Do Free Trade Agreements Encourage Decoupling in East Asia?

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ABSTRACT

This paper quantitatively studies the structural change caused by East Asian Free Trade Agreements (FTAs). An interregional input-output (I-O) model is combined with a computable general equilibrium model to evaluate structural change. I first simulate East Asian FTAs and then apply I-O analysis to pre- and post-simulation interregional I-O tables. I measure trade and production in value added and decompose the change in output into technology change and final-demand change. The value-added analysis suggests that East Asian FTAs are likely to strengthen decoupling in East Asia. However, Japan appears to slightly weaken its East Asia production network in real terms due to increases in the leakage rate of value added to North America and the EU. The structural decomposition analysis shows that China decreases aggregate output with the presence of East Asian FTAs as the negative technology change contribution exceeds the positive final-demand change contribution.

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1. INTRODUCTION

Significant and rapid shrinking in international trade after the Lehman Shock required reconsideration of a decoupling hypothesis suggesting that East Asia had become an autonomous economy. This situation may additionally imply the need to assess the impacts of free trade agreements (FTAs) in East Asia from a different perspective. Do East Asian FTAs encourage decoupling in East Asia? In other words, we need to know how FTAs change the structure of production and trade.

A number of studies have already employed computable general equilibrium (CGE) analysis to study the effects of FTAs. These studies primarily investigate the FTA effects on output, equivalent variation, trade terms, prices and other factors. Few studies focus on the structural change in production and trade caused by FTAs.[1]

To better understand the structure of production and trade, an Input Output (I-O) analysis that considers interregional relationship provides useful information. Hummels et al. (2001) calculated the share of foreign value added embodied in exports to measure the extent of fragmentation. These authors primarily used the OECD I-O database for 10 OECD countries and found that the share of foreign value added embodied in exports grew between the first and last year of the sample for every country except Japan. Although their model contains a strong assumption that a country's exports are completely absorbed in final demand abroad, a rise of the share can be thought to evidence deepening fragmentation. Fujikawa, et al.

(1) Ban (2013) analyzes the structural change in demand caused by East Asian FTAs.

(2005) used I-O tables for the Asia-Pacific region to decompose the value added embodied in final products according to the region where added and showed that it is premature to conclude that the East Asian region is an autonomous economy. Johnson and Noguera (2012a) combined I-O tables and bilateral trade data to construct an interregional I-O table and calculated the share of foreign value added embodied in exports. These authors suggested the possibility that Canada-United States Free Trade Agreement (CUSFTA) and the North American Free Trade Agreement (NAFTA) encouraged fragmentation within the region.

I combine an I-O model with a CGE model to study the structural change caused by East Asian FTAs. A static CGE model is typically composed of the equilibrium conditions for the factor and goods markets and zero-profit conditions. In a CGE model, output and prices are determined endogenously, and economic agents determine their optimal demand for factor and goods given their prices. In contrast, a basic I-O model only includes goods market equilibrium conditions and does not guarantee factor market equilibrium. Given final demand, the equilibrium outputs are determined under fixed input coefficients and constant prices. From the perspective of factor market adjustments and input substitution, we may interpret a static CGE model to fall in between the long and short run (a "middle-run" model) and an I-O model as a short-run.

In this paper, I study the impact of East Asian FTAs in two stages. In the first stage, I investigate the middle-run effects of FTAs using a CGE model. In the second stage, I apply I-O analysis to pre- and post-simulation interregional I-O tables to study the structure of production and trade essentially in accordance with Fujikawa, et al. (2005).

This paper is organized as follows. Section 2 describes the CGE model used in this paper and briefly reports the simulation results. Section 3 explains a basic interregional I-O model and an I-O table. Section 4 reports the results of I-O analysis, and Section 5 concludes.

2. CGE analysis on the impacts of East Asian FTAs

To investigate the impacts of East Asian FTAs, I use the Global Trade Analysis Project (GTAP) model and the GTAP Database.[2] This section briefly describes the essential components of the GTAP model and reports the simulation scenario and results.

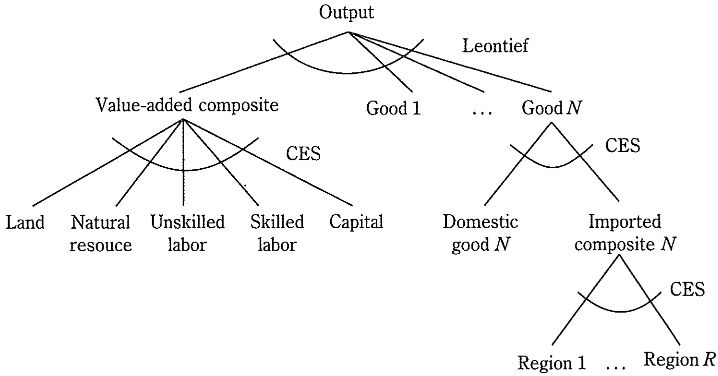
2.1. The GTAP model

The GTAP model is composed of market equilibrium conditions for factors and goods and zero-profit conditions, similar to a basic CGE model. Firms purchase production factors from the regional household and produce output with a constant-return to scale production function. The regional household in the GTAP model plays a role in both the private households and government. The GTAP model divides income into consumption, government expenditure and saving.

The GTAP model assumes two global sectors. The first is a global banking sector that assembles savings from each region and distributes investment to each region. Regional investment is distributed so that the rate of change in the expected rate of return on capital equalizes across regions. The second is a global transportation sector that purchases transport services from regions and supplies international transport services. This assumption solves the problem of a lack of information about which particular regional transport services are associated with particular imports.

Fig. 1 depicts the production function in the GTAP model. This function has a Leontief structure with zero elasticity of substitution at the top level and a constant

(2) See Hertel (Ed.) (1997) and the GTAP website for details.



Notes: Based on Hertel (Ed.) (1997).

Fig. 1. Production structure in the GTAP model

elasticity of substitution (CES) structure at the lower level. The model based on the Armington assumption that products are differentiated by country of origin. Firms first determine the source of their imports and then compare the prices of domestic goods and the optimal mix of imports.

In the GTAP model, every sector and the regional household faces the same price of the optimal mix of imports, indicating that the share of imported goods from some country in total imported goods is the same across both intermediate demand from each sector and final demand from the regional households.

2.2. Simulation scenario and results

The simulation is implemented to evaluate the impact of East Asian FTAs on the economy. Specifically, the simulation involves the complete abolition of any ad valorem import tariffs within East Asian countries. Existing export subsidies and taxes are unaltered.

For the CGE analysis, I use the GTAP 8.1 Database, which corresponds to the global economy in 2007 with 129 countries/regions and 57 industries. I aggregate these data into fourteen regions (Oceania, China, Japan, South Korea, Taiwan, ASEAN, South Asia, North America, Latin America, EU, Former Soviet Union and East Europe, Middle East and North Africa, Sub-Sahara Africa, and Rest of the World) and twenty industries (agriculture, livestock, forest, fishing, mining, food, textiles and clothing, light manufacture, petroleum and coal products, chemical products, heavy manufacture, automobile, transport equipment, electronic equipment, machinery and equipment, electricity and gas manufacture, water, construction, transport services, and other services)(3). In this paper, "East Asia" implies China, Japan, South Korea, Taiwan and ASEAN.

The FTA simulation results substantially depend on the initial tariff rates. Some features of the initial tariff rates within East Asia can be described. First, roughly speaking, Japanese tariff rates are lower than other FTA members. Notably, most tariff rates on manufactured products in Japan are close to zero. Second, the tariff rates on agriculture and food products are remarkably high in South Korea. Third, ASEAN imposes relatively high tariff rates on manufactured products imported from other FTA members(4).

Table 1 reports East Asian FTA effects on the macro economy. As shown, the effects of FTAs on GDP do not appear to be large. Even South Korea, which derives the most benefit from FTAs, only has a 0.26% increase. The effects on exports and imports are relatively large compared with the effects on GDP. The same holds true for the output of each industry. For example, the textiles and clothing output increases by 14.4%, and the electronics output decreases by 6.7% in

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(3) China includes Hong Kong. ASEAN is composed of Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Vietnam and Rest of Southeast Asia. See Appendix A for details of correspondence to GTAP classification number.

(4) See Appendix Table 1 for the tariff rates on imports from China and Japan.

Table 1. The effects of East Asian FTAs on the macro economy

	GDP (%)	Export (%)	Import (%)	Price index (%)	Factor prices (%)		
					Unskilled labor	Skilled labor	Capital
China	0.06	3.55	4.48	-0.28	0.44	0.18	0.23
Japan	0.04	1.73	4.91	1.71	1.97	2.00	1.96
South Korea	0.26	3.62	5.94	1.14	2.66	2.63	2.65
Taiwan	0.10	3.38	5.79	2.56	3.98	3.51	3.39
ASEAN	0.19	3.21	4.84	-0.02	1.70	1.33	1.43
North America	-0.00	0.06	-0.46	-0.38	-0.39	-0.38	-0.38
EU	-0.00	0.08	-0.17	-0.36	-0.37	-0.36	-0.36

Source: Author's calculations based on the GTAP 8.1 Database.

Taiwan. Transportation equipment, electronics and food outputs increase by nearly 2%, and chemical and automobile outputs decrease by nearly 2% in China. These results suggest that FTAs cause relatively large changes in production and trade structure.

Table 1 additionally reports changes in price index and factor prices. Notably, the prices of labor and capital rise in FTA members but fall in non-FTA members. As I later discuss, the relative rise in factor prices in FTA members could promote imports from non-FTA members and dampen exports to non-FTA members.

3. Interregional I-O analysis

This section briefly explains an interregional I-O model and database.

3.1. Structure measured in value added

Assume the economy consisted of N-industries and R-regions. Under constant input coefficient, the market equilibrium conditions for goods are as follows:

$$x_i^s = \sum_{r=1}^{R} \sum_{j=1}^{N} a_{ij}^{sr} x_j^r + \sum_{r=1}^{R} f_i^{sr},\ i=1 \cdots N,\ s=1 \cdots R \qquad (1)$$

where x_i^s denotes the gross output of industry i in region s, a_{ij}^{sr} denotes the direct input coefficient indicating the amount of intermediate good i produced in region s required to produce a unit of good j in country r and f_i^{sr} denotes final demand for good i produced in region s from country r.

Let

$$\mathbf{x}^s=\begin{pmatrix} x_1^s \\ \vdots \\ x_N^s \end{pmatrix},\ \mathbf{A}^{sr}=\begin{pmatrix} a_{11}^{sr} & \cdots & a_{1N}^{sr} \\ \vdots & \ddots & \vdots \\ a_{N1}^{sr} & \cdots & a_{NN}^{sr} \end{pmatrix},\ \mathbf{f}^S=\begin{pmatrix} f_1^{s1}+f_1^{s2}+\cdots+f_1^{sR} \\ \vdots \\ f_N^{s1}+f_N^{s2}+\cdots+f_N^{sR} \end{pmatrix}.$$

With these notations, Eq. (1) can be represented in matrix form as:

$$\begin{pmatrix} \mathbf{x}^1 \\ \vdots \\ \mathbf{x}^R \end{pmatrix}=\begin{pmatrix} \mathbf{A}^{11} & \cdots & \mathbf{A}^{1R} \\ \vdots & \ddots & \vdots \\ \mathbf{A}^{R1} & \cdots & \mathbf{A}^{RR} \end{pmatrix}\begin{pmatrix} \mathbf{x}^1 \\ \vdots \\ \mathbf{x}^R \end{pmatrix}+\begin{pmatrix} \mathbf{f}^1 \\ \vdots \\ \mathbf{f}^R \end{pmatrix}. \tag{2}$$

If we know the values of the input coefficients and final demand, we can solve Eq. (2) for equilibrium gross output. Gross output vector $\mathbf{x}$ can be expressed as a product of the Leontief inverse matrix $\mathbf{L}$ and a final demand vector $\mathbf{f}$ as follows:

$$\mathbf{x}=\mathbf{Lf} \tag{3}$$

where

$$\mathbf{x}=\begin{pmatrix} \mathbf{x}^1 \\ \mathbf{x}^2 \\ \vdots \\ \mathbf{x}^R \end{pmatrix},\ \mathbf{f}=\begin{pmatrix} \mathbf{f}^1 \\ \mathbf{f}^2 \\ \vdots \\ \mathbf{f}^R \end{pmatrix}$$

$$\mathbf{L}=\begin{pmatrix} \mathbf{I}-\mathbf{A}^{11} & -\mathbf{A}^{12} & \cdots & -\mathbf{A}^{1R} \\ -\mathbf{A}^{21} & \mathbf{I}-\mathbf{A}^{22} & \cdots & -\mathbf{A}^{2R} \\ \vdots & \vdots & \ddots & \vdots \\ -\mathbf{A}^{R1} & -\mathbf{A}^{R2} & \cdots & \mathbf{I}-\mathbf{A}^{RR} \end{pmatrix}^{-1}=\begin{pmatrix} \mathbf{L}^{11} & \mathbf{L}^{12} & \cdots & \mathbf{L}^{1R} \\ \mathbf{L}^{21} & \mathbf{L}^{22} & \cdots & \mathbf{L}^{2R} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{L}^{R1} & \mathbf{L}^{R2} & \cdots & \mathbf{L}^{RR} \end{pmatrix}.$$

$\mathbf{L}^{sr}$ is an $N\times N$ matrix consisting of coefficients that imply the amount of total output in each industry of region s directly and indirectly required to satisfy one unit of final demand for each industry in region r.

Let $\mathbf{v}^S$ be the $1 \times N$ direct value-added coefficient vector:

$$\mathbf{v}^s = (v_1^s,\ v_2^s,\ \cdots v_N^s) \tag{4}$$

where v_j^s is the value-added coefficient (value added/gross output) of industry j in region s. I define the $R \times NR$ value-added coefficient matrix $\hat{\mathbf{v}}$ as:

$$\hat{\mathbf{v}} = \begin{pmatrix} \mathbf{v}^1 & 0 & \cdots & 0 \\ 0 & \mathbf{v}^2 & & \vdots \\ \vdots & & \ddots & 0 \\ 0 & \cdots & 0 & \mathbf{v}^R \end{pmatrix}. \tag{5}$$

Pre-multiplying the Leontief inverse matrix $\mathbf{L}$ by the value-added coefficient matrix $\hat{\mathbf{v}}$ generates the following the $R \times NR$ matrix that illustrates how value added is geographically generated to satisfy one unit of final demand for each industry in each region.

$$\hat{\mathbf{v}}\mathbf{L} = \begin{pmatrix} \mathbf{v}^1\mathbf{L}^{11} & \cdots & \mathbf{v}^1\mathbf{L}^{1R} \\ \vdots & \ddots & \vdots \\ \mathbf{v}^R\mathbf{L}^{R1} & \cdots & \mathbf{v}^R\mathbf{L}^{RR} \end{pmatrix} \tag{6}$$

Each element of $\mathbf{v}^s\mathbf{L}^{sr}$ presents the amount of value added embodied in one unit of each final good produced in region r with origin in region s. In other words, each column of $\hat{\mathbf{v}}\mathbf{L}$ shows the geographic division of value added directly and indirectly embodied in one unit of each final good. Because the value added embodied in a unit of final good is shared completely, the sum of each column is one.[5]

We use a value-added division matrix (6) to calculate the structure of trade and production sharing. First, multiplying $\hat{\mathbf{v}}\mathbf{L}$ by final demand vector $\mathbf{f}$ gives value added accompanied by equilibrium gross output induced by the final demand.

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(5) See Wang et al. (2009) for mathematical proof.

$$\hat{\mathbf{v}}\mathbf{Lf}=\begin{pmatrix}\mathbf{v}^1\mathbf{L}^{11}\mathbf{f}^1+\cdots+\mathbf{v}^1\mathbf{L}^{1R}\mathbf{f}^R\\ \vdots \\ \mathbf{v}^R\mathbf{L}^{R1}\mathbf{f}^1+\cdots+\mathbf{v}^R\mathbf{L}^{RR}\mathbf{f}^R\end{pmatrix} \qquad (7)$$

The vector $\hat{\mathbf{v}}\mathbf{Lf}$ consists of R elements that imply the value-added contribution of each region to gross output induced from the total final demand. Using Eq. (7), the value added induced from the final demand from specified region can be decomposed according to the region where created.

Second, multiplying $\hat{\mathbf{v}}\mathbf{L}$ by a diagonal matrix of final demand gives the following the $R\times R$ matrix that tells us the geographical origin of the value added embodied in the total final goods produced in each region.

$$\hat{\mathbf{v}}\mathbf{L}\hat{\mathbf{f}}=\begin{pmatrix}\mathbf{v}^1\mathbf{L}^{11} & \cdots & \mathbf{v}^1\mathbf{L}^{1R}\\ \vdots & \ddots & \vdots \\ \mathbf{v}^R\mathbf{L}^{R1} & \cdots & \mathbf{v}^R\mathbf{L}^{RR}\end{pmatrix}\begin{pmatrix}\mathbf{f}^1 & 0 & \cdots & 0\\ 0 & \mathbf{f}^1 & & \vdots\\ \vdots & & \ddots & 0\\ 0 & \cdots & 0 & \mathbf{f}^1\end{pmatrix}$$

$$=\begin{pmatrix}\mathbf{v}^1\mathbf{L}^{11}\mathbf{f}^1 & \cdots & \mathbf{v}^1\mathbf{L}^{1R}\mathbf{f}^R\\ \vdots & \ddots & \vdots \\ \mathbf{v}^R\mathbf{L}^{R1}\mathbf{f}^1 & \cdots & \mathbf{v}^R\mathbf{L}^{RR}\mathbf{f}^R\end{pmatrix} \qquad (8)$$

For example, the rth column decomposes the value added embodied in total final goods produced in region r according to the region of generation.

3.2. Structural decomposition

Eq. (3) can be used for structural decomposition analysis. Compare an economy at two different points in time. Let an apostrophe note a later point in time. Eq. (3) is as follows:

$$\mathbf{x}=\mathbf{Lf} \text{ and } \mathbf{x}'=\mathbf{L}'\mathbf{f}'. \qquad (9)$$

The change in gross output over time is

$$\Delta\mathbf{x}=\mathbf{L}'\mathbf{f}'-\mathbf{Lf}. \qquad (10)$$

According to Miller and Blair (2009), we can decompose the change in output as follows:(6)

$$\mathbf{\Delta x} = (1/2)(\mathbf{\Delta L})(\mathbf{f}+\mathbf{f}') + (1/2)(\mathbf{L}+\mathbf{L}')(\mathbf{\Delta f}). \tag{11}$$

The first term on the right side is the technology change contribution, and the second term is the final-demand change contribution.

Furthermore, the final-demand contribution is decomposed as follows:

$$\begin{aligned}\mathbf{\Delta f} &= (1/2)(\Delta f)(\mathbf{Bd}+\mathbf{B}'\mathbf{d}) + (1/2)(f\mathbf{B}+f'\mathbf{B}')(\mathbf{\Delta d}) \\ &\quad + (1/2)\{f(\mathbf{\Delta B})\mathbf{d}' + f'(\mathbf{\Delta B})\mathbf{d}\}\end{aligned} \tag{12}$$

where

$$\mathbf{B} = \begin{pmatrix} f_1^{11}/y^1 & f_1^{12}/y^2 & \cdots & f_1^{1R}/y^R \\ f_2^{11}/y^1 & f_2^{12}/y^2 & \cdots & f_2^{1R}/y^R \\ \vdots & \vdots & \ddots & \vdots \\ f_N^{R1}/y^1 & f_N^{R2}/y^2 & \cdots & f_N^{RR}/y^R \end{pmatrix}, \mathbf{d} = \begin{pmatrix} y^1/f \\ y^2/f \\ \vdots \\ y^R/f \end{pmatrix},$$

$$y^r = \sum_{s=1}^{R}\sum_{i=1}^{N} f_i^{sr},\ f = \sum_{r=1}^{R} y^r.$$

y^r is the total final demand from region r, and f is the total final-demand expenditure. Each column in the $RN \times R$ matrix $\mathbf{B}$ indicates the distribution of y^r across $R \times N$ products. The R-elements vector $\mathbf{d}$ represents the proportion of final-demand expenditure from each region.

The terms of the right side of Eq. (12) represent the contribution of change in the level of total final demand expenditure (final-demand level effect), the contribution of change in the distribution of final demand across regions (final-demand distribution effect) and the contribution of change in the distribution of final demand of each region across products (final-demand mix effect), respectively.

(6) Eq. (10) can be rewritten as follows: $\mathbf{\Delta x} = (\mathbf{\Delta L})\mathbf{f} + \mathbf{L}'(\mathbf{\Delta f})$ or $\mathbf{\Delta x} = (\mathbf{\Delta L})\mathbf{f}' + \mathbf{L}(\mathbf{\Delta f})$. Adding two equations yields Eq. (12).

3.3. Interregional I-O table

The interregional I-O analysis detailed in the preceding sections requires interregional I-O tables. However, the GTAP Database used here does not contain enough data on cross-border trade between industries. Therefore, I essentially follow the proportional procedure in Bems et al. (2010, 2011) and Johnson and Noguera (2012b). I assume that the share of imported goods i from country s in total imported goods i is the same across both industries and final demand. Although these assumptions are rather strong, this method is helpful when investigating the structural change caused by FTAs by combining an I-O model with a CGE model. This method is additionally consistent with the Armington approach in the GTAP model.

Table 2 represents the interregional I-O table for two regions, two sectors and a global transportation sector. The row in the global transportation sector indicates international transport service distribution through sales to sectors and final demand. International transport services accompanied with imported intermediate input are treated as an intermediate input from the global transportation sector. The global transportation sector purchases transport services from regional sectors as an intermediate input. In Table 2, only sector 2 supplies transport services. As the GTAP model assumes, the global transportation sector does not use factors.

As shown in section 2.2, I aggregate the GTAP Database into 14 regions and 20 industries. Because I take the global transportation sector into consideration, the interregional I-O tables made from the GTAP Database have 281 sectors. Therefore, the input coefficient matrix in Eq. (2) is 281×281.

Pre- and post-simulation interregional I-O tables are necessary to investigate structural change due to FTAs. I constructed three interregional I-O tables. One table is calculated with the pre-simulation GTAP Database. The others tables are calculated with the post-simulation database. One table is an I-O table evaluated by

Table 2. Interregional I-O table for two regions and two sectors

		Intermediate input demand					Final demand		Total
		$r=1$		$r=2$		$r=G$	$r=1$	$r=2$	
		$j=1$	$j=2$	$j=1$	$j=2$				
$s=1$	$i=1$	Z_{11}^{11}	Z_{12}^{11}	Z_{11}^{12}	Z_{12}^{12}	0	F_1^{11}	F_1^{12}	X_1^1
	$i=2$	Z_{21}^{11}	Z_{22}^{11}	Z_{21}^{12}	Z_{22}^{12}	Z_2^{1G}	F_2^{11}	F_2^{12}	X_2^1
$s=2$	$i=1$	Z_{11}^{21}	Z_{12}^{21}	Z_{11}^{22}	Z_{12}^{22}	0	F_1^{21}	F_1^{22}	X_1^2
	$i=2$	Z_{21}^{21}	Z_{22}^{21}	Z_{21}^{22}	Z_{22}^{22}	Z_2^{2G}	F_2^{21}	F_2^{22}	X_2^2
$s=G$		Z_1^{G1}	Z_2^{G1}	Z_1^{G2}	Z_2^{G2}	0	F^{G1}	F^{G2}	X^G
Value added		V_1^1	V_2^1	V_1^2	V_2^2	0			
Total		X_1^1	X_2^1	X_1^2	X_2^2	X^G			

Notes: A superscript G represents the global transportation sector. Z_{ij}^{sr}, F_i^{sr}, X_i^s, V_i^s are purchases of intermediate products from sector i in region s to sector j in region r, purchases of final products from sector i in region s to region r, amount of output of sector i in region s, and value added of sector i in region s, respectively.

initial prices (in real terms), while the other table is an I-O table evaluated by post-simulation prices (in nominal terms). I will primarily show the results of calculations using the pre- and post- simulation I-O table evaluated by initial prices.

4. Results of interregional I-O analysis

I will report the structural change caused by East Asian FTAs in the following order: value- added trade, production sharing measured in value added and decomposition of structural change in output.

4.1. Value-added trade

According to Eq. (7), I decomposed the value added absorbed by the final demand from each region according to the region where created. Table 3 represents the value-added decomposition calculated using the pre-simulation data. Each column shows the source regions of value added absorbed in the region as indicated by each column header. Subtracting the domestic contribution (the diagonal element) from the total value added absorbed in the region indicated by the header yields its value-added import. Each row shows the export destination of value added generated in the region indicated by each row header. Subtracting part of the domestic absorption (the diagonal element) from the total value added generated in the region indicated as by the header yields its value-added export. Table 3 shows that although all FTA members have a positive value-added trade balance, China has negative balance with all other members.

Table 3. Pre-FTAs value-added trade ($ billion)

	China	Japan	Korea	Taiwan	ASEAN	ROW[1]	Total	Export
China	2,489	89	35	11	46	748	3,417	928
Japan	101	3,623	29	19	45	434	4,251	629
Korea	48	20	713	4	14	182	981	268
Taiwan	39	12	4	232	9	93	390	158
ASEAN	64	58	17	7	749	351	1,246	497
ROW	430	360	142	60	226	41,626	42,845	1,219
Total	3,172	4,161	940	333	1,091	43,433	53,130	3,699
Import	683	539	227	101	342	1,807	3,699	

Source: Author's calculations based on the GTAP 8.1 Database.
Note: 1 "ROW" includes Oceania, South Asia, North America, Latin America, EU, Former Soviet Union and East Europe, Middle East and North Africa, Sub-Sahara Africa, and Rest of the World.

Table 4 reports the change in value-added trade with the presence of East Asian FTAs. For example, the value-added part that originated and absorbed in China decreases by $24.6 billion as a result of FTAs. However, the value-added Chinese imports from the other FTA members and the value-added exports from China to the other FTA members increase. Table 4 reports that a similar tendency appears for other members.

I calculated the value-added import share by source region and the value-added

Table 4. Change in value-added trade in real terms ($ billion)

	China	Japan	Korea	Taiwan	ASEAN	ROW[1]	Total	Export
China	-24.6	11.3	8.1	1.7	7.1	-4.6	-1.0	23.6
Japan	17.2	-2.8	3.6	1.9	6.6	-25.8	0.7	3.5
Korea	7.0	1.2	-2.6	0.5	2.5	-7.0	1.6	4.2
Taiwan	4.9	0.4	0.8	-1.7	2.2	-6.3	0.3	2.0
ASEAN	5.1	5.2	2.2	1.1	-6.4	-5.8	1.3	7.8
ROW	-9.8	6.0	-3.0	0.3	-4.0	10.0	-0.6	-10.6
Total	-0.2	21.3	9.1	3.7	7.9	-39.5	2.3	30.4
Import	24.4	24.0	11.7	5.4	14.4	-49.5	30.4	

Source: Author's calculations based on the GTAP 8.1 Database.
Note: The post-simulation interregional I-O table used here is in real terms. The total value added in each region can change disregarding constant endowments of production factor and full employment because FTAs can alter allocation efficiency. See note in Table 3.

export share by destination region. When East Asia is considered to be one region, the FTAs seem to strengthen decoupling from both the import and export sides. The domestic contribution share to the total value added absorbed by East Asia rises from 87.4% to 87.6% in real terms or 87.7% in nominal terms. The share of domestic absorption in East Asia to total value added generated in East Asia increases from 82.4% to 82.9% in real terms (83.9% in nominal terms).

Turning to member connections in the East Asia region, Japan shows a somewhat different response to East Asian FTAs although the other members are likely to strengthen member connections.(7) The share of the East Asia contribution, in-

(7) Consideration of the impact of FTAs indicates that the share of contribution of East Asia to the total value added absorbed by each member except Japan seems to slightly rise as following: from 86.4% to 86.7% (86.8%) in China, 84.9% to 85.4% (85.6%) in Korea, 82.0% to 82.1% (82.5%) in Taiwan, and 79.2% to 79.8% (79.9%) in ASEAN. The shares of value added absorbed in East Asia to total value added originating in each member seems to slightly increase as following: from 78.1% to 78.2% (78.3%) in China, 81.5% to 82.2% (82.2%) in Korea, 76.1% to 77.8% (77.9%) in

cluding Japan, to the total value added absorbed in Japan decreases from 91.3% to 91.2% in real terms. In other words, the share of value-added imports to Japan from outside East Asia increases.(8) Evaluation in nominal terms raises the share to 91.4%. The share of value added absorbed in East Asia to the total of value added generated in Japan rises from 89.8% to 90.4% in both real and nominal terms.

4.2. Production sharing measured by value added

To measure aggregate production sharing, I use Eq. (8) to decompose the value added embodied in total final goods produced in each region. Table 5 reports the production sharing for FTA members based on the pre-simulation data. The values from the second to ninth cell in each column sum to 100 percent. The domestic value-added acquisition rate is the highest in all members yet differs from 76.5% in Taiwan to 90.5% in Japan. Japan has the relatively low acquisition rate of other FTA members.

Table 6 details the change in aggregate production sharing caused by East Asian FTAs. The share of domestic value-added acquisition rate decreases, and the leakage rate into other member increases for all FTA members. China, Korea, Taiwan and ASEAN tend to decrease their leakage rates of value added into North America and EU and deepen production networks inside East Asia. However, Japan tends to increase its leakage rate of value added into North America, EU and ROW. The rises in leakage rates in North America and EU are due to Japan's initial low tariff rates, Japan's initial low acquisition rate of other FTA members and relative rises in Japan's factor prices, which results from FTAs. Japan's initial tariff rates on manufactures are near zero, and Japan cannot derive enough East Asian FTA bene-

Taiwan, and 71.9% to 72.4% (72.5%) in ASEAN. The figures in parenthesis are in nominal terms.

(8) I discuss this reason later.

Table 5. Pre-FTAs production sharing measured in value added (%)

	China	Japan	Korea	Taiwan	ASEAN
China	81.9	1.2	2.8	2.5	3.2
Japan	2.6	90.5	2.7	3.7	2.9
Korea	1.3	0.3	80.0	1.0	1.0
Taiwan	1.1	0.2	0.4	76.5	0.8
ASEAN	1.8	1.0	1.5	1.9	77.0
Name	2.2	1.5	2.9	3.5	3.0
EU	3.3	1.6	2.9	3.3	4.9
ROW[1]	5.9	3.7	6.8	7.6	7.3
East Asia[2]	88.6	93.2	87.4	85.7	84.9
East Asia*[3]	6.6	2.7	7.3	9.2	7.9

Source: Author's calculations based on the GTAP 8.1 Database.
Note: 1 "ROW" includes Oceania, South Asia, Latin America, Former Soviet Union and East Europe, Middle East and North Africa, Sub-Sahara Africa, and Rest of the World. 2 "East Asia" includes its own region. 3 "East Asia*" excludes its own region.

Table 6. Change in production sharing measured in value added (% points)

	China	Japan	Korea	Taiwan	ASEAN
China	-0.62	0.14	0.56	0.22	0.42
Japan	0.42	-0.28	0.28	0.20	0.38
Korea	0.17	0.02	-0.63	0.08	0.17
Taiwan	0.11	0.00	0.06	-0.58	0.16
ASEAN	0.15	0.06	0.16	0.12	-0.77
Name	-0.08	0.01	-0.16	-0.06	-0.09
EU	-0.15	0.03	-0.10	-0.03	-0.15
ROW[1]	-0.01	0.02	-0.18	0.05	-0.11
East Asia[2]	0.23	-0.06	0.43	0.04	0.35
East Asia*[3]	0.86	0.22	1.06	0.62	1.12

Source: Author's calculations based on the GTAP 8.1 Database.
Note: See Note in Table 5.

fits from a cost-cutting point of view. In addition, factor prices in North America and EU fall compared with FTA members, and Japan increases imported intermediate goods from North America and the EU. Increases in demand for imported energy goods are main reason for the leakage into ROW.

The calculation in nominal terms indicates that Japan decreases the rise in leakage rates into North America, EU and ROW and shows an increase in value-added acquisition rate of East Asia.(9)

4.3. Structural decomposition

I use Eqs. (11) and (12) to decompose the change in output. The aggregated results are shown in Table 7. I first consider the rows of total value. The negative technology change contribution exceeds the positive final-demand change contribution and total output subsequently decreases in China. In this case, the negative technology change contribution indicates the substitution of intermediate input from domestic products to imported products. Conversely, the positive contribution of technology change exceeds the negative contribution of final demand in Japan. Korea and ASEAN have dominant positive contribution of final demand, and Taiwan has both positive contributions. In terms of decomposition of final-demand change contribution, China and ASEAN show positive effects while Japan, South Korea and Taiwan show negative final-demand mix effects. From the perspective of substitution effects, East Asian FTAs gives China and ASEAN negative effects on intermediate demand and positive effects on final demand. Japan and Taiwan have opposite effects, and South Korea has only positive effects.

Next, my examination of a three-sector classification indicates that China in-

(9) When measured in nominal terms, the changes in acquisition rate of each region to total value added embodied in Japan's total final products are as follows: North America 0.01 % points, EU 0.02% points, ROW 0.01% points, and East Asia 0.07% points.

creases output in the primary sector and decreases output in the other sectors. The negative technology change contribution of secondary and tertiary sectors in China is so large that their output decreases instead of a positive final-demand contribution. Japan increases the output of the tertiary sector and decreases the output of the other sectors. Japan's negative final-demand contribution in the secondary sector is likely due to a decrease in final direct demand for Japanese products from North America (-$8,749 million) and the EU (-$4,587 million). South Korea, Taiwan and ASEAN principally increase their outputs of secondary outputs.

Table 7. Structural decomposition ($ million)

		Change in output	Tech	Final				Direct change	
				Total	Level	Mix	Distribution	Intermediate	Final
China	Primary[1]	2,811	898	1,912	39	1,718	155	3,166	-355
	Secondary[2]	-11,493	-26,719	15,226	240	14,040	947	-17,616	6,123
	Tertiary[3]	-670	-4,286	3,617	165	3,341	110	-1,484	814
	total	-9,352	-30,107	20,756	444	19,099	1,213	-15,934	6,582
Japan	Primary	-1,603	-1,591	-12	5	-551	534	-1,559	-44
	Secondary	-306	9,736	-10,042	129	-19,637	9,466	6,747	-7,053
	Tertiary	3,789	-6,038	9,827	249	-17,045	26,624	-5,272	9,061
	total	1,880	2,107	-227	382	-37,232	36,623	-84	1,964
Korea	Primary	-960	-1,004	45	2	-326	369	-716	-243
	Secondary	6,362	3,972	2,390	50	-2,643	4,983	6,252	110
	Tertiary	1,083	-3,152	4,235	53	-5,612	9,795	-1,926	3,010
	total	6,485	-184	6,670	105	-8,581	15,146	3,609	2,877
Taiwan	Primary	-38	-29	-9	1	-191	181	19	-57
	Secondary	7,332	7,341	-9	22	-1,613	1,582	8,428	-1,096
	Tertiary	-1,033	-1,404	371	17	-2,986	3,340	-1,352	319
	total	6,261	5,908	354	40	-4,790	5,104	7,095	-833
ASEAN	Primary	45	-432	476	13	-840	1,304	484	-439
	Secondary	5,314	-2,531	7,845	58	3,669	4,117	1,424	3,890
	Tertiary	-419	-4,813	4,393	57	-2,509	6,845	-2,690	2,270
	total	4,939	-7,775	12,714	128	320	12,266	-782	5,721

Source: Author's calculations based on the GTAP 8.1 Database.
Note: 1 Primary sector: agriculture, livestock, forest, fishing, mining. 2 Secondary sector: food, textiles and clothing, light manufacture, petroleum and coal products, chemical products, heavy manufacture, automobile, transport equipment, electronic equipment, machinery and equipment. 3 Tertiary sector: other industries.

Taiwan's secondary sector has a positive technology change contribution. ASEAN's secondary sector has a positive final-demand contribution, and South Korea's secondary sector has both changes.

Notably, there are different signs between structural decomposition and direct change in demand. For example, although the total of direct final demand for Japanese products increases, the final-demand change contribution is negative. This decrease is from the difference of spillover effects into other industries. In the case of Japan, East Asian FTAs move output toward the tertiary industry, which has relatively low spillover effects into other industries. There are observed opposite signs in the final-demand change contribution of primary sectors except Japan, which implies that final demand from other sectors has a relatively large effect on the primary sector. The primary and secondary sectors in ASEAN have a negative technology change contribution, although the direct intermediate input demand increases. This situation is because intermediate demand increases due to final demand changes offset by a negative technological change.

5. Concluding remarks

In this paper, I quantitatively evaluated the structural change caused by East Asian FTAs. The findings suggest that East Asian FTAs appear to encourage decoupling in East Asia as a whole. However, the impacts on the link between an individual member and East Asia differ. Initial tariff rates and initial structure of production and trade are crucial determinants of these links. The factor price behaviors in FTA members encourage decoupling from export side and discourage it from import side in real terms.

Appendix A

In this paper, region and GTAP region number correspond as follows: Oceania: 1, 2;

Appendix Table 1. Bilateral tariff rates

Panel A: Bilateral tariff rates on products exported from China (%)

Destination	Japan	Korea	Taiwan	ASEAN
Agriculture	18.4	30.2	10.7	3.4
Livestock	4.2	8.1	0.4	0.7
Forest	0.5	3.8	4.7	1.9
Fishing	4.1	15.2	12.0	2.4
Mining	0.0	0.5	0.2	0.9
Food	14.4	34.3	17.4	13.7
Textiles & clothing	8.1	9.3	9.3	12.3
Light manufacture	2.5	4.7	3.4	7.3
Petroleum & Coal prod.	0.2	4.3	2.3	4.6
Chemical	0.1	5.2	2.9	4.4
Heavy manufacture	0.2	2.2	1.0	4.8
Automobile	0.0	1.9	2.8	14.0
Transport Equipment	0.0	2.7	5.7	7.0
Electronics	0.0	1.2	0.6	0.7
Machinery	0.0	4.8	2.8	3.2
Electricity & Gas	0.0	0.0	0.0	0.8

Panel B: Bilateral tariff rates on products exported from Japan (%)

Destination	China	Korea	Taiwan	ASEAN
Agriculture	3.0	16.7	15.9	8.4
Livestock	3.7	5.1	6.4	3.6
Forest	5.3	1.9	3.5	4.2
Fishing	1.3	17.0	16.1	4.1
Mining	2.9	2.6	0.3	1.6
Food	6.7	38.0	13.2	9.9
Textiles & clothing	8.3	9.2	8.4	18.2
Light manufacture	7.0	5.3	3.6	8.6
Petroleum & Coal pro.	6.1	5.0	2.5	7.0
Chemical	5.8	4.9	3.0	6.8
Heavy manufacture	4.8	2.3	1.5	7.6
Automobile	13.5	8.0	13.3	18.7
Transport Equipment	5.5	0.7	3.7	6.3
Electronics	3.5	0.9	2.5	0.4
Machinery	6.1	6.1	3.2	3.5
Electricity & Gas	0.0	0.0	0.0	0.0

Source: GTAP Database Version 8.1 for 2007.

Note: Tariff rates on imported products of water, construction, transport services and other services are zero in all regions.

China: 4, 5; Japan: 6; South Korea: 7; Taiwan: 9; ASEAN: 11-19; South Asia: 20-25; North America: 26-28; Latin America: 30-48; EU: 49-73, 78, 81; Former Soviet Union and East Europe: 77, 79, 80, 82-84, 86-91; Middle East and North America: 92-105; Sub-Sahara Africa: 106-133; and Rest of the World: 3, 8, 10, 29, 74-76, 85.

In this paper, industry and GTAP sector number correspond as follows: agriculture: 1-8; livestock: 9-12; forest: 13; fishing: 14; mining: 15-18; food: 19-26; textiles and clothing: 27, 28; light manufacture: 29-31, 37, 42; petroleum and coal products: 32; chemical products: 33; heavy manufacture: 34-36; automobile: 38; transport equipment: 39; electronic equipment: 40; machinery and equipment: 41; electricity and gas manufacture: 43, 44; water: 45; construction: 46; transport: 48-50; and services: 47, 51-57. See the GTAP web site on region and sector listing.

References

Ban, Hikari, 2013. The impact of East Asian FTAs on the structure of demand In: Kinkyo, Takuji, Matsubayashi, Yoiichi, Hamori, Shigeyuki (Eds), Chapter 4 of Global Linkages and Economic Rebalancing in East Asia. World Scientific Publishing, Singapore.

Bems, Rudolfs; Johnson, Robert C.; Yi, Kei-Mu, 2010. Demand spillovers and the collapse of trade in the global recession. IMF Economic Review, 58(2), 295-326.

Bems, Rudolfs; Johnson, Robert C.; Yi, Kei-Mu, 2011. Vertical linkages and the collapse of global trade. American Economic Review 101(3), 308-312.

Fujikawa, Kiyoshi; Shimoda, Mitsru; Watanabe, Takatoshi, 2005. The structure of international division of labor in the Asia-Pacific Region—an empirical study using IDE international IO tables—. Konan Ronshu 46(3), 210-234.

GTAP Homepage, accessed September 14, 2013. <http://www.gtap.agecon.purdue.edu/>

Hummels, David; Ishii, Jun; Yi, Kei-Mu, 2001. The nature and growth of vertical specialization in world trade. Journal of International Economics 54(1), 75-96.

Hertel, Thomas W (Ed.)., 1997. Global Trade Analysis — Modeling and Applications. Cambridge University Press, Cambridge.

Johnson, Robert C.; Noguera, Guillermo, 2012a. Proximity and Production Fragmentation American Economic Review 102 (3 May), 407-11.

Johnson, Robert C.; Noguera, Guillermo, 2012b. Accounting for intermediates: production sharing and trade in value added. Journal of International Economics 86(2), 224-236.

Miller, Ronald E.; Blair, Peter D., 2009. Input-Output Analysis Foundations and Extensions, Second Edition, Cambridge.

Wang, Zhi; Powers, William; Wei, Shang-Jin, 2009. Value chains in East Asian production networks — an international Input-Output model based analysis. Office of economics working paper, U.S. International Trade Commission, 09-10-c.