCs increased, whereas that in the four Asian countries decreased. From Table 4, it can be seen that the contribution of wage basket changes (line 2) is positive and high except in Japan. The contribution of labor value (line 3) is negative and large in China, Korea, and Taiwan, but negative and small in ADCs. The contribution of direct labor 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 labor 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.

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

Table 4. Contribution to Change in the Sum of Labor Embodied in Wage Basket: $\mathbf{\Delta(\Sigma_r t^r b^s)}$.

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

Source: Author's calculation from WIOD database.

Table 5. Contribution to Change in Own-Country Labor Embodied in Wage Basket: $\mathbf{\Delta(t^s b^s)}$.

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

Source: Author's calculation from WIOD database.

Table 6. Contribution to Change in Foreign Labor Embodied in Wage Basket: $\mathbf{\Delta(\Sigma_{r\neq s} t^r b^s)}$.

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

Source: Author's calculation from WIOD database.

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

The sum of labor embodied in the wage basket ($\mathbf{\Sigma_r t^r b^s}$) is divided into the own-country's labor (Table 5) and foreign labor (Table 6).

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

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

In ADCs, the large contribution of b and A comes from foreign labor. 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 labor (Table 7) does not show a significant difference between ADCs and the three Asian countries of Japan, Korea, and Taiwan. Tables 6 and 7 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 labor from China is large but other foreign labor is also significant, which is obvious from Figure 2(a).

In case of China and DVCs, the effect of foreign labor is negligible; own-country labor dominates (Tables 5 and 6), as can be seen in these countries' own labor value far exceeding other countries' labor values.

China in Table 7 is omitted because it is the same as Chinese own-country labor in Table 5.

Table 7. Contribution to Change in Chinese Labor Embodied in Wage Basket: $\mathbf{\Delta(t^{China}b^s)}$.

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

Source: Author's calculation from WIOD database.

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

CONCLUSION

In this paper, we discussed labor value and exploitation in the context of international input–output analysis. Each country's labor is treated as heterogeneous. Evaluation of exploitation needs a conversion rate for labor. There exists a conversion rate for labor such that each country's laborers 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 labor value coexist; and (3) the labor 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.

NOTES

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.

2. Assuming a square matrix $\mathbf{H}$ with a positive diagonal and non-positive off-diagonal and vector $\mathbf{b}$, 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 $\mathbf{H}$ is positive (Hawkins-Simon Condition), and
(4) The inverse of $\mathbf{H}$ is non-negative.

3. Researches in line with Sraffa (1960), like Gupta and Steedman (1971), Ochoa (1989) and Fröhlich (2012), neglected the labor value of imports. Steedman (2008) commented that the labor value of imports can be incorporated by using exports, an idea similar to that of Okishio (1958).

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 United States 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).

5. Bowles and Gintis (1979).

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

7. An alternative conversion rate of labor 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, Dietzenbacher, Los, Stehrer, and de Vries (2015). Calculation based on WIOD release 2013.

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.

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)

REFERENCES

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

Bowles, S., & Gintis, H. (1977). The Marxian theory of value and heterogeneous labor: A critique and reformulation. *Cambridge Journal of Economics*, *1*(2), 173–192.

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*, *37*(5), 1107–1126.

Gupta, S., & Steedman, I. (1971). An input-output study of labor productivity in the British economy. *Bulletin of the Institute of Economics and Statistics*, *33*(1), 21–34.

Hagiwara, T. (2004). Measurement of global labor value. *Kokumin Keizai Zasshi*, *189*(2), 17–31 (in Japanese).

Hertel, T. (1997). *Global trade analysis: Modeling and applications*. Cambridge: Cambridge University Press.

Katano, H. (1984). Basics of international input-output relations. *Kokumin Keizai Zasshi*, *151*(4), 1–14 (in Japanese).

Lenzen, M., Moran, D., Kanemoto, K., & Geschke, A. (2013). Building Eora: A global multi-regional input-output database at high country and sector resolution. *Economic Systems Research*, *25*(1), 20–49.

Leontief, W. (1941). *The structure of American economy, 1919–1929*. Cambridge, MA: Harvard University Press.

Morishima, M. (1973). *Marx's Economics*. Cambridge: Cambridge University Press.

Nakajima, A., & Izumi, H. (1995). Economic development and unequal exchange among nations: Analysis of the U.S., Japan and South Korea. *Review of Radical Political Economics*, *27*(3), 86–94.

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

Ochoa, E. M. (1989). Values, prices, and wage-profit curves in the US economy. *Cambridge Journal of Economics*, *13*, 413–429.

Okishio, N. (1955). Value and price – Labor value theory and equilibrium price theory. *Annals of Economics Research (Kobe University)*, *1*, 211–296, (Okishio (**1977**), in Japanese).

Okishio, N. (1958). Empirical study of unequal exchange. *Shogaku ronshu (Fukushima University)*, *27*(3), 156–175, (Okishio (1977), in Japanese).

Okishio, N. (1965). *Fundamental theory of capitalist economy*. Tokyo: Sobunsha (in Japanese).

Okishio, N. (1977). *Marxian economics*. Tokyo: Chikuma Publishers (in Japanese).

Okishio, N., & Nakatani, T. (1985). A measurement of the rate of surplus value in Japan: The 1980 case. *Kobe University Economic Review*, *31*, 1–13.

Sraffa, P. (1960). *Production of commodities by means of commodities – Prelude to a critique of economic theory*. Cambridge: Cambridge University Press.

Steedman, I. (2008). Marx after Sraffa and the open economy. *Bulletin of Political Economy*, *2*(2), 165–174.

Timmer, M. P., Dietzenbacher, E., Los, B., Stehrer, R., & de Vries, G. J. (2015). An illustrated user guide to the world input–output database: The case of global automotive production. *Review of International Economics*, *23*, 575–605.

Downloaded by UNIVERSITY OF ADELAIDE At 04:28 20 August 2017 (PT)