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Applied General Equilibrium Analysis of Mega-Regional Free Trade Initiatives in the Asia-Pacific*

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Hiro Lee†
Osaka School of International Public Policy, Osaka University

Ken Itakura
Graduate School of Economics, Nagoya City University

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***Abstract*:** Asia-Pacific countries are currently negotiating two mega-regional free trade agreements (FTAs), namely Trans-Pacific Partnership (TPP) and Regional Comprehensive Economic Partnership (RCEP). The objectives of this paper are twofold. First, by using a dynamic applied general equilibrium model with several plausible sequences of region-wide FTAs, we offer results that are highly policy relevant. Second, we examine additional effects of mega-regional FTAs, including the positive impact on productivity, reductions in compliance costs associated with rules of origin, and FTA-induced agricultural policy reforms in Japan. When the mega-regional FTAs are assumed to exerts a positive effect on productivity, the magnitudes of welfare gains for all the member countries increase significantly. When implementations of these FTAs are assumed to lead to reductions in compliance costs associated with rules of origin, it would also boost welfare gains of the member economies. Finally, when Japan's agricultural policy reforms would result in an increase in productivity of its agricultural sectors, the extent of output contraction of agricultural and processed food sectors in the country would be reduced significantly except for dairy products.

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† Corresponding author. Osaka School of International Public Policy, Osaka University, 1-31 Machikaneyama, Toyonaka, Osaka 560-0043, Japan. Email: hlee@osipp.osaka-u.ac.jp.

1. Introduction

In response to slow progress in the Doha Round, Asia-Pacific countries have accelerated bilateral and regional trade initiatives. While global free trade is the ultimate goal, many countries strive not to be left out of the recent wave of free-trade agreements (FTAs). Negotiations for two mega-regional FTAs – Trans-Pacific Partnership (TPP) and Regional Comprehensive Economic Partnership (RCEP) – are in progress.[1] Japan joined TPP negotiations in July 2013 as the 12th member, and Korea has considered its merits and demerits of participating in the TPP. RCEP was launched in November 2012 and negotiations among 10 ASEAN countries and their six FTA partners started in May 2013. Both the TPP and RCEP are open to new members, and some other Asian countries are expected to join the TPP in the medium term. Over the longer term, enlarged TPP and/or enlarged RCEP might lead to the creation of a Free Trade Area of the Asia-Pacific (FTAAP).

The objectives of this paper are twofold. First, by providing several plausible sequences of region-wide FTAs in the Asia-Pacific, we offer results that are highly policy relevant. Second, we examine additional effects of mega-regional FTAs, including the positive impact on productivity, the cost-mitigating effect of consolidating FTAs, and FTA-induced agricultural policy reforms in Japan. Using a global dynamic applied general equilibrium model, we evaluate the welfare and sectoral output effects under various FTA scenarios. In Scenario 1, we assume that an RCEP agreement is signed in 2017 and implemented over the 2018-2027 period. Taiwan is assumed to join the RCEP in 2022 and completes implementation with the RCEP countries in 2030. In Scenario 2, we assume that the 12 countries that are currently negotiating a TPP agreement plus Korea (TPP-13) will implement a trade accord over the period 2016-25.[2] Three additional countries – Indonesia, the Philippines and Thailand – join the TPP in 2020 and complete preferential liberalization with the TPP-13 countries in 2029 (TPP-16). Scenario 3 is the same as

[1] The twelve negotiating countries of the TPP are Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, United States and Vietnam. The sixteen negotiating countries of the RCEP are Australia, Brunei, Cambodia, China, Lao PDR, India, Indonesia, Japan, Korea, Malaysia, Myanmar, New Zealand, the Philippines, Singapore, Thailand and Vietnam.

[2] Although the twelve negotiating countries are likely to sign a TPP agreement first, Korea is expected to be approved as a new member in a relatively short period thereafter.

Scenario 2, except that China, India and Taiwan join TPP-16 in 2024 to form TPP-19. It is assumed that 70% of the three new members' preferential liberalization with TPP-16 will be effectuated in 2030. In Scenario 4A, TPP-13 and TPP-16 are implemented during 2016-2025 and 2019-2028, respectively. In addition, TPP-19 and FTAAP start from 2022 and 2025, respectively, in which 90% of TPP-19 and 60% of FTAAP are completed in 2030.

Scenarios 4B-4D assume the same FTA sequencing as Scenario 4A, but include additional assumptions. Coe and Helpman (1995), Coe et al. (2009), Trefler (2004), Lileeva (2008), Chen et al. (2009) and Wolszczak-Derlacz (2014) suggest that import and export penetrations result in an increase in productivity.[3] Scenario 4B adds an assumption that productivity, measured by efficiency on overall output, for manufacturing sectors is assumed to increase from 1% a year to 1.1% a year in the TPP-13, TPP-16, TPP-19 and FTAAP countries during 2016-18, 2019-21, 2022-24 and 2025-30, respectively. In addition to increases in productivity, Scenario 4C assumes that real trade cost will fall by 0.1% per year among the TPP-13, TPP-16 and TPP-19 countries during 2016-18, 2019-21 and 2022-24, respectively. In addition, it is assumed to fall by 0.2% per year among the FTAAP countries during 2025-30. Finally, Scenario 4D adds an assumption that productivity of Japan's agricultural sectors increases from 1% to 1.5% per annum starting in 2018, resulting from its policy reforms.[4]

A number of studies have quantified the effects of various FTAs in the Asia-Pacific region using a CGE model (e.g., Cheong, 2013; Itakura and Lee, 2012; Kawai and Wignaraja, 2009; Lee et al., 2009; Li and Whalley, 2014; Petri, Plummer and Zhai, 2012ab). While Petri et al.'s (2012b) study was the first to examine the effects of "Asian track" and "Trans-Pacific track" of FTA sequencings, RCEP had not been launched at the

[3] Coe and Helpman (1995) and Coe et al. (2009) show that imports of technology-embodied products accelerate productivity growth in the recipient country. Trefler (2004) finds that the Canada-U.S. FTA resulted in large increases in labor productivity in industries with steep tariff cuts, whereas Lileeva (2008) finds that Canada's tariff cuts raised industry-level productivity by increasing the market shares of highly productive plants. Using a trade model with firm heterogeneity, Chen et al. (2009) show that trade openness exerts a positive effect on productivity and a negative effect on markups in the short run. Joanna (2014) finds that both import and export penetrations are positively associated with an increase in total factor productivity (TFP).

[4] Mercurio (2014) suggests that the TPP may become the catalyst needed for the structural reform agenda of the Japanese government.

time of their writing. As a result, the Asian track of a China-Japan-Korea FTA, followed by ASEAN+3 FTA (EAFTA) and FTAAP in their study is no longer realistic. One of our aims is to construct FTA sequences that are reasonable estimates of the future sequences of region-wide FTAs in the Asia-Pacific.

Using an 11-country numerical general equilibrium model, Li and Whalley (2014) investigate how China's participation in the TPP would affect China and other countries. Whereas their study includes only aggregate results, a significant share of TPP negotiations has been devoted to sectoral issues, such as agriculture, automobiles, insurance and other services. Their model has only two sectors, and the tradable sector includes extremely heterogeneous sectors, such as agriculture, textiles and apparel, electronics products and automobiles. However, there are large differences in tariff rates, relative factor endowments and technology among these sectors. By constructing a 22-region, 32-sector model, this study attempts to overcome the aggregation bias inherent in highly aggregated models.

An overview of the model and data is given in the next section, followed by descriptions of the baseline and policy scenarios in Section 3. In Section 4 assessments of welfare and sectoral output effects under each policy scenario are offered. Concluding remarks are provided in the final section.

2. Analytical Framework and Data

2.1 Overview of the Dynamic GTAP Model

The numerical simulations undertaken for this study are derived from the dynamic GTAP model, described in detail by Ianchovichina and McDougall (2001) and Ianchovichina and Walmsley (2012). This model extends the comparative static framework of the standard GTAP model developed by Hertel (1997) to the dynamic framework by incorporating international capital mobility and capital accumulation. The dynamic GTAP model allows international capital mobility and capital accumulation, while it preserves all the features of the standard GTAP, such as constant returns to production technology, perfectly competitive markets, and product differentiation by countries of origin, in

keeping with the so-called Armington assumption.[5] At the same time, it enhances the investment theory by incorporating international capital mobility and ownership. In this way it captures important FTA effects on investment and wealth that are missed by a static model.

In the dynamic GTAP model, each of the regions is endowed with fixed physical capital stock owned by domestic firms. The physical capital is accumulated over time with new investment. This dynamics are driven by net investment, which is sourced from regional households' savings. The savings in one region are invested directly in domestic firms and indirectly in foreign firms, which are in turn reinvested in all regions. The dynamics arising from positive savings in one region is related to the dynamics from the net investment in other regions. Overall, at the global level, it must hold that all the savings across regions are completely invested in home and overseas markets.

In the short run, an equalization of the rates of return seems unrealistic, and there exist well-known empirical observations for "home bias" in savings and investment. These observations suggest that capital is not perfectly mobile, causing some divergence in the rates of return across regions. The dynamic GTAP model allows inter-regional differences in the rates of return in the short run, which will be eventually equalized in the very long run. It is assumed that differences in the rates of return are attributed to the errors in investors' expectations about the future rates of return. During the process, these errors are gradually adjusted to the actual rate of return as time elapses, and eventually they are eliminated and a unified rate of return across regions can be attained. Income accruing from the ownership of the foreign and domestic assets can then be appropriately incorporated into total regional income.

Participating in an FTA could lead to more investment from abroad. Trade liberalization often makes prices of goods in a participating country lower due to removal of tariffs, creating an increase in demand for the goods. Responding to the increased

[5] See Armington (1969). The model uses a nested CES structure, where at the top nested level, each agent chooses to allocate aggregate demand between domestically produced goods and an aggregate import bundle, while minimizing the overall cost of the aggregate demand bundle. At the second level, aggregate import demand is allocated across different trading partners, again using a CES specification, wherein the aggregate costs of imports are minimized.

demand, production of the goods expands in the member country. The expansion of production is attained by using more intermediate inputs, labor, capital, and other primary factor inputs. These increased demands for production inputs raise the corresponding prices, wage rates, and rental rates. Higher rental rates are translated into higher rates of return, attracting more investment from both home and foreign countries.

2.2 Data, aggregation, and initial tariffs

In this study we employ the GTAP database version 8.1, which has a 2007 base year and distinguishes 129 countries/regions and 57 sectors (Narayanan et al., 2012). For the purposes of the present study, the data has been aggregated to 22 countries/regions and 32 sectors, as shown in Table 1. Foreign income data are obtained from the International Monetary Fund (IMF)'s *Balance of Payments Statistics*, which are used to track international capital mobility and foreign wealth. The values of key parameters, such as demand, supply and CES substitution elasticities, are based upon previous empirical estimates. The model calibration primarily consists of calculating share and shift parameters to fit the model specifications to the observed data, so as to be able to reproduce a solution for the base year.

The sectoral tariff rates for the 22 countries/regions in 2007 are summarized in Table 2. There are striking differences in the tariff structures across the countries/regions. Singapore is duty free with the exception of alcohol and tobacco. The exceptionally high tariff rate on rice in Japan stands out. The tariff rates in a number of other agricultural and food products in Japan are also high, as well as in Korea and India. With the exception of Australia, New Zealand and Chile, the tariff rates on some agricultural and food products are also relatively high in other regions, such as sugar in the United States, Russia and the EU, dairy products and meats in Canada, and rice in the Philippines. In manufacturing the tariff rates on textiles and apparel are relatively high in all regions except China, Singapore, Chile and the EU. The tariff rate on motor vehicles exceeds 20% in Thailand, Vietnam and India.

Ad valorem tariff equivalents of nontariff barriers (NTBs) in nine services sectors are computed as unweighted averages of the gravity-model estimates of Wang et al. (2009)

and the values employed by the Michigan Model of World Production and Trade (e.g. Brown, Kiyota and Stern, 2010). There are even greater variations in tariff equivalents of NTBs in services than in commodities.

3. The Baseline and Policy Scenarios

3.1 The Baseline Scenario

In order to evaluate the effects of region-wide FTAs in the Asia-Pacific, the baseline scenario is first established, showing the path of each of the 22 economies/regions over the period 2007-2030. The baseline contains information on macroeconomic variables as well as expected policy changes. The macroeconomic variables in the baseline include projections for real GDP, gross investment, capital stocks, population, skilled and unskilled labor, and total labor. Real GDP projections were obtained from IMF's *World Economic Outlook Database*. The data on gross fixed capital formation were acquired from the IMF's *IFS Online*. Projections for population were taken from the U.S. Census Bureau's *International Data Base*, while those for labor were obtained from International Labor Organisation (ILO)'s *Economically Active Population Estimates and Populations*.

The projections for population, investment, skilled labor and unskilled labor obtained for over 150 countries were aggregated, and the growth rates were calculated to obtain the macroeconomic shocks describing the baseline. Changes in the capital stocks were not imposed exogenously, but were determined endogenously as the accumulation of projected investment. Any changes in real GDP not explained by the changes in endowments are attributed to technological change.

In addition, policy projections are also introduced into the baseline. The policies included in the baseline are those which are already agreed upon and legally binding, including the ASEAN Free Trade Area (AFTA), the ASEAN-China, ASEAN-Korea, ASEAN-Japan, ASEAN-Australia-New Zealand, ASEAN-India, EU-Korea, and Korea-US FTAs. It is assumed that tariffs are cut by 80% among the member countries of the FTAs that are being implemented. Rice is excluded from tariff liberalization in FTAs that include Japan or Korea as a member country.

3.2 Policy Scenarios

Welfare and sectoral output effects of mega-regional FTAs and their implications for Japan and other Asia-Pacific countries are to be evaluated in this study. The following seven scenarios are designed and summarized in Table 3.

***Scenario 1** (RCEP)*: RCEP over the period 2018-2027 and RCEP + Taiwan from 2022-2030.

***Scenario 2** (TPP)*: TPP-13 over the period 2016-2025 and TPP-16 from 2020-2029.

***Scenario 3** (Enlarged TPP)*: TPP-13 from 2016-2025, TPP-16 from 2020-2029 and TPP-19 from 2024. 70% of TPP-19 is assumed to be implemented in 2030.

***Scenario 4A** (Trans-Pacific)*: TPP-13 from 2016-2025 and TPP-16 from 2019-2028. TPP-19 and FTAAP start from 2022 and 2025, respectively, in which 90% of TPP-19 and 60% of FTAAP are assumed to be implemented in 2030.

***Scenario 4B** (Trans-Pacific with productivity gain)*: Same as Scenario 4A, except that efficiency on overall output for manufacturing sectors is assumed to increase from 1% a year to 1.1% a year in the TPP-13, TPP-16, TPP-19 and FTAAP countries during 2016-18, 2019-21, 2022-24 and 2025-30, respectively.

***Scenario 4C** (Trans-Pacific with productivity gain and trade cost reduction)*: Same as Scenario 4B, except that real trade cost is assumed to fall by 0.1% per year among the TPP-13, TPP-16 and TPP-19 countries during 2016-18, 2019-21 and 2022-24, respectively. In addition, it is assumed to fall by 0.2% per year among the FTAAP countries during 2025-30.

***Scenario 4D** (Trans-Pacific with productivity gain, trade cost reduction and Japan's agricultural policy reform)*: Same as Scenario 4C, except that efficiency on overall output for Japan's agricultural sectors is assumed to increase from 1% a year to 1.5% a year starting from 2018.

In all scenarios rice is excluded from tariff liberalization. It is assumed that tariff rates on commodities other than rice decline linearly to zero and tariff equivalents of NTBs in services are reduced by 20 percent during the periods in consideration among the

member countries. In addition, time cost of trade – e.g. shipping delays arising from regulatory procedures and inadequate infrastructure – is assumed to fall by 20 percent among them.[6] Since manufacturing firms are much more exposed than non-manufacturing firms to foreign competition in both domestic and export markets, we assume that additional productivity growth occurs only in manufacturing sectors in Scenarios 4B-4D. Scenarios 4C-4D add an assumption that formations of mega-regional FTAs will result in reductions in compliance costs associated with rules of origin (ROOs). As bilateral FTAs are consolidated, compliance costs are projected to fall, leading to a reduction in real trade cost.[7]

Petri, Plummer and Zhai (2012b) also compare between Asian-track and Trans-Pacific-track FTA sequencings. There are, however, three notable differences between their scenarios and ours. First, we allow FTAAP to start before the full implementation of the TPP. Since the TPP is open to new members, it is likely that it would include a number of Asian economies before it is fully implemented. Second, while Petri et al. (2012b) assume that a China-Japan-Korea (CJK) FTA is implemented first in the Asian track, we assume that an RCEP agreement would be reached roughly at the same time as a CJK FTA. This is because there are high political tensions, including territorial disputes, between China and Japan, as well as between Japan and Korea. Such disputes and tensions represent an additional barrier that must be surmounted in negotiations aiming to fashion an FTA. Third, mainly because RCEP negotiations started more than three years after the first round of TPP negotiations in Melbourne, we assume that it takes a few years longer for the RCEP to reach an agreement than the TPP.

Two caveats should be borne in mind when interpreting the results presented in the next section. First, investment liberalization among the member countries is not considered because it requires data on foreign direct investment (FDI) flows by source and host countries and industry, which are unavailable. A challenging extension of the paper would

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[6] For a detailed analysis of time cost of trade, see Hummels and Schaur (2013) and Minor (2013).

[7] Baldwin and Kawai (2013) suggest that administrative costs of using FTAs might increase when the number of bilateral FTAs increase in the region. However, over the long term these costs are likely to fall, as a relatively large percentage of firms utilizing FTA preferences uses mega-regional FTAs (such as TPP, RCEP and FTAAP) and a relatively small percentage uses bilateral FTAs.

be to endogenize FDI flows to consider attraction of these flows to developing member countries, which may have a significant impact, as were the cases for Mexico joining NAFTA in 1994 and Spain and Portugal joining the EU in 1986. Second, NTBs in manufacturing are not incorporated in this study due to a lack of reliable empirical estimates. NTBs also exist in a number of manufacturing sectors, including automobiles, pharmaceutical products, and some food products. In these products regulatory and other barriers, such as stringent standards and testing and certification procedures, exist. Thus, reductions of NTBs in manufacturing are expected to enlarge the benefits of the FTAs. These issues are left for future research.

4. Empirical Findings

4.1 Welfare Effects

Economic welfare is largely determined by four factors: (1) allocative efficiency, (2) the terms of trade, (3) the contribution to equivalent variation (EV) of change in the price of capital investment goods, and (4) the contribution to EV of change in equity owned by a region. The fourth factor is determined by the change in equity income from ownership of capital endowments, and it can be further decomposed into three parts: a change in the domestic capital stock, a change in household income earned on capital abroad, and a change in the domestic capital owned by foreigners.

With respect to these four factors, the direction of a welfare change may be summarized as follows. The allocative efficiency effect is generally positive for members of region-wide FTAs. This effect is particularly large for a country with high average initial tariffs. However, it may become negative when the extent of trade diversion is considerably large in FTAs with relatively low intraregional trade. The terms-of-trade effect is usually positive for the members with low average initial tariffs and negative for those with high initial tariffs. An increase in the price of capital investment goods generally raises welfare. A welfare change resulting from a change in the equity holdings is positive if the sum of the region's foreign income receipts and an increase in the domestic capital stock is greater than the foreign income payment, and vice versa.

The welfare results for the seven policy scenarios, as percentage deviations in equivalent variation from the baseline for the years 2020, 2025 and 2030, are summarized in Table 4. Under Scenario 1, the welfare level of all RCEP countries increases in 2020-2030, whereas that of Taiwan increases in 2025-2030. The welfare gains in 2030 for the RCEP countries and Taiwan range from 0.5% (India) to 3.4% (Korea and Taiwan). The economic welfare of several nonmember regions decreases slightly in 2020, 2025 and/or 2030.[8]

In Scenario 2, economic welfare of envisaged TPP-16 members increases during 2025-2030. The welfare gains in 2030 for the TPP-16 countries range from 0.2% (United States) to 2.7% (Vietnam). A comparison of welfare gains in the first two scenarios suggest that more Asian countries are expected to realize larger welfare gains under Scenario 1, but the differences are relatively small except for Korea. Korea's gain is significantly smaller under Scenario 2, since not only it is currently implementing a bilateral FTA with the United States, which is already included in the baseline scenario, but it is also highly dependent on trade with China, a nonmember of the TPP. In Scenario 3, China, India and Taiwan are assumed to join the TPP, which will consist of 19 members (TPP-19) by 2024. The welfare effects of the acceding economies change from negative under Scenario 2 to positive under this scenario in 2025-2030. Among the TPP-16 countries, Korea's welfare gain from the three economies' accession to the TPP are large, primarily because of its high trade dependence on China.

Under Scenario 4A, TPP and enlarged TPP are followed by FTAAP, which is assumed to be launched in 2025, and 60% of the FTA for APEC countries will be implemented during 2025-2030. By 2030 welfare gains of APEC countries become significantly greater compared with those under Scenario 1. The size of welfare gains in those years is larger for most of the prospective TPP-19 members, in comparison with Scenario 3. When the mega-regional FTAs are assumed to induce productivity growth in manufacturing sectors in Scenario 4B, the magnitudes of welfare gains for the FTA

[8] Before Taiwan becomes a member of the RCEP grouping, its welfare is predicted to fall by considerably more than other nonmembers, largely because the shares of its trade with ASEAN+6 countries is high (about 60% of its total trade) and the extent of trade diversion would be relatively large. Thus, it has a strong incentive to join the RCEP.

members are amplified considerably.[9] The welfare gain for the United States increases to 1.0%, compared with 0.2% when productivity growth is assumed to be fixed. Thus, for some countries economic impacts resulting from productivity gain through a competitive effect could become larger than those resulting from tariff cuts and reductions in NTBs.

Scenario 4C adds the assumption that real trade cost among the members of the mega-regional FTAs falls over time. The cost-mitigating effect of consolidating FTAs is particularly large for the economies with large exports-GDP and imports-GDP ratios, such as Singapore and Malaysia. However, the results should be interpreted with caution because we do not know to what extent compliance costs associated with rules of origin would be reduced by creations of mega-regional FTAs such as the TPP and FTAAP.

In Scenario 4D, the assumption that productivity of Japan's agricultural sectors increases from 1% to 1.5% per annum starting in 2018 is added. The Japanese government has approved a plan to phase out *gentan* – the system that has paid farmers to reduce rice crops since 1971 – by 2018. In addition, in December 2013 the Japanese Diet enacted a bill to consolidate small plots of agricultural land.[10] Under this law, prefectural governments will establish farmland banks. The banks will borrow pieces of farmland from small-scale part-time farmers or those who have stopped farming, and consolidate and lease them to large-scale farmers. These policies are expected to improve productivity of agricultural sectors in Japan. Other prospective reforms include provisions of direct payments to full-time farmers, abolitions of subsidies to part-time farmers, lessening regulations on corporations to participate in agricultural production, and reforming the distribution system of agricultural inputs and final products. It remains to be seen to what extent the Japanese government would carry out agricultural policy reforms.

If the Japanese government is successful in accomplishing reforms and improving productivity of its agricultural sectors, then Japan's welfare gains in 2030 are projected to

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[9] Using the plant-level data in manufacturing sectors, Trefler (2004) finds that labor productivity in industries that experienced the deepest Canadian and U.S. tariff cuts from the Canada-U.S. FTA increased 14-15 percent. Thus, additional productivity growth of 0.1 percentage point per year in this study might be rather conservative, particularly in sectors with relatively high initial tariffs.

[10] Honma (2010) states that agricultural land per farm in Japan is about 1/120 of that in the United States and between 1/45 and 1/20 of that in European countries.

increase by 0.3 percentage point compared with the case of no reforms. Other countries' economic welfare is virtually unchanged. Considering that agriculture accounted for only 1.1% of Japan's GDP in 2012, an increase of 0.3 percentage point in welfare is large. Lower prices of agricultural products would reduce intermediate input cost of processed food sectors and some services sectors.

4.2 Sectoral Output Adjustments

Structural adjustments and resource reallocations result from trade accords. The FTA groupings and differences in the initial tariff rates across sectors and member countries play a critical role in determining the direction of the adjustments in sectoral output. Other factors that affect the magnitude and direction of output adjustments for each product category include the import-demand ratio, the export-output ratio, the share of each imported intermediate input in total costs, and the elasticity of substitution between domestic and imported products.[11]

Tables 5.1-5.3 present the sectoral output adjustments for Japan, the United States and Vietnam, expressed in percent deviations from the baseline in 2030.[12] In Japan, the change in rice output is rather small under all scenarios because the tariff rate on this commodity is assumed to be fixed. Output of other grains and dairy products contracts by more than 10% under most of the scenarios, while that of meats decreases by more than 9% under all scenarios except Scenarios 1 and 4D. Output of sugar and livestock contracts 3-6% with exceptions of livestock under Scenario 1 and both sectors under Scenario 4D. Output of other crops (consisting mostly of vegetables, fruits and oil seeds) and other food products expand slightly under most cases.

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[11] A sector with a larger import-demand ratio generally suffers from proportionately larger output contraction through greater import penetration when initial tariff levels are relatively high. In contrast, a sector with a higher export-output ratio typically experiences a larger extent of output expansion, as a result of the removal of tariffs in the member countries. The share of imported intermediate inputs in the total cost of a downstream industry (e.g., the share of imported textiles in the cost of the apparel industry) would evidently affect the magnitude and direction of output adjustments in the latter sector. Finally, the greater the values of substitution elasticities between domestic and imported products, the greater the sensitivity of the import-domestic demand ratio to changes in the relative price of imports, thereby magnifying the effects of FTAs.

[12] The sectoral output effects for other regions in the model are available upon request from the corresponding author.

When agricultural productivity in Japan is assumed to increase from 1% to 1.5% per annum under Scenario 4D, the extent of contraction would be reduced significantly in other grains, but not in dairy products (Table 5.1). In sugar, livestock and meats output changes become positive, whereas in other crops and other food products output expands by 5-6%. These results suggest that appropriate policy reforms would sufficiently strengthen the competitiveness of Japan's agricultural and processed food sectors other than daily products.

Under most of the scenarios, the manufacturing and services sectors in Japan increase with the exception of apparel, machinery, electronic equipment, other transport equipment and air transport. The contraction of the apparel sector results from the removal of relatively high tariffs and sharp increase in imports from China, except under Scenario 2 in which China remains nonmember of the TPP. The reduction in output of electronic equipment in Japan is also reported by Petri et al. (2014) and might result from Japanese electronics manufacturers' relocation to China and ASEAN countries, fragmentation of production processes and substantial increase in imports of both parts and components and assembled products from emerging Asia.[13] For similar reasons, output of machinery and other transport equipment contracts in Japan. Finally, the reduction in air transport appears to suggest that Japan's comparative advantage in sea transport and the resulting substitution from air transport to sea transport.

In the United States, meats, dairy products and other food products expand in the TPP, enlarged TPP, and all Trans-Pacific scenarios (Scenarios 2, 3 and 4A-4D, Table 5.2). Among the manufacturing sectors, the nonferrous metal sector, consisting of aluminum, copper and other nonferrous metals, are expected to expand considerably, particularly under the scenarios in which China becomes a member country. Other manufacturing sectors that are projected to increase output include wood and paper, petroleum products and chemical products. By contrast, output of machinery, electronic equipment and metal

[13] Kimura and Obashi (2010, 2011) show the increasing importance in machinery parts and components in intra-East Asian trade, particularly in electronic parts and components. In 2007, 17% of total intra-regional merchandise exports are accounted for by ICT-related parts and components in East Asia, whereas the corresponding figures are only 2-3% in Europe and the Americas (Kimura and Obashi, 2010, p. 10).

products would decline relative to the baseline. While the motor vehicles sector is expected to contract in Scenarios 2, 3 and 4A, it is projected to expand in Scenario 4B when productivity is assumed to increase from 1% a year to 1.1% a year. Finally, all services sectors are estimated to increase their output.

Table 5.3 summarizes Vietnam's sectoral output adjustments. We have chosen Vietnam because it is a rapidly growing economy with relatively high tariffs and NTBs on imports from countries that it does not have free-trade accords. The percentage changes in sectoral output are large in many sectors, particularly in manufacturing. In particular, the textiles sectors would expand by 44-58% and the apparel sector would expand by 63-90% relative to the baseline under Scenarios 2, 3 and 4A-4D. Other notable sectors that expand include machinery, electronic equipment and motor vehicles. While large presence of multinational corporations, fragmentation of production processes and global production networks appear to contribute to substantial increases in output of these sectors, further investigation would be required to determine the large percentage increases in sectoral output.

5. Conclusion

In this paper, we have used the dynamic GTAP model to investigate how mega-regional FTAs in the Asia-Pacific region might affect the welfare changes and sectoral output adjustments. A comparison of the RCEP and TPP scenarios suggest that more Asian countries are expected to realize larger welfare gains under the former. This is largely caused by the fact that most Asian countries have greater trade shares with RCEP countries than with envisaged TPP-16 countries. However, the differences in welfare gains between the two tracks are relatively small in 2030 and are sensitive to assumptions in the baseline scenario. As China, India and Taiwan are assumed to join the TPP, and the enlarged TPP is followed by FTAAP, welfare gains of APEC countries become significantly greater compared with the RCEP scenario.

When the mega-regional FTAs are assumed to exerts a positive effect on productivity in manufacturing sectors, the magnitudes of welfare gains for the FTA members increase significantly. Furthermore, when implementations of mega-regional

FTAs are assumed to lead to reductions in compliance costs associated with rules of origin, it would also boost welfare gains of the member economies. Finally, when Japan's agricultural policy reforms would result in an increase in productivity of its agricultural sectors by 0.5 percentage point per annum, its overall welfare gains are expected to increase by 0.3 percentage point relative to the case where agricultural productivity is fixed.

With respect to sectoral output adjustments, there appear to be no significant differences among the first six policy scenarios for countries that are both members of the RCEP and the TPP. In Japan, output of many agricultural and processed food sectors contract, while that of manufacturing and services sectors expand with the exception of apparel, machinery, electronic equipment, other transport equipment and air transport. In many emerging Asian countries, output of textiles, apparel, machinery, electronic equipment and other transport equipment is projected to increase.

When Japan's agricultural productivity is assumed to increase by 0.5 percentage point per annum, the extent of output contraction of agricultural and processed food sectors in the country would be reduced significantly except for dairy products. Output changes in some of the products, such as sugar, livestock and meats, are predicted to become positive, indicating the beneficial effects of agricultural policy reforms in Japan.

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Table 1: Regional and sectoral aggregation

A. Regional aggregation

	Country/region	Corresponding economies/regions in the GTAP 8 database
1	Japan	Japan
2	China	China, Hong Kong
3	Korea	Korea
4	Taiwan	Taiwan
5	Singapore	Singapore
6	Indonesia	Indonesia
7	Malaysia	Malaysia
8	Philippines	Philippines
9	Thailand	Thailand
10	Vietnam	Vietnam
11	Rest of ASEAN	Cambodia, Lao People's Democratic Republic, Myanmar, rest of Southeast Asia
12	India	India
13	Australia	Australia
14	New Zealand	New Zealand
15	United States	United States
16	Canada	Canada
17	Mexico	Mexico
18	Chile	Chile
19	Peru	Peru
20	Russia	Russian Federation
21	EU-28	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom
22	Rest of world	All the other economies/regions

Table 1 (continued)

B. Sectoral aggregation

	Sector	Corresponding commodities/sectors in the GTAP 8 database
1	Rice	Paddy rice, processed rice
2	Other grains	Wheat, cereal grains nec
3	Sugar	Sugar, sugar cane and sugar beet
4	Other crops	Vegetables and fruits, oil seeds, plant-based fibers, crops nec
5	Livestock	Cattle, sheep and goats, animal products nec, raw milk, wool
6	Fossil fuels	Coal, oil, gas
7	Natural resources	Forestry, fishing, minerals nec
8	Meats	Cattle, sheep, goat, and horse meat products, meat products nec
9	Dairy products	Dairy products
10	Other food products	Vegetable oils, food products nec, beverages and tobacco products
11	Textiles	Textiles
12	Apparel	Wearing apparel, leather products
13	Wood and paper	Wood products, paper products, publishing
14	Petroleum products	Petroleum, coal products
15	Chemical products	Chemical, rubber, plastic products
16	Steel	Iron and steel
17	Nonferrous metal	Nonferrous metal
18	Metal products	Fabricated metal products
19	Machinery	Machinery and equipment
20	Electronic equipment	Electronic equipment
21	Motor vehicles	Motor vehicles and parts
22	Other transport equip.	Transport equipment nec
23	Other manufactures	Mineral products nec, manufactures nec
24	Construction and utilities	Construction, electricity, gas manufacture and distribution, water
25	Trade	Trade
26	Sea transport	Sea transport
27	Air transport	Air transport
28	Other transport	Other transport
29	Communication	Communication
30	Financial services	Insurance, financial services nec
31	Other private services	Business services, recreation and other services
32	Government services	Public administration and defense, education, health services

Source: GTAP database, version 8.1.

Note: nec = not elsewhere classified.

Table 2: Tariff rates on merchandise imports and tariff equivalents of nontariff barriers on services, 2004 (%)

	Sector	Japan	China	Korea	Taiwan	Singapore	Indonesia	Malaysia	Philippines	Thailand	Vietnam	Rest of ASEAN
1	Rice	421.7	1.4	4.7	0.2	0.0	8.6	39.7	49.9	5.8	13.5	2.6
2	Other grains	27.4	1.7	5.2	2.9	0.0	2.6	0.0	5.1	2.5	4.2	1.5
3	Sugar	39.4	0.1	3.6	10.4	0.0	20.4	0.0	21.7	12.1	16.5	6.2
4	Other crops	4.6	2.8	51.2	8.2	0.0	2.2	10.6	6.7	13.1	13.0	8.0
5	Livestock	5.7	15.7	6.5	5.2	0.0	3.0	0.1	5.9	4.7	1.3	3.3
6	Fossil fuels	0.0	0.1	2.7	1.0	0.0	0.0	2.2	3.0	0.0	1.1	1.1
7	Natural resources	0.2	0.3	1.1	1.5	0.0	1.0	0.2	2.9	1.5	2.1	2.9
8	Meats	24.1	4.7	29.3	16.3	0.0	3.6	0.3	15.8	15.5	18.8	4.7
9	Dairy products	53.3	6.4	45.0	11.2	0.0	4.3	0.8	1.8	9.1	17.3	7.1
10	Other food products	9.9	4.7	30.6	14.3	0.6	7.0	10.6	5.6	14.6	16.3	10.9
11	Textiles	6.3	5.3	8.4	7.6	0.0	7.5	7.1	7.2	6.6	28.8	7.7
12	Apparel	9.6	4.0	8.9	8.1	0.0	7.5	7.9	9.1	20.2	19.1	11.6
13	Wood and paper	1.0	1.7	1.9	0.9	0.0	3.1	4.6	5.0	5.8	7.8	5.3
14	Petroleum products	0.3	4.5	4.4	2.6	0.0	0.7	0.4	2.4	9.2	14.7	8.4
15	Chemical products	1.0	6.1	4.8	3.0	0.0	3.7	3.8	4.0	7.0	4.5	3.8
16	Steel	0.9	3.9	0.3	0.4	0.0	4.1	17.4	2.9	4.1	3.9	2.2
17	Nonferrous metal	0.4	2.8	2.4	1.0	0.0	2.8	3.4	2.0	1.5	0.9	3.6
18	Metal products	0.4	8.2	5.3	6.1	0.0	6.0	8.4	6.5	11.2	10.9	4.1
19	Machinery	0.1	6.1	5.3	3.1	0.0	2.7	2.2	2.4	5.1	4.4	4.5
20	Electronic equipment	0.0	1.2	1.2	1.9	0.0	0.6	0.1	0.5	1.5	4.7	6.2
21	Motor vehicles	0.0	14.6	7.2	12.1	0.0	11.9	14.0	11.6	23.6	23.2	19.1
22	Other transport equip.	0.0	2.8	1.2	3.9	0.0	1.8	2.0	3.9	3.8	12.2	7.2
23	Other manufactures	0.6	6.0	6.0	5.0	0.0	6.5	6.7	5.3	8.7	15.8	6.0
24	Construction and utilities	5.0	25.2	13.0	10.8	0.0	64.4	17.4	52.6	44.9	53.7	20.6
25	Trade	22.7	109.6	33.0	28.8	1.3	98.5	36.0	80.2	63.5	82.7	32.5
26	Sea transport	7.6	21.5	15.7	12.6	1.3	67.3	17.6	53.5	40.5	54.4	6.4
27	Air transport	19.5	61.5	29.4	25.4	1.3	91.9	32.1	74.6	58.7	76.7	28.4
28	Other transport	20.2	74.3	30.2	26.1	1.3	93.4	33.0	75.8	59.7	78.0	14.9
29	Communication	17.8	48.1	27.4	23.6	1.3	88.4	30.0	71.5	56.1	73.5	32.8
30	Financial services	17.1	83.3	30.4	27.5	1.5	92.5	30.2	72.6	58.1	74.7	20.0
31	Other private services	16.6	81.2	29.2	26.7	1.5	91.1	29.8	70.8	54.9	73.7	7.3
32	Government services	25.9	84.1	34.3	29.1	2.8	97.8	36.5	76.9	61.5	84.2	24.1

Table 2 (continued)

	Sector	India	Australia	New Zealand	United States	Canada	Mexico	Chile	Peru	Russia	EU-27	Rest of world
1	Rice	39.0	0.0	0.0	1.9	0.0	0.2	5.8	17.7	9.3	8.9	15.9
2	Other grains	98.9	0.0	0.0	0.0	0.0	12.2	0.5	8.0	2.4	1.3	9.9
3	Sugar	91.7	0.0	0.0	24.2	0.4	5.1	2.6	2.5	50.1	25.7	15.0
4	Other crops	34.1	0.4	0.0	2.1	0.2	1.3	1.1	8.0	5.7	1.5	8.5
5	Livestock	11.9	0.1	0.0	0.3	16.3	0.5	0.3	6.7	4.3	0.4	3.8
6	Fossil fuels	11.1	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.1	0.0	1.3
7	Natural resources	9.6	0.1	0.0	0.1	0.0	1.6	0.1	6.9	2.6	0.1	1.5
8	Meats	21.7	0.2	0.8	2.4	31.0	0.7	3.4	10.8	23.8	5.1	19.8
9	Dairy products	31.9	2.1	1.3	15.0	146.0	6.1	0.9	16.3	7.4	1.4	14.0
10	Other food products	79.8	1.6	1.0	2.1	10.9	2.5	1.1	4.0	12.9	1.5	13.1
11	Textiles	15.9	9.1	6.0	7.0	6.5	4.6	3.3	13.5	12.4	2.1	9.6
12	Apparel	13.2	11.7	11.5	9.8	11.7	16.7	3.8	16.3	16.5	3.4	10.0
13	Wood and paper	13.5	3.0	1.3	0.2	0.6	1.6	0.9	5.8	11.3	0.1	5.4
14	Petroleum products	13.9	0.0	0.1	0.7	0.3	0.8	1.7	2.5	4.0	0.2	4.5
15	Chemical products	13.8	1.9	1.5	1.1	0.6	1.3	0.8	6.1	8.7	0.4	4.0
16	Steel	19.0	3.4	1.6	0.2	0.1	2.4	1.2	6.0	3.0	0.1	4.8
17	Nonferrous metal	14.9	0.6	0.9	0.6	0.0	0.6	0.8	4.4	3.9	0.4	1.3
18	Metal products	14.9	4.3	3.0	1.4	1.0	2.8	1.1	7.1	12.1	0.4	6.8
19	Machinery	14.0	2.3	2.5	0.7	0.4	2.8	0.8	5.4	4.4	0.4	4.9
20	Electronic equipment	2.4	0.9	0.9	0.3	0.2	1.4	0.6	5.1	6.0	0.7	3.6
21	Motor vehicles	24.7	12.4	7.2	0.6	1.0	3.5	3.1	7.2	10.6	0.9	9.7
22	Other transport equip.	6.5	0.8	0.6	0.4	0.7	1.6	0.2	8.9	9.3	0.7	4.7
23	Other manufactures	14.7	2.8	2.6	1.2	1.1	3.4	1.1	9.0	12.3	0.6	6.0
24	Construction and utilities	109.7	4.3	1.0	2.3	9.2	40.8	25.8	27.2	52.9	5.6	26.7
25	Trade	153.3	18.2	8.2	6.8	20.7	61.8	33.8	51.0	73.5	12.0	48.2
26	Sea transport	109.6	3.3	3.3	6.8	6.0	38.8	16.7	30.7	48.2	5.4	22.0
27	Air transport	144.1	15.1	5.7	6.8	17.6	56.9	30.2	46.7	68.1	11.1	49.5
28	Other transport	146.1	15.7	6.2	6.8	18.3	58.0	31.0	47.7	69.3	10.3	39.9
29	Communication	139.2	13.4	4.3	6.8	15.9	54.3	28.3	44.4	65.3	9.3	36.6
30	Financial services	139.5	13.5	4.3	7.8	19.8	57.6	27.5	46.4	65.9	8.7	43.3
31	Other private services	137.1	13.5	3.7	7.8	19.2	58.2	26.5	43.8	65.1	9.7	40.5
32	Government services	154.8	23.5	10.2	6.3	17.5	60.3	33.0	47.3	69.7	14.2	45.8

Sources: Sectors 1-23: GTAP database, version 8.1. Sectors 24-32: averages of the gravity-model estimates of Wang et al. (2009) and the values employed by the Michigan Model of World Production and Trade.

Table 3: Policy scenarios and assumptions

	2016-17	2018	2019	2020-21	2022-23	2024	2025	2026-27	2028-30
Scenario 1: RCEP		RCEP (ASEAN+6 FTA) (2018-2027)							
					RCEP+Taiwan (2022-2030)				
	Assumptions: 1) NTBs on services and logistic time in merchandise trade are cut by 20%. 2) Rice is excluded from trade liberalization.								
Scenario 2: TPP	TPP-13 (2016-2025)								
				TPP-16 (2020-2029)					
	Same assumptions as in Scenario 1.								
Scenario 3: Enlarged TPP	TPP-13 (2016-2025)								
				TPP-16 (2020-2029)					
						TPP-19 (2024-2030) (70% implemented)			
	Same assumptions as in Scenario 1.								
Scenario 4A: Trans-Pacific	TPP-13 (2016-2025)								
			TPP-16 (2019-2028)						
					TPP-19 (2022-2030) (90% implemented)				
							FTAAP (2025-30) (60% impl.)		
	Same assumptions as in Scenario 1.								
Scenario 4B: Trans-Pacific + productivity gain	Same FTA sequencing as in Scenario 4A								
	Assumptions: 1) and 2) are same as in Scenario 1. 3) Efficiency on overall output (ao) for manufacturing sectors 8-23 increases from 1% a year to 1.1% a year in TPP-13 countries during 2016-18, in TPP-16 countries during 2019-21, in TPP-19 countries during 2022-24, and in FTAAP countries during 2025-30.								
Scenario 4C: Trans-Pacific + productivity gain + trade cost reduction	Same FTA sequencing as in Scenario 4A								
	Assumptions: 1) - 3) are same as in Scenario 4B. 4) Real trade cost falls by 0.1% per year among TPP-13 countries during 2016-18, among TPP-16 countries during 2019-21, and among TPP-19 countries during 2022-24. It falls by 0.2% per year among FTAAP countries during 2025-30. Reductions in real trade cost are assumed to result from lower administrative costs associated with consolidations								
Scenario 4D: Trans-Pacific + prod gain+trade cost reduc + ag reform in Japan	Same FTA sequencing as in Scenario 4A								
	Assumptions: 1) - 4) are same as in Scenario 4C. 5) Starting in 2018, efficiency on overall output (ao) for sectors 1-5 in Japan increases from 1% a year to 1.5% a year, resulting from Japan's agricultural policy reform.								

Note: RCEP: 10 ASEAN members plus China, Japan, Korea, India, Australia and New Zealand. TPP-13: Australia, Canada, Brunei, Chile, Japan, Korea, Malaysia, Mexico, New Zealand, Peru, Singapore, United States and Vietnam. TPP-16: TPP-13 plus Indonesia, Philippines and Thailand. TPP-19: TPP-16 plus China, India and Taiwan.

Table 4: The welfare effects of mega-regional FTAs
(Percentage deviations in utility from the baseline)

	Scenario 1 (RCEP)			Scenario 2 (TPP)			Scenario 3 (Enlarged TPP)			Scen. 4A (Trans-Pacific)		
	2020	2025	2030	2020	2025	2030	2020	2025	2030	2020	2025	2030
Japan	0.21	0.59	0.88	0.24	0.59	0.77	0.24	0.64	0.87	0.24	0.69	0.96
China	0.30	0.58	0.56	-0.07	-0.16	-0.21	-0.07	0.12	0.58	-0.08	0.37	0.83
Korea	0.73	2.37	3.41	0.55	1.41	1.84	0.55	1.71	3.09	0.56	2.04	3.53
Taiwan	-0.23	0.75	3.40	-0.05	-0.16	-0.30	-0.05	0.46	2.35	-0.06	1.12	3.25
Singapore	0.38	1.42	2.21	0.40	1.41	2.40	0.40	1.40	2.06	0.44	1.44	2.06
Indonesia	0.32	1.17	1.57	0.05	0.61	1.11	0.05	0.71	1.49	0.17	0.95	1.60
Malaysia	0.23	0.88	1.05	0.47	1.19	1.42	0.47	1.20	1.24	0.49	1.23	1.24
Philippines	0.29	0.71	0.71	0.07	0.87	2.10	0.07	0.86	1.67	0.19	0.97	1.54
Thailand	0.49	1.19	1.09	-0.01	0.83	1.65	-0.01	0.89	1.50	0.18	1.11	1.45
Vietnam	0.67	2.08	2.68	1.50	2.68	2.66	1.50	2.79	2.94	1.52	2.96	3.17
Rest of ASEAN	0.31	1.15	1.64	-0.07	-0.09	0.00	-0.07	-0.14	0.04	-0.07	0.02	1.12
India	0.61	0.98	0.45	-0.05	-0.21	-0.31	-0.05	0.31	0.92	-0.07	0.75	0.89
Australia	0.43	1.83	2.84	0.15	0.34	0.39	0.15	0.53	1.61	0.16	0.84	2.22
New Zealand	0.19	0.63	0.89	0.31	0.86	0.99	0.31	0.88	0.91	0.31	0.89	0.92
United States	-0.02	-0.09	-0.12	0.05	0.12	0.15	0.05	0.12	0.16	0.05	0.12	0.20
Canada	-0.04	-0.04	0.04	0.30	0.55	0.59	0.30	0.57	0.73	0.31	0.61	0.82
Mexico	-0.02	-0.08	-0.14	0.44	0.79	0.79	0.44	0.82	0.73	0.44	0.83	0.68
Chile	0.07	0.33	0.56	0.33	1.02	1.19	0.33	1.16	1.83	0.33	1.34	2.08
Peru	0.02	0.14	0.23	0.13	0.28	0.27	0.13	0.35	0.53	0.14	0.43	0.64
Russia	-0.06	-0.01	0.13	-0.02	-0.01	0.03	-0.02	-0.04	0.06	-0.02	0.05	0.53
EU-28	-0.02	-0.10	-0.18	-0.01	-0.05	-0.12	-0.01	-0.08	-0.25	-0.01	-0.12	-0.38
Rest of world	-0.07	-0.06	0.06	-0.04	-0.08	-0.07	-0.04	-0.12	-0.08	-0.04	-0.13	-0.07

Definitions of scenarios:

Scenario 1: RCEP from 2018-2027 and RCEP + Taiwan from 2022-2030. Scenario 2: TPP-13 from 2016-2025 and TPP-16 from 2020-2029. Scenario 3: TPP-13 from 2016-2025, TPP-16 from 2020-2029 and TPP-19 from 2024. 70% of TPP-19 will be implemented in 2030. Scenario 4A: TPP-13, TPP-16 and TPP-19 will be implemented during 2016-2025, 2019-2028 and 2022-2030, respectively. FTAAP will start from 2025 and 60% of the accord will be implemented in 2030. Scenario 4B: Same as Scenario 4A, except that efficiency on overall output for manufacturing sectors is assumed to increase from 1% a year to 1.1% a year in the TPP-13, TPP-16, TPP-19 and FTAAP countries during 2016-18, 2019-21, 2022-24 and 2025-30, respectively. Scenario 4C: Same as Scenario 4B, except that real trade cost is assumed to fall by 0.1% per year among the TPP-13, TPP-16 and TPP-19 countries during 2016-18, 2019-21 and 2022-24, respectively. In addition, it is assumed to fall by 0.2% per year among the FTAAP countries during 2025-30. Scenario 4D: Same as Scenario 4C, except that efficiency on overall output for Japan's agricultural sectors is assumed to increases from 1% a year to 1.5% a year from 2018.

Table 4 (continued)

	Scen. 4B (Trans-Pacific with productivity gain)			Scen. 4C (Trans-Pacific with productivity gain and trade cost reduction)			Scen. 4D (Trans-Pacific with prod gain, trade cost reduction and Japan's ag policy reform)		
	2020	2025	2030	2020	2025	2030	2020	2025	2030
Japan	0.76	1.70	2.41	0.86	1.97	3.02	0.91	2.14	3.35
China	0.02	1.23	2.40	0.02	1.43	2.96	0.02	1.43	2.95
Korea	1.61	4.19	6.58	1.83	4.84	8.07	1.83	4.83	8.05
Taiwan	0.10	1.89	4.69	0.11	2.29	6.03	0.12	2.31	6.06
Singapore	1.14	3.05	4.59	1.55	4.40	7.87	1.55	4.40	7.87
Indonesia	0.35	1.63	2.75	0.39	1.96	3.63	0.40	1.97	3.64
Malaysia	1.16	2.90	3.75	1.46	3.89	5.91	1.46	3.90	5.93
Philippines	0.56	2.16	3.26	0.66	2.83	5.05	0.66	2.85	5.09
Thailand	0.65	2.63	3.65	0.78	3.39	5.45	0.78	3.39	5.46
Vietnam	1.93	3.88	4.62	2.29	4.89	6.76	2.28	4.89	6.76
Rest of ASEAN	-0.19	-0.01	1.47	-0.25	-0.01	2.07	-0.23	0.06	2.19
India	0.01	1.38	2.04	0.02	1.56	2.59	0.01	1.54	2.55
Australia	0.26	1.13	2.82	0.32	1.32	3.32	0.31	1.31	3.31
New Zealand	0.64	1.72	2.25	0.75	2.04	2.94	0.74	2.01	2.87
United States	0.32	0.68	1.06	0.36	0.78	1.28	0.35	0.77	1.26
Canada	0.46	1.00	1.58	0.63	1.43	2.50	0.63	1.42	2.49
Mexico	0.87	1.69	1.88	1.08	2.18	2.79	1.09	2.19	2.79
Chile	0.62	2.32	3.66	0.75	2.80	4.74	0.74	2.79	4.72
Peru	0.48	1.20	1.92	0.53	1.36	2.30	0.53	1.35	2.29
Russia	-0.11	0.07	0.95	-0.14	0.04	1.08	-0.14	0.05	1.10
EU-28	0.02	-0.14	-0.52	0.02	-0.14	-0.60	0.02	-0.15	-0.60
Rest of world	-0.15	-0.27	-0.10	-0.19	-0.36	-0.25	-0.19	-0.35	-0.24

Source: Model simulations.

Table 5.1: Japan's sectoral output adjustments for the year 2030
(Percentage deviation from the baseline)

	Scenarios						
Sector	1	2	3	4A	4B	4C	4D
Rice	0.2	0.3	0.2	0.4	0.4	0.4	2.5
Other grains	-5.4	-11.5	-10.7	-11.0	-12.0	-13.1	-3.2
Sugar	-3.1	-4.4	-3.5	-3.5	-3.1	-3.2	0.2
Other crops	-0.2	0.7	0.5	0.4	0.3	0.1	5.7
Livestock	0.0	-6.1	-4.8	-4.6	-4.5	-4.6	4.8
Fossil fuels	-3.9	-3.1	-3.6	-4.0	-6.0	-6.9	-7.4
Natural resources	0.7	0.5	0.6	0.7	0.9	0.9	1.0
Meats	-0.2	-10.5	-9.9	-9.9	-9.3	-10.3	1.1
Dairy products	-7.9	-21.5	-14.8	-14.8	-13.5	-14.1	-10.1
Other food products	1.7	2.1	2.1	2.1	4.0	4.5	5.4
Textiles	12.6	10.0	11.9	12.8	12.8	13.0	11.0
Apparel	-5.1	1.1	-2.4	-3.5	-2.2	-3.0	-3.3
Wood and paper	0.7	0.3	0.4	0.3	1.0	0.8	0.7
Petroleum products	3.8	1.7	3.2	3.7	5.7	6.8	6.8
Chemical products	5.2	2.5	3.6	4.0	5.9	6.2	5.7
Steel	3.4	1.5	3.1	3.2	4.6	5.5	4.8
Nonferrous metal	5.7	4.8	3.6	2.8	3.8	5.8	5.1
Metal products	0.2	0.5	0.3	0.2	1.2	0.7	0.6
Machinery	-1.7	-1.2	-1.2	-2.0	-2.5	-4.0	-5.0
Electronic equipment	-4.8	-2.5	-3.5	-4.3	-4.9	-8.4	-9.0
Motor vehicles	-0.4	2.7	1.4	2.3	3.9	2.8	1.9
Other transport equip.	-7.2	-1.5	-4.5	-6.6	-5.2	-5.7	-6.8
Other manufactures	2.1	2.2	2.0	2.1	4.0	4.1	3.9
Construction and utilities	3.0	2.3	2.5	3.0	6.5	8.2	8.8
Trade	0.8	0.8	0.8	0.9	2.2	2.7	2.9
Sea transport	1.5	-0.1	1.6	2.0	2.2	2.5	2.3
Air transport	-0.7	0.1	-0.3	-0.9	-1.4	-1.2	-1.5
Other transport	0.8	0.8	0.7	0.8	2.1	2.5	2.7
Communication	0.6	0.5	0.5	0.5	1.5	1.9	2.1
Financial services	0.4	0.3	0.3	0.3	1.1	1.3	1.4
Other private services	0.7	0.6	0.6	0.7	1.9	2.3	2.5
Government services	0.2	0.1	0.1	0.1	0.8	1.0	1.1

Definitions of scenarios: See notes on Table 4.

Source: Model simulations.

Table 5.2: U.S. sectoral output adjustments for the year 2030
(Percentage deviation from the baseline)

	Scenarios						
Sector	1	2	3	4A	4B	4C	4D
Rice	0.6	-0.7	-0.4	-0.8	-1.1	-1.0	-1.4
Other grains	-0.1	-0.1	-0.2	-0.4	-0.7	-0.9	-0.8
Sugar	0.0	-0.9	-0.7	-0.6	-0.3	-0.1	-0.1
Other crops	-0.1	-0.2	-0.2	-0.4	-0.4	-0.5	-0.5
Livestock	0.2	0.9	1.2	2.2	2.5	2.8	2.7
Fossil fuels	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1
Natural resources	0.1	0.1	0.7	0.8	0.9	0.9	0.9
Meats	0.6	1.4	1.8	4.8	6.6	7.0	6.9
Dairy products	0.1	3.8	3.6	2.6	4.1	4.5	4.6
Other food products	-0.2	1.1	1.1	1.2	2.8	3.1	3.2
Textiles	-0.8	-4.6	-8.1	-9.5	-8.3	-9.4	-9.5
Apparel	-0.8	-7.7	-12.3	-14.2	-12.1	-13.9	-13.9
Wood and paper	-0.1	0.4	0.4	0.4	1.4	1.5	1.5
Petroleum products	-0.6	0.3	0.3	0.3	2.0	2.2	2.2
Chemical products	-1.0	0.8	0.9	0.9	2.3	2.5	2.5
Steel	-0.1	-0.4	0.2	0.0	-0.9	-1.4	-1.3
Nonferrous metal	-2.0	0.6	7.4	9.4	10.3	10.7	10.9
Metal products	0.0	-0.3	-1.0	-1.3	-1.0	-1.7	-1.7
Machinery	-0.3	-0.5	-1.5	-2.2	-2.1	-3.5	-3.4
Electronic equipment	-1.1	-0.4	-1.3	-2.1	-1.4	-3.6	-3.5
Motor vehicles	0.2	-1.8	-1.5	-1.5	0.5	0.1	0.2
Other transport equip.	0.0	-0.1	-0.1	-0.6	-0.2	0.1	0.1
Other manufactures	-0.2	0.6	0.0	-0.2	1.1	0.7	0.8
Construction and utilities	-0.7	0.1	0.0	0.2	2.0	2.2	2.1
Trade	-0.2	0.0	0.0	0.1	0.7	0.7	0.7
Sea transport	0.5	0.3	0.8	1.0	1.6	1.8	1.8
Air transport	-0.1	0.3	0.3	0.3	1.2	1.3	1.3
Other transport	-0.4	0.2	0.2	0.2	1.1	1.2	1.2
Communication	-0.1	0.1	0.1	0.1	0.6	0.7	0.7
Financial services	-0.1	0.1	0.1	0.1	0.3	0.4	0.4
Other private services	-0.1	0.1	0.1	0.1	0.6	0.7	0.7
Government services	0.1	0.1	0.1	0.1	0.3	0.4	0.4

Definitions of scenarios: See notes on Table 4.

Source: Model simulations.

Table 5.3: Vietnam's sectoral output adjustments for the year 2030
(Percentage deviation from the baseline)

	Scenarios						
Sector	1	2	3	4A	4B	4C	4D
Rice	0.0	-0.5	-0.1	-0.1	0.0	0.1	0.2
Other grains	0.8	3.6	2.8	2.6	2.9	2.2	2.2
Sugar	0.6	0.0	0.6	0.8	0.9	0.8	0.8
Other crops	-1.3	-1.3	-1.5	-1.6	-2.5	-3.4	-3.4
Livestock	1.0	0.7	0.9	1.1	1.7	2.2	2.1
Fossil fuels	-0.3	-0.5	-0.4	-0.4	-0.7	-0.9	-0.9
Natural resources	1.1	1.7	1.5	1.6	2.4	2.9	2.9
Meats	-6.1	-28.7	-26.3	-26.1	-27.9	-32.9	-32.7
Dairy products	2.0	-6.5	-3.8	-2.9	-2.0	-4.2	-4.0
Other food products	-1.7	-2.8	-2.9	-2.6	-1.6	-2.4	-2.4
Textiles	16.6	55.4	45.2	43.7	53.5	58.4	58.4
Apparel	36.2	74.0	63.7	63.3	79.2	90.4	90.3
Wood and paper	-7.0	-0.8	-3.6	-5.0	-3.3	-5.9	-5.9
Petroleum products	-0.1	-2.7	-2.9	-0.8	0.2	-3.1	-3.0
Chemical products	11.5	15.2	15.5	16.0	21.0	22.9	23.1
Steel	14.6	14.0	16.5	17.0	20.3	21.6	21.8
Nonferrous metal	20.5	16.1	19.5	20.5	30.4	33.3	33.3
Metal products	15.4	13.8	16.2	17.7	25.7	33.8	33.8
Machinery	17.8	18.1	22.1	24.9	33.3	39.6	39.9
Electronic equipment	23.3	20.7	26.8	29.0	38.5	44.7	44.7
Motor vehicles	13.6	15.0	15.9	17.1	23.6	29.1	29.4
Other transport equip.	4.3	13.8	9.6	8.6	16.2	21.3	21.3
Other manufactures	7.6	17.3	13.4	13.1	19.3	22.8	22.7
Construction and utilities	14.4	16.6	15.4	16.4	22.8	30.7	30.6
Trade	5.3	7.7	7.3	7.5	10.0	12.8	12.8
Sea transport	17.5	18.9	17.8	19.2	26.4	35.7	35.7
Air transport	17.4	20.5	18.9	19.9	26.7	35.3	35.2
Other transport	8.6	11.4	10.1	10.3	13.5	16.9	16.9
Communication	5.0	8.6	8.4	8.3	9.9	10.9	10.9
Financial services	3.2	5.6	6.4	6.1	6.6	6.0	6.0
Other private services	3.9	5.4	5.8	5.8	7.1	8.6	8.6
Government services	1.0	0.0	0.8	0.9	1.2	1.5	1.4

Definitions of scenarios: See notes on Table 4.

Source: Model simulations.