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IDE DISCUSSION PAPER No. 623

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with international input-output data**

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November 2016

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**Keywords:** value chain mapping, trade in value added, agricultural value chains

**JEL classification:** C67, F14, Q17

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# Mapping agricultural value chains with international input-output data

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## Abstract

In recent years, the analysis of trade in value added has been explored by many researchers. Although they have made important contributions by developing GVC-related indices and proposing techniques for decomposing trade data, they have not yet explored the method of value chain mapping—a core element of conventional value chain analysis. This paper introduces a method of value chain mapping that uses international input-output data and reveals both upstream and downstream transactions of goods and services induced by production activities of a specific commodity or industry. This method is subsequently applied to the agricultural value chain of three Greater Mekong Sub-region countries (i.e., Thailand, Vietnam, and Cambodia). The results show that the agricultural value chain has been increasingly internationalized, although there is still room for obtaining benefits from GVC participation, especially in a country such as Cambodia.

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## 1. Introduction

Participation in global value chains (GVCs) has become increasingly important as a strategy for economic development in less developed countries. Previously, the sequence of industrial development proceeded according to a certain order, for instance, from import to domestic production, and then to the export of manufactured goods, as illustrated by the fundamental flying geese pattern of development (Akamatsu 1962). Simultaneously, sequences of structural transformation occur in industries upgrading from consumer to intermediate goods and capital goods, and from technologically simple products to complex and sophisticated ones.

However, this sequence of industrial development has become less clear due to the expansion of GVCs in recent decades: a currently developing country can ascend into GVCs for sophisticated products, including high-tech products, by specializing in a niche segment of the value chain, and become an exporter of these products apparently. Note that such a phenomenon has occurred due to the rapid decline in trade and communication costs, caused, in turn, by technological development and trade liberalization. The spread of GVCs has also affected the development strategy of developing economies. On the one hand, it is no longer necessary or efficient to build an entire value chain from scratch through infant industry protection, as assumed in Akamatsu's model (Akamatsu 1962). Rather, a country can specialize in a niche segment of the value chain, and then proceed to higher value chain activities through its own upgrade efforts. On the other hand, globalization of the economy, spurred by trade liberalization and economic integration, has narrowed policy space for developing countries, making infant industry protection increasingly difficult to implement.

Against this background, trade in value added has been explored in recent years as a method of analyzing international trade, where production processes have been increasingly fragmented across borders and the difference between gross exports and value added exports has grown rapidly.<sup>1</sup> Particularly, VS (vertical specialization, that is, foreign content in exports) and VS1 (domestic content used as input for re-export) were originally developed by Hummels, Ishi, and Yi (2001). Moreover, Daudin, Riffart, and Schweisguth (2011) considered VS1\* (the domestic content of import) as well. Johnson and Noguera (2012) defined the concept of value added exports. Finally, Koopman, Wang, and Wei (2014) synthesized these studies by tracing the value added and the double-counted elements contained in gross exports.

However, many of these studies have focused on the structure of vertical trade—particularly trade in intermediate inputs—and have not explored the method of the value chain mapping, which is a core element of conventional value chain analysis.

Consequently, the objective of this paper is to introduce a method of value chain mapping using international input-output data. The major drawback of the current value chain analysis—mainly conducted by sociologists, economic geographers, and business strategists—is the lack of objective or quantitative data. For instance, a value chain map is typically drawn using information collected via interviews or other secondary sources. Consequently, “the analysis and policy recommendations provided in GVC studies are often based on qualitative data and are therefore subjective” (Frederik 2014: page 19). As shown below, the method of value chain mapping—based on Ozaki’s structural analysis—fills this void and provides objective information

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<sup>1</sup> As discussed later, trade in value added accounts for the double counting implicit in the gross flow of trade and measures the flows of value added embodied in the trade of goods or services.

regarding inter-industry transactions of goods and services—as well as the creation of value added—that emerge along the value chain. Furthermore, as discussed below, the method of value chain mapping is closely related to the concept of trade in value added, because both of them consider the value added embodied in the final output.

As an application of this method, this paper investigates the agricultural value chains in three Greater Mekong Sub-region (GMS) countries: Thailand, Vietnam, and Cambodia. The agricultural value chain appears to be different from that of the manufacturing sector because it is more difficult to fragment the agricultural production processes across space and utilize the benefits of specialization and exchange.<sup>2</sup> However, this opportunity can still be explored. First, modern agricultural inputs—particularly fertilizers, pesticides, and petroleum fuel—are procured from abroad, especially if countries do not have a strong industrial base. Second, agricultural products are exported directly or indirectly as inputs for processed products. As shown below, the agricultural value chains have been increasingly internationalized in recent decades, although there is still room for obtaining benefits from GVC participation, especially in a country such as Cambodia.

This paper uses OECD's inter-country input-output (ICIO) tables for 1995 and 2011 to analyze trade in value added and quantitatively demonstrate the transformation

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<sup>2</sup> Since a great portion of agricultural value added is generated from domestic soil, opportunities for production fragmentation across borders are limited in comparison with the machinery industry, for example. Actually, as in the mining industry, the agricultural industry has a significantly lower foreign content embodied in exports than the machinery industry. For instance, the foreign content of agriculture in Thailand, Vietnam, and Cambodia in 2011 was 0.18, 0.14, and 0.01, respectively, while that for electronics machinery was 0.65, 0.70, and 0.56, respectively (calculated from the OECD ICIO tables).

of the agricultural value chains in the three GMS countries.<sup>3</sup> Furthermore, the method of value chain mapping is applied to the ICIO tables for 2011.

The remainder of this paper is organized as follows. Section 2 introduces the structural analysis method. Section 3, as a part of the empirical results, first compares the structure of the agricultural sector in the three GMS countries. Subsequently, it is followed by the results of the trade in value added analysis and the method of value chain mapping. The results show significant differences between the three countries in terms of the structure of agricultural value chains—particularly the usage of agricultural inputs, sourcing of foreign inputs, and access to foreign markets. Section 4 concludes the paper with a summary of the findings.

## 2. Method of analysis

This section introduces the structural analysis method, originally developed by Ozaki (1980), to investigate industrial production structure. In this paper, the structural analysis is extended in two directions. First, Ozaki's method, originally developed for a single-country input-output model, is extended to a multi-country model. Second, unlike Ozaki's method, which considers only input structure of industry (i.e., upstream transactions) using the Leontief inverse, the technique introduced here is also applied to the analysis on output structure (i.e., downstream transactions) using the Ghosh inverse.

### 2.1 Upstream transactions

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<sup>3</sup> The OECD's inter-country tables are available for 1995, 2000, 2005, 2008, 2009, 2010, and 2011, from which 1995 and 2011 tables are used in this study. Additionally, it should be noted that the original ICIO tables cover 62 countries or regions, but were aggregated into 21 countries or regions, as shown in Figures 2.1–2.3. The ICIO tables cover 34 sectors, as shown in Table A1.

In the following, unit structure analysis is applied to multi-country input-output data to calculate the inter-industry transactions of agricultural inputs, such as seeds, pesticides, and fertilizers—as well as the creation of value added—directly or indirectly induced by one unit of agricultural output.

First, using an input coefficient matrix, the accounting identity on the output side (i.e., the equality between total output and intermediate outputs plus final demand) can be expressed as:

$$\mathbf{x} = \mathbf{Ax} + \mathbf{f}, \quad (1)$$

where

$$\mathbf{x} = \begin{bmatrix} \mathbf{x}^1 \\ \vdots \\ \mathbf{x}^r \\ \vdots \\ \mathbf{x}^m \end{bmatrix}$$

is the vector of total output ( $\mathbf{x}^r$  is country  $r$ 's  $n \times 1$  vector of output:  $m$  and  $n$  represent the number of countries and sectors, respectively).

$$\mathbf{A} = \begin{bmatrix} \mathbf{A}^{11} & \dots & \mathbf{A}^{1s} & \dots & \mathbf{A}^{1m} \\ \vdots & & \vdots & & \vdots \\ \mathbf{A}^{r1} & \dots & \mathbf{A}^{rs} & \dots & \mathbf{A}^{rm} \\ \vdots & & \vdots & & \vdots \\ \mathbf{A}^{m1} & \dots & \mathbf{A}^{ms} & \dots & \mathbf{A}^{mm} \end{bmatrix}$$

is the multi-country input coefficient matrix ( $\mathbf{A}^{rs}$  is an  $n \times n$  sub-matrix that indicates the ratios of intermediate inputs provided by industries in country  $r$  to industries in country  $s$  relative to the industrial outputs in country  $s$ ).

$$\mathbf{f} = \begin{bmatrix} \mathbf{f}^1 \\ \vdots \\ \mathbf{f}^s \\ \vdots \\ \mathbf{f}^m \end{bmatrix}$$

is the vector of final demand ( $\mathbf{f}^s$  is country  $s$ '  $n \times 1$  vector of final demand).



Solving Equation (1) for  $X$  yields

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} = \mathbf{L}\mathbf{f}, \quad (2)$$

where

$$\mathbf{I} = \begin{bmatrix} \mathbf{I} & \cdots & \mathbf{O} & \cdots & \mathbf{O} \\ \vdots & \ddots & \vdots & & \vdots \\ \mathbf{O} & \cdots & \mathbf{I} & \cdots & \mathbf{O} \\ \vdots & & \vdots & \ddots & \vdots \\ \mathbf{O} & \cdots & \mathbf{O} & \cdots & \mathbf{I} \end{bmatrix}$$

is the identity matrix (sub-matrix  $\mathbf{I}$  is the  $n \times n$  identity matrix and  $\mathbf{O}$  represents the  $n \times n$  matrix of zeros).

$$\mathbf{L} = \begin{bmatrix} \mathbf{L}^{11} & \cdots & \mathbf{L}^{1s} & \cdots & \mathbf{L}^{1m} \\ \vdots & & \vdots & & \vdots \\ \mathbf{L}^{r1} & \cdots & \mathbf{L}^{rs} & \cdots & \mathbf{L}^{rm} \\ \vdots & & \vdots & & \vdots \\ \mathbf{L}^{m1} & \cdots & \mathbf{L}^{ms} & \cdots & \mathbf{L}^{mm} \end{bmatrix}$$

is the multi-country Leontief inverse matrix ( $\mathbf{L}^{rs}$  is the  $n \times n$  Leontief inverse sub-matrix).

Then, differentiating each element in  $\mathbf{x}$  in Equation (2) with regard to each element in  $\mathbf{f}$  yields

$$l_{ij}^{rs} = \frac{\Delta X_i^r}{\Delta f_j^s}. \quad (3)$$

In other words, the  $ij$  element of the  $rs$  sub-matrix in the Leontief inverse indicates the output of sector  $i$  in country  $r$ , induced directly or indirectly by one unit of final demand for sector  $j$  in country  $s$ . Thus, the column vector of sector  $j$  in country  $s$  indicates the output of all sectors (i.e., sectors 1 through  $n$ ) in all countries (i.e., countries 1 through  $m$ ), which is induced by one unit of final demand (for industry  $j$  in country  $s$ ), as shown below:

$$\begin{aligned} \mathbf{I}_{(j)}^{(s)} &= [l_{1j}^{1s}, \dots, l_{nj}^{1s}, \dots, l_{1j}^{rs}, \dots, l_{nj}^{rs}, \dots, l_{1j}^{ms}, \dots, l_{nj}^{ms}]' \\ &= \left[ \frac{\Delta X_1^1}{\Delta f_j^s}, \dots, \frac{\Delta X_n^1}{\Delta f_j^s}, \dots, \frac{\Delta X_1^r}{\Delta f_j^s}, \dots, \frac{\Delta X_n^r}{\Delta f_j^s}, \dots, \frac{\Delta X_1^m}{\Delta f_j^s}, \dots, \frac{\Delta X_n^m}{\Delta f_j^s} \right]'. \end{aligned} \quad (4)$$

Subsequently, the unit structure for the upstream transactions can be obtained by post-multiplying  $\mathbf{A}$  by the diagonal matrix of column vector  $\mathbf{I}_{(j)}^{(s)}$ .

$$\mathbf{U}_{(j)}^{(s)} = \mathbf{A} \hat{\mathbf{L}}_{(j)}^{(s)}$$

$$= \begin{bmatrix} \mathbf{A}^{11} & \dots & \mathbf{A}^{1s} & \dots & \mathbf{A}^{1m} \\ \vdots & & \vdots & & \vdots \\ \mathbf{A}^{r1} & \dots & \mathbf{A}^{rs} & \dots & \mathbf{A}^{rm} \\ \vdots & & \vdots & & \vdots \\ \mathbf{A}^{m1} & \dots & \mathbf{A}^{ms} & \dots & \mathbf{A}^{mm} \end{bmatrix} \begin{bmatrix} \hat{\mathbf{L}}_{(j)}^{(s)1} & \dots & 0 & \dots & 0 \\ \vdots & \ddots & \vdots & & \vdots \\ 0 & \dots & \hat{\mathbf{L}}_{(j)}^{(s)r} & \dots & 0 \\ \vdots & & \vdots & \ddots & \vdots \\ 0 & \dots & 0 & \dots & \hat{\mathbf{L}}_{(j)}^{(s)m} \end{bmatrix}, \quad (5)$$

where  $\hat{\mathbf{L}}_{(j)}^{(s)}$  is the diagonal matrix of column vector  $\mathbf{I}_{(j)}^{(s)}$ . Then, using Equation (3), it can be shown that  $\mathbf{U}_{(j)hi}^{(s)qr} = \mathbf{A}_{hi}^{qr} \mathbf{L}_{ij}^{rs} = \frac{\Delta \mathbf{Z}_{hi}^{qr} \Delta \mathbf{x}_i^r}{\Delta \mathbf{x}_i^r \Delta \mathbf{f}_j^s} = \frac{\Delta \mathbf{Z}_{hi}^{qr}}{\Delta \mathbf{f}_j^s}$ ,<sup>4</sup> where  $\mathbf{Z}_{hi}^{qr}$  denotes the value of intermediate inputs produced by industry  $h$  in country  $q$ , and used by industry  $i$  in country  $r$ . Hence, if  $j$  is specified as the agricultural sector,  $\mathbf{U}_{(j)hi}^{(s)qr}$  represents a transaction of inputs from industry  $h$  in country  $q$  to industry  $i$  in country  $r$ , which is induced by one unit of final demand for the agricultural products in country  $s$ . Then,  $\mathbf{U}_{(j)}^{(s)}$  indicates the sequences of inter-industry transactions of goods and services that occur along the upstream agricultural value chain.

Similarly, induced value added—actually paid as remuneration for primary inputs, such as labor compensation, profits, and taxes—is calculated by post-multiplying the row vector of the value added coefficients by  $\hat{\mathbf{L}}_{(j)}^{(s)}$ .

$$\mathbf{v}_{(j)}^{(s)'} = \mathbf{v}' \hat{\mathbf{L}}_{(j)}^{(s)}$$

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<sup>4</sup> Due to the assumption of linearity in the input-output model, it holds that  $\mathbf{A}_{hi}^{qr} = \frac{\mathbf{Z}_{hi}^{qr}}{\mathbf{x}_i^r} = \frac{\Delta \mathbf{Z}_{hi}^{qr}}{\Delta \mathbf{x}_i^r}$ .

$$= [\mathbf{v}^{1'} \quad \dots \quad \mathbf{v}^{r'} \quad \dots \quad \mathbf{v}^{m'}] \begin{bmatrix} \hat{\mathbf{L}}_{(j)}^{(s)1} & \dots & 0 & \dots & 0 \\ \vdots & \ddots & \vdots & & \vdots \\ 0 & \dots & \hat{\mathbf{L}}_{(j)}^{(s)r} & \dots & 0 \\ \vdots & & \vdots & \ddots & \vdots \\ 0 & \dots & 0 & \dots & \hat{\mathbf{L}}_{(j)}^{(s)m} \end{bmatrix}, \quad (6)$$

where

$$\mathbf{v} = \begin{bmatrix} \mathbf{v}^1 \\ \vdots \\ \mathbf{v}^r \\ \vdots \\ \mathbf{v}^m \end{bmatrix}$$

is a column vector of the value added coefficients<sup>5</sup> ( $\mathbf{v}^r$  is country  $r$ 's  $n \times 1$  vector of the value added coefficients).

Here, similar to Equation (5), it holds that

$$\mathbf{v}_{(j)i}^{(s)r} = \mathbf{v}_i^r \mathbf{L}_{ij}^{rs} = \frac{\Delta \mathbf{v}_i^r \Delta \mathbf{x}_i^r}{\Delta \mathbf{x}_i^r \Delta \mathbf{f}_j^s} = \frac{\Delta \mathbf{v}_i^r}{\Delta \mathbf{f}_j^s}, \quad (7)$$

where  $\mathbf{v}_i^r$  denotes the value added for industry  $i$  in country  $r$ . Hence, if  $j$  is specified as the agricultural sector,  $\mathbf{v}_{(j)i}^{(s)r}$  represents the value added in industry  $i$  in country  $r$  required to produce one unit of the agricultural products in country  $s$ .

Furthermore, it should be noted that  $\mathbf{v}_{(j)i}^{(s)r}$  ( $r \neq s$ ) represents the value added exports produced by industry  $i$  in source country  $r$  and absorbed by industry  $j$  in destination country  $s$ .<sup>6</sup>

It is also important to note that the sum of row  $\mathbf{v}_{(j)}^{(s)r}$  in Equation (6) always equals one, because of the equality between exogenously given final demand—one unit of final demand for sector  $j$  in country  $s$ —and the sum of value added generated endogenously in all sectors of all countries or regions.

## 2.2 Downstream transactions

For mapping downstream transactions, a different approach is necessary. This paper proposes to use the Ghosh inverse (Ghosh 1958) as an alternative to the Leontief

<sup>5</sup> A value added coefficient is the ratio of value added to total output.

<sup>6</sup> For the definition of value added exports, see Johnson and Noguera (2012).

inverse. As a mirror image of the Leontief inverse, the Ghosh inverse indicates output in the respective sectors induced by one unit of primary inputs for a specific sector<sup>7</sup>.

Using the allocation coefficient matrix, the accounting identity on the input side (i.e., the equality between total inputs and intermediate inputs plus value added) is expressed as

$$\mathbf{x}' = \mathbf{x}'\mathbf{B} + \mathbf{v}', \quad (8)$$

where

$$\mathbf{B} = \begin{bmatrix} \mathbf{B}^{11} & \dots & \mathbf{B}^{1s} & \dots & \mathbf{B}^{1m} \\ \vdots & & \vdots & & \vdots \\ \mathbf{B}^{r1} & \dots & \mathbf{B}^{rs} & \dots & \mathbf{B}^{rm} \\ \vdots & & \vdots & & \vdots \\ \mathbf{B}^{m1} & \dots & \mathbf{B}^{ms} & \dots & \mathbf{B}^{mm} \end{bmatrix}$$

is the multi-country output coefficient matrix ( $\mathbf{B}^{rs}$  is the  $n \times n$  sub-matrix that indicates the ratio of intermediate outputs distributed by the industries in country  $r$  to the industries in country  $s$  relative to the industrial outputs in country  $r$ ).

$$\mathbf{v} = \begin{bmatrix} \mathbf{v}^1 \\ \vdots \\ \mathbf{v}^r \\ \vdots \\ \mathbf{v}^m \end{bmatrix}$$

is the vector of value added ( $\mathbf{v}^r$  is country  $r$ 's  $n \times 1$  vector of value added).

Solving Equation (8) for  $\mathbf{x}$  gives

$$\mathbf{x}' = \mathbf{v}'(\mathbf{I} - \mathbf{B})^{-1} = \mathbf{v}'\mathbf{G}, \quad (9)$$

where

$$\mathbf{G} = \begin{bmatrix} \mathbf{G}^{11} & \dots & \mathbf{G}^{1s} & \dots & \mathbf{G}^{1m} \\ \vdots & & \vdots & & \vdots \\ \mathbf{G}^{r1} & \dots & \mathbf{G}^{rs} & \dots & \mathbf{G}^{rm} \\ \vdots & & \vdots & & \vdots \\ \mathbf{G}^{m1} & \dots & \mathbf{G}^{ms} & \dots & \mathbf{G}^{mm} \end{bmatrix}$$

is the multi-country Ghosh inverse matrix ( $\mathbf{G}^{rs}$  is the  $n \times n$  Ghosh inverse sub-matrix).

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<sup>7</sup> For the repercussion mechanism of the Ghosh model, see Chapter 12 in Miller and Blair (2009).

Then, differentiating each element in  $\mathbf{x}$  in Equation (8) with regard to each element in  $\mathbf{v}$  yields

$$g_{ij}^{rs} = \frac{\Delta X_j^s}{\Delta v_i^r}. \quad (10)$$

It should be noted that, contrary to Equation (3),  $g_{ij}^{rs}$  represents the output of sector  $j$  in country  $s$ , induced directly or indirectly by one unit of primary inputs (i.e., primary inputs whose total remuneration adds up to one unit of value added) in sector  $i$  in country  $r$ . Therefore, the row vector of sector  $i$  in country  $r$  reveals the output of all sectors in all countries, induced by sector  $i$  in country  $r$ :

$$\begin{aligned} \mathbf{g}_{(i)}^{(r)} &= [g_{i1}^{r1}, \dots, g_{in}^{r1}, \dots, g_{i1}^{rs}, \dots, g_{in}^{rs}, \dots, g_{i1}^{rm}, \dots, g_{in}^{rm}] \\ &= \left[ \frac{\Delta X_1^1}{\Delta v_i^r}, \dots, \frac{\Delta X_n^1}{\Delta v_i^r}, \dots, \frac{\Delta X_1^s}{\Delta v_i^r}, \dots, \frac{\Delta X_n^s}{\Delta v_i^r}, \dots, \frac{\Delta X_1^m}{\Delta v_i^r}, \dots, \frac{\Delta X_n^m}{\Delta v_i^r} \right]. \end{aligned} \quad (11)$$

Then, the unit structure for the downstream transactions can be obtained by pre-multiplying  $\mathbf{B}$  by the diagonal matrix of row vector  $\mathbf{g}_{(i)}^{(r)}$ .

$$\begin{aligned} \mathbf{D}_{(i)}^{(r)} &= \widehat{\mathbf{G}}_{(i)}^{(r)} \mathbf{B} \\ &= \begin{bmatrix} \widehat{\mathbf{G}}_{(i)}^{(r)1} & \dots & 0 & \dots & 0 \\ \vdots & \ddots & \vdots & & \vdots \\ 0 & \dots & \widehat{\mathbf{G}}_{(i)}^{(r)s} & \dots & 0 \\ \vdots & & \vdots & \ddots & \vdots \\ 0 & \dots & 0 & \dots & \widehat{\mathbf{G}}_{(i)}^{(r)m} \end{bmatrix} \begin{bmatrix} \mathbf{B}^{11} & \dots & \mathbf{B}^{1s} & \dots & \mathbf{B}^{1m} \\ \vdots & & \vdots & & \vdots \\ \mathbf{B}^{r1} & \dots & \mathbf{B}^{rs} & \dots & \mathbf{B}^{rm} \\ \vdots & & \vdots & & \vdots \\ \mathbf{B}^{m1} & \dots & \mathbf{B}^{ms} & \dots & \mathbf{B}^{mm} \end{bmatrix}, \end{aligned} \quad (12)$$

where  $\widehat{\mathbf{G}}_{(i)}^{(r)}$  is the diagonal matrix of row vector  $\mathbf{g}_{(i)}^{(r)}$ . Note that, similar to Equation (5),

it holds that  $\mathbf{D}_{(i)jk}^{(r)st} = \mathbf{G}_{ij}^{rs} \mathbf{B}_{jk}^{st} = \frac{\Delta x_j^s}{\Delta v_i^r} \frac{\Delta Z_{jk}^{st}}{\Delta x_j^s} = \frac{\Delta Z_{jk}^{st}}{\Delta v_i^r}$ . Thus, if  $i$  is specified as the

agricultural sector,  $\mathbf{D}_{(i)}^{(r)}$  indicates sequences of inter-industry transactions of goods and services that occur along the downstream agricultural value chain in country  $r$ .

Similarly, the final demand induced by agricultural value added is calculated

as:

$$\mathbf{F}_{(i)}^{(r)} = \widehat{\mathbf{G}}_{(i)}^{(r)} \mathbf{F}$$

$$= \begin{bmatrix} \widehat{\mathbf{G}}_{(i)}^{(r)1} & \dots & 0 & \dots & 0 \\ \vdots & \ddots & \vdots & & \vdots \\ 0 & \dots & \widehat{\mathbf{G}}_{(i)}^{(r)s} & \dots & 0 \\ \vdots & & \vdots & \ddots & \vdots \\ 0 & \dots & 0 & \dots & \widehat{\mathbf{G}}_{(i)}^{(r)m} \end{bmatrix} \begin{bmatrix} \mathbf{F}^1 \\ \vdots \\ \mathbf{F}^s \\ \vdots \\ \mathbf{F}^m \end{bmatrix}, \quad (13)$$

where

$$\mathbf{F} = \begin{bmatrix} \mathbf{F}^1 \\ \vdots \\ \mathbf{F}^s \\ \vdots \\ \mathbf{F}^m \end{bmatrix};$$

is the matrix of the final demand coefficient,<sup>8</sup> ( $\mathbf{F}^r$  is country  $r$ 's  $n \times 6$  sub-matrix of the final demand coefficients).<sup>9</sup>

It should be noted that, similar to Equation (6), the sum of all matrix elements in  $\mathbf{F}_{(i)}^{(r)}$  in Equation (13) always equals one because of the equality between exogenously given value added—one unit of value added (or primary inputs) for sector  $i$  in country  $r$ —and the sum of final demand (or final outputs) endogenously generated in all sectors for all countries or regions.

### 3. Empirical results

#### 3.1 The structure of the agricultural sector

<sup>8</sup> A final demand coefficient is the ratio of final demand to total output.

<sup>9</sup> The reason that the final demand matrix for each country has  $6 \times m$  columns is that, in the ICIO tables, the distribution of goods and services for final consumption is divided into  $m$  destination countries and six final demand columns (i.e., household consumption, non-profit institutions serving households, general government final consumption, gross fixed capital formation, changes in inventories, and direct purchases abroad by residents) for each destination country.

In this section, agricultural value chains are discussed from the viewpoint of production and trade structure. It should be noted that the three countries—Thailand, Vietnam, and Cambodia—are in different stages of industrial development and, thus, their agricultural value chains can be situated in different positions with regard to the regional production networks.

Table 1 compares the agricultural sector in the three countries in terms of the shares of agricultural value added, exports, and the degree of diversification in the industrial structure.<sup>10</sup> During 1995–2011, the agricultural sector grew rapidly in these three countries, with Thailand generating the largest value added, followed by Vietnam and Cambodia. During the same period, the share of agricultural value added declined, with the exception of Thailand, and the diversification of industrial structure increased in all countries, as reflected by a decrease in the Herfindahl index.<sup>11</sup> However, it should be noted that the agricultural sector still occupies a relatively high value added share, although a higher income country tends to register a lower share.

- Table 1 -

During 1995–2011, agricultural exports also increased sharply in Thailand and Vietnam, but declined slightly in Cambodia. Correspondingly, the share of agricultural exports increased in Thailand and Vietnam, but declined sharply in Cambodia, with a slight decrease in export diversification. It should be noted, however, that Cambodia's

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<sup>10</sup> In the OECD ICIO tables, the agricultural sector is actually composed of agriculture, hunting, forestry, and fishing (see Table A1 in Appendix 1).

<sup>11</sup> The Herfindahl index is calculated as  $H^S = \sum_{i=1}^n (\lambda_i^S)^2$ , where  $\lambda_i^S$  is the value added (or exports) share of sector  $i$  in country  $S$ , and  $n$  is the number of industrial sectors in country  $S$ .

export structure was unconventional in the sense that the share of textile products and footwear had increased drastically, achieving 40 percent of total exports in 2011, thus reducing the share occupied by the other sectors, including the agricultural sector.

Regarding the export orientation of the agricultural sector, Thailand and Vietnam increased their export dependency, their ratio of exports to value added reaching 29.6 percent and 24.1 percent, respectively, in 2011; on the other hand, Cambodia's export ratio was 4.7 percent in 2011.<sup>12</sup>

### 3.2 Trade in value added: VS share

Figure 1 shows the VS share of the agricultural sector for 21 countries or regions. The VS share of the agricultural sector represents the percentage share of foreign value added that is embodied in agricultural exports (i.e., the share of value added that is induced by agricultural exports, but accrues to foreign countries).<sup>13</sup>

Figure 1 shows that in all countries or regions, except New Zealand, the VS share increased significantly during 1995–2011. This demonstrates that these countries increased their dependency on imported agricultural inputs, such as fertilizers and pesticides. Among the three countries, Thailand had the highest VS share, followed by Vietnam. On the other hand, Cambodia had an extremely low VS share, lower than some large countries, such as China, Indonesia, and India. This implies that the agricultural value chain in Cambodia was highly self-sufficient with little dependency on foreign inputs. From the viewpoint of a value chain, it can be said that Cambodia

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<sup>12</sup> It should also be noted that Cambodia's agricultural exports could be seriously underestimated due to unofficial export of agricultural products—such as paddy, cassava, and maize—to Vietnam and Thailand.

<sup>13</sup> For details on the VS share and the method of decomposition introduced in this paper, see Appendix 2.



was not fully utilizing opportunities to improve productivity by participating in GVCs. It should be noted that engagement with GVCs can increase productivity by facilitating access to cheaper or higher-quality inputs.<sup>14</sup> It is particularly relevant in a country such as Cambodia, where procurement of high-quality agricultural inputs is severely constrained by underdeveloped manufacturing sectors.

-Figure 1-

Figures 2.1 to 2.3 breakdown the VS share into the country of origin, where the foreign value added is created by the agricultural exports of the three countries. It is notable that, among the three countries, China's share increased remarkably, suggesting that it has become an important supplier of agricultural inputs for these countries. It is also worth noting that, along with the major exporters of agricultural inputs—such as China, the EU, the USA, and the rest of the world (ROW)—Vietnam and Thailand became important suppliers of agricultural inputs to Cambodia.

-Figures 2.1, 2.2, 2.3-

Figures 3.1 to 3.3 breakdown the VS share into the sector of origin, where the foreign value added is generated by agricultural exports. In Thailand, the share of the

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<sup>14</sup> It is shown that an industry with a high share of imported inputs displays, on average, higher productivity among OECD countries, because foreign inputs embody more productive technology, and resources are re-allocated more efficiently. Particularly, increased productivity results from: (1) a price effect—increased intermediate imports result in stronger competition and therefore lower prices for inputs; (2) a supply effect—increased imports enhance the variety of inputs available; (3) a productivity effect: new intermediate inputs may spur innovation in the final goods sector by enhancing access to knowledge (OECD 2013).

foreign content was high for minerals, chemicals, agriculture, food products, and refined petroleum. Additionally, the service sectors, such as wholesale and retail trade, financial intermediation, transport, and business services, showed high foreign content share. It should be noted that these sectors were ranked highly in Vietnam and Cambodia as well, reflecting similarity in terms of imported inputs.

-Figures 3.1, 3.2, 3.3-

### 3.3 Mapping the value chain

The VS indicates the share of foreign content embodied in exports. Furthermore, the decomposition of the VS is useful to trace the source country and industry of the foreign content. However, since these are aggregate data, they cannot provide sufficient information to trace value added activities along the chain. Furthermore, unlike the conventional value chain analysis, trade in value added does not provide any information regarding the transactions of goods and services that accompany value-added activities. However, the method of value chain mapping discussed below takes into account these constraints.

#### (1) Upstream transactions

The unit structure analysis provides information regarding the flow of goods and services transactions, as well as the creation of value added, which is induced by one unit of final demand for a specific sector. Using the above information, a value chain is mapped, with the transactions traced along the chain.

For instance, Figures 4.1, 4.2, and 4.3 are respectively constructed based on the inter-industry transactions in Tables A2.1, A2.2, and A2.3 (Appendix 3). The direction of the arrows in Figure 4.1 indicates which inputs (shown on the left-hand side of the arrows) are used to produce which outputs (shown on the right-hand side), with the final destination of the arrows being one unit of an agricultural product. In summary, these figures demonstrate the sequence of upstream transactions of goods and services, induced by one unit of agricultural products. Additionally, it should be noted that the value added activities that accompany the transactions of goods and services are recorded by the corresponding sectors under the VA row in Tables A2.1, A2.2, and A2.3. For instance, Figure 4.1 shows that inputs from FOD (1.4) and AGR (2.9) were used to produce FOD outputs in Thailand (the figures in the parenthesis are derived from Table A2.1). Simultaneously, it is demonstrated that value added (2.8) was generated in the FOD sector in this production process.

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- Figure 4.1, Figure 4.2 and Figure 4.3 -

Figure 4.1 shows that, in 2011, the Thai agricultural sector received inputs from refined petroleum, chemicals, rubber, food products, and agriculture. Additionally, it had service inputs from the wholesale and retail trade, transport, and financial intermediation (for the volume of inter-industry transactions and the value added generated, see Table A2.1). Among them, a value chain sequence, minerals → refined petroleum → agriculture, can be seen in both the domestic and foreign inputs. Because a higher consumption of refined petroleum is considered to reflect a higher usage of

agricultural machinery—such as tractors and harvesters—the existence of such a sequence reflects a higher level of mechanization in the Thai agricultural sector.

Moreover, since chemical products, which include chemical fertilizers and pesticides, are critical inputs for agriculture, the sequence of chemicals → agriculture, is an important segment of the agricultural value chain, for which the major suppliers of chemicals were Thailand, Japan, China, and the ROW.

Figure 4.2 shows significant similarities in the structure of the value chains between Vietnam and Thailand, but a notable difference is that chemical inputs were relatively low in Vietnam (see Tables A2.1 and A2.2). Furthermore, unlike Thailand, inputs from refined petroleum do not appear in Figure 4.2. Regarding foreign inputs, inputs from food products, agriculture, and wholesale and retail trade were relatively high, but neither chemicals nor refined petroleum were included in this category. These results suggest that there is still room for improving the productivity of Vietnam's agricultural sector in terms of usage of chemicals and agricultural machinery, particularly those imported.

The above structure is more clearly demonstrated in Figure 4.3. As shown in Table A2.3, Cambodia had an extremely high value added share of the agricultural sector (98.14). This implies that Cambodia's agricultural sector was highly self-sufficient and its backward linkage with other sectors, including chemical inputs and refined petroleum, was extremely weak. As in other countries, a variety of industries stimulated by agricultural output are shown in Figure A4.3, but their volume

is strikingly small.<sup>15</sup> However, it is notable that refined petroleum imported from Vietnam was used by the Cambodian agricultural sector.

## (2) Downstream transactions

Figures 5.1, 5.2, and 5.3 are produced based on Tables A3.1, A3.2, and A3.3 respectively. Unlike Figure 4.1, Figure 5.1 starts with one unit of an agricultural output, used as an intermediate input for other sectors, such as food products. The outputs of the other sectors are subsequently used as inputs and stimulate the outputs of other sectors such as hotels and restaurants. Consequently, these figures demonstrate the sequence of downstream transactions of goods and services induced by one unit of an agricultural output.

- Figure 5.1, Figure 5.2 and Figure 5.3 -

Figure 5.1, shows that Thai agricultural outputs were used as intermediate inputs for the manufacturing sectors, such as food products, rubber products, wood products, and textiles. Among them, food products received the largest amount of inputs from agriculture (35.6 units; see Table A3.1). Then, the food products were consumed by other sectors, including household consumption in Thailand, Japan, the USA, the EU, and the ROW. Hotels and restaurants, whose services were finally consumed by households, were an important sales destination for agricultural outputs.

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<sup>15</sup> Regarding agricultural inputs in Cambodia, a government official whom the author met at the Ministry of Agriculture, Forestry, and Fisheries (MAFF) appreciated that “chemicals used in agriculture are too little because of higher prices of agricultural chemicals imported from abroad and traditional farming systems, where the main purpose of farming is for household-consumption.”

Some agricultural outputs were exported to China and Japan. Food products produced using agricultural outputs from Thailand were consumed by households in these countries (see the right hand side of Table A3.1).

Figure 5.2 shows that the basic structure of Vietnam's agricultural value chain is similar to that of Thailand. Particularly, similar to Thailand, Vietnam's food products were stimulated strongly by agricultural outputs (41.9 units; see Table A3.2), and the sectors that used food products as inputs were also similar to Thailand's. In Vietnam, however, household consumption in the EU played a more important role as a destination for Vietnam's food products.

In Cambodia, transactions of goods and services induced by a unit of agricultural output were significantly small (see Figure 5.3 and Table A3.3). First, this reflects the nature of the Cambodian agricultural sector, where a large percentage of agricultural output was consumed by domestic households; thus, its forward linkage with other sectors was extremely weak.<sup>16</sup> Second, unlike Thailand and Vietnam, Cambodia's food products had no significant impact on household consumption abroad. This is because Cambodia's food processing industry is underdeveloped, and the bulk of agricultural products were exported directly without processing.

Third, part of hotels and restaurants services, which had inputs from the agricultural sector, were consumed by direct purchase by residents from the USA. This reflects the fact that Cambodia attracted a large number of foreign tourists, who spent large amounts of money at hotels and restaurants in Cambodia. Finally, it is worth noting that neighboring countries were becoming important trade partners of Cambodia; for instance, a significant amount of Cambodia's agricultural output was exported to

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<sup>16</sup> As previously discussed, Cambodia's external linkages could be significantly underestimated because of unofficial trade with neighboring countries.

Vietnam, thus stimulated the output of food products here. However, this implies that potentially lucrative markets, such as the EU, the USA, Japan, China, and Korea, have not been fully exploited by Cambodian producers yet.

#### 4. Conclusion

This paper introduced a method of the value chain mapping that uses international input-output data. The international input-output tables are one of the most reliable data sources that document the transactions of goods and services across borders. Therefore, this method combines the concept of value chain mapping with the technique of input-output analysis. The method clearly demonstrates that the value chain of a specific sector or commodity can be mapped with both upstream and downstream transactions of goods and services along the chain. Furthermore, the method provides more detailed information regarding the sequences of the value added activities along the chain than does analysis of trade in value added.

The result of the analysis shows that Thailand's agricultural value chains are the most advanced and internationalized among the three countries. Particularly, critical agricultural inputs, such as chemicals and refined petroleum, were procured from both international and domestic sources. On the other hand, Vietnam and Cambodia were not fully utilizing opportunities to improve productivity by participating in GVCs. Specifically, Cambodia's agricultural sector was highly self-sufficient with little dependency on imported inputs. Conversely, Thailand and Vietnam show rather diversified downstream transactions. In particular, food products produced using agricultural outputs were widely consumed by households in both domestic and international markets. It is also worth noting that hotels and restaurants were important

sales destinations of agricultural outputs. In Cambodia, the transactions of goods and services stimulated by agricultural production were significantly smaller. Moreover, Cambodia's food products had no significant impact on household consumption abroad, due to the underdevelopment of the food processing industry in Cambodia.

Although the method proves useful, there are some constraints regarding the data and methodology. First, it is desirable to construct more disaggregated data with a greater number of sector classifications, particularly for agriculture and related industries. Second, the current input-output data has an industrial activity-based sector classification, while a conventional value chain analysis concerns business functions—such as design, production, marketing, distribution, and support to the final consumer—performed by each firm. Therefore, this difference needs to be reconciled so that input-output analysis can be performed more in line with the concept of the value chain analysis. Finally, it is important to improve trade statistics, especially for a country such as Cambodia, whose trade statistics could be underestimated due to unofficial trade.



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## Appendix 1: Sectoral classification of OECD ICIO tables

The following table shows the sectoral classification of the OECD ICIO tables.

- Table A1 -

## Appendix 2: The VS share and its decomposition

The VS share represents the percentage share of foreign content embodied in exports, i.e., the share of value added induced by exports but accrued to foreign countries. The methodology was originally developed by Hummels, Ishi, and Yi (2001), and it was introduced into the analysis of trade in value added by Koopmans, Wang, and Wei (2014).

Using Equation (7) in Section 2.1, the VS share of sector  $j$  in country  $s$  (Equation (40) in Koopmans, Wang, and Wei, 2014) can be expressed as:

$$VS_{(j)}^{(s)} \text{ share} = 100 \times \sum_{r \neq s}^m \sum_{i=1}^n \mathbf{v}_i^r \mathbf{L}_{ij}^{rs} = 100 \times \sum_{r \neq s}^m \sum_{i=1}^n \mathbf{v}_{(j)i}^{(s)r}, \quad (\text{a1})$$

where  $\mathbf{v}_{(j)i}^{(s)r}$  represents the value added in sector  $i$  in country  $r$  that is induced by one unit of final demand for sector  $j$  in country  $s$ .<sup>17</sup> Here, the VS share is expressed in percentage terms, so that it can range from 0 to 100.<sup>18</sup> Furthermore, the  $VS_{(j)}^{(s)}$  share can be decomposed as follows.

### (1) Share of foreign content by country of origin

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<sup>17</sup> Note that, in the input-output framework, the induced output or value added is identical regardless of whether it is induced by exports or other final demand items.

<sup>18</sup> It should also be noted that, as a mirror image of the  $VS_{(j)}^{(s)}$  share, a measure of vertical specialization can be calculated using the Ghosh inverse as follows:  
 $VS(G)_{(i)}^{(r)} \text{ share} = 100 \times \sum_{s \neq r}^m \sum_{j=1}^n \mathbf{G}_{ij}^{rs} f_j^s$ , where  $f_j^s$  indicates the final demand coefficient for sector  $j$  in country  $s$ . Therefore, the  $VS(G)_{(i)}^{(r)}$  share indicates the share of the final outputs produced by foreign producers when one unit of value added is generated by sector  $i$  in country  $r$ . Theoretically, the  $VS(G)_{(i)}^{(r)}$  can be a sector-level counterpart for VS1, which measures the value of the exported goods used as imported inputs by other countries to produce their exports—this, in turn, indicates the strength of forward linkages across countries. Actually, as in VS1 in Koopman, Wang, and Wei (2014), the  $VS(G)_{(i)}^{(r)}$  share will be higher, when the industry is located in the upstream of the value chain and provides a large amount of inputs to foreign producers. However, unlike the VS1, the VS(G) share does not discern whether the final product is consumed in its producing country or re-exported to a third country.

$$VS_{(j)}^{(s)r} \text{ share} = 100 \times \sum_{i=1}^n \mathbf{v}_{(j)i}^{(s)r}. \quad (\text{a2})$$

(2) Share of foreign content by sector of origin

$$VS_{(j)i}^{(s)} \text{ share} = 100 \times \sum_{r \neq s}^m \mathbf{v}_{(j)i}^{(s)r}. \quad (\text{a3})$$

### Appendix 3: Results of the unit structure analysis

Tables A2.1 and A3.1 show the results of the unit structure for the agricultural sector in Thailand, where the downstream and upstream transactions of goods and services induced by one unit of agricultural output are recorded, by employing the method discussed in Section 2.<sup>19</sup> Similarly, Tables A2.2 and A3.2, and Tables A2.3 and A3.3 respectively demonstrate the unit structure of the agricultural sector in Vietnam and Cambodia.

- Tables A2.1, A2.2, and A2.3 -
- Tables A3.1, A3.2, and A3.3 -

Each column in Table A2.1 (A2.2, A2.3) indicates how the intermediate inputs and value added are used or generated by each column sector, when one unit (normalized to 100) of agricultural product is produced in Thailand (Vietnam, Cambodia). The transactions that occur outside Thailand (Vietnam, Cambodia) are recorded on the right-hand side of the tables: these transactions may include transactions of intermediate inputs, as well as value added generated outside Thailand (Vietnam, Cambodia). As the transactions actually occurring within and outside the country are numerous,<sup>20</sup> only the 25 largest transactions (whose values may differ depending on the country) are reported.

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<sup>19</sup> For clarity, one unit is actually normalized to 100 in all tables.

<sup>20</sup> For instance, there are potentially 510,510 (= (34 x 21)<sup>2</sup>) intermediate transactions plus 680 (= 34 x 21) value added for each Table A2.1 to Table A2.3. The percentage shares of transactions recorded in the tables (= 100 X (intermediate transactions plus value added or final demand that appear in respective tables)/(all intermediate transactions plus value added or final demand induced by a unit of agricultural production) are as follows: 64.7 percent (Table A2.1), 73.5 percent (Table A2.2), 95.8

On the other hand, each column in Table A3.1 (A3.2, A3.3) indicates how the outputs are distributed in the respective row sectors (for domestic and foreign markets), when one (100) unit of agricultural output is produced. Note that the row sectors include the intermediate sectors, as well as the final demand sectors; a large portion of food products, for instance, is distributed for household consumption. As in the upstream transactions, the downstream transactions that occur outside Thailand (Vietnam, Cambodia) are recorded on the right-hand side of the tables, and only the 25 largest transactions are reported.

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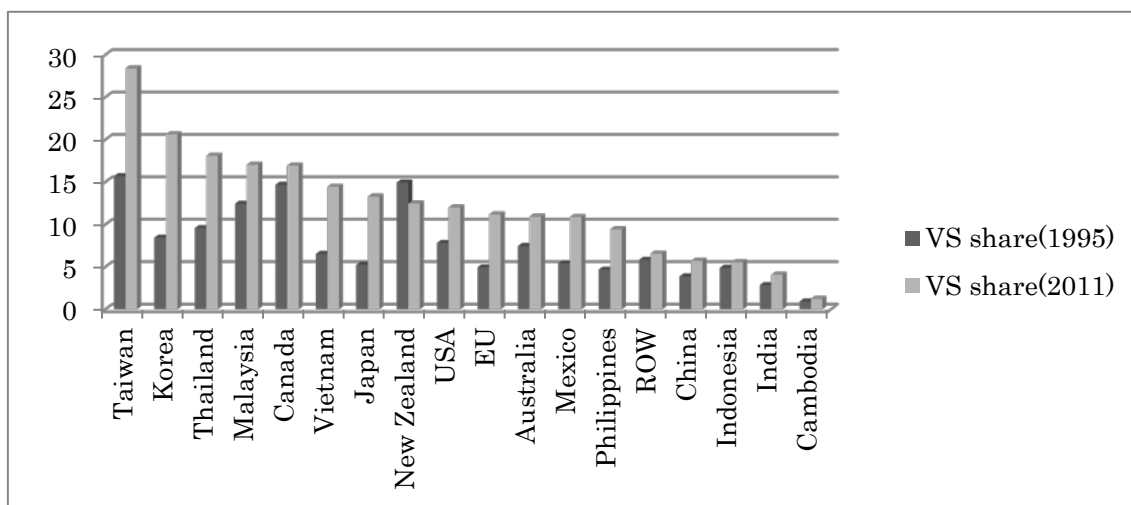
percent (Table A2.3), 56.2 percent (Table A3.1), 68.4 percent (Table A3.2), and 82.0 percent (Table A3.3).

Table 1 Agricultural sector in Thailand, Vietnam, and Cambodia (1995, 2011)

	Thailand		Vietnam		Cambodia	
	1995	2011	1995	2011	1995	2011
AGR value added (1,000USD)	15,375,127	41,700,614	5,415,244	28,677,206	1,638,451	4,382,146
Share of AGR value added (%)	9.1	11.4	27.2	22.0	50.6	35.4
Herfindahl index (VA)	0.07	0.06	0.12	0.10	0.29	0.16
AGR export (1,000USD)	1,228,837	12,336,873	380,336	6,917,529	393,279	324,498
Share of AGR export (%)	1.8	4.9	5.6	7.3	38.3	4.7
Herfindahl index (EXP)	0.09	0.06	0.10	0.08	0.22	0.23
EXP/VA ratio (%)	8.0	29.6	7.0	24.1	24.0	7.4

Source: Calculated from OECD ICIO tables, 1995, 2011

Figure 1 VS share of agricultural exports by country (1995, 2001)<sup>a</sup>

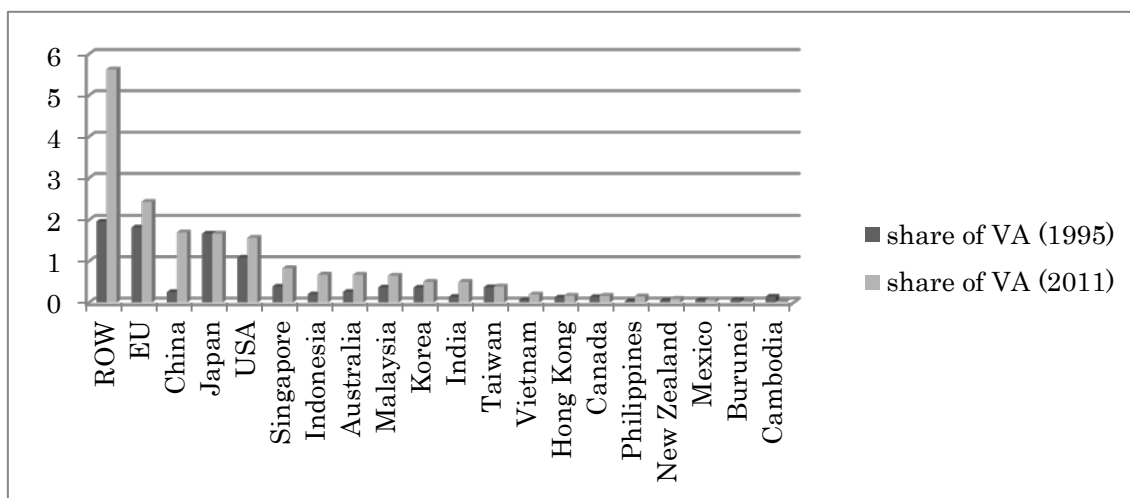


Source: Calculated from OECD ICIO tables, 1995, 2011

<sup>a</sup>The original OECD ICIO tables cover 62 countries. In this paper, these countries are aggregated into 21 countries or regions, which include the EU and the ROW.

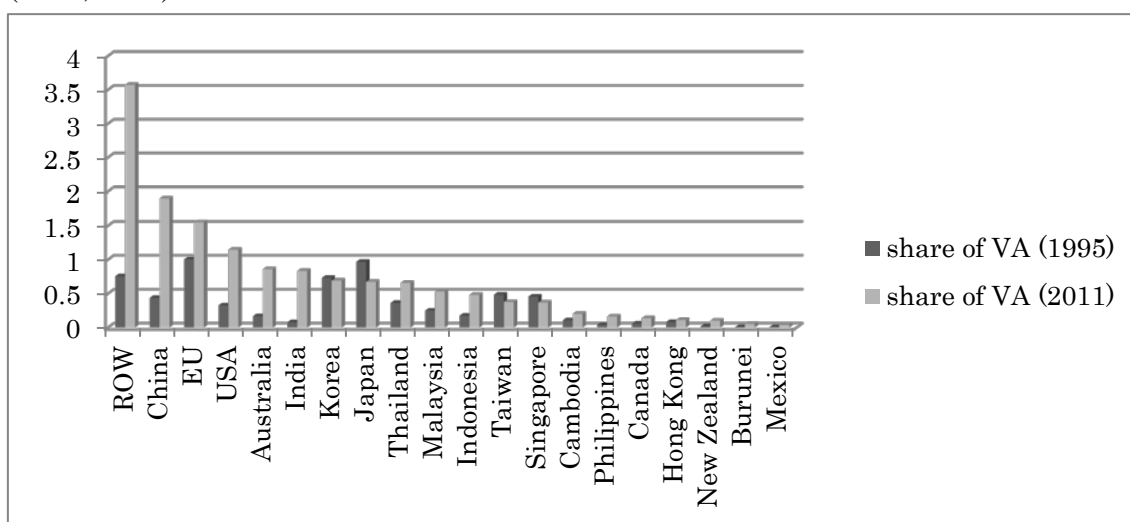


Figure 2.1 Share of foreign content by country of origin: Thai agricultural sector (1995, 2011)



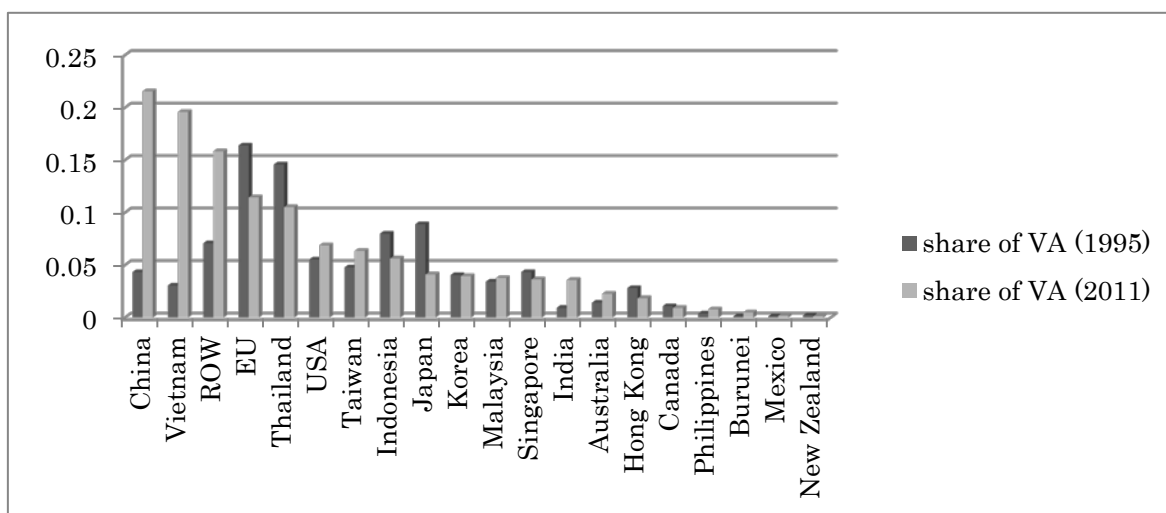
Source: Calculated from OECD ICIO tables, 1995, 2011

Figure 2.2 Shares of foreign content by country of origin: Vietnamese agricultural sector (1995, 2011)



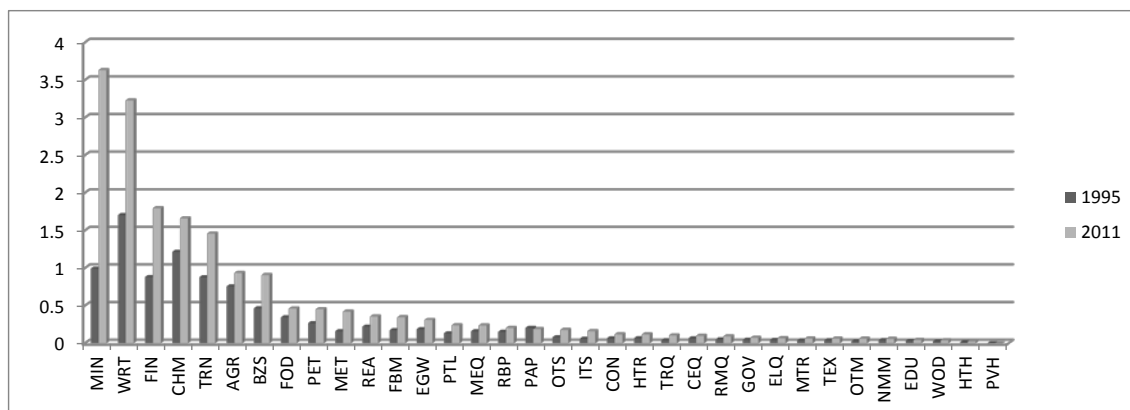
Source: Calculated from OECD ICIO tables, 1995, 2011

Figure 2.3 Share of foreign content by country of origin: Cambodian agricultural sector (1995, 2011)



Source: Calculated from OECD ICIO tables, 1995, 2011

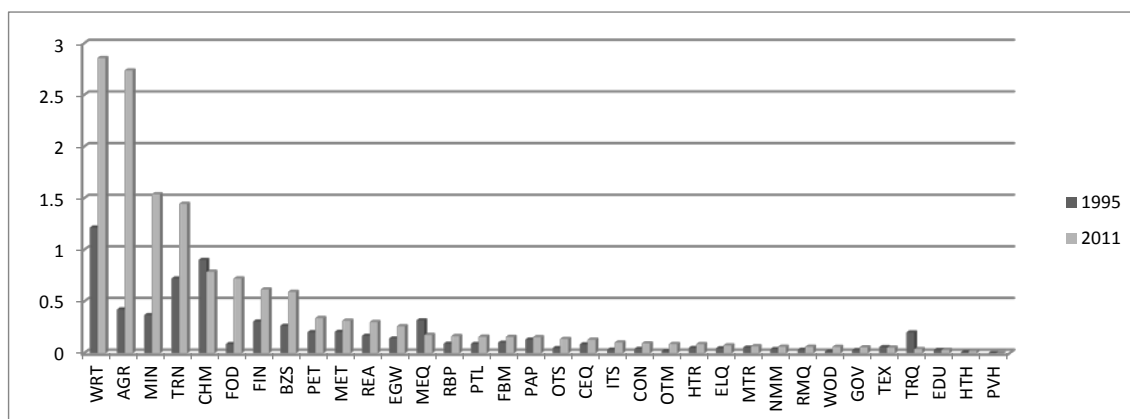
Figure 3.1 Share of foreign content by sector of origin: Thai agricultural sector (1995, 2011)<sup>a</sup>



Source: Calculated from OECD ICIO tables, 1995, 2011

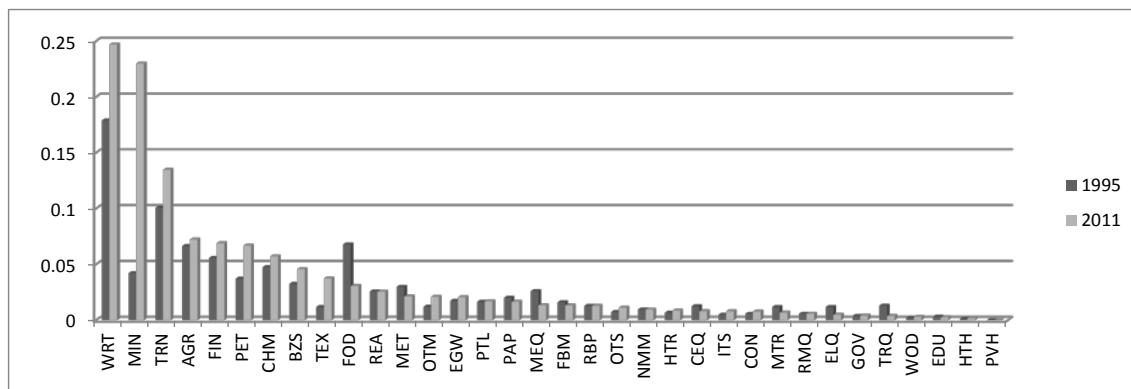
<sup>a</sup>For the sector classification of Figures 3.1–3.3, see Appendix 1.

Figure 3.2 Share of foreign content by sector of origin: Vietnamese agricultural sector (1995, 2011)



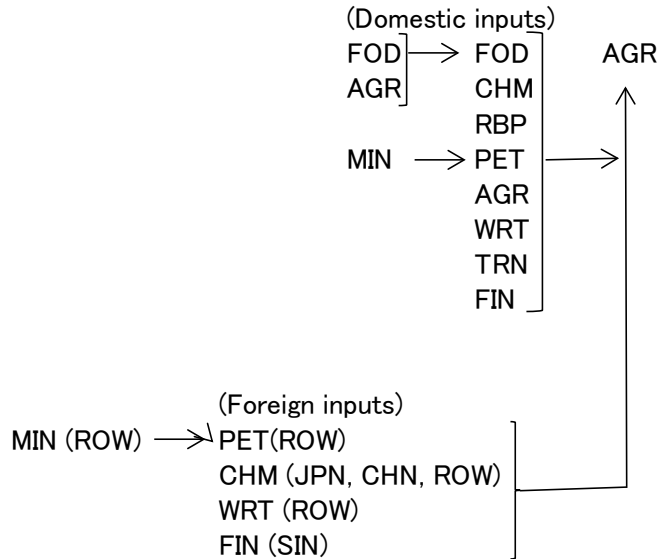
Source: Calculated from OECD ICIO tables, 1995, 2011

Figure 3.3 Share of foreign content by sector of origin: Cambodian agricultural sector (1995, 2011)



Source: Calculated from OECD ICIO tables, 1995, 2011

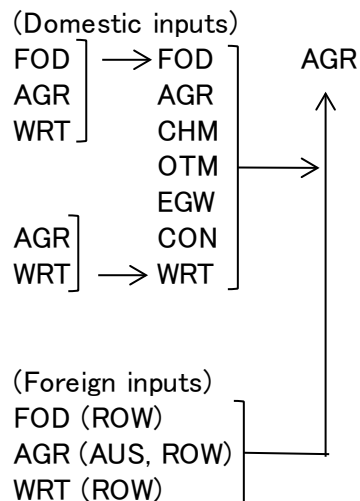
Figure 4.1 Flow of upstream transactions: Agricultural sector in Thailand (2011)



Source: Calculated from OECD ICIO tables, 2011

Notes: This figure is based on Table A2.1 (the volume of transactions and the value added generated in the respective sectors are omitted from the figure). For the sector classification of Figures 4.1–4.3, see Table A1.

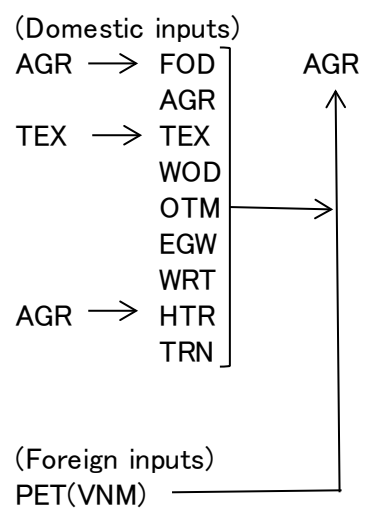
Figure 4.2 Flow of upstream transactions: Agricultural sector in Vietnam (2011)



Source: Calculated from OECD ICIO tables, 2011

Note: This figure is based on Table A2.2.

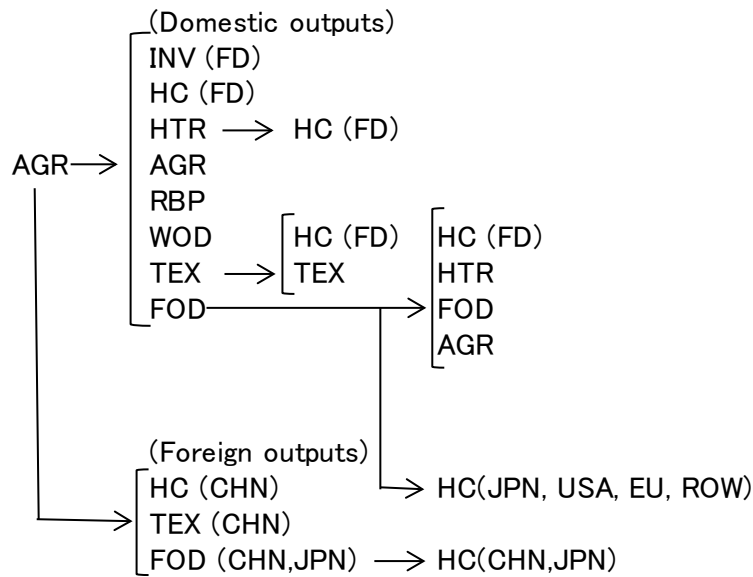
Figure 4.3 Flow of upstream transactions: Agricultural sector in Cambodia (2011)



Source: Calculated from OECD ICIO tables, 2011

Note: This figure is based on Table A2.3.

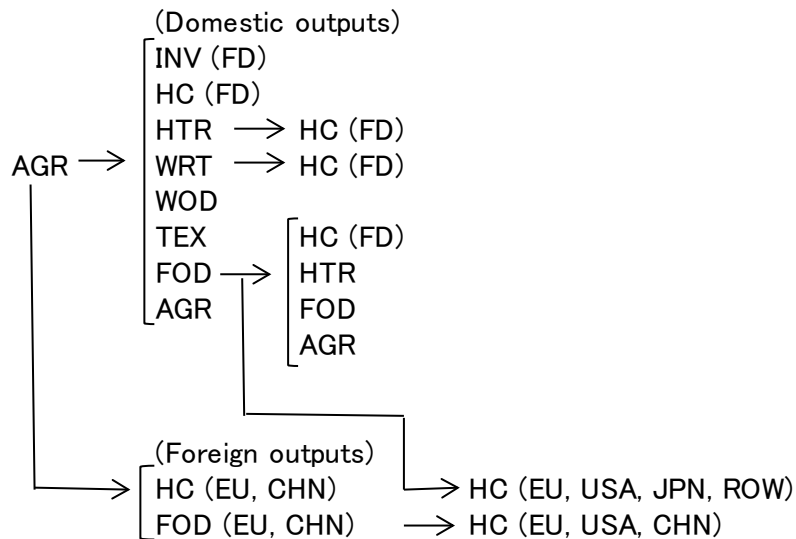
Figure 5.1 Flow of downstream transactions: Agricultural sector in Thailand (2011)



Source: Calculated from OECD ICIO tables, 2011

Notes: This figure is based on Table A3.1. For the sector classification of Figures 5.1–5.3, see Tables A1.

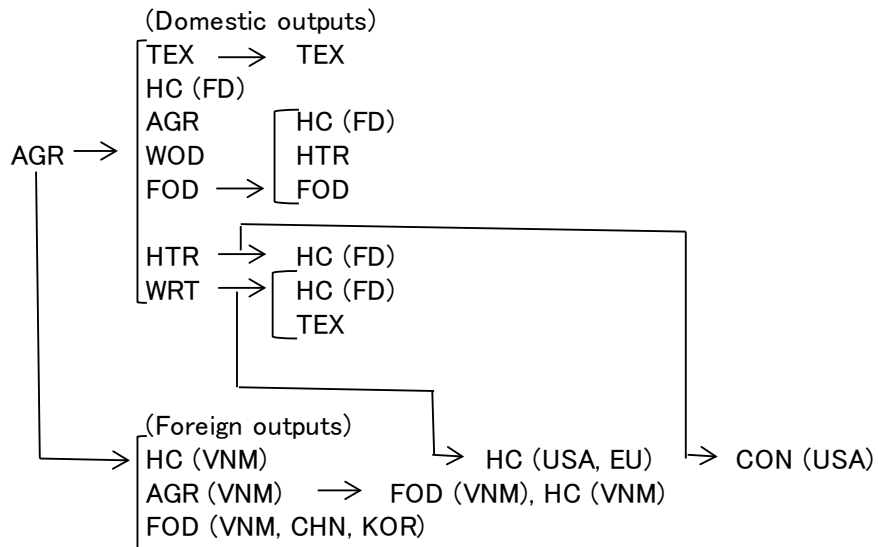
Figure 5.2 Flow of downstream transactions: Agricultural sector in Vietnam (2011)



Source: Calculated from OECD ICIO tables, 2011

Note: This figure is based on Table A3.2.

Figure 5.3 Flow of downstream transactions: Agricultural sector in Cambodia (2011)



Source: Calculated from OECD ICIO tables, 2011

Note: This figure is based on Table A3.3.



Table A1 Sector classification in OECD ICIO tables

AGR	Agriculture, hunting, forestry, and fishing	EDU	Education
MIN	Mining and quarrying	HTH	Health and social work
FOD	Food products, beverages, and tobacco	OTS	Other community, social and personal services
TEX	Textiles, textile products, leather, and footwear	PUH	Private households with employed persons
WOD	Wood and products of wood and cork		
PAP	Pulp, paper, paper products, printing, and publishing	HC	Household consumption
PET	Coke, refined petroleum products, and nuclear fuel	NPI	Non-profit institution serving household
CHN	Chemicals and chemical products	GGF	General government final consumption
RBP	Rubber and plastic products	GFC	Gross fixed capital formation
NMM	Other non-metallic mineral products	INV	Changes in inventories
MET	Basic metals	CON	Direct purchase abroad by residents
FBM	Fabricated metal products	DISC	Discrepancies
MEQ	Machinery and equipment, n.e.c.		
CEO	Computer, Electronic and optical equipment	VA	Value added
ELQ	Electrical machinery and apparatus, nec	CT	Output at basic prices
MTR	Motor vehicles, trailers, and semi-trailers		
TRQ	Other transport equipment		
OTM	Manufacturing nec; recycling		
EGW	Electricity, gas, and water supply		
CON	Construction		
WRT	Wholesale and retail trade; repairs		
HTR	Hotels and restaurants		
TRN	Transport and storage		
PTL	Post and telecommunications		
FIN	Financial intermediation		
REA	Real estate activities		
RMQ	Renting of machinery and equipment		
ITS	Computer and related activities		
BZS	R&D and other business activities		
GOV	Public administration and defense; compulsory social security		

Source: OECD ICIO tables

Table A2.1 Unit structure (upstream transactions: 100 units): Agricultural sector in Thailand (2011)

	RBP	FOD	AGR	CHM	PET	MIN	WRT	TRN	FIN	
Foreign inputs	RBP									
	FOD									
	AGR			0.5(CHN)						
	CHM			0.6(JPN)						
	PET			0.5(ROW)						
	MIN					1.7(ROW)				
	WRT									
	TRN									
	FIN			0.5(SIN)						
Domestic inputs	RBP									
	FOD		1.4	7.9						
	AGR		2.9	9.1						
	CHM			2.2						
	PET			4.1						
	MIN					1.1				
	WRT			2.8						
	TRN			0.8						
	FIN			3.7						
VA		2.8	67	0.8	0.9	0.8	3		3.4	PET (ROW) VA 2.7
	RBP	FOD	AGR	CHM	PET	MIN	WRT	TRN	FIN	WRT (ROW) VA 0.9

Source: Calculated from OECD ICIO tables, 2011

Notes: For Tables A2.1–A2.3, only the 25 large transactions are reported in each table. For sector classification in Tables A2.1–A2.3, see Table A1.

Table A2.2 Unit structure (upstream transactions: 100 units): Agricultural sector in Vietnam (2011)

	FOD	AGR	CHM	MIN	OTM	EGW	CON	WRT	REA	
Foreign inputs	FOD		0.5(ROW)							
	AGR		0.5(AUS)							
	CHM		0.9(ROW)							
	OTM									
	EGW									
	CON									
	WRT		0.4(ROW)							
Domestic inputs	FOD	1.4	9.6							
	AGR	5.2	38					0.4		
	CHM		0.6							
	OTM		0.5							
	EGW		0.9							
	CON		0.5							
	WRT	0.8	6.1					0.4		
REA										
VA	1.9	75		0.9		1		4.2	0.4	AGR (ROW) VA 1
	FOD	AGR	CHM	MIN	OTM	EGW	CON	WRT	REA	MIN (ROW) VA 0.8
										WRT(ROW) VA 0.6

Source: Calculated from OECD ICIO tables, 2011

Table A2.3 Unit structure (upstream transactions: 100 units): Agricultural sector in Cambodia (2011)

	FOD	AGR	PET	MIN	TEX	WOD	OTM	EGW	WRT	HTR	TRN
Foreign inputs	FOD										
	AGR										
	PET		0.26(VNM)								
	MIN										
	TEX										
	WOD										
	OTM										
Domestic inputs	EGW										
	WRT										
	HTR										
	TRN										
	FOD		0.16								
	AGR	0.06	5							0.04	
	PET										
MIN											
TEX		0.12			0.12						
WOD		0.04									
OTM		0.09									
EGW		0.06									
WRT		0.19									
HTR		0.12									
TRN		0.15									
VA	0.05	98.14	0.03		0.05	0.05	0.04		0.012	0.05	0.09
	FOD	AGR	PET	MIN	TEX	WOD	OTM	EGW	WRT	HTR	TRN

MIN (ROW) VA 0.07  
 MIN (VNM) VA 0.08  
 PET (VNM) VA 0.03  
 MIN(VNM)→PET(VNM) 0.08

Source: Calculated from OECD ICIO tables, 2011

Table A3.1 Unit structure (downstream transactions: 100 units): Agricultural sector in Thailand (2011)

		HTR	PBR	WOD	TEX	FOD	AGR	
Foreign outputs	INV							
	HC					1.5(JPN) 1.2(USA) 1.2(EU) 1.8(ROW)	1.9(CHN)	
	HTR							
	RBP							
	WOD							
	TEX							1(CHN)
	FOD							2.4(CHN) 1(JPN)
AGR								
Domestic outputs	INV							2.2
	HC	4.9			1.3	13.9		25.3
	HTR					3.6		5.6
	RBP							7.7
	WOD							1.7
	TEX				1.1			1.5
	FOD					6.2		35.6
AGR					2.9		9.1	
		HTR	RBP	WOD	TEX	FOD	AGR	
								FOD(CHN)→HC(FOD) 1.8 FOD(JPN)→HC(JPN) 1.1

Source: Calculated from OECD ICIO tables, 2011

Notes: For Tables A3.1–A3.3, only the 25 large transactions are reported in each table. For the sector classification in Tables A3.1–A3.3, see Table A1.

Table A3.2 Unit structure (downstream transactions: 100 units): Agricultural sector in Vietnam (2011)

		HTR	WRT	WOD	TEX	FOD	AGR	
Foreign outputs	INV							
	HC					1(JPN) 1.5(USA) 1.7(EU) 1.9(ROW)	1.1(CHN) 1.8(EU)	
	HTR							
	WRT							
	WOD							
	TEX							
	FOD							1.3(CHN) 2.2(EU)
AGR								
Domestic outputs	INV							2.6
	HC	4	1.4			18.9		28
	HTR					1.2		5.5
	WRT							4.8
	WOD							1.3
	TEX							1.4
	FOD					6.2		41.9
AGR					5.2		38	
		HTR	WRT	WOD	TEX	FOD	AGR	
								FOD(CHN)→HC(CHN) 1 FOD(USA)→HC(USA)1.2 FOD(EU)→HC(EU)2.1

Source: Calculated from OECD ICIO tables, 2011

Table A3.3 Unit structure (downstream transactions: 100 units): Agricultural sector in Cambodia (2011)

		HTR	WRT	WOD	TEX	FOD	AGR
Foreign outputs	CON	0.5(USA)					
	HC		0.9(USA) 0.7(EU)				0.9(VNM)
	HTR						
	WRT						
	WOD						
	TEX						
	AGR						0.4(CHN) 0.4(KOR) 1.4(VNM) 1.2(VNM)
Domestic outputs	CON						
	HC	8	0.5			4.9	71
	HTR					0.5	9.1
	WRT						4.3
	WOD						0.9
	TEX		0.5		0.8		
	AGR					0.4	6.3
							5
		HTR	WRT	WOD	TEX	FOD	AGR

AGR(VNM)→AGR(VNM) 0.6  
 AGR(VNM)→FOD(VNM) 0.6  
 AGR(VNM)→HC(VNM) 0.4

Source: Calculated from OECD ICIO tables, 2011

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