Regional Economic Integration and its Impacts on Growth, Poverty and Income Distribution: The Case of Thailand[1]

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Abstract

Along with regional frameworks, Thailand has made serious efforts to establish Economic Partnership Agreements, including Free Trade Agreements (FTAs), with several countries, namely, China, India, Australia, New Zealand, Japan and the U.S. The aim of this paper is to discuss a policy simulation analysis on the economic impacts of free trade agreements on the Thai economy using a Global Computable General Equilibrium (CGE) model. Suffice it to say that the FTA strategy and the formation of Free Trade Areas in East Asia would stimulate growth and investment, and improve welfare for Thailand. However, the impacts on income distribution vary due mainly to the pattern of production and trade and the extent of trade liberalization in the partner countries. The simulation results show that Thailand would gain most from

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the Thailand-Japan FTA both in terms of welfare and improved income distribution. It is advisable for Thailand to pursue the FTA with Japan to offset the adverse impacts on income distribution from the already concluded FTAs with China and ASEAN countries as well as those under negotiation. Moreover, most of the potential gain could be realized by promoting the process of regional economic integration in East Asia. In the case of the FTA with the U.S., the simulation analysis shows that the extent of liberalization in the U.S. agricultural sector is an important factor that determines income distribution consequences in Thailand.

Keyword: *CGE Model, Income Distribution, Free Trade Agreement (FTA)*

บทคัดย่อ

ตามกรอบของภูมิภาค ประเทศไทยได้ดำเนินความพยายามอย่างยิ่งยวด ที่จะทำข้อตกลงความร่วมมือ รวมถึงข้อตกลงการค้าเสรี กับหลายประเทศ ได้แก่ จีน อินเดีย ออสเตรเลีย นิวซีแลนด์ ญี่ปุ่น และสหรัฐอเมริกา จุดประสงค์ของบทความนี้ก็คือ การวิเคราะห์ด้านนโยบายของข้อตกลงดังกล่าว ที่มีผลต่อเศรษฐกิจไทย โดยใช้แบบจำลองดุลยภาพทั่วไปของโลก อาจกล่าวได้ว่า กลยุทธ์การทำข้อตกลงการค้าเสรี และการก่อตั้งเขตการค้าเสรีในเอเชียตะวันออกนั้น จะเป็นการกระตุ้นความเจริญเติบโตและการลงทุน ตลอดจนสวัสดิการของประเทศไทย อย่างไรก็ตาม ผลกระทบต่อการกระจายรายได้นั้น แตกต่างกันไปตามรูปแบบของการผลิตและการค้า ตลอดจนขนาดของการเปิดการค้าเสรีในประเทศคู่ตกลงนั้น ผลการวิเคราะห์แสดงให้เห็นว่า ประเทศไทยจะได้ประโยชน์จากการทำข้อตกลงกับประเทศญี่ปุ่นมากที่สุด ทั้งในแง่ของสวัสดิการ และการกระจายรายได้ ผลการศึกษายังได้นำไปสู่ข้อแนะนำที่สำคัญอีกว่า ประเทศไทยควรสานต่อข้อตกลงเขตการค้าเสรีกับประเทศญี่ปุ่น เพราะเป็นเงื่อนไขที่สำคัญในการลดผลกระทบในทางลบต่อการกระจายรายได้ที่เกิดขึ้นจากการทำข้อตกลงกับประเทศอื่น ๆ นอกจากนั้น ประเทศไทยจะได้ประโยชน์จากการสนับสนุนการก่อตั้งเขตการค้าเสรีในเอเชียตะวันออกอีกด้วย สำหรับข้อตกลงเขตการค้าเสรีกับสหรัฐอเมริกานั้น ผลการศึกษาแสดงให้เห็นว่า เงื่อนไขสำคัญในการลดผลกระทบต่อการกระจายรายได้ของไทยก็คือ การเปิดเสรีภาคการเกษตรของสหรัฐอเมริกานั่นเอง

คำสำคัญ: *CGE โมเดล การค้าเสรี การจัดการรายได้*

I. Introduction

Regional integration coexists with the principle of multilateral trade in the process of globalization of the world economy. According to a recent report published by WTO, more than 259 regional trade agreements are in place (WTO Secretariat, 2003). Since the European Union (EU) and the North America Free Trade Agreement (NAFTA) significantly had the effect of promoting intra-regional trade, other countries have become active in exploring options for such regional agreements.

In Asia, such a trend has recently come to the surface. The ASEAN Free Trade Area (AFTA) has been effective since 2003. The Japan-Singapore Economic Agreement for a New Age Partnership was concluded and took effect in 2002. China and ASEAN have also concluded a framework toward the establishment of a free trade agreement.

Along with these regional frameworks, Thailand has made serious efforts to conclude Economic Partnership Agreements (EPAs), including Free Trade Agreements (FTAs) with several countries. In particular, it has concluded the agreements with China, India, Australia, New Zealand, and most recently, Japan. Now, it is negotiating with the U.S..

In fact, the pattern of Thailand's FTA strategies began with the ASEAN Free Trade Area (AFTA) in 1992. The AFTA was launched to eliminate tariffs and to integrate member economies into a single production base and regional market of about 550 million people. Tariffs were reduced to 0-5% in 2003 for ASEAN-6 (Brunei, Indonesia, Malaysia, the Philippines, Singapore and Thailand) and will be eliminated totally by 2015 for all ASEAN members. Effective January 1, 2010, ASEAN-6 markets will be open to investors in most sectors, including manufacturing, agriculture, fishery, mining and related services.

Prior to the establishment of the ASEAN-China FTA, Thailand entered into an FTA with China that took effect in October 2003, eliminating duties on 188 fruits and vegetables. But negotiations regarding additional items are on hold, as they will be covered under the ASEAN-China agreement. In addition to the export

market for Thailand, China has offered various incentives such as an early harvest and advanced trade liberalization in agricultural products.

The ASEAN-China trade agreement on goods took effect on July 1, 2005, creating the world's largest free trade area of 1.7 billion consumers. Tariffs will be phased out between 2010 and 2018. But an Early Harvest Scheme (EHS) between China and ASEAN-6 began in January 2004, cutting tariffs on meat, fish, dairy products, other animal products, trees, vegetables, fruits and nuts. Duties on these goods were eliminated in 2006.

An EHS, part of a broader Thailand-India FTA, took effect on September 1, 2004. The scheme reduced tariffs on 82 agricultural and industrial items by 50%, including various fruits, wheat, sardines, salmon, mackerel and processed crab. It also covers other major Thai exports, such as gems and jewelry, household electrical appliances, integrated circuits, furniture and auto parts. Tariffs on these items were eliminated on September 1, 2006. Full liberalization will occur by 2010.

The Thailand-Australia FTA took effect on January 1, 2005. It eliminated Australia's 5% import tax on autos and parts. It also provided incentives to attract Australian foreign direct investment. The agreement eliminated tariffs on 83% of Thai exports and 80% of Australian exports, and by 2010, 95% of all trade between Australia and Thailand will be free. At almost the same time, Thailand concluded a Closer Economic Partnership Agreement with New Zealand on July 1, 2005, eliminating duties on 71% of annually traded goods.

Recently, Thailand and Japan have decided to sign an agreement of Japan-Thailand Economic Partnership (JTEP), which has reached basic agreement since July 2005. Under the agreement, Thailand is subject to lowering its import duties on cars with an engine of 3000cc or larger from the present 80% to 60% by 2010. Import duties on auto parts will be phased out entirely by 2011, and those on steel products will be eliminated within 10 years of the implementation of the agreement. As for Japan's concession, rice is to be exempted, while import duties on pork are to be lowered from 21.3% to 10.65% in 5 years after the agreement goes into effect, and a low import-duty framework will be set for

bananas. Thai care workers will be permitted to enter into Japan, while the length of previous work experience as a precondition for the residence of Thai cooks in Japan will be shortened from the present 10 years to 5 years.

It should be noted that most of the FTAs between Thailand and its partners cover not only liberalization of trade, but also various types of economic cooperation. Some of them are termed as a Closer Economic Partnership Agreement (Thailand-Japan, Thailand-Australia) or Trade and Investment Framework Agreement (Thailand-U.S.). The main elements of these new types of FTAs involve bilateral liberalization and facilitation of trade through reduction of tariff and non-tariff barriers, as well as the mutual recognition of national standards, streamlining customs procedures, facilitation of increased services trade and establishment of a framework for foreign investment. They also enhance collaboration on intellectual property, education and tourism. To some extent, the basic philosophy of these new types of FTAs is similar to that of the Asia Pacific Economic Cooperation (APEC) forum.

Theoretically, when an FTA is used as a market integration mechanism, it will bring about tangible economic benefits when trade creation exceeds trade diversion effects. The total economic effects are likely to be positive due to market expansion and cost reduction. However, opponents of FTAs may raise strong criticisms regarding agreements that are not sufficient for growth. Thailand, for example, also needs other supportive policies. The protection of infant industries against imports will provide an opportunity for learning and growth. The openness of the country has been accompanied also by concerns that it will cause some negative impacts, and that the incidence of poverty and distribution of income in Thailand will deteriorate. Accordingly, the issue of trade liberalization and poverty in Thailand has become the focus of much research in the last several years.

The argument is also based on the truth that the potential advantages gained from an FTA will vary in accordance with the counterpart's economic structure and trade patterns. Moreover, integration of the domestic market with that of another country will create winners and losers for both parties. In this context, political consideration must be paid to alleviating and minimizing the internal discord that may stem from external integration.

It is obvious that Japan, China, India, Australia and New Zealand have regarded FTAs as a fundamental element of their external economic policy. In this context, Thailand would be an ideal FTA partner for them for several reasons. First, an agreement with Thailand should be manageable since Thailand's economic scale is much smaller than that of those countries. Moreover, Thailand's proximity (distance, size and area) is seen as a positive factor that could yield geographical benefits in terms of regional integration. Second, since Thailand's average tariff rate of 17.4 percent is still above the world level of 7 percent, the potential benefits for Thailand and its partners, related to an elimination of tariffs, would be considerably higher than that for other nations. Finally, the Thai government is still confident of pursuing FTA negotiations with other countries. With strong political power, the government may have the potential to find ways to mitigate the negative impacts and emerging political conflicts.

The aim of this paper is to discuss a policy simulation analysis on the economic impact of FTAs and regional integration in East Asia applying a Computable General Equilibrium (CGE) model. The simulation experiments of the Global Linked CGE model (Nguyen and Ezaki (2005)) will analyze the impact of FTAs between Thailand and its trading partners on the Thai economy with special reference to China, India, Australia, New Zealand, Japan and the U.S.. The conclusion drawn from these model simulations will help to clarify the main source of the economic impact of FTAs on growth, poverty and income distribution.

II. Model Specification

The global CGE model employed in this paper is an extension of the global model developed by Nguyen and Ezaki (2005) to analyze the impacts of regional integration on Vietnam's economy. The extended version of this model goes along the lines of the GTAP world model (Hertel (1997)) to allow for greater regional and industrial disaggregation, a detailed treatment of taxes and subsidies, international capital mobility and transportation costs. The current global CGE model specifies 20 industries and 16 regions. The regional classification is focussed on East Asia, consisting of all major economies in the region as well as the U.S., the EU and Oceania. Industrial activities are specified with an emphasis on the

agricultural and manufacturing sectors, taking into consideration the diversified pattern of production and comparative advantage as well as the structure of protection in each individual country and region. The details of the regional and industrial classification are shown in appendix A.

Country Models

The global CGE model consists of 16 country models, which are linked together through international trade and foreign investment. Country models generally follow the standard neoclassical CGE model (Dervis et al. (1982)), in which capital and labor are mobile across economic sectors with the assumption of full employment. For each country model, there are three production factors, i.e. capital, skilled labor and unskilled labor. Skilled and unskilled labor are combined in a Constant Elasticity of Substitution (CES) function to form a composite labor input, and sectoral output is a CES function of capital and composite labor.

In each country model, nine categories of taxes and subsidies were specified, consisting of tariffs, export duties, production taxes, capital and output subsidies, and sales taxes imposed on consumer goods, intermediate inputs and capital goods. The detailed treatment of taxes and subsidies makes it possible to analyze other policy instruments in addition to tariffs. Government revenue consists of revenues from all taxes and subsidies. Total government revenue is allocated to savings and consumption in fixed proportions. The government demand for final goods is defined using fixed expenditure shares of real government spending.

Household income consists of labor and capital income. To allow for a inspection of the impact of trade liberalization on income distribution in Thailand, the household sector in Thailand's model is disaggregated into 20 household groups according to the level of income, consisting of 10 urban and 10 rural groups. On the demand side, household consumption demand is determined using the Linear Expenditure System (LES) function. The major advantage of the LES function is that it allows for the effect of the change in income on the structure of consumption. As income rises, people tend to spend less on agricultural goods and other necessities, and consume more manufacturing goods.

The external sector in country models is specified according to the assumption of product differentiation, in which domestic and foreign goods are imperfect substitutes. Sectoral output is a Constant Elasticity of Transformation (CET) function of exports and domestically produced products. The supply for domestic and foreign markets is determined from the revenue maximization condition, depending on the relative prices at home and abroad. Total domestic demand is satisfied through domestic production and imports, and the demand for imports and domestically produced goods is specified by using the Armington structure. In this context, the demand for import and domestic products depends on the changes in their relative prices.

International Linkages

Country models are linked together through trade and investment flows. Domestic consumers and producers differentiate imports by sources; that is, imports coming from different countries are considered as imperfect substitutes. This characteristic is also specified in accordance with the Armington structure. At the aggregate level, total import is a CES function of imports from different sources, and then the demand for imports from each country is derived from the cost minimization condition. Export commodities supplied to foreign countries are supposed to be perfectly homogenous and are sold at the same price. The consistency is held so that total exports supplied by home countries are equal to the sum of imports by foreign countries. More specifically, the sum of imports from a country or region must be equal to total exports by that country or region.

Some recent studies using CGE models have indicated that the change in capital inflows resulting from trade liberalization could produce considerable additional welfare gains (Lee and Mensbrugghe (2001), Bchir et al. (2002)). In these studies, investment or capital stock is allocated across regions and industries, depending on the rate of return to capital. Both approaches require detailed information on foreign investment and capital at the sectoral level. However, such information is not available at the level of the disaggregation adopted in this paper.

In our model, we employed a simple approach discussed in Hertel (1997) to allow for international capital mobility. In this context, the expected return on capital is assumed to decline with the addition to the capital stock at the rate determined by a flexibility parameter. Investment decisions are made in such a way that the rates of return on capital are equalized across countries and regions. Thus, the change in global savings is allocated across countries and regions to equalize the regional expected rates of return. In this case, investment is partially adjusted in response to the changes in the rate of return caused by trade liberalization. However, a large change in investment is required to equalize the expected rate of return to capital. This means that a high flexibility parameter or a high degree of capital mobilization across the border is necessary.

Equilibrium Conditions

Equilibrium conditions are required in factor, commodity and foreign exchange markets. In the factor market, we adopted the assumption of full employment, and factor prices serve as equilibrating variables. In the labor market, total supply of skilled and unskilled labor is fixed at the base-run level, indicating that the labor market equilibrium determines wage rates. Capital rents adjust to maintain the equilibrium between the supply of and demand for capital in the capital market. Equilibrium in product markets equates the supply of domestic goods in each sector to the demand for domestically produced products with domestic prices serving as equilibrating variables.

The fiscal balance is assumed in the government sector, in which government consumption and savings are determined as fixed shares of government revenue. In the foreign exchange market, foreign savings adjust to the change in foreign investment inflows, and equilibrium is achieved through price adjustments. We adopt a so-called savings-driven closure, in which total nominal investment is determined by available savings. All exchange rates are fixed at the base run. This allows the change in domestic prices and the adjustment of all exchange rates in real terms to attain the equilibrium condition in that market.

III. Simulation Analysis

The Data

In this study, we use the GTAP database version 6.0 constructed for 2001.[2] All 57 industries and 87 regions are aggregated into 20 industries and 16 countries or regions in accordance with the model. We use the data to calculate most of the parameters in the model, such as consumption shares, saving rates, tax rates, wage rates and capital rents. The elasticities of substitution in trade and production functions are taken from the GTAP database, consisting of the elasticity of substitution between labor and capital, the elasticity of substitution between domestically produced goods and imports, and the elasticity of substitution between imports from different sources. The GTAP database provides high values to the elasticities in trade functions, while assigning relatively low values to the elasticity of substitution in production functions. However, in contrast to the GTAP database, we assign a value of 1.2 to the elasticity of transformation in the export supply function for all industries. Given the type of functions and the value of the elasticities, the scale and share parameters can then be calculated directly.

In Thailand's model, household data are constructed using the socio-economic survey conducted by the National Statistical Office of Thailand in 2000.[3] The survey data are grouped into deciles according to income ranges, and each decile is divided into urban and rural groups. Municipal areas are classified as urban areas, while sanitary districts and villages are classified as rural areas in a broad sense. The types of enterprise to which households belong, together with the occupation of household heads, are used to define the sectors of households. Skilled labor and unskilled labor are separated by level of education. Those with educational attainment less than a third-year elementary level (grade ninth) are categorized as unskilled labor. Consequently, the income of each labor type

[2] More details about GTAP database version 6 can be found at the GTAP homepage (http://www.gtap.agecon.purdue.edu/).

[3] The socio-economic survey is conducted every two years of even numbers. The survey of 2001 was available only for half of the year, so the survey of 2000 was used in the model.

in twenty industries is obtained through total monthly income of members of households aged equal or over 15 years. Labor income is defined as wages and salaries, whereas capital income is defined as profit from non-farm business. Profit from farming is divided equally into labor and capital income. Consumption data are based on household consumption expenditure on goods and services provided in the survey.

The survey data are then incorporated into the GTAP data. Income shares are computed from the survey data and are used to allocate the data on factor income taken from the GTAP database to each household groups and industries. Similarly, the expenditure shares are computed and are used to allocate the GTAP data on private consumption to household groups. Data on household employment are also derived from the socio-economic survey 2000. These data are computed for each type of workers, i.e. skilled and unskilled workers, and are used to allocate employment data derived from the GTAP database to household groups.

Simulation Scenarios

We employ the CGE model described in the previous section to analyze the impacts of regional economic integration on the Thai economy. Eleven simulation scenarios are performed and described briefly in Table 1. These simulations cover all the major integration options currently facing Thailand, including the bilateral FTAs between Thailand and China, Japan, India, Oceania and the U.S.. In addition, we include the ASEAN free trade area (AFTA) and the possible formation of the East Asian free trade area in the analysis.

The GTAP database does not quantify the tariff-equivalent effect of non-tariff barriers. Our simulation analysis will thus concentrate on the removal of tariff barriers and their impact on Thailand's economy due mainly to data shortage. In addition, agricultural subsidies are, however, taken into account whenever they are found significant. In relation to Japan, the U.S., Oceania and the East Asian countries, two sets of simulations are performed. The first set concentrates only on the impacts of tariff removal, while the second one quantifies the combined effect of removing both tariffs and agricultural subsidies.

Macroeconomic Impacts of Economic Integration

The simulation results show that Thailand would gain significantly in terms of output and welfare in all cases. The magnitude of the gains, however, is different, varying with the FTA partners. In our analysis, we specify three sources for the gains in welfare and output respectively. First is the level of protection prior to trade liberalization in Thailand. Tariff reductions in Thailand reduce the prices of imported goods and improve the efficiency of resource allocation. The second source is trade liberalization in the partner countries. The removal of tariffs by trading partners would expand the market for Thailand's exports, thus stimulating the development of the industries in which Thailand possesses a comparative advantage. Finally is the linkage between trade and investment. When trade liberalization is accompanied with an increase in investment, the latter would further stimulate growth through its impacts both on the supply and demand side.

The impact of the AFTA on the Thai economy was first investigated in simulation S1, in which we removed the tariffs imposed on the bilateral trade between Thailand and five major ASEAN countries, namely, Vietnam, Malaysia, Singapore, Philippines and Indonesia. Combined, these ASEAN economies occupy a large share in Thailand's trade, with Singapore and Malaysia being the largest trading partners in the Southeast Asia region. This indicates that trade liberalization in this region could bring about significant gains for Thailand. As shown in the simulation results, the real GDP of Thailand increases by 0.4%, while the welfare index increases by 2.3%. In addition, Vietnam, Malaysia and Singapore are also big gainers from AFTA liberalization.

One of the major motives lying behind economic integration in ASEAN is to improve the competitiveness of ASEAN countries and to make them a production hub capable of competing with China and India in attracting foreign investment. It is interesting to see in S1 that the AFTA would significantly improve the investment environment in ASEAN countries, as reflected in the increase in the return to capital across the region. Since the model allows for capital to partially adjust in response to the difference in the rate of return to capital, foreign

investment would flow in ASEAN countries following AFTA liberalization. For Thailand, the increase in real investment amounts to 8.7%, largely compensating for the decline in government consumption and leading to an overall output gain.

The trade relation between Thailand and China has been on a rapid rise in recent years, and is expected to increase further in the future due to the implementation of the Thailand-China and China-ASEAN FTA. China currently accounts for 5.2% of Thailand's total imports and 6.1% of total exports. The FTA between Thailand and China is examined in simulation S2. The simulation results show that this FTA would bring benefits to both Thailand and China. Thailand would gain 0.7% in real GDP and 1.9% in welfare. The FTA with China also increases foreign investment, exports and imports in Thailand. However, the gain for China is only marginal, given the large size of its economy.

Unlike China, Japan has traditionally been the largest trading partner and foreign investor in Thailand, and thus the FTA with Japan plays a very important role in Thailand's integration strategy. The FTA with Japan could not only bring about a greater market for Thailand's exports, but also lure Japanese FDI into Thailand and expand opportunities for other economic and technical cooperation. The impact on the Thai economy of the FTA with Japan was analyzed in simulations S3a and S3b. The first one only takes into account the impact of the tariff removal, whereas the second one analyzes the combined effect resulting from the removal of both tariffs and Japanese agricultural subsidies.

The FTA with Japan would substantially increase the gains for Thailand as compared to those with China and ASEAN countries. For Thailand, the real GDP increases by 0.5%, but the increase in welfare amounts to 4.3%, which is around two times higher than the gain resulting from the Thailand-China FTA. The increase in real investment is also impressive, amounting to nearly 20%. The big welfare gain from Thailand-Japan FTA not only results from the large trade volume, but also from the fact that the two economies are more complementary than competitive. It should be noted that the inclusion of Japanese agricultural subsidies in S3b does not significantly raise the welfare gain for Thailand, even though it may have some significant effect at the sectoral level.

While Japan is the largest import market of Thailand, the U.S. is the largest market for Thailand's exports. As shown in simulations S4a and S4b, the FTA with the U.S. could bring benefits to Thailand, but to a lesser extent compared to the FTAs with East Asian countries. The Real GDP rises by only 0.2%, and the increase in welfare amounts to 1.6%. Investment, exports and imports also increase less as compared to the previous simulations. The removal of agricultural subsidies in S4b does not significantly affect the results at the aggregate level. The relatively small gain from the FTA with the U.S. is largely due to the low level of protection in the U.S.. Indeed the U.S. market has been largely liberalized for manufacturing products, while the U.S. tariffs imposed on processed food, textiles and leather are well below the level adopted in Japan, China or ASEAN countries.

The next three simulations examine the impacts of the FTAs with India, New Zealand and Australia. None of these countries is a major trading partner of Thailand. The simulation results show very modest gains from these FTAs. The Real GDP of Thailand even declines slightly in the case of the Thailand-Oceania FTA. This decline is mainly due to the contraction in agricultural production and food processing industries.

Recently, there has been an increasing interest in the establishment of a free trade area in East Asia. The last two simulations (S7a and S7b) examine the impact of this establishment. The simulation takes into account all major economies in the region, including Vietnam, Indonesia, Malaysia, Philippines, Thailand, Singapore, China, Korea, Hong Kong, Taiwan and Japan. The first simulation (S7a) only investigates the removal of tariffs, while the second one takes into account the removal of agricultural subsidies in Japan and Korea, together with the tariff removal. As shown in Table 2, Thailand, together with Malaysia, Korea and Vietnam, are the big gainers. For Thailand, the GDP increases by 1.7% in real terms, and the welfare index increases by 7.8%. Thailand also gains a lot in terms of foreign capital inflows, with the increase in real investment amounting to over 30%. Similar to the case of the FTA with Japan, the removal of agricultural subsidies could bring about some additional benefits at the aggregate level, but

only to a marginal extent[4].

It is interesting to note that Thailand's gain is largely attributed to trade liberalization in Japan. The Thailand-Japan FTA contributes more than half of the total gains in welfare and investment under the East Asian free trade area. The simulation results also indicate that Thailand could gain more from the FTAs with its trading partners in East Asia than those with its partners outside the region. Furthermore, Thailand could realize most of the potential gain from free trade by promoting economic integration in East Asia.

Sectoral Impacts of Economic Integration

We continued the discussion in this section with an analysis of the impacts of the FTAs at the sectoral level. The sectoral impacts of regional integration are largely determined by the structure of trade and protection in Thailand and its trading partners. The industries, which were highly protected prior to trade liberalization, are likely to contract when tariffs are reduced. By contrast, the industries facing high protection in foreign markets are expected to grow following the removal of trade barriers in foreign markets. Since the trading partners involved in the investigated FTAs are very diversified in the level of development, the pattern of comparative advantage and the resulting structure of protection, these FTAs are likely to have different impacts on Thailand's production and trade at the sectoral level.

In regards to ASEAN, Thailand trades mainly in electronics, transportation means and some other heavy industries. Although agricultural and labor-intensive

[4] The East Asian Free Trade Area has been investigated in some recent studies, including Urata and Kiyota (2003) and Kawasaki (2003). These studies have also reached conclusions similar to our analysis, showing positive impacts on all East Asian economies. The welfare gains from our simulation analysis, however, are lower than those found in Urata and Kiyota (2003) and Kawasaki (2003). This is largely due to the differences in the database and model structure. Urata and Kiyota (2003) and Kawasaki (2003) employed GTAP database version 5.0, and thus are able to quantify the impacts of both tariff and non-tariff barriers. Furthermore, the very high welfare gains found in Kawasaki (2003) are largely attributable to the productivity and capital accumulation effects incorporated in his model.

products are the major exports in many ASEAN members, Thailand's trade with ASEAN countries in these products is rather small. This reflects the fact that most ASEAN members have a comparative advantage in agricultural and labor-intensive products, and that these products are usually protected with high tariffs in Thailand's domestic market. For Thailand and more advanced ASEAN countries, AFTA trade liberalization leads to an expansion in trade and production in electronics, transportation means and some other heavy industries, but a contraction in agriculture and labor-intensive industries. Vietnam and less developed ASEAN members experience an expansion in the production of agriculture and labor intensive industries, where they possess a comparative advantage.

For Thailand, the changes in the pattern of trade and production resulting from the Thailand-China FTA are generally similar to those under AFTA trade liberalization. Output declines in agriculture, textiles and leather, but expands in most heavy industries with capital intensiveness. The changes in the production pattern occur in an opposite direction in China, with a contraction in heavy manufacturing and an expansion in agriculture and light manufacturing. For some industries like electronics and transportation means, production expands in both countries largely due to the increase in intra-industry trade. The similar changes in production and output are also observed in the case of Thailand-India FTA, although the extent of changes is much smaller.

Unlike the FTAs discussed above, the other FTAs involve trading partners from industrial countries like Japan, the U.S. and Oceania. Since all these economies are more complementary to Thailand in economic terms, forming FTAs with them is expected to have greater impacts on resource reallocation. In the FTA with Japan, agriculture and food processing industries experience a big gain in output, and this expansion occurs at the expense of other manufacturing industries. Whereas the contraction in some of Thailand's heavy industries like automobiles or electronics is expected, the decline in textile and leather industries seems not be in line with the conventional thinking that Thailand must have a comparative advantage in these labor-intensive industries. However, our result is conformable to the fact that the protection level provided to the

textile and leather industries in Thailand is considerably higher than that in Japan. The removal of Japanese agricultural subsidies in S3b further stimulates the expansion in agriculture and also leads to a greater contraction in most manufacturing industries.

Unlike Japan, both the U.S. and Oceania have a highly competitive agricultural sector, and the FTAs with these countries adversely affect the agricultural sector in Thailand, which experiences a small decline in output. However, the simulation analysis shows that agricultural subsidies are indeed an important protective instrument in these countries, and particularly in the U.S.. When these subsidies are removed, the agricultural sector in Thailand declines to a lesser extent, and even expands in the case of the Thailand-U.S. FTA. In the manufacturing sectors, the simulation results show an expansion in Thailand's labor-intensive industries in its FTA with the U.S., but a decline in capital-intensive industries. For the FTA with Oceania countries, output increases in all manufacturing sectors in Thailand with the exception of food processing industry.

The formation of an East Asian free trade area could have a significant impact on the pattern of trade and production in the region. With some exceptions, the reallocation of industrial production in East Asian countries is generally in line with the current structure of protection and the pattern of comparative advantage. Automobile production tends to move to the developed economies like Japan and Korea, while the less capital-intensive manufacturing like electronics and other transportation means moves to China and middle-income ASEAN countries, such as Thailand and Malaysia. As for labor-intensive industries, Vietnam becomes the biggest gainer in textiles and leather, but these industries also unexpectedly expand in some high income countries like Malaysia and Korea.

For Thailand, agriculture and relating industries experience a large expansion in output, and this is largely attributable to the removal of Japanese tariffs imposed on agricultural products. Unlike the Thailand-Japan FTA, however, the inclusion of East Asian developing countries mostly benefits the manufacturing sectors in Thailand. This reflects the fact that Thailand still has a comparative advantage over China and some ASEAN countries in the capital intensive industries. The simulation results show an expansion in the electronics, chemical and metal

industries, while in the shrinking sectors like automobiles, output declines to a lesser extent.

Impacts on Income Distribution and Poverty

CGE models have been widely used in analyzing the income distribution outcomes of trade liberalization. The advantage of CGE models is that they could take into account the inter-industry linkage and the relative price changes through which macroeconomic shocks are translated into microeconomic impacts. In particular, CGE models offer two channels through which trade liberalization and regional economic integration affects household welfare. The first channel works through the changes in consumer prices resulting from trade liberalization. Consumers will have a gain when prices decline, and they lose otherwise. Since households have different patterns of consumption, trade liberalization will have different impacts on their welfare.

The second channel translates factor incomes to the income of individual households. Since the impacts of trade liberalization vary from industry to industry, they have different impacts on factor remuneration. The prices of the production factors that are intensively employed in the expanding industries would increase, and for those production factors involved mainly in the shrinking industries, the factor prices could decline. Since households have different compositions of factor endowment, their income will be differently affected by trade liberalization and the resulting changes in production structure and factor prices.

The impacts of trade liberalization and regional integration on household welfare in Thailand vary greatly, depending on the FTA partners selected. The expansion of certain manufacturing sectors under AFTA liberalization raises the wage rate for urban unskilled labor and benefits mainly urban low-income groups. In general, poor urban groups have greater gains compared to the rich. However, because of the contraction in the agriculture and food processing industries, the pattern of income changes in the rural areas goes in the opposite direction. Rural households have smaller welfare gains as compared to urban households, and the poor rural households gain less than the rural rich. Thus, while AFTA trade liberalization could improve income distribution in urban areas, it seems to

increase income inequality in rural areas as well as the income gap between the urban and rural area.

Unlike the AFTA, the Thailand-China FTA would lead to a worsening of income distribution in both rural and urban areas. The expansion of relatively capital-intensive industries benefits mostly skilled labor, thus resulting in higher income gains for high-income groups. Meanwhile, the contraction in agricultural production adversely affects rural households and the rural poor in particular. As a result, urban households gain more than rural households and the rich get more benefits than the poor. Thailand's income distribution is also likely to worsen under the FTAs with India and Oceania countries. Due mainly to the contraction in agricultural production and food processing industries, these FTAs would result in an income loss for rural households, and poor households in particular. In the FTAs with India, the contraction in agriculture is not fully compensated for by the expansion in the manufacturing sectors and leads to a decline in the return to unskilled labor, thus affecting the welfare of the urban poor.

Unlike the FTAs discussed above, the FTA with Japan seems to have a very significant impact on income distribution and poverty reductions in Thailand. The large expansion in agricultural production and food processing industries resulting from the removal of Japanese tariffs benefits mainly poor and rural households. In relative terms, the income gain of rural households is nearly three times higher than that of urban households. In addition, poor households also gain more than rich ones. The impact on income distribution and poverty reductions is also found positive under the East Asian free trade area. It should be noted that the positive impact under the East Asian free trade area mostly comes from trade liberalization in Japan. Meanwhile, the inclusion of China and ASEAN countries mainly benefits urban households through the positive impacts on the manufacturing sectors.

Finally, the simulation results show that the Thailand-U.S. FTA could have different implications for income distribution in Thailand, depending on the extent of trade liberalization in the U.S. market. When only the tariff removal is taken into account, agricultural production shrinks in Thailand, and this lowers

the welfare gain for rural and poor households. Consequently, the income gap between the rich and the poor, as well as the gap between rural and urban areas, become widened. These negative impacts, however, turn positive when we removed both the U.S. tariffs and agricultural subsidies. Furthermore, most of the additional benefits from the removal of U.S. agricultural subsidies accrue to rural households and the rural poor in particular. Actually, agricultural subsidy issues have been the most debated topic under the current negotiation round of the WTO. Our simulation results also confirm, in the case of Thailand, the importance of removing such subsidies in fighting poverty in developing countries.

IV. Concluding Remarks

Along with the regional frameworks such as APEC and AFTA, Thailand has made serious efforts to establish Economic Partnership Agreements, including Free Trade Agreements (FTAs), with several countries: China, India, Australia, New Zealand, Japan and the U.S.. We have employed, in this paper, a global CGE model and made use of a GTAP database to analyze the impacts of regional economic integration on Thailand's economy, focusing on growth, poverty reductions and income distribution. Several simulations scenarios have been performed, covering major integration options for Thailand. In addition to four bilateral FTAs, we have also examined the impact of the East Asian economic free trade area and the already implemented ASEAN free trade area.

As discussed above, the impacts of the investigated FTAs on Thailand's economy are basically positive. These FTAs not only bring about a higher output and welfare, they also stimulate the flow of foreign investment into Thailand. In regards to income distribution, however, the impacts of economic integration vary greatly with the simulation scenarios, reflecting the different sectoral impacts caused by the different FTAs. In general, the FTAs with ASEAN countries and China mostly benefit the manufacturing sectors with relatively high capital intensity, thereby generating greater income gains for urban and rich households. The welfare of rural and poor households is also adversely affected by the contraction of agricultural production under the FTAs with the U.S. and Oceania countries. In the case of the FTA with the U.S., the simulation analysis also shows that the

extent of liberalization in the U.S. agricultural sector is an important factor that determines income distribution consequences in Thailand.

Among the bilateral FTAs investigated, Japan appears to be the best FTA option for Thailand. The FTA with Japan not only results in significant gains in welfare and output, but also leads to a substantial improvement in income distribution in Thailand. It is advisable for Thailand to pursue the FTA with Japan to offset the adverse impacts on income distribution from the already concluded FTAs with China and ASEAN countries, as well as those under negotiation. It is also recommended for Thailand to promote a broader economic integration in East Asia, where the major trading partners of Thailand are located.

The global CGE model employed in this paper has proved to be useful in analyzing ongoing regional economic integration in Thailand. Our model, however, has mainly focused on the removal of tariffs imposed on merchandise trade, and thus is not capable of fully capturing the impacts of economic integration. In addition to tariffs, non-tariff barriers are also important protective instruments in Thailand and its trading partners. Incorporating such barriers into the simulation analysis could allow for a better quantification of the impacts of economic integration on Thailand's economy. Furthermore, the FTAs in investigation cover not only merchandise trade, but also liberalization in investment regimes and services trade, which obviously have important implications for the pattern of trade and production and income distribution in Thailand. The CGE model and the database need to be further elaborated to take into account such liberalization measures.

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Table 1 Simulation Scenarios

S0	Base run
S1	ASEAN FTA
S2	Thailand-China FTA
S3a	Thailand-Japan FTA, removal of tariffs
S3b	Thailand-Japan FTA, removal of tariffs and agricultural subsidies
S4a	Thailand-U.S. FTA, removal of tariffs
S4b	Thailand-U.S. FTA, removal of tariffs and agricultural subsidies
S5	Thailand-India FTA
S6a	Thailand-Oceania FTA, removal of tariffs
S6b	Thailand-Oceania FTA, removal of tariffs and agricultural subsidies
S7a	East Asian FTA, removal of tariffs
S7b	East Asian FTA, removal of tariffs and agricultural subsidies

Table 2 Macroeconomic Impacts of Economic Integration on the Thai economy (Percentage changes compared to the base-run)

	S1	S2	S3a	S3b	S4a	S4b	S5	S6a	S6b	S7a	S7b
GDP deflator	-0.08	1.95	1.98	2.03	0.61	0.88	0.27	-0.42	-0.41	2.24	2.30
Consumer price index	-0.43	1.08	0.72	0.75	-0.01	0.22	-0.03	-0.65	-0.64	0.61	0.63
Wage rate of skilled labor	1.65	3.07	3.47	3.50	1.45	1.53	0.69	0.13	0.13	6.58	6.60
Wage rate of unskilled labor	1.87	2.75	5.63	5.73	1.60	2.12	0.56	-0.13	-0.12	8.78	8.88
Capital rent	1.41	2.64	3.68	3.73	1.22	1.44	0.55	0.00	0.00	6.44	6.49
Real GDP	0.41	0.65	0.54	0.54	0.16	0.14	0.12	-0.01	-0.01	1.66	1.66
Output	0.82	0.87	0.62	0.60	0.36	0.17	0.19	0.17	0.17	1.72	1.69
Private consumption	2.32	1.90	4.33	4.37	1.56	1.65	0.65	0.64	0.63	7.80	7.84
Government consumption	-9.63	-2.56	-13.98	-14.04	-4.81	-5.02	-1.51	-2.76	-2.75	-25.45	-25.50
Real investment	8.68	9.12	18.26	18.47	5.42	5.62	1.84	0.77	0.78	30.21	30.42
Imports	5.92	5.57	7.94	7.95	2.83	2.49	1.43	1.23	1.23	16.64	16.63
Exports	2.63	1.84	0.64	0.56	0.60	0.18	0.55	0.80	0.79	4.29	4.19
Household income	1.90	3.09	4.89	4.96	1.56	1.84	0.64	0.01	0.02	8.32	8.39
Labor income (skilled labor)	1.65	3.07	3.47	3.50	1.45	1.53	0.69	0.13	0.13	6.58	6.60
Labor income (unskilled labor)	1.87	2.75	5.63	5.73	1.60	2.12	0.56	-0.13	-0.12	8.78	8.88
Capital income	1.94	3.20	4.83	4.89	1.55	1.79	0.66	0.05	0.05	8.39	8.45
Government revenue	-8.91	-0.57	-11.67	-11.69	-3.96	-3.94	-1.15	-2.95	-2.94	-22.12	-22.14
Welfare	2.32	1.90	4.31	4.35	1.55	1.65	0.65	0.64	0.63	7.75	7.79

Source: Authors' calculation

Table 3 Sectoral Impacts of Economic Integration on Thailand (Percentage changes compared to the base-run)

	S1	S2	S3a	S3b	S4a	S4b	S5	S6a	S6b	S7a	S7b
Crop	-0.36	-1.49	9.08	9.52	-2.53	0.52	-1.17	-2.11	-2.07	8.95	9.42
Livestock	-2.02	-3.66	20.76	21.13	-0.03	0.34	-1.48	-1.85	-1.74	15.74	16.19
Forestry	-1.26	-1.47	-3.49	-3.59	-1.62	-2.12	-0.19	0.49	0.48	-4.86	-4.97
Fishing	-1.69	-1.82	14.86	15.09	-0.51	-0.32	-1.26	-1.67	-1.63	11.86	12.12
Mining	-2.80	-0.07	-11.36	-11.55	-3.31	-3.97	-0.62	0.87	0.84	-11.45	-11.63
Food processing	-3.49	-3.78	27.66	28.11	-1.26	-0.96	-2.54	-3.48	-3.40	21.34	21.84
Beverage	-0.68	0.17	0.38	0.38	0.01	-0.01	0.11	0.12	0.12	-0.40	-0.39
Wood	-1.67	-2.15	-6.46	-6.62	-2.15	-2.82	0.02	0.83	0.81	-8.57	-8.73
Chemical	-0.59	8.03	-5.68	-5.78	-1.05	-1.45	0.60	0.67	0.66	0.53	0.41
Automobile	2.20	3.15	-9.06	-9.09	-1.55	-1.70	1.44	0.28	0.28	-6.45	-6.48
Other Transport means	83.04	0.34	13.14	13.08	3.54	3.25	1.80	0.86	0.86	23.68	23.59
Electronics	5.20	4.93	-6.57	-6.90	-2.20	-3.33	0.23	0.79	0.77	1.78	1.36
Machine	5.04	2.35	-0.19	-0.46	0.37	-0.59	2.33	2.99	2.96	7.77	7.47
Metal	3.26	-1.87	-8.77	-9.00	-2.12	-2.94	2.99	1.12	1.09	-6.43	-6.69
Textile	-1.26	-4.87	-6.64	-6.77	10.21	9.71	0.05	1.13	1.12	-13.56	-13.68
Leather	-1.63	-5.33	-2.11	-2.22	13.39	12.90	0.27	1.99	1.96	-9.73	-9.80
Other manufactures	-0.67	-4.95	-4.81	-4.97	-1.24	-1.92	0.97	1.08	1.06	-8.26	-8.40
Utility	0.52	1.11	0.36	0.33	0.51	0.28	0.30	0.33	0.32	1.66	1.63
Construction	8.06	8.40	16.84	17.03	5.00	5.18	1.71	0.75	0.76	27.93	28.12
Services	-0.22	0.20	-0.74	-0.76	-0.15	-0.30	0.05	0.05	0.05	-0.86	-0.88

Sources: Authors' calculation

Table 4 Impacts of Economic Integration on Thailand's Household Income
(Percentage changes compared to the base-run)

	S1	S2	S3a	S3b	S4a	S4b	S5	S6a	S6b	S7a	S7b
Urban households											
Group 1	3.27	3.01	4.55	4.57	2.02	2.09	0.79	0.23	0.23	8.38	8.39
Group 2	2.76	2.91	4.68	4.68	1.88	1.82	0.81	0.25	0.25	8.42	8.42
Group 3	2.28	2.51	2.73	2.71	2.77	2.72	0.90	0.49	0.49	5.60	5.58
Group 4	1.96	2.47	5.24	5.28	1.84	1.84	0.57	0.00	0.01	7.93	7.96
Group 5	2.02	3.12	2.93	2.93	2.09	2.04	0.84	0.34	0.34	6.33	6.31
Group 6	1.76	3.19	2.14	2.14	1.67	1.63	0.83	0.35	0.35	5.47	5.46
Group 7	1.91	3.26	3.01	3.02	1.83	1.80	0.74	0.24	0.24	6.40	6.40
Group 8	1.79	2.79	2.81	2.82	2.15	2.18	0.79	0.29	0.29	5.69	5.69
Group 9	1.56	5.80	1.65	1.65	0.86	0.88	0.91	0.27	0.27	6.99	6.99
Group 10	2.13	3.80	4.52	4.56	1.64	1.74	0.85	0.20	0.20	8.64	8.67
Rural households											
Group 1	1.12	1.15	11.63	12.01	0.16	2.35	-0.29	-1.43	-1.40	13.83	14.24
Group 2	1.40	1.64	10.65	10.94	0.70	2.29	-0.06	-1.05	-1.02	13.14	13.45
Group 3	1.59	1.78	9.77	10.00	1.01	2.21	0.04	-0.83	-0.81	12.22	12.47
Group 4	1.66	1.69	7.17	7.32	2.48	3.38	0.29	-0.26	-0.25	9.41	9.58
Group 5	2.24	2.56	6.84	6.99	1.31	2.11	0.44	-0.35	-0.34	10.33	10.48
Group 6	1.66	2.06	7.40	7.54	2.19	2.80	0.43	-0.23	-0.22	9.85	9.99
Group 7	1.64	2.18	6.61	6.73	1.30	1.87	0.39	-0.27	-0.26	9.32	9.45
Group 8	1.91	2.46	5.77	5.85	1.56	1.98	0.55	-0.09	-0.08	8.83	8.91
Group 9	1.88	2.68	6.24	6.33	1.26	1.59	0.54	-0.15	-0.14	9.44	9.53
Group 10	1.76	3.03	5.53	5.62	1.10	1.42	0.58	-0.10	-0.09	8.92	9.01
Average household income											
Urban areas	2.01	3.63	3.36	3.38	1.72	1.74	0.82	0.25	0.25	7.17	7.18
Rural areas	1.77	2.46	6.69	6.82	1.36	1.96	0.44	-0.27	-0.25	9.68	9.81

Sources: Authors' calculation

Appendix A: Regional and Industrial Classification

Table A1 Regional Mapping

Regions and Countries	Description
1. Vietnam	Vietnam
2. Indonesia	Indonesia
3. Malaysia	Malaysia
4. Philippines	Philippines
5. Thailand	Thailand
6. Singapore	Singapore
7. China	China
8. Korea	Korea
9. Hong Kong	Hong Kong
10. Taiwan	Taiwan
11. Japan	Japan
12. India	India
13. Oceania	Australia, New Zealand and other Oceania countries
14. The United States	The United States
15. European Union	Austria, Belgium, Denmark, Finland, France, Germany, England, Greece, Ireland, Italia, Luxemburg, Netherlands, Portugal, Spain, Sweden
16. Rest of the World	Other countries

Table A2 Industrial Mapping

Industries	Description
1. Crop	Paddy rice, wheat, cereal grains, vegetable, fruit, nuts, oil seeds, sugar cane, sugar beet, plant-based fibers, other crops
2. Livestock	Cattle, sheep, goats, horses, other animal products, raw milk, wool, silk-worm, cocoons
3. Forestry	Forestry
4. Fishing	Fishing
5. Mining	Coal, oil, gas, other minerals
6.Food processing	Processed meat, vegetable, oils and fats, diary products, processed rice, sugar, other food products
7. Beverages	Beverages and tobacco products
8. Wood	Wood products, paper, publishing
9. Chemical	Petroleum, coal product, chemical products, plastic products, rubber, other mineral products
10. Automobile	Motor vehicles and parts
11. Other transportation means	Transportation equipments etc
12. Electronics	Electronic equipments
13. Machinery	Other machinery and equipment
14. Metal	Ferrous and non-ferrous metals
15. Textiles	Textiles and wearing apparel
16. Leather	Leather products
17. Other manufactures	Other manufactures
18. Utility	Electricity, gas manufactures and distribution, water
19. Construction	Construction
20. Services	Public and private services

Appendix B: The Global CGE Model

B1. Equations of the Model

Price Relations

(1) $$PMS_{irk} = PM\$_{ik} \times ER_r \times (1+ tm_{irk})$$

(2) $$PM_{ir} = a_{S_{ir}}^{-1} \left(\sum_k \omega_{S_{irk}}^{1/(1+\theta_{ir})} PMS_{irk}^{\theta_{ir}/(1+\theta_{ir})}\right)^{(1+\theta_{ir})/\theta_{ir}}$$

$$\text{where } M_{ir} PM_{ir} = \sum_k MS_{irk} PMS_{irk}$$

(3) $$PE_{ir} = PE\$_{ir} \times ER_r \times (1+ te_{ir})$$

(4) $$P_{ir} = a_{M_{ir}}^{-1} \left(\omega_{M_{ir}}^{1/(1+\delta_{ir})} PM_{ir}^{\delta_{ir}/(\delta_{ir}+1)} + (1-\omega_{M_{ir}})^{1/(1+\delta_{ir})} PD_{ir}^{\delta_{ir}/(\delta_{ir}+1)}\right)^{(\delta_{ir}+1)/\delta_{ir}}$$

$$\text{where } P_{ir} Q_{ir} = PM_{ir} M_{ir} + PD_{ir} D_{ir}$$

(5) $$PX_{ir} = a_{E_{ir}}^{-1} \left(\omega_{E_{ir}}^{1/(1-\gamma_{ir})} PE_{ir}^{\gamma_{ir}/(\gamma_{ir}-1)} + (1-\omega_{E_{ir}})^{1/(1-\gamma_{ir})} PD_{ir}^{\gamma_{ir}/(\gamma_{ir}-1)}\right)^{(\gamma_{ir}-1)/\gamma_{ir}}$$

$$\text{where } PX_{ir} X_{ir} = PE_{ir} E_{ir} + PD_{ir} D_{ir}$$

(6) $$WM_{ir} = a_{L_{ir}}^{-1} \left(\sum_l \omega_{L_{lir}}^{1/(1+\lambda_{iir})} WKM_{lir}^{\lambda_{ir}/(\lambda_{ir}+1)}\right)^{(\lambda_{ir}+1)/\lambda_{ir}}$$

$$\text{where } WM_{ir} L_{ir} = \sum_l WKM_{lir} LK_{lir}$$

(7) $$PVA_{ir} = PX_{ir}(1-tp_{ir}) - \sum_j iocf_{ijr} PNM_{jr}$$

(8) $$PINDEX_r = \sum_i cpcf_{ir} \times P_{ir}$$

Definition of Market Prices

(9) $$PCM_{ir} = P_{ir}(1+tc_{ir})$$

(10) $$PGM_{ir} = P_{ir}(1+tg_{ir})$$

(11) $$PNM_{ijr} = P_{ir}(1+tn_{ijr})$$

(12) $$PKM_{ir} = P_{ir}(1+tk_{ir})$$

(13) $$WKM_{lir} = WK_{lir}(1+tw_{lir})$$

(14) $$RM_{ir} = R_{ir}(1+tr_{ir})$$

Production and Factor Demand

(15) $$X_{ir}^S = a_{X_{ir}} \left(\omega_{X_{ir}} L_{ir}^{-\rho_{ir}} + (1- \omega_{X_{ir}}) K_{ir}^{-\rho_{ir}}\right)^{-1/\rho_{ir}}$$

(16) $$L_{ir} = a_{X_{ir}}^{-\rho_{ir}/(1+\rho_{ir})} \left(\omega_{X_{ir}} PVA_{ir} / WM_{ir}\right)^{1/(1+\rho_{ir})} \times X_{ir}^S$$

(17) $$LK_{lir} = a_{L_{ir}}^{-\lambda_{ir}/(1+\lambda_{lir})} \left(\omega_{L_{lir}} WM_{ir} / WKM_{lir}\right)^{1/(1+\lambda_{ir})} \times L_{ir}$$

$$\text{where } L_{ir} = a_{L_{ir}} \left(\sum_l \omega_{L_{lir}} LK_{lir}^{-\lambda_{ir}}\right)^{-1/\lambda_{ir}}$$

(18) $$WK_{lir} = wagecf_{lir} WK_{lr}^e, \quad \text{here } wagecf_{lir} = \text{constant}$$

(19) $$K_{ir} = a_{X_{ir}}^{-\rho_{ir}/(1+\rho_{ir})} \left((1-\omega_{X_{ir}}) PVA_{ir} / RM_{ir}\right)^{1/(1+\rho_{ir})} X_{ir}^S$$

(20) $$R_{ir} = rentcf_{lir} R_r^e, \quad \text{here } rentcf_{ir} = \text{constant}$$

Supply

(21) $$D_{ir}^{S} = a_{E_{ir}}{}^{\gamma_{ir}/(1-\gamma_{ir})} ((1-\omega_{E_{ir}})\ PX_{ir} / PD_{ir})^{1/(1-\gamma_{ir})} \times X_{ir}^{S}$$

where $X_{ir} = a_{E_{ir}} (\omega_{E_{ir}} E_{ir}{}^{\gamma_{ir}} + (1-\omega_{E_{ir}}) D_{ir}{}^{\gamma_{ir}})^{1/\gamma_{ir}}$,

(22) $$E_{ir} = a_{E_{ir}}{}^{\gamma_{ir}/(1-\gamma_{ir})} (\omega_{E_{ir}} \times PX_{ir} / PE_{ir})^{1/(1-\gamma_{ir})} \times X_{ir}^{S},$$

Income and Saving

(23) $$YH_r = \sum_i K_{ir} \times R_{ir} + \sum_{li} LK_{lir} \times WK_{lir} + \sum_i PR_{ir}$$

for $r \neq Thailand$

(24) $$YH_{hr} = (\sum_i ykcf_{hir} \times R_{ir} \times K_{ir} + \sum_i ylcf_{hlir} \times WK_{lir} \times LK_{lir})$$

for $r = Thailand$

(25) $$YG_r = \sum_i tp_{ir} PX_{ir} X_{ir} + \sum_i tc_{ir} P_{ir} C_{ir} + \sum_i tg_{ir} P_{ir} G_{ir} + \sum_{ij} tn_{ijr} P_{ir} iocf_{ijr} X_{jr} + \sum_i tk_{ir} P_{ir} ID_{ir} + \sum_{ik} tm_{irk} PM\$_{irk} MS_{irk} ER_r + \sum_i te_{ir} PE_{ir} E_{ir} + \sum_{li} tw_{lir} WK_{lir} LK_{lir} + \sum_i tr_{ir} R_{ir} K_{ir}$$

(26) $$SH_r = s_{P_r} \times YH_r$$

for $r \neq Thailand$

(27) $$SH_r = \sum_h s_{P_{hr}} \times YH_{hr}$$

for $r = Thailand$

(28) $$SG_r = s_{G_r} \times YG_r$$

(29) $$S_r = SH_r + SG_r$$

Consumers

(30) $$C_{ir} = PCM_{ir} subs_{ir} + bshr_{ir} \left[(1-s_{P_r}) YH_r - PCM_{ir} subs_{ir} \right]$$

for $r \neq Thailand$

(31) $$C_{hir} = PCM_{ir} subs_{hir} + bshr_{hir} \left[(1-s_{P_{hr}}) YH_{hr} - PCM_{ir} subs_{hir} \right]$$

for $r = Thailand$

(32) $$C_{ir} = \sum_h C_{hir}$$

for $r = Thailand$

(33) $$C_r = \sum_i C_{ir}$$

(34) $$PC_r = (1\text{-}s_{P_r}) YH_r / C_r$$

Government

(35) $$G_r = (YG_r - SG_r) / PG_r$$

(36) $$G_{ir} = cgcf_{ir}\ G_r$$

(37) $$PG_r = \sum_i cgcf_{ir} PGM_{ir}$$

External Sectors

(38) $$Q_{ir} = \sum_j X^S_{jr} \times iocf_{ijr} + C_{ir} + G_{ir} + ID_{ir} + V_{ir} + TMQ_{ir}$$

where $$Q_{ir} = a_{M_{ir}} (\omega_{M_{ir}} M_{ir}^{-\delta_{ir}} + (1-\omega_{M_{ir}}) D_{ir}^{-\delta_{ir}})^{-1/\delta_{ir}}$$

(39) $$D_{ir} = a_{M_{ir}}{}^{\delta_{ir}/(1+\delta_{ir})} ((1-\omega_{M_{ir}})\, P_{ir} / PD_{ir})^{1/(1+\delta_{ir})} \times Q_{ir}$$

(40) $$M_{ir} = a_{M_{ir}}{}^{\delta_{ir}/(1+\delta_{ir})} (\omega_{M_{ir}}\, P_{ir} / PM_{ir})^{1/(1+\delta_{ir})} \times Q_{ir}$$

Linkage between Countries or Regions

(41) $$MS_{irk} = a_{S_{ir}}{}^{\theta_{ir}/(1+\theta_{ir})} (\omega_{S_{irk}} PMS_{irk} / PM_{ir})^{1/(1+\theta_{ir})} M_{ir}$$

where $$M_{ir} = a_{S_{ir}} (\sum_l \omega_{S_{irk}} MS_{irk}^{-\theta_{ir}})^{-1/\theta_{ir}}$$

(42) $$E^S_{ir} = \sum_k M_{ikr}$$

(43) $$PM\$_{irk} = PE\$_{ik} (1 + tmr_{irk})$$

(44) $$\sum_r F\$_r = 0$$

International Transportation Services

(45) $$PTM.TMG = \sum_{irk} \frac{tmr_{irk}}{1+tmr_{irk}} PM\$_{irk} MS_{irk}$$

(46) $$TMQ_{ir} = a_T{}^{\tau/(1+\tau)} \left[\omega_{T_{ir}} (P_{ir} / ER_r) / PTM\right]^{1/(1+\tau)} TMG$$

(47) $$PTM = a_T{}^{-1} \left[\sum_{ir} \omega_{T_{ir}}{}^{1/(1+\tau)} (P_{ir} / ER_r)^{\tau/(1+\tau)}\right]^{(1+\tau)/\tau}$$

Capital Formation

(48) $$I^n_r = PIM_r\, I_r$$

(49) $$ID_{ir} = invcf_{ir}\, I_r$$

(50) $$V_{ir} = invtr_{ir}\, X^S_{ir}$$

(51) $$DEP_r = depr_r K^S_r$$

(52) $$PIM_r = \sum_i invcf_{ir} PKM_{ir}$$

(53) $$PI_r = \sum_i invcf_{ir} P_{ir}$$

International Capital Mobility

(54) $RA_r = R_r^e / PI_r - depr_r$

(55) $RE_r = RA_r (K_r^S / KLAG_r^S)^{\phi}$

(56) $RE_r = recf_r RGE$

(57) $K_r^S = KLAG_r^S - DEP_r + I_r$

GDP Indentities

(58) $GDPR_r = \sum_i C_{ir} PCM0_{ir} + \sum_i G_{ir} PGM0_{ir} + \sum_i iocf_{ijr} X_{jr} PNM0_{ir}$
$\sum_i V_{ir} PX0_{ir} + \sum_i ID_{ir} PKM0_{ir}$
$\sum_{ik} MS_{irk} PM\$0_{irk} + \sum_i E_{ir} PE\$0_{ir}$

(59) $GDPN_r = \sum_i C_{ir} PCM_{ir} + \sum_i G_{ir} PGM_{ir} + \sum_i iocf_{ijr} X_{jr} PNM_{ir}$
$\sum_i V_{ir} PX_{ir} + \sum_i ID_{ir} PKM_{ir}$
$\sum_{ik} MS_{irk} PM\$_{irk} + \sum_i E_{ir} PE\$_{ir}$

Equilibrium Conditions

(60) $\sum_i K_{ir} = K_r^S$

(61) $\sum_i L_{lir} = \overline{L_{lr}^S}$

(62) $D_{ir}^S = D_{ir}$

(63) $\sum_{ik} MS_{irk} \times PM\$_{irk} - \sum_i E_{ir} PE\$_{ir} - \sum_i TMQ_{ir} P_{ir} / ER_r - F\$_r = 0$

Walrasian Law

(64) $\sum_i PD_{ir} \times (D_{ir}^s - D_{ir}) + (S_r + F_r - I_r^n - \sum_i P_{ir} \times V_{ir}) +$
$ER_r \times \sum_{ik} (MS_{irk} \times PM\$_{irk} - \sum_i E_{ir} PE\$_{ir} - \sum_i TMQ_{ir} P_{ir} / ER_r - F\$_r) = 0$

(65) $\sum_r (\sum_{ik} MS_{irk} \times PM\$_{irk} - \sum_i E_{ir} PE\$_{ir} - \sum_i TMQ_{ir} P_{ir} / ER_r - F\$_r) = 0$

B2. Model Notation

Sets

i,j	industries
r,k	countries or regions
l	labor types
h	households

Price Variables

$PM\$_{irk}$	world price of imports
PMS_{irk}	domestic prices of imports by sources of imports
PM_{ir}	domestic prices of imports
$PE\$_{ir}$	world price of exports
PE_{ir}	domestic prices of exports
PX_{ir}	output prices
PD_{ir}	domestic prices of domestically produced products
P_{ir}	prices of composite goods
PN_{i}	value added prices by sectors
PCM_{ir}	market prices of consumer's goods
PGM_{ir}	market prices of public goods
PNM_{ir}	market prices of intermediate inputs
PKM_{ir}	market prices of capital goods
Pl_{r}	investment price index
PIM_{r}	investment price index
PC_{r}	consumer price index
PG_{r}	price index of public goods
PTM	price index of international transportation services
W_{ir}	wage rates by sectors
WK_{tir}	wage rates by sectors and types of labor
WM_{ir}	composite market wage rates
WKM_{lir}	composite market wage rates by sectors and types of labor
WK^{e}_{ir}	equilibrium wage rates by types of labor
R_{ir}	capital rents
RM_{ir}	market capital rents

R_r^e	equilibrium capital rent
RA_r	net real rate of return to capital
RE_r	expected rate of return to capital
RGE	global expected rate of return to capital
ER_r	exchange rate

Quantity Variables

X_{ir}^S	domestic output
L_{ir}	composite labor demand
LK_{lir}	labor demand by types of labor
$\overline{L_{ir}^S}$	supply of labor by types
K_{ir}	capital demand by sector
K_r^S	total supply of capital
$KLAG_r^S$	total capital stock in the previous period
Q^{ir}	composite good demand
D_{ir}	domestic supply of domestically produced products
E_{ir}	export supply
M_{ir}	imports
MS_{ir}	imports by country of origin
TMG	total demand for international transportation services
TMQ_{ir}	demand for international transportation services by countries and regions
C_{ir}	household consumption by sectors
C_r	total demand for household consumption
G_{ir}	demand for government consumption
G_r	total demand for government consumption
$F\$_r$	foreign savings
I_r	total real fixed investment
ID_{ir}	demand for capital goods
V_{ir}	demand for inventory investment
DEP_r	total depreciation expenditure
$GDPR_r$	Real GDP by countries

Nominal Variables

YH_r	household income
YG_r	government revenue
SH_r	household savings
SG_r	government savings
S_r	domestic savings
I_r^n	nominal fixed investment
$GDPN_r$	nominal GDP by countries

Parameters

$a_{x_{ir}}$	scale parameters in production functions
$\omega_{x_{ir}}$	share parameters in production functions
ρ_{ir}	exponent parameters in production functions
$a_{L_{ir}}$	scale parameters in labor demand functions
$\omega_{L_{ir}}$	share parameters in labor demand functions
λ_{ir}	exponents in labor demand functions
$a_{M_{ir}}$	scale parameters in composite goods functions
$\omega_{M_{ir}}$	share parameters in composite goods functions
δ_{ir}	exponents in composite goods functions
$a_{S_{ir}}$	scale parameters in import demand functions
$\omega_{S_{ir}}$	share parameters in import demand functions
θ_{ir}	exponents in import demand functions
$a_{E_{ir}}$	scale parameters in export supply functions
$\omega_{E_{ir}}$	share parameters in export supply functions
γ_{ir}	exponents in export supply functions
$iocf_{ijr}$	intermediate input coefficient of good j in industry i
$ykcf_{bir}$	share of capital income accrued to household h
$ylcf_{hlir}$	share of labor income accrued to household h
$subs_{ir}$	subsistence consumption (for other countries rather than Thailand)
$subs_{bir}$	subsistence consumption (for Thailand)
$bshr_{ir}$, $bshr_{bir}$	marginal budget shares
$cgcf_{ir}$	government consumption shares

$invcf_{ir}$	fixed investment shares
$invtr_{ir}$	ratios of inventory investment to real production
S_P, SP_{br}	private saving rate
S_{G_r}	government saving rate
tm_{ir}	import tariff rates
te_{ir}	export duty rates
tc_{ir}	sale taxes on consumers' goods
tg_{ijr}	sale taxes on public goods
tn_{ijr}	sale taxes on intermediate inputs
tk_{ir}	sale taxes on capital goods
tp_{ir}	production taxes/subsidies
tw_{lir}	labor taxes/subsidies
tr_{ir}	capital taxes/subsidies