Analysis of Japan-Thailand Free Trade Agreement using Asian International Input-Output Model

Ms. Wilairat Tongsiri
Ph.D. Student Graduate School of
Media and Governance, Keio University, Tokyo

Prof. Hiroyuki Kosaka
Professor Graduate School of
Media and Governance, Keio University, Tokyo

Abstract

Since September 2005, Japan and Thailand have agreed upon establishing Japan-Thailand Economic Partnership Agreement (JTEPA). The agreement, mainly, focuses on setting up free trade between the two nations. Specifically, Japan would be grated tariff reduction on automobiles, auto parts, and iron and steel products. On the other hand, Thailand would gain market assess to Japan in textile and agricultural products, mainly fruits, vegetables, prepared or preserved chicken and pork, and fishery products. (excluding rice wheat, and sugar) Even though the agreement on tariff reduction was sector-specific rather than across the board, the impact of the free trade agreement would fall upon various sectors. The model that considering interaction among sectors has become essential, hence, input output model turned out to be appropriate tool for this type of analysis. Moreover, this bilateral trade agreement has not only impacted on Japan and Thailand economy, but also affected other Asian countries. Therefore, international input-output table becomes a powerful mechanism for analyzing the issue.

The model framework could be termed as international input-output model, basing on Asian International Input Output Table developed by Institute of Developing Economies, Tokyo. The Asian international input-output model consists of 24-sector time series input-output table in 1985, 1990, 1995, and 2000, scoping on China, Japan, Korea Taiwan, Singapore, Malaysia, Indonesia, Thailand, Philippines and the United States.

1. Introduction

Recently, the network of bilateral free trade agreement flourishes everywhere. As many other nations, the Japanese and Thai governments started exploring a possibility for bilateral free trade area in 2001, but official negotiations did not start until February 2004. In 2005, Japan and Thailand have agreed upon establishing Japan-Thailand Economic Partnership Agreement (JTEPA). The JTEPA will facilitate the trade flow between two nations by reducing the import tariff in the following sectors. Japan will reduce tariff on Thai textile and agricultural products, mainly fruits, vegetables, prepared or preserved chicken and pork, and fishery products. (excluding rice wheat, and sugar). Thailand agrees to reduce tariff on Japanese automobiles, auto parts, and iron and steel products. According to the plan of two nations, this bilateral trade agreements will be sign in 2007.

This study aims to estimate the import elasticity of substitution among countries within Asian-Pacific region, as well as, simulate the bilateral trade scenarios and their impacts on Asia-Pacific economy. The scenario would be subdivided into (1) across the board tariff reduction between Japan and Thailand, and (2) sector specific tariff reduction between Japan and Thailand.

2. Asian International Input-Output (AIIO) Model

Asian international input-output model is essentially based on the Leontief input-output model, which determines sector output but exogenously given final demands. The model consists of two main blocks namely, determinations of sector output and price.

2.1 Determination of Sector Output

First, total distribution of the *i*th product from the *h*th economy, $X_{i(h)}$, would be used to serve intermediate demand of various production sector(the *j*th) from various economies (the *k*th) , $\sum_j \sum_k X^k_{ij(h)}$, as well as, final demands (F).

$$X_{i(h)} = \sum_j \sum_k X^k_{ij(h)} + F \tag{1}$$

Regarding to the final demands, they are divided into the economies composing an Asian international input output table $\left(\sum_k F^k \right)$ and the rest of the world $\left(F^o\right)$.

$$F = \sum_k F^k + F^o \tag{2}$$

The components of final demand $\left(F^k\right)$ consist of private consumption, government consumption, investment, and change in inventory, in which total level of these components are exogenously given.

Regarding the determination of intermediate demand, the technical coefficient is defined as;

$$X^k_{ij} = a^k_{ij} X^k_j \tag{3}$$

where X^k_{ij} is intermediate inputs of the *i*th commodity in the production of the *j*th sector in the *k*th economy. X^k_j is total production of the *j*th sector in the *k*th economy. a^k_{ij} is technical coefficient identifying how much the *i*th commodity use in one unit of production of the *j*th sector of the *k*th economy.

Moreover, intermediate inputs of the *i*th commodity come from domestically produced (the *k*th economy) or imported from other countries. Therefore, $X^k_{ij} = \sum_h X^k_{ij(h)}$, where $X^k_{ij(h)}$ is intermediate inputs of the *i*th commodity imported from the *h*th economy (in the case of domestically produced $h = k$) in the production of the jth sector in the kth economy. Then, technical coefficient could be written as;

$$a_{ij}^{k} = \sum_{h} X_{ij(h)}^{k} \Big/ X_{j}^{k} \qquad (4)$$

In order to analyze international trade pattern, inputs from domestic and various imported sources must be distinguished. Applying the Hickman and Lau (1973) trade linkage model, the intermediate input share from various import sources is defined as;

$$s_{ij(h)}^{k} = \left(s_{ij(h)}^{k*}\right) * \left[\left(1 + t_{i(h)}^{k}\right) PX_{ij(h)}^{k} \Big/ \left(\sum \left(1 + t_{i(h)}^{k}\right) PX_{ij(h)}^{k} \right) \right]^{-\mu ijk} \qquad (5)$$

where $s_{ij(h)}^{k} = X_{ij(h)}^{k} \Big/ X_{ij}^{k}$, is the base year share of the ith commodity imported from the hth economy in the jth sector of the kth economy. $PX_{ij(h)}^{k}$ is export price of ith commodity from the hth economy to the jth sector production in the kth economy. $t_{i(h)}^{k}$ is import tariff imposed on the ith commodity imported from the hth economy set up by the kth economy. μ_{ijk} is the elasticity of substitution of the ith commodity in production of the jth sector in the kth economy.

In other word, the trade share of each country, $s_{ij(h)}^{k}$, depends on the trade share in base period ($s_{ij(h)}^{k*}$) and import price (including import tariff) $\left[\left(1 + t_{i(h)}^{k}\right) PX_{ij(h)}^{k}\right]$relative to average import price $\left(\sum \left(1 + t_{i(h)}^{k}\right) PX_{ij(h)}^{k} \right)$, as well as, the elasticity of substitution of ith commodity among competitor .

. In the model, intermediate input is determined by both technical coefficients in equation (4) as well as trade coefficients in equation (5).

2.2 Determination of Sector Price

Sector prices are explained endogenously in the model by utilizing another identity which equates total revenue in each sector with its total cost.

$$P_{j}^{k} X_{j}^{k} = V_{j}^{k} + \sum_{i} \sum_{h} PX_{ij(h)}^{k} X_{ij(h)}^{k} + \left(C_{j1}^{k} + C_{jo}^{k}\right) \qquad (6)$$

where P_{j}^{k} is the price level in the jth sector of the kth economy, V_{j}^{k} is value added in the jth sector of the kth economy, C_{j1}^{k} is tariff on import commodities in the jth sector of the kth economy. C_{jo}^{k} is other costs in the jth sector of the kth economy. Dividing equation (6) by total output (X_{j}^{k}), yields price equation as;

$$P_j^k = \frac{V_j^k}{X_j^k} + \frac{\sum_i \sum_h PX_{ij(h)}^k X_{ij(h)}^k}{X_j^k} + \frac{\left(C_{j1}^k + C_{jo}^k\right)}{X_j^k}$$

$$P_j^k = v_j^k + \frac{\sum_i \sum_h PX_{ij(h)}^k X_{ij(h)}^k}{X_j^k} + \left(\frac{C_{j1}^k}{X_j^k} + c_{j0}^k\right) \tag{7}$$

where v_j^k is value added coefficient in the *j*th sector of the *k*th economy. The prices level in the *j*th sector of the *k*th economy in the base year is unity.

Then, we explain the components of the price equation. First, the value added is explained. The value added can be divided into total wage and the other factors. Since total wage is wage rate multiplied by employment, value added could be formulated as follows;

$$V_j^k = W_j^k + V_{jo}^k = w_j^k L_j^k + V_{jo}^k \tag{8}$$

where W_j^k is total wage paid by the *j*th sector of the *k*th economy. V_{jo}^k is other value added items in the *j*th sector of the *k*th economy. w_j^k is the wage rate in the *j*th sector of the *k*th economy, and L_j^k is employment in the *j*th sector of the *k*th economy. In this model, In this model, we assume that the sector wage rate is a function of labor productivity. The formulation of the sector wage rate is as follows;

$$w_j^k = \alpha_{0j}^k \left(\frac{X_j^k}{L_j^k}\right)^{\alpha_{1j}^k} \tag{9}$$

The sector employment is determined by Ozaki(1979) employment function, depending upon level of sector output;

$$L_j^k = \beta_{oj}^k \left(X_j^k\right)^{\beta_{1j}^k} \tag{10}$$

Dividing equation (8) by X_j^k results in value added coefficient as;

$$v_j^k = \frac{V_j^k}{X_j^k} = \frac{w_j^k L_j^k}{X_j^k} + \frac{V_{jo}^k}{X_j^k} = \frac{w_j^k L_j^k}{X_j^k} + v_{jo}^k \tag{11}$$

where v_{jo}^k is the ratio of the other value added items of X_j^k.

Second, tariff could be formulated as; $C_{j1}^k = \sum_{h \neq k} \sum_i t_{i(h)}^k PX_{ij(h)}^k X_{ij(h)}^k$ and the other cost is assumed to be fixed proportion with sector output; $C_{jo}^k = c_{jo}^k X_j^k$ where c_{jo}^k is the base year ratio of the other factors to sector output (X_j^k).

Finally, export prices depends on export subsidies and domestic price; $PX_{ij(h)}^k = \left(1 - \tau_i^h\right) P_i^h$,where τ_i^h is export subsidies of the *i*th commodity of the *h*th economy and P_i^h is the price level in the *i*th sector of the *h*th economy.

3 Empirical Results of Elasticity of Substitution

To analyze international trade pattern in Asian International Input-Output model, the trade shares are estimated by logarithmic function of (5) using pooled data of the ten countries in the year 1985 1990 1995 and 2000. The estimation method uses weight least square with fixed effect. The estimated equation could be written as

$$\log\left(s_{ij(h)}^{k}\right) = \beta 1_{ij(h)}^{k} + \beta 2_{ij(h)}^{k} \log\left(PM_{ij(h)}^{k} \big/ \overline{PM}_{i}^{k}\right) \tag{12}$$

where $PM_{ij(h)}^{k}$ is import price of the i*th* commodity from the *h*th economy using in production of the *j*th sector in the *k*th economy (this price includes import tariff). $PM_{ij(h)}^{k} = \left(1 + t_{i(h)}^{k}\right) PX_{ij(h)}^{k}$ and $\overline{PM}_{j}^{k}$ is average import price. $\overline{PM}_{j}^{k} = \sum \left(1 + t_{i(h)}^{k}\right) PX_{ij(h)}^{k}$.

The estimated value of $\beta 2_{ij(h)}^{k}$ represents import elasticity of substitution of the *i*th commodity imported from the *h*th economy in production of the *j*th sector in the *k*th economy. With the database from Asian International Input-Output Table, there are 57,600 intermediate trade share time-series, coming from 240 sectors (24 sectors with 10 countries) and 240 commodities. A total of 5,760 equations would be estimated (since each equation comes from pooled series). Among these equations, only 1,178 out of 5,760 equations have negative value of estimated $\beta 2_{ij(h)}^{k}$, as well as, statistically significant at 10% significant level. Hence, only 11,780 intermediate trade share time-series are estimated and integrated in to model simulation.

Figure1 represents an example of trade share estimation. In the production of Japanese food manufacturing, agricultural inputs are domestically produced, as well as, imported from various origins. From figure 1, the import share of each region depends on (1) regional specific factor representing in different intercept and (2) regional import price relative with average price. Regarding import from Thailand, if import price increased by 1 percent, the Japanese food manufacturing producer would substitute away from Thai's agricultural input, reducing Thailand's import share by 4.97%. So the estimated value of Thailand elasticity of substitution is -4.97%.

After analyzing trade pattern of intermediate input demand, international trade pattern in final demand should also be analyzed. In this study, investment and change in inventory are assumed fixed at both aggregate and sectoral level. In contrary, both private consumption and government consumption are assumed fixed at aggregate level but depending on relative imported price at commodity level. The private and government consumption are estimated by logarithmic function as follow;

$$\log\left(c_{i(h)}^{k}\right) = \gamma 1_{i(h)}^{k} + \gamma 2_{i(h)}^{k} \log\left(ctotal^{k}\right) + \gamma 3_{i(h)}^{k} \log\left(PM_{i(h)}^{k} \big/ \overline{PM}_{i}^{k}\right) \tag{13}$$

where $c_{i(h)}^{k}$ is the *k*th economy private or government consumption of the *i*th commodity imported from the *h*th economy. $ctotal^{k}$ is total level of private or government consumption in the *k*th economy. $\gamma 2_{i(h)}^{k}$ is the *k*th economy income elasticity (in the case of total income equal total consumption) of the *i*th commodity imported from the *h*th economy. $\gamma 3^{k}_{i(h)}$ is the kth economy import elasticity of substitution of the ith commodity from the hth economy.

With this type of estimate equation, income elasticity as well as import elasticity of substitution could be identified. There are 4,800 time-series of private and government consumption to be estimated from 480 pooled equations. In the estimation process, if $\gamma 3^{k}_{ij(h)}$ had positive sign or negative sign but insignificant at 10% significant level, the new functional form, $\log\left(c^{k}_{i(h)}\right) = \gamma 1^{k}_{i(h)} + \gamma 2^{k}_{i(h)} \log\left(ctotal^{k}\right)$, would be estimated. Among these equation, 156 out of 240 private consumption equations have correct sign and statistically significant, whereas, only 11 out of 240 government consumption equations pass this criteria and be integrated into the simulation model.

Figure1 Trade share of Agricultural inputs using in Food Manufacturing sector in Japan

$$\log\left(s^{JPN}_{2,8(THA)}\right) = -6.538 - 4.972\log\left(PM^{JPN}_{2,8(THA)} / \overline{PM}^{JPN}_{2}\right)$$

$$\log\left(s^{JPN}_{2,8(IDN)}\right) = -4.808 - 4.972\log\left(PM^{JPN}_{2,8(IDN)} / \overline{PM}^{JPN}_{2}\right)$$

$$\log\left(s^{JPN}_{2,8(MLS)}\right) = -6.778 - 4.972\log\left(PM^{JPN}_{2,8(MLS)} / \overline{PM}^{JPN}_{2}\right)$$

$$\log\left(s^{JPN}_{2,8(PHL)}\right) = -6.149 - 4.972\log\left(PM^{JPN}_{2,8(PHL)} / \overline{PM}^{JPN}_{2}\right)$$

$$\log\left(s^{JPN}_{2,8(SGP)}\right) = -11.913 - 4.972\log\left(PM^{JPN}_{2,8(SGP)} / \overline{PM}^{JPN}_{2}\right)$$

$$\log\left(s^{JPN}_{2,8(CHN)}\right) = -3.231 - 4.972\log\left(PM^{JPN}_{2,8(CHN)} / \overline{PM}^{JPN}_{2}\right)$$

$$\log\left(s^{JPN}_{2,8(TWN)}\right) = -6.403 - 4.972\log\left(PM^{JPN}_{2,8(TWN)} / \overline{PM}^{JPN}_{2}\right)$$

$$\log\left(s^{JPN}_{2,8(KOR)}\right) = -8.002 - 4.972\log\left(PM^{JPN}_{2,8(KOR)} / \overline{PM}^{JPN}_{2}\right)$$

$$\log\left(s^{JPN}_{2,8(JPN)}\right) = -0.606 - 4.972\log\left(PM^{JPN}_{2,8(JPN)} / \overline{PM}^{JPN}_{2}\right)$$

$$\log\left(s^{JPN}_{2,8(USA)}\right) = -1.408 - 4.972\log\left(PM^{JPN}_{2,8(USA)} / \overline{PM}^{JPN}_{2}\right)$$

(-2.639)
t-stats

R-squared = 0.982 F-statistic = 149.885
Adjusted R-square = 0.975

Figure 2 illustrates the estimation of Thailand's private consumption for transportation equipment. The private consumption demand for transportation equipment of Thai consumers depends on (1) the level of total consumption or total level of income (in case of income equal to total consumption) (2) regional import price relative with average price, and regional specific factor representing in different intercept. From figure 2, the estimated value of income elasticity of automobiles[1] is 1.84. It could be interpreted as luxury product for Thai consumer since income elasticity is greater than 1. Regarding import price, 1 percent increase in import price of automobile from one region would lead to 2.18% decline of automobile import from that region, reflecting substitution elasticity of automobile from various regions.

Figure2 Thailand's private consumption for Automobiles

$$\log\left(CPR_{18(JPN)}^{THA}\right) = -19.581 + 1.844\log\left(CTOTAL^{THA}\right) - 2.181\left(PM_{18(JPN)}^{THA} / \overline{PM}_{18}^{THA}\right)$$

$$\log\left(CPR_{18(IDN)}^{THA}\right) = -27.076 + 1.844\log\left(CTOTAL^{THA}\right) - 2.181\left(PM_{18(IDN)}^{THA} / \overline{PM}_{18}^{THA}\right)$$

$$\log\left(CPR_{18(MLS)}^{THA}\right) = -26.018 + 1.844\log\left(CTOTAL^{THA}\right) - 2.181\left(PM_{18(MLS)}^{THA} / \overline{PM}_{18}^{THA}\right)$$

$$\log\left(CPR_{18(PHL)}^{THA}\right) = -33.918 + 1.844\log\left(CTOTAL^{THA}\right) - 2.181\left(PM_{18(PHL)}^{THA} / \overline{PM}_{18}^{THA}\right)$$

$$\log\left(CPR_{18(SGP)}^{THA}\right) = -26.827 + 1.844\log\left(CTOTAL^{THA}\right) - 2.181\left(PM_{18(SGP)}^{THA} / \overline{PM}_{18}^{THA}\right)$$

$$\log\left(CPR_{18(THA)}^{THA}\right) = -17.326 + 1.844\log\left(CTOTAL^{THA}\right) - 2.181\left(PM_{18(THA)}^{THA} / \overline{PM}_{18}^{THA}\right)$$

$$\log\left(CPR_{18(CHN)}^{THA}\right) = -26.026 + 1.844\log\left(CTOTAL^{THA}\right) - 2.181\left(PM_{18(CHN)}^{THA} / \overline{PM}_{18}^{THA}\right)$$

$$\log\left(CPR_{18(TWN)}^{THA}\right) = -23.645 + 1.844\log\left(CTOTAL^{THA}\right) - 2.181\left(PM_{18(TWN)}^{THA} / \overline{PM}_{18}^{THA}\right)$$

$$\log\left(CPR_{18(KOR)}^{THA}\right) = -24.916 + 1.844\log\left(CTOTAL^{THA}\right) - 2.181\left(PM_{18(KOR)}^{THA} / \overline{PM}_{18}^{THA}\right)$$

$$\log\left(CPR_{18(USA)}^{THA}\right) = -24.249 + 1.844\log\left(CTOTAL^{THA}\right) - 2.181\left(PM_{18(USA)}^{THA} / \overline{PM}_{18}^{THA}\right)$$

(52.993) *t-stats* (-9.774) *t-stats*

R-squared = 0.999 F-statistic = 16388.47
Adjusted R-square = 0.999

[1]Transportation equipment according to AIIO classification.

Figure 3 and figure 4 represente Japan's private consumption for agricultural products (exclude rice, wheat, and sugar) and livestock, respectively. Japanese income elasticity of livestock is less than one, 0.82%. Similarly, the income elasticity of agricultural product is closed to one, 1.02%. So these two products could be considered as necessity product as income elasticities were relatively low. The substitution elasticity is relatively high in agricultural products (-12.0%) comparing to that of livestock (-3.6%), as well as, that of automobile (-2.2%). This reflects characteristic of agricultural product, homogenous in the eyes of consumers. So change in import price in one region could have greater substitution impact on private consumption of agricultural products.

Figure3 Japan's private consumption for Agricultural Products(exclude rice, wheat, and sugar)[2]

$$\log\left(CPR_{2(THA)}^{JPN}\right) = -13.557 + 1.024\log\left(CTOTAL^{JPN}\right) - 12.018\left(PM_{2(THA)}^{JPN} / \overline{PM}_{2}^{JPN}\right)$$

$$\log\left(CPR_{2(IDN)}^{JPN}\right) = -14.330 + 1.024\log\left(CTOTAL^{JPN}\right) - 12.018\left(PM_{2(IDN)}^{JPN} / \overline{PM}_{2}^{JPN}\right)$$

$$\log\left(CPR_{2(MLS)}^{JPN}\right) = -14.656 + 1.024\log\left(CTOTAL^{JPN}\right) - 12.018\left(PM_{2(MLS)}^{JPN} / \overline{PM}_{2}^{JPN}\right)$$

$$\log\left(CPR_{2(PHL)}^{JPN}\right) = -11.402 + 1.024\log\left(CTOTAL^{JPN}\right) - 12.018\left(PM_{2(PHL)}^{JPN} / \overline{PM}_{2}^{JPN}\right)$$

$$\log\left(CPR_{2(SGP)}^{JPN}\right) = -11.738 + 1.024\log\left(CTOTAL^{JPN}\right) - 12.018\left(PM_{2(SGP)}^{JPN} / \overline{PM}_{2}^{JPN}\right)$$

$$\log\left(CPR_{2(CHN)}^{JPN}\right) = -9.877 + 1.024\log\left(CTOTAL^{JPN}\right) - 12.018\left(PM_{2(CHN)}^{JPN} / \overline{PM}_{2}^{JPN}\right)$$

$$\log\left(CPR_{2(TWN)}^{JPN}\right) = -10.314 + 1.024\log\left(CTOTAL^{JPN}\right) - 12.018\left(PM_{2(TWN)}^{JPN} / \overline{PM}_{2}^{JPN}\right)$$

$$\log\left(CPR_{2(KOR)}^{JPN}\right) = -14.634 + 1.024\log\left(CTOTAL^{JPN}\right) - 12.018\left(PM_{2(KOR)}^{JPN} / \overline{PM}_{2}^{JPN}\right)$$

$$\log\left(CPR_{2(JPN)}^{JPN}\right) = -5.631 + 1.024\log\left(CTOTAL^{JPN}\right) - 12.018\left(PM_{2(JPN)}^{JPN} / \overline{PM}_{2}^{JPN}\right)$$

$$\log\left(CPR_{18(USA)}^{THA}\right) = -8.404 + 1.024\log\left(CTOTAL^{THA}\right) - 12.081\left(PM_{18(USA)}^{THA} / \overline{PM}_{18}^{THA}\right)$$

(9.619) *t-stats* (-3.388) *t-stats*

R-squared = 0.999 F-statistic = 3623.492
Adjusted R-square = 0.999

[2] This is other agricultural product according to AIIO classification

Figure 4 Japan's private consumption for Livestock

$$\log\left(CPR_{3(THA)}^{JPN}\right) = -15.081 + 0.817\log\left(CTOTAL^{JPN}\right) - 3.603\left(PM_{3(THA)}^{JPN} / \overline{PM}_{3}^{JPN}\right)$$

$$\log\left(CPR_{3(IDN)}^{JPN}\right) = -12.318 + 0.817\log\left(CTOTAL^{JPN}\right) - 3.603\left(PM_{3(IDN)}^{JPN} / \overline{PM}_{3}^{JPN}\right)$$

$$\log\left(CPR_{3(MLS)}^{JPN}\right) = -12.606 + 0.817\log\left(CTOTAL^{JPN}\right) - 3.603\left(PM_{3(MLS)}^{JPN} / \overline{PM}_{3}^{JPN}\right)$$

$$\log\left(CPR_{3(PHL)}^{JPN}\right) = -14.671 + 0.817\log\left(CTOTAL^{JPN}\right) - 3.603\left(PM_{3(PHL)}^{JPN} / \overline{PM}_{3}^{JPN}\right)$$

$$\log\left(CPR_{3(SGP)}^{JPN}\right) = -14.400 + 0.817\log\left(CTOTAL^{JPN}\right) - 3.603\left(PM_{3(SGP)}^{JPN} / \overline{PM}_{3}^{JPN}\right)$$

$$\log\left(CPR_{3(CHN)}^{JPN}\right) = -8.618 + 0.817\log\left(CTOTAL^{JPN}\right) - 3.603\left(PM_{3(CHN)}^{JPN} / \overline{PM}_{3}^{JPN}\right)$$

$$\log\left(CPR_{3(TWN)}^{JPN}\right) = -11.752 + 0.817\log\left(CTOTAL^{JPN}\right) - 3.603\left(PM_{3(TWN)}^{JPN} / \overline{PM}_{3}^{JPN}\right)$$

$$\log\left(CPR_{3(KOR)}^{JPN}\right) = -12.912 + 0.817\log\left(CTOTAL^{JPN}\right) - 3.603\left(PM_{3(KOR)}^{JPN} / \overline{PM}_{3}^{JPN}\right)$$

$$\log\left(CPR_{3(JPN)}^{JPN}\right) = -2.834 + 0.817\log\left(CTOTAL^{JPN}\right) - 3.603\left(PM_{3(JPN)}^{JPN} / \overline{PM}_{3}^{JPN}\right)$$

$$\log\left(CPR_{3(USA)}^{JPN}\right) = -8.864 + 0.817\log\left(CTOTAL^{JPN}\right) - 3.603\left(PM_{3(USA)}^{JPN} / \overline{PM}_{3}^{JPN}\right)$$

(11.694) *t-stats* (-16.833) *t-stats*

R-squared = 0.998 F-statistic = 1348.39
Adjusted R-square = 0.997

4. Scenario Analysis

In this study, the economic setting or the initial condition of the Asian economies was based upon the year 2000 of Asian International Input Output table: AIIO (2006). According to AIIO tables, Asian economies consisted of ten regions, including China, Japan, Korea Taiwan, Singapore, Malaysia, Indonesia, Thailand, Philippines and the United States. Each region consists of 24 production sectors, in which the production sectors are interdependence. The elasticity of substitution among commodity as well as income elasticity are estimated to capture the economic interlink among Asian countries. There are 2 simulation scenarios namely, (1) a 5% annually across the board tariff reduction from 2007 to 2010 and (2) a 5% annually tariff reduction from 2007 to 2010 on Japanese steel products, automobile and automobile parts[3], as well as, Thai agricultural products (except rice, wheat, and sugar), livestock, fishery, and textile[4]. The study assumes a 5% annually tariff reduction as hypothetical example. Nevertheless, many items in the agreement had annually tariff reduction.

4.1 Results of a 5% annually across the board tariff reduction from 2007 to 2010

The bilateral across the board tariff reduction results in decreasing of import prices of Thailand and Japan, relative to other Asian countries. This stimulates both intermediate input demand and final consumption in both economies, as well as, creates

Figure5 Perecentage Change in Sectoral Output of Thailand

		2007	2008	2009	2010
1	Paddy	0.00	0.01	0.01	0.02
2	Other Agricultural Products	0.46	0.79	1.52	2.55
3	Livestock	0.01	0.01	0.02	0.03
4	Forestry	0.45	0.60	1.12	1.44
5	Fishery	0.03	0.04	0.04	0.06
6	Crude petroleum and natural gas	0.00	0.00	0.00	0.01
7	Other mining	0.33	0.49	0.74	1.15
8	Food, beverage, and tobacco	0.02	0.02	0.03	0.06
9	Textile, leather, and the products thereof	0.07	0.08	0.10	0.13
10	Timber and wooden products	0.70	0.91	1.22	1.69
11	Pulp, paper, and printing	0.04	0.05	0.08	0.12
12	Chemical products	0.10	0.14	0.20	0.29
13	Petroleum and petro products	0.00	0.00	0.00	0.00
14	Rubber products	0.00	0.00	0.00	0.00
15	Non-metallic mineral products	0.00	0.00	0.00	0.00
16	Metal products	0.00	0.00	0.00	0.00
17	Machinery	0.00	0.00	0.00	0.00
18	Transport equipment	0.02	0.03	0.05	0.09
19	Other manufacturing products	0.68	0.96	1.40	2.08
20	Electricity, gas, and water supply	0.04	0.05	0.08	0.12
21	Construction	0.00	0.00	0.00	0.00
22	Trade and transport	0.08	0.11	0.16	0.24
23	Services	0.01	0.02	0.03	0.06
24	Public administration	0.00	0.00	0.00	0.00

[3] Steel products, automobile and automobile part were classified as (16) metal products and (18) transportation equipment according to Asian international Input-Output Table developed by IDE.
[4] agricultural products (except rice, wheat, and sugar), livestock, fishery, and textile were classified as (2) other agricultural products, (3) livestock, (5) fishery , (9) textile and the products.

the spillover effect all over the region. The sectoral production of both Thailand and Japan, see Figure 5 and 6. From figure 5, the expansion of Thai production concentrates on other agriculture (2.6% in 2010), other manufacturing (2.1% in 2010), forestry (1.4% in 2010), and timber and wooden products (1.7% in 2010). These outcomes reflect high substitution elasticities of the products. From figure 6, the expansion of Japan production is far more little comparing to that of Thailand. The expansion concentrated on textiles (0.3% in 2010), other manufacturing (0.2% in 2010), and transportation equipment (0.16% in 2010).

Figure6 Perecentage Change in Sectoral Output of Japan

		2007	2008	2009	2010
1	Paddy	0.002	0.002	0.003	0.003
2	Other Agricultural Products	0.000	0.000	0.000	0.000
3	Livestock	0.002	0.002	0.003	0.003
4	Forestry	0.001	0.001	0.003	0.005
5	Fishery	0.001	0.002	0.006	0.008
6	Crude petroleum and natural gas	0.000	0.000	0.000	0.000
7	Other mining	0.001	0.002	0.003	0.005
8	Food, beverage, and tobacco	0.006	0.007	0.009	0.012
9	Textile, leather, and the products thereof	0.016	0.021	0.026	0.034
10	Timber and wooden products	0.001	0.001	0.002	0.002
11	Pulp, paper, and printing	0.001	0.002	0.002	0.003
12	Chemical products	0.025	0.025	0.030	0.060
13	Petroleum and petro products	0.000	0.000	0.000	0.000
14	Rubber products	0.000	0.000	0.000	0.000
15	Non-metallic mineral products	0.000	0.000	0.000	0.000
16	Metal products	0.000	0.000	0.000	0.000
17	Machinery	0.000	0.000	0.000	0.000
18	Transport equipment	0.008	0.010	0.012	0.016
19	Other manufacturing products	0.011	0.013	0.016	0.020
20	Electricity, gas, and water supply	0.001	0.001	0.001	0.002
21	Construction	0.000	0.000	0.000	0.000
22	Trade and transport	0.003	0.004	0.004	0.006
23	Services	0.000	0.000	0.001	0.001
24	Public administration	0.000	0.000	0.000	0.000

Figure7 Bilateral Trade Flow between Thailand and Japan(in million U.S. $)

	2007	2008	2009	2010
Thailand export to Japan	145.23	214.39	330.23	535.50
Thailand import to Japan	58.59	75.67	99.66	134.23
Bilateral Trade Balance	86.64	138.72	230.57	401.26

The estimated values of bilateral trade between Thailand and Japan are illustrated in Figure 7. From the figure, Thailand has 401.3 million U.S. $ trade surplus over Japan in 2010 as results of bilateral tariff reduction. Next, the spill over effect and impact on output and household income are examined. Figure 8 illustrated the percentage change in GDP within the region. The increase in GDP in Thailand (0.41% in 2010) is far more than that of Japan (0.04% in 2010). The spillover effects, resulting from higher Thai and Japan GDP, are positive but not significant because the increase in Thai and Japan GDP are quite small at the beginning. There are 0.0001-0.0002% increase in GDP of Malaysia, Singapore, Philippines, Taiwan and Korea. Figure9 is illustrated change in household income within the region. Similar to GDP, the increase in household income are mainly in Thailand (0.01% in 2010) and Japan (0.001% in 2010), while impacts on other Asian countries were insignificant (less than 0.00005%).

Figure8 Percentage change in GDP

	2007	2008	2009	2010
Thailand	0.1123	0.1658	0.2553	0.4139
Japan	0.0017	0.0022	0.0029	0.0039
China	0.0000	0.0000	0.0000	0.0000
Taiwan	0.0000	0.0000	0.0001	0.0001
Korea	0.0000	0.0000	0.0000	0.0001
Indonesia	0.0000	0.0000	0.0000	0.0000
Malaysia	0.0001	0.0001	0.0001	0.0002
Philippines	0.0000	0.0000	0.0000	0.0001
Sigapore	0.0001	0.0001	0.0001	0.0002
U.S.A.	0.0000	0.0000	0.0000	0.0000

Figure9 Percentage change in household income

	2007	2008	2009	2010
Thailand	0.0307	0.0453	0.0697	0.1128
Japan	0.0005	0.0006	0.0008	0.0011
China	0.0000	0.0000	0.0000	0.0000
Taiwan	0.0000	0.0000	0.0000	0.0000
Korea	0.0000	0.0000	0.0000	0.0000
Indonesia	0.0000	0.0000	0.0000	0.0000
Malaysia	0.0000	0.0000	0.0000	0.0000
Philippines	0.0000	0.0000	0.0000	0.0000
Sigapore	0.0000	0.0000	0.0000	0.0000
U.S.A.	0.0000	0.0000	0.0000	0.0000

4.2 Results of a 5% annually tariff reduction on sector specific from 2007 to 2010

The sector specific tariff reduction results in decreasing in import prices of Thai other agricultural, livestock, fishery, and textiles product to Japan and decreasing in import prices of Japan steel, automobile and parts to Thailand. From figure 10, the tariff reduction stimulates production in Thai other agricultural products (0.26% in 2010), livestock (0.0003% in 2010), fishery (0.10% in 2010) and textiles (0.08% in 2010). The relatively small increase in livestock production comparing to that of other agriculture is resulted from small import substitution elasticity of livestock (-3.6 comparing with -12.1: see figure 3 and figure 4). Moreover, there are increase in production of other sectors such as trade and transportation, corresponding to increase in production of tariff reduction sectors.

Figure10 Perecentage Change in Sectoral Output of Thailand

		2007	2008	2009	2010
1	Paddy	0.00	0.00	0.00	0.01
2	Other Agricultural Products	0.04	0.08	0.15	0.26
3	Livestock	0.0001	0.0001	0.0002	0.0003
4	Forestry	0.00	0.00	0.00	0.00
5	Fishery	0.01	0.02	0.04	0.10
6	Crude petroleum and natural gas	0.00	0.00	0.00	0.00
7	Other mining	0.00	0.00	0.00	0.00
8	Food, beverage, and tobacco	0.00	0.00	0.01	0.01
9	Textile, leather, and the products thereof	0.05	0.06	0.06	0.08
10	Timber and wooden products	0.01	0.01	0.03	0.05
11	Pulp, paper, and printing	0.00	0.01	0.01	0.01
12	Chemical products	0.01	0.01	0.02	0.03
13	Petroleum and petro products	0.00	0.00	0.00	0.00
14	Rubber products	0.00	0.00	0.00	0.00
15	Non-metallic mineral products	0.00	0.00	0.00	0.00
16	Metal products	0.00	0.00	0.00	0.00
17	Machinery	0.00	0.00	0.00	0.00
18	Transport equipment	0.00	0.01	0.01	0.02
19	Other manufacturing products	0.00	0.00	0.01	0.01
20	Electricity, gas, and water supply	0.00	0.00	0.00	0.01
21	Construction	0.00	0.00	0.00	0.00
22	Trade and transport	0.01	0.01	0.02	0.04
23	Services	0.00	0.01	0.01	0.03
24	Public administration	0.00	0.00	0.00	0.00

Figure 11 illustrates percentage change in sectoral production in Japan. From figure 11, the tariff reduction stimulates production in Japan automobiles and parts[5] by 0.14% in 2010. However, there is insignificant impact on Japanese steel industry (less than 0.0001% change[6]). This outcome resulted from no substitution elasticity or very low substitution elasticity in steel industry in every Thai production sectors. Moreover, the final demand consumption of steel industry is very low, since steel products tended to use as intermediate inputs rather than final consumption. There are positive but not significant increasing in Japan production of chemical product and textiles.

Figure11 Perecentage Change in Sectoral Output of Japan

		2007	2008	2009	2010
1	Paddy	0.000	0.000	0.000	0.000
2	Other Agricultural Products	0.000	0.000	0.000	0.000
3	Livestock	0.000	0.000	0.000	0.000
4	Forestry	0.000	0.000	0.000	0.000
5	Fishery	0.000	0.000	0.000	0.000
6	Crude petroleum and natural gas	0.000	0.000	0.000	0.000
7	Other mining	0.000	0.000	0.000	0.000
8	Food, beverage, and tobacco	0.000	0.000	0.000	0.000
9	Textile, leather, and the products thereof	0.000	0.001	0.001	0.001
10	Timber and wooden products	0.000	0.000	0.000	0.000
11	Pulp, paper, and printing	0.000	0.000	0.000	0.000
12	Chemical products	0.000	0.000	0.005	0.005
13	Petroleum and petro products	0.000	0.000	0.000	0.000
14	Rubber products	0.000	0.000	0.000	0.000
15	Non-metallic mineral products	0.000	0.000	0.000	0.000
16	Metal products	0.000	0.000	0.000	0.000
17	Machinery	0.000	0.000	0.000	0.000
18	Transport equipment	0.008	0.009	0.011	0.014
19	Other manufacturing products	0.000	0.000	0.001	0.001
20	Electricity, gas, and water supply	0.000	0.000	0.000	0.000
21	Construction	0.000	0.000	0.000	0.000
22	Trade and transport	0.000	0.000	0.000	0.000
23	Services	0.000	0.000	0.000	0.000
24	Public administration	0.000	0.000	0.000	0.000

[5] Automobiles and parts were treated as Transportation equipment products.
[6] See the impact in metal products because steel industry was subsector of metal products.

Figure 12 shows the estimated values of bilateral trade between Thailand and Japan. From the figure, Thailand has 119.35 million U.S. $ trade surplus over Japan in 2010, relatively little comparing with that of across the board tariff reduction case. Finally, the impacts on GDP across the region are examined; see figure 13. There are insignificant changes in GDP of other Asian countries. The increases in GDP concentrate mainly to 2 trading partners, 0.1% in 2010 for Thailand and 0.0001% in 2010 for Japan. The increases in GDP for sector specific tariff reduction are much smaller that those of across the board case, creating even more insignificant impact on other Asian countries.

Figure12 Bilateral Trade Flow between Thailand and Japan(in million U.S. $)

	2007	2008	2009	2010
Thailand export to Japan	22.32	37.69	70.05	141.88
Thailand import to Japan	13.10	15.51	18.56	22.53
Bilateral Trade Balance	9.21	22.17	51.48	119.35

Figure14 Percentage change in GDP

	2007	2008	2009	2010
Thailand	0.0174	0.0294	0.0545	0.1103
Japan	0.00004	0.00005	0.00005	0.00007
China	0.00000	0.00000	0.00000	0.00000
Taiwan	0.00000	0.00000	0.00000	0.00000
Korea	0.00000	0.00000	0.00000	0.00000
Indonesia	0.00000	0.00000	0.00000	0.00000
Malaysia	0.00000	0.00000	0.00000	0.00000
Philippines	0.00000	0.00000	0.00000	0.00000
Sigapore	0.00000	0.00000	0.00000	0.00000
U.S.A.	0.00000	0.00000	0.00000	0.00000

5. Conclusion

The establishment of Japan Thai free trade agreement would have positive impact on GDP and household income of both trading partners. From the simulation results, Thailand seems to receive more benefit in term of higher GDP growth and household income growth than Japan counterpart. Moreover, the bilateral trades balance between Thai and Japan results in trade surplus for Thailand. The bilateral across the board tariff reduction yields more positive impact on both economies than sector specific one. Finally, there are very small insignificant positive spillover effects on GDP of other Asia nations.

References

Armington, P.S.(1969). *A Theory of Demand for Products Distinguished by Place of Production.* International Monetary Fund Staff Papers, Vol.16, p159-176.

Bulmer-Thomas, V.(1982) *Input-output Analysis in Developing Countries: Sources, Methods and Applications.* John Wiley and Sons Ltd.

Hertel, Thomas W.(ed). (1997) *Global Trade Analysis: Modeling and Applications.* Cambridge: Cambridge University Press.

Institute of Developing Economies. (1992) *Asian International Input-Output Table 1985.* Tokyo.

Institute of Developing Economies. (1998) *Asian International Input-Output Table 1990.* Tokyo.

Institute of Developing Economies. (2001) *Asian International Input-Output Table 1995.* Tokyo.

Institute of Developing Economies. (2006) *Asian International Input-Output Table 2000 Volumn1 Explanatory Notes.* Tokyo.

Institute of Developing Economies. (2006) *Asian International Input-Output Table 2000 Volumn2 Data.* Tokyo.

Kosaka, Hiroyuki. (1994) *Gurobaru shisutemu no moderu bunseki [Model analysis on the global system].* Tokyo: Yuhikaku.

Kosaka, Hiroyuki., Yano, Takashi. (2004) *An International Input-Output Analysis on the Effects of Free Trade Agreements in Asia.* International Conference on Policy Modeling, Paris, France.

Miler, Ronald E., and Blair Peter D. (1984) *Input-Output Analysis: Foundations and Extensions.* Prentice Hall.

Torii, Yasuhiko., Seung-Jin Shim., and Yutaka Akiyama. (1989). *"Effects of Tariff Reductions on Trade in the Asia-Pacific Region."* in *Frontiers in Input-Output Analysis,* ed. Ronald E. Millar, Karen R. Polenske and Adam Z. Rose. New York: Oxford University Press.

Uno, Kimio(ed). (2002) *Economy-Energy-Environment Simulation: Beyond the Kyoto Protocol.* Dordrecht: Kluwer Academic Publisher.

Figure1 Layout of the Asian International Input-Output Table 1

			Intermediate Demand (A)										Final Demand (F)										Export (L)					Statistical	Total
			(AI)	(AM)	(AP)	(AS)	(AT)	(AC)	(AN)	(AK)	(AJ)	(AU)	(FI)	(FM)	(FP)	(FS)	(FT)	(FC)	(FN)	(FK)	(FJ)	(FU)	(LH)	(LE)	(LF)	(LG)	(LW)	Discrepancy	Output
	Indonesia	(AI)	A^{II}	A^{IM}	A^{IP}	A^{IS}	A^{IT}	A^{IC}	A^{IN}	A^{IK}	A^{IJ}	A^{IU}	F^{II}	F^{IM}	F^{IP}	F^{IS}	F^{IT}	F^{IC}	F^{IN}	F^{IK}	F^{IJ}	F^{IU}	LH^{I}	LE^{I}	LF^{I}	LG^{I}	LW^{I}	Q^{I}	X^{I}
	Malaysia	(AM)	A^{MI}	A^{MM}	A^{MP}	A^{MS}	A^{MT}	A^{MC}	A^{MN}	A^{MK}	A^{MJ}	A^{MU}	F^{MI}	F^{MM}	F^{MP}	F^{MS}	F^{MT}	F^{MC}	F^{MN}	F^{MK}	F^{MJ}	F^{MU}	LH^{M}	LE^{M}	LF^{M}	LG^{M}	LW^{M}	Q^{M}	X^{M}
	Philippines	(AP)	A^{PI}	A^{PM}	A^{PP}	A^{PS}	A^{PT}	A^{PC}	A^{PN}	A^{PK}	A^{PJ}	A^{PU}	F^{PI}	F^{PM}	F^{PP}	F^{PS}	F^{PT}	F^{PC}	F^{PN}	F^{PK}	F^{PJ}	F^{PU}	LH^{P}	LE^{P}	LF^{P}	LG^{P}	LW^{P}	Q^{P}	X^{P}
	Singapore	(AS)	A^{SI}	A^{SM}	A^{SP}	A^{SS}	A^{ST}	A^{SC}	A^{SN}	A^{SK}	A^{SJ}	A^{SU}	F^{SI}	F^{SM}	F^{SP}	F^{SS}	F^{ST}	F^{SC}	F^{SN}	F^{SK}	F^{SJ}	F^{SU}	LH^{S}	LE^{S}	LF^{S}	LG^{S}	LW^{S}	Q^{S}	X^{S}
	Thailand	(AT)	A^{TI}	A^{TM}	A^{TP}	A^{TS}	A^{TT}	A^{TC}	A^{TN}	A^{TK}	A^{TJ}	A^{TU}	F^{TI}	F^{TM}	F^{TP}	F^{TS}	F^{TT}	F^{TC}	F^{TN}	F^{TK}	F^{TJ}	F^{TU}	LH^{T}	LE^{T}	LF^{T}	LG^{T}	LW^{T}	Q^{T}	X^{T}
	China	(AC)	A^{CI}	A^{CM}	A^{CP}	A^{CS}	A^{CT}	A^{CC}	A^{CN}	A^{CK}	A^{CJ}	A^{CU}	F^{CI}	F^{CM}	F^{CP}	F^{CS}	F^{CT}	F^{CC}	F^{CN}	F^{CK}	F^{CJ}	F^{CU}	LH^{C}	LE^{C}	LF^{C}	LG^{C}	LW^{C}	Q^{C}	X^{C}
	Taiwan	(AN)	A^{NI}	A^{NM}	A^{NP}	A^{NS}	A^{NT}	A^{NC}	A^{NN}	A^{NK}	A^{NK}	A^{NU}	F^{NI}	F^{NM}	F^{NP}	F^{NS}	F^{NT}	F^{NC}	F^{NN}	F^{NK}	F^{NJ}	F^{NU}	LH^{N}	LE^{N}	LF^{N}	LG^{N}	LW^{N}	Q^{N}	X^{N}
	Korea	(AK)	A^{KI}	A^{KM}	A^{KP}	A^{KS}	A^{KT}	A^{KC}	A^{KN}	A^{KK}	A^{KJ}	A^{KU}	F^{KI}	F^{KM}	F^{KP}	F^{KS}	F^{KT}	F^{KC}	F^{KN}	F^{KK}	F^{KJ}	F^{KU}	LH^{K}	LE^{K}	LF^{K}	LG^{K}	LW^{K}	Q^{K}	X^{K}
	Japan	(AJ)	A^{JI}	A^{JM}	A^{JP}	A^{JS}	A^{JT}	A^{JC}	A^{JN}	A^{JK}	A^{JJ}	A^{JU}	F^{JI}	F^{JM}	F^{JP}	F^{JS}	F^{JT}	F^{JC}	F^{JN}	F^{JK}	F^{JJ}	F^{JU}	LH^{J}	LE^{J}	LF^{J}	LG^{J}	LW^{J}	Q^{J}	X^{J}
	U.S.A.	(AU)	A^{UI}	A^{UM}	A^{UP}	A^{US}	A^{UT}	A^{UC}	A^{UN}	A^{UK}	A^{UJ}	A^{UU}	F^{UI}	F^{UM}	F^{UP}	F^{US}	F^{UT}	F^{UC}	F^{UN}	F^{UK}	F^{UJ}	F^{UU}	LH^{U}	LE^{U}	LF^{U}	LG^{U}	LW^{U}	Q^{U}	X^{U}
Freight and Insurance		(BF)	BA^{I}	BA^{M}	BA^{P}	BA^{S}	BA^{T}	BA^{C}	BA^{N}	BA^{K}	BA^{J}	BA^{U}	BF^{I}	BF^{M}	BF^{P}	BF^{S}	BF^{T}	BF^{C}	BF^{N}	BF^{K}	BF^{J}	BF^{U}							
Import from Hong Kong		(CH)	HA^{I}	HA^{M}	HA^{P}	HA^{S}	HA^{T}	HA^{C}	HA^{N}	HA^{K}	HA^{J}	HA^{U}	HF^{I}	HF^{M}	HF^{P}	HF^{S}	HF^{T}	HF^{C}	HF^{N}	HF^{K}	HF^{J}	HF^{U}							
Import from R.O.W.		(CW)	WA^{I}	WA^{M}	WA^{P}	WA^{S}	WA^{T}	WA^{C}	WA^{N}	WA^{K}	WA^{J}	WA^{U}	WF^{I}	WF^{M}	WF^{P}	WF^{S}	WF^{T}	WF^{C}	WF^{N}	WF^{K}	WF^{J}	WF^{U}							
Import Duty and Sales Tax		(DT)	DA^{I}	DA^{M}	DA^{P}	DA^{S}	DA^{T}	DA^{C}	DA^{N}	DA^{K}	DA^{J}	DA^{U}	DF^{I}	DF^{M}	DF^{P}	DF^{S}	DF^{T}	DF^{C}	DF^{N}	DF^{K}	DF^{J}	DF^{U}							
Value Added		(VV)	V^{I}	V^{M}	V^{P}	V^{S}	V^{T}	V^{C}	V^{N}	V^{K}	V^{J}	V^{U}																	
Total Inputs		(XX)	X^{I}	X^{M}	X^{P}	X^{S}	X^{T}	X^{C}	X^{N}	X^{K}	X^{J}	X^{U}																	