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

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Received November 9, 2006; final version accepted July 19, 2007

This paper aims at analyzing regional impact throughout Asian-Pacific as a result of free trade agreement between Japan and Thailand. To analyze regional impact, Asian International Input-Output Model is constructed basing on 4-data set of Asian international input-output table developed by Institute of Developing Economies (IDE). The model estimates income, price, and substitution elasticities providing insight to behavioral parameters. Moreover, sector prices are modeled taking into account international comparison of purchasing power using data from UNSTAT and Eurostat(1994).

KEYWORDS: Bilateral Free Trade Agreement, International Input-Output Model, Asia-Pacific

1. Introduction

As international trade and globalization flourish everywhere, the international dimension in economic model becomes essential. Many models are constructed considering international linkage in multisector economic context. To name a few, there are computable general equilibrium (CGE) models (eg. Global Trade Analysis Project: GTAP (Hertel; 1997)), and econometric input output models (eg. INFORUM (Almon; 1991), COMPASS (Uno; 2002)). Under CGE models, GTAP is theoretically well constructed, relying on regional household demand system as well as CES production function on supply side. The model, however, bases on elasticity parameters, determined outside the model. Econometric input output models utilize time series of system of national account and national input output table to econometrically estimate the multisector economy and interlink with other economies via trade matrix. Regarding elasticity parameters, both INFORUM and COMPASS estimate the parameters within the model.

Asian international input output model could be considered as econometric input output model as elasticity parameters are econometrically estimated from Asian international input output tables. Nevertheless, there is special feature of the model as there is no need of national input output tables and trade matrix. Asian international input output table (AIIO) is an integrated version of 10 national input output tables and trade matrix together. This increases depth of analysis where elasticities of substitution of different agents (producer and consumer) could be individually estimated.

2. Asian International Input Output (AIIO) Model

This section attempts to explain the entire modeling process starting from data preparation to model construction and policy simulation. In particular, the following steps are implemented in the study.

- Step1: Obtain current price AIIO tables
- Step2: Determine sector prices
- Step3: Convert current price AIIO tables into constant price AIIO tables except value added variables
- Step4: Estimate behavioral parameters and construct AIIO model
- Step5: Make scenario analysis

Step1: Obtain current price AIIO tables

To construct AIIO model, the first step is to obtain 4 data sets of AIIO table in 1985, 1990, 1995, and 2000. AIIO table developed by IDE could be considered as current price table as all transactions are valued at current market prices, varying overtime from 1985 to 2000. The basic structure of AIIO model in determining gross output is represented as $x = Ax + F$ where x is vector of gross output, A is technical coefficient matrix measuring in constant price, and F is matrix of final demand by category. To determine gross output, AIIO table in constant price is required. Then next step is to determine sector prices in order to convert nominal AIIO tables into the real one.

Step2: Determine sector prices

Sector prices are determined by unit cost basing on identity of Asian international input output table, which is

$$p_j^k x_j^k = \sum_i \sum_h q_{ij(h)}^k x_{ij(h)}^k + v_j^k + m_j^k + o_j^k \quad (1)$$

p_j^k is sector price of the j^{th} industry in the k^{th} economy. x_j^k is gross output of the j^{th} industry in the k^{th} economy. Note that $x = [x_j^k]$. $q_{ij(h)}^k$ is import price of the i^{th} commodity from the h^{th} economy to the j^{th} sector production in the k^{th}

economy. $q_{ij(h)}^k = (1 + \tau_{i(h)}^k)p_i^h$ Import price is defined as sector price of imported country (p_i^h) taking into account import tariff that the country imposed on import of the i^{th} commodity in the h^{th} country ($\tau_{i(h)}^k$). $x_{ij(h)}^k$ is intermediate input of the i^{th} commodity from the h^{th} economy using in production of the j^{th} sector in the k^{th} economy. v_j^k is value added of the j^{th} industry in the k^{th} economy. o_j^k is other cost of the j^{th} industry in the k^{th} economy. m_j^k is import outside Asian region of the j^{th} industry in the k^{th} economy. Note that import within the region is represented as $q_{ij(h)}^k x_{ij(h)}^k$.

Basing on the identity, unit cost can be calculated by divided equation (1) by gross output of the sector. The study classifies the unit cost into (1) the unit cost that is determined endogenously in the model, (2) cost of import from outside the region, and (3) other cost. The model for sector price is estimated using regression equation;

$$p = \alpha + \beta_1 uc + \beta_2 p_{oil} + \varepsilon \quad (2)$$

$p = [p_j^k]$, which is vector of sector price. α, β_1, β_2 are vectors of estimated regression coefficient. uc is vector of the unit cost determined within the model, $uc = \left[\sum_i \sum_h q_{ij(h)}^k x_{ij(h)}^k + v_j^k \right] / x_j^k$. p_{oil} is vector of oil price representing cost of import outside the region. ε is vector of random error representing other cost.

While data on uc comes from AIIO tables and data on oil price obtains from International Energy Agency (IEA), the data on sector prices are quite problematic. International price comparison at sector level is difficult to find and requires some adjustment. Sakuma, Rao, and Kurabayashi (2000) discuss about appropriate method of aggregation that makes international price comparison consistent.

Generally, there are two methods of international price comparison, namely, (1) International Comparison Program (ICP) developed by UNSTAT and Eurostat (1994), (2) International Comparisons of Output and Productivity (ICOP) developed by Groningen Growth & Development Centre, University of Groningen (Timmer; 2005). The ICP works on international comparison from the expenditure side of the national account, considered as demand side approach. On the other hand, the ICOP focuses on real output and productivity of each production sector, determining international prices. This study relies on the ICP work as the AIIO could be considered as demand orient model. Moreover, the ICP data covers many economies across Asian countries.

Step3: Convert current price AIIO tables into constant price AIIO tables

The sector price data from ICP is used to convert all gross output determining variables from current price AIIO table into constant price AIIO table. By dividing current price AIIO with the sector prices, we are able to derived constant price AIIO. There is no need to convert value added variables into constant price since the variables are irrelevant to gross output determination. At this moment, AIIO table is measured in constant price and ready for further analysis.

Step4: Estimate behavioral parameters and construct AIIO model

AIIO model consists of 2 sub-model, (a) intermediate input and its trade share model, and (b) private consumption demand and its trade share model. In each sub-model, the estimation of behavioral parameters becomes core feature that makes the model realistic and applicable for policy analysis.

a) Intermediate input and its trade share model

From the determination of gross output $x = Ax + F$, intermediate demand is represented as Ax , where A is technical coefficient matrix. Each element in A could be written as:

$$a_{ij(h)}^k = x_{ij(h)}^k / x_j^k \quad (3)$$

where $a_{ij(h)}^k$ is technical coefficient identifying how much the i^{th} commodity from the h^{th} economy is used in one unit of production of the j^{th} sector in the k^{th} economy. Define a_{ij}^k as:

$$a_{ij}^k = \sum_h x_{ij(h)}^k / x_j^k \quad (4)$$

where $\sum_h x_{ij(h)}^k$ is summation of intermediate input of the i^{th} commodity from various sources representing by subscript h using in production of the j^{th} sector in the k^{th} economy. In the model, a_{ij}^k is assumed as constant. Even a_{ij}^k is fixed, $a_{ij(h)}^k$ could be varied depending upon import prices as well as domestic price of the input.

Applying Armington(1969)'s trade elasticity approach, the intermediate input share from various import sources is defined as:

$$s_{ij(h)}^k = \gamma_{ij(h)}^k [q_{ij(h)}^k / (q_{ij}^k)]^{\mu_{ijk}} \quad (5)$$

where $s_{ij(h)}^k = x_{ij(h)}^k / x_j^k$, is trade share of the i^{th} commodity imported from the h^{th} economy in the j^{th} sector of the k^{th} economy. $q_{ij(h)}^k$ is import price of the i^{th} commodity from the h^{th} economy to the j^{th} sector production in the k^{th} economy. q_{ij}^k is average commodity price of the i^{th} commodity in the j^{th} sector production in the k^{th} economy. It is the weighted average import and domestic prices of the i^{th} input using import share as the weight. $\gamma_{ij(h)}^k$ and μ_{ijk} are behavioral parameters. μ_{ijk} represents elasticity of substitution of the i^{th} commodity among various origin.

b) Private consumption demand and its trade share model

From the determination of gross output $x = Ax + F$, private consumption demand is one component within final demand matrix (F).

$$F = [f_{iM(h)}^k] \quad (6)$$

where $f_{iM(h)}^k$ is M category final demand of the k th economy for the i th commodity imported from the h th economy.

Final demand is classified into 4 categories, $M = c, g, i, v$, private consumption (c), government consumption (g), investment (i), and inventory (v). This study focuses on private consumption demand, the largest component of final demand. The other components are treated as exogenous. Define cpr_i^k as:

$$cpr_i^k = \sum_h f_{ic(h)}^k \quad (7)$$

where cpr_i^k is private consumption of the i th commodity of the k th economy, the summation of the i th commodity from various origins denoting as subscript h . Private consumption demand of the i th commodity in the k th economy (cpr_i^k) is determined by the real national wage income $\left(rwage \equiv \frac{wage^k}{\bar{q}^k} \right)$ and average consumer price of the i th commodity (q_i^k). Real national wage represents purchasing power of consumer in the economy, calculated as summation of sector wage $\left(wage^k \equiv \sum_j wage_j^k \right)$ divided by average consumer price ($\bar{q}^k$). $\bar{q}^k$ is weight average of q_i^k , representing general price level of private consumption bundle.

$$cpr_i^k = f \left(\frac{wage^k}{\bar{q}^k}, q_i^k \right) \quad (8)$$

Define $s_{ic(h)}^k = f_{ic(h)}^k / \sum_h f_{ic(h)}^k$ as trade share of the i th commodity imported from the h th economy for private consumption in the k th economy. Similar to intermediate input, the model applies Armington(1969)'s trade elasticity approach to trade share of private consumption demand.

$$s_{ic(h)}^k = \gamma_{ic(h)}^k [q_{ic(h)}^k / (q_i^k)]^{\mu_{ik}} \quad (9)$$

where $q_{ic(h)}^k$ is import price of the i th commodity from the h th economy for private consumption in the k th economy. q_i^k , a average consumer price of the i th commodity in the k th economy, is weighted average import and domestic prices of the i th commodity using import share of private consumption as the weight. $\gamma_{ic(h)}^k$ and μ_{ik} are behavioral parameters. μ_{ik} represents elasticity of substitution of the i th commodity among various origin.

Step5: Make scenario analysis

After estimating behavioral parameters and constructing the model, the scenario analysis could be simulated. This paper focuses on regional impact across Asian-Pacific as a result of free trade agreement between Japan and Thailand. There are 2 simulation scenarios, (1) 25% across the board tariff reduction and (2) 25% sector specific tariff reduction.

3. Empirical Results of Income, Price and Substitution Elasticities

Before presenting the scenario analysis, it would be useful considering the estimated behavioral parameters as those parameters play an important role in determining simulation results. Regarding private consumption demand (cpr_i^k), the estimated equation could be written as:

$$\log(cpr_i^k)_t = \lambda 1_i^k + \lambda 2_i^k \log(rwage^k)_t + \lambda 3_i^k \log(q_i^k)_t \quad (10)$$

Note that additional subscript t representing time. $\lambda 2_i^k$ and $\lambda 3_i^k$ represent wage income elasticity and price elasticity of private consumption demand of the i th commodity in the k th economy. Due to limited time series of AIIIO table, the model estimates the equation using pooled data of those 10 economies. The estimated values of income and price elasticities are represented in Table 1.

From Table 1, the estimated value of income elasticity is higher in industrial and service sectors than in food and agricultural product, indicating necessity of food items, not varying much in consumption as income change. The values of price elasticity are around -0.4 to -1.4 .

Regarding trade share of intermediate input and private consumption demands, $s_{ic(h)}^k$ and $s_{ij(h)}^k$, the estimated equations could be represented as:

$$\log(s_{ic(h)}^k)_t = \delta 1_{ic}^k + \delta 2_{ic}^k \log((q_{ic(h)}^k)_t / (q_i^k)_t) \quad (11)$$

$$\log(s_{ij(h)}^k)_t = \delta 1_{ij}^k + \delta 2_{ij}^k \log((q_{ij(h)}^k)_t / (q_i^k)_t) \quad (12)$$

where $\delta 2_{ic}^k$ and $\delta 2_{ij}^k$ represent trade share elasticity of substitution of the i th commodity for private consumer and for producer in the j th sector of the k th economy.

Table 1. Income and price elasticities across Asian-Pacific Economy.

		Income elasticity	Price elasticity
1	Paddy	—	—
2	Other Agricultural Products	0.38	−0.02
3	Livestock	0.47	−0.75
4	Forestry	—	—
5	Fishery	0.61	−0.59
6	Crude petroleum and natural gas	—	—
7	Other mining	—	—
8	Food, beverage, and tobacco	0.75	−0.29
9	Textile, leather, and the products	0.89	−0.11
10	Timber and wooden products	0.95	−0.26
11	Pulp, paper, and printing	1.28	−0.38
12	Chemical products	0.78	−0.24
13	Petroleum and petroproducts	1.15	−0.35
14	Rubber products	1.20	−1.64
15	Non-metallic mineral products	1.19	−0.76
16	Metal products	1.20	−1.28
17	Machinery	1.18	−0.01
18	Transport equipment	1.24	−1.20
19	Other manufacturing products	0.94	−0.24
20	Electricity, gas, and water supply	1.08	−0.04
21	Construction	—	—
22	Trade and transport	0.90	−0.07
23	Services	1.09	−0.18
24	Public administration	—	—

Table 2. Trade share elasticity of substitution for private consumption in Japan and Thailand.

		Japan	Thailand
1	Paddy	—	—
2	Other Agricultural Products	−1.31	−1.02
3	Livestock	−1.09	−1.81
4	Forestry	—	—
5	Fishery	−1.04	−1.41
6	Crude petroleum and natural gas	—	—
7	Other mining	—	—
8	Food, beverage, and tobacco	−1.55	−1.00
9	Textile, leather, and the products	−1.42	−1.01
10	Timber and wooden products	−1.56	−1.42
11	Pulp, paper, and printing	−1.20	—
12	Chemical products	−0.90	−1.68
13	Petroleum and petroproducts	−1.23	−0.65
14	Rubber products	−0.80	—
15	Non-metallic mineral products	—	−0.64
16	Metal products	—	—
17	Machinery	−1.87	−1.20
18	Transport equipment	—	−0.40
19	Other manufacturing products	−1.79	−0.71
20	Electricity, gas, and water supply	—	—
21	Construction	—	—
22	Trade and transport	−1.02	−0.99
23	Services	—	—
24	Public administration	—	—

Table 3. Percentage change in real gross domestic product (rgdp) and real national wage (rwage) under 1st scenario.

	rgdp	rwage
Japan	0.004	0.010
Thailand	0.146	0.275
Indonesia	0.002	0.004
Malaysia	0.004	0.007
Philippines	0.002	0.003
Singapore	0.005	0.008
China	0.001	0.001
Taiwan	0.001	0.002
Korea	0.001	0.001
U.S.A.	0.001	0.001

In this model, the estimated values of trade share elasticity differ from one economy to another economy, as well as from each industrial producer to private consumer. This feature elaborates the model to the extent that makes policy analysis more realistic. As there are thousands of estimated values of trade elasticity of substitution, an example of trade share elasticity of substitution is shown in Table 2. In Table 2, the estimate values of trade share elasticity are around -0.5 to -2 in all industries for both Japan and Thailand consumers. These indicate that change in import price of one trade partner leads to import substitution for another, but the degree of substitution is not high.

4. Scenario Analysis

First scenario: 25% across the board tariff reduction between Japan and Thai

The across the board tariff reduction results in declining of import prices in all sectors in both trading partners, stimulating import demand for both intermediate input and private consumption. Higher import demands induce more production and higher national wage. Higher national wage incorporates with lower import prices resulting in higher real national wage in Japan and Thailand. This effect stimulates private consumption demand further and has positive spill over effect all over regional economy. Simultaneously, lower import prices of both countries reduce unit cost of production leading to lower domestic prices. The rest of the region would face lower import prices from Thailand and Japan. This would lead to higher real national wage for the rest of the region and stimulate private consumption demand further throughout the region. The effect on level of production and real national income is illustrated in Table 3. The real gross domestic product (rgdp) is higher, ranging from 0.001% in the United States to 0.146% in Thailand. The real national wage (rwage) increases, ranging from 0.001% in the United States to 0.275% in Thailand.

The effect on trade balance is illustrated in Table 4. Trade balance of Thailand is improving by 204 million U.S. dollar while Japan's trade balance is worsening by 86 million U.S. dollar. Thailand's trade balance has been improved resulting from higher export to all over region as Thailand sector prices decline. Worsen in Japan's trade balance comes from 2 factors. Firstly, higher real national wage stimulates import demand from all over the region. Secondly, the tariff reduction leads to higher import on textile and agricultural products from Thailand. The effect of trade balance is mixed for the rest of the region.

The impact on sector production is demonstrated in Table 5. Even the impact on total production is positive the impact on sector production is mixed in Japan. The production in agriculture, livestock, fishery, and textile industries decline in Japan but increase in Thailand. It indicates Thailand's comparative advantage¹ in agricultural sectors and primary industry sectors. The production of food industry rises significantly in Japan (1st rank at 0.018%) as the producer gains access to lower cost of agricultural, livestock, and fishery inputs from Thailand.

The production of transportation equipment and rubber product rise in Japan (2nd rank at 0.012% and 3rd rank at 0.010%) indicating comparative advantage in transportation equipment, particularly automobile. However, the production of transportation equipment increases slightly in Thailand as well. This is due to deep interrelate relationship between Thailand and Japan in automobile industry. Increase in automobile production in Japan stimulates higher automobile part demand from Thailand, as many of Japanese automobile subsidiaries are located in Thailand.

The production of machinery and non-metallic mineral product decline slightly in Thailand but increase in Japan. It indicates comparative disadvantage of Thai machinery and non-metallic mineral sectors.

Second scenario: 25% sector specific tariff reduction between Japan and Thai

The second scenario aims at replicating Japan-Thailand Economic Partnership Agreement (JTEPA), that has been agreed upon by both nations. Japan would be granted tariff reduction on automobiles, auto parts, iron and steel products, represented by transportation equipment and metal product in the model. Thailand would gain market access

Table 4. Change in trade balance in million U.S. \$ under 1st scenario.

	trade balance
Japan	-86.0
Thailand	204.1
Indonesia	12.5
Malaysia	1.9
Philippines	-0.6
Singapore	-0.2
China	11.5
Taiwan	-20.6
Korea	-11.7
U.S.A.	-110.8

Table 5. Percentage change in sector production in Japan and Thailand under 1st scenario.

		Japan	Thailand
1	Paddy	-0.005	0.129
2	Other Agricultural Products	-0.001	0.096
3	Livestock	-0.013	0.126
4	Forestry	0.000	0.066
5	Fishery	-0.012	0.136
6	Crude petroleum and natural gas	0.002	0.071
7	Other mining	0.001	0.024
8	Food, beverage, and tobacco	0.018	0.106
9	Textile, leather, and the products	-0.003	0.170
10	Timber and wooden products	0.000	0.058
11	Pulp, paper, and printing	0.001	0.086
12	Chemical products	0.001	0.075
13	Petroleum and petroproducts	0.002	0.071
14	Rubber products	0.010	0.060
15	Non-metallic mineral products	0.002	-0.003
16	Metal products	0.003	0.079
17	Machinery	0.002	-0.009
18	Transport equipment	0.012	0.036
19	Other manufacturing products	0.001	0.058
20	Electricity, gas, and water supply	0.004	0.099
21	Construction	0.000	0.001
22	Trade and transport	0.003	0.061
23	Services	0.004	0.129
24	Public administration	0.000	0.000

in textile, and agricultural products; mainly fruits, vegetables, prepared or preserved chicken, pork, and fishery products (excluding rice, wheat, and sugar). These products are represented by other agricultural products, livestock, fishery, and textile.

The result on aggregate variables such as real gross domestic product and wage income is similar to the first scenario (see Table 6). The differences are lower positive impact on production of both trading partner, as well as, lower spillover effect through all over region. Change in trade balance of both Japan and Thailand is moving in the same direction as the first scenario as well (see Table 7).

There are some different in first and second scenario on sector production in Japan (see Table 8). As rice, wheat, and sugar are protected from free trade agreement, there is no contraction in production of agricultural sectors. There is no negative impact on livestock and fishery sectors as well. Only textile, leather, and products would be contracted as a result of JTEPA. The production of food industry still increases (3rd rank at 0.004%) but the benefit of lower intermediate input cost declines significantly. The production of transportation equipment and rubber still rise in Japan (1st rank at 0.006% and 2nd rank at 0.005%).

For Thailand, the production of textile increases significantly (1st rank at 0.073%). The agriculture, livestock, and

Table 6. Percentage change in real gross domestic product (rgdp) and real national wage (rwage) under 2nd scenario.

	rgdp	rwage
Japan	0.002	0.004
Thailand	0.058	0.126
Indonesia	0.000	0.001
Malaysia	0.001	0.001
Philippines	0.000	0.001
Singapore	0.001	0.001
China	0.000	0.000
Taiwan	0.000	0.000
Korea	0.000	0.000
U.S.A.	0.000	0.000

Table 7. Change in trade balance in million U.S. \$ under 2nd scenario.

	trade balance
Japan	−97.5
Thailand	125.8
Indonesia	5.9
Malaysia	1.0
Philippines	−1.6
Singapore	−0.5
China	−7.1
Taiwan	−2.1
Korea	−4.9
U.S.A.	−18.9

Table 8. Percentage change in sector production in Japan and Thailand under 2nd scenario.

		Japan	Thailand
1	Paddy	0.003	0.012
2	Other Agricultural Products	0.000	0.015
3	Livestock	0.002	0.017
4	Forestry	0.000	0.005
5	Fishery	0.003	0.019
6	Crude petroleum and natural gas	0.003	0.008
7	Other mining	0.001	0.000
8	Food, beverage, and tobacco	0.004	0.028
9	Textile, leather, and the products	−0.013	0.073
10	Timber and wooden products	0.001	0.014
11	Pulp, paper, and printing	0.002	0.012
12	Chemical products	0.002	0.017
13	Petroleum and petroproducts	0.003	0.012
14	Rubber products	0.005	0.001
15	Non-metallic mineral products	0.001	0.002
16	Metal products	0.003	0.005
17	Machinery	0.001	0.003
18	Transport equipment	0.006	0.005
19	Other manufacturing products	0.002	0.013
20	Electricity, gas, and water supply	0.003	0.021
21	Construction	0.000	0.000
22	Trade and transport	0.002	0.013
23	Services	0.003	0.036
24	Public administration	0.000	0.000

fishery still expand the production but at the lesser degree than the first scenario. There is no contraction in machinery and non-metallic mineral product as these two sectors are excluded from tariff reduction.

5. Conclusion

The study has evaluated the impact of Japan-Thailand Economic Partnership Agreement (JTEPA) using Asian International Input Output (AIIO) model. AIIO model is able to capture impact on both trading partners, as well as repercussion impact all over the Asian region. The model incorporates estimation of behavioral parameters that would elaborate and enhance ability for scenario analysis. From the AIIO model, JTEPA will benefit both trading partners without negative impact on other countries within the region. Moreover, both Japan and Thailand could gain more benefit by implementing across the board tariff reduction rather than sector specific tariff reduction.

Even though, it would be better for both countries to pursue across the board tariff reduction at national level, at sector level, the Japan agriculture sector would have some negative impact as its production would contract. This is the main reason why rice, sugar, and cassava are excluded from tariff reduction. Not only agricultural sector but also textile and leather sector in Japan would have negative impact from JTEPA. Although Japan has decided to lower tariff rate for textile and leather products from Thailand, Japan keeps relatively restrict rules of origin² of these products. This could be considered as one form of non-tariff barrier. Therefore there are still many issues relating to non tariff barrier that worthwhile for further study such as rules of origin, technical standard, and sanitary standard. These issues will definitely impact pattern of trade, wage, and level production of both countries.

Notes

- ¹ Comparative advantage is commonly used in determination of international trade. The countries has comparative advantage in one industry meaning that the country has relatively lower cost in the industry comparing to the other countries.
- ² Rules of origin require that the export country must use significant amount of domestically produced inputs so that re-export (without significant transformation process) from the third country could be prevented. However, the strict rules of origin would prevent the export country from using the cheapest source of import inputs and reduce cost advantage in the export country.

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