The Contribution of Productivity Linkages to the General Equilibrium Analysis of Free Trade Agreements

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Abstract

Applied general equilibrium (AGE) analysis is often found to under-predict the increases in trade and economic growth that result from trade liberalization. One potential reason is that conventional AGE models ignore the strong correlations that exist between firm productivity, on the one hand, and exporting, importing, and investment, on the other. To examine this possibility, this study incorporates econometric evidence of these linkages into the dynamic Global Trade Analysis Project AGE model, and then uses this model to analyze a recently proposed East Asian free trade agreement. While conventional AGE modeling effects are found to predominate and be reinforced by the productivity effects, in some cases the latter actually reverse the changes predicted by the conventional effects.

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Despite the economic arguments in favor of conducting trade negotiations multilaterally under the auspices of the World Trade Organization (WTO), there have been more than 100 regional trade agreements signed since the WTO was created in 1995 (WTO, 2002). The European Union, for example, signed regional trade agreements with 20 nations between 1991 and 2001 – most of them developing countries (WTO, 2002). Not to be left out, the United States continues to explore the possibility of extending NAFTA (the North America Free Trade Agreement) further to the South, with a free trade agreement of the Americas as the ultimate goal. A free trade agreement between U.S. and Chile was recently concluded and discussions are under way with the Central American nations. Now the boom in regional agreements has spread to East Asia. Officials from ASEAN (the Association of South East Asian Nations) and China, for example, have endorsed the concept of a Free Trade Agreement (FTA) between those two regions. Japan, long a staunch advocate of multilateralism, concluded an FTA with Singapore in 2001, and is now actively negotiating other FTAs within the East Asian region, including potential agreements between: Japan and ASEAN, Japan and Korea, and even a Japan-Korea-China-ASEAN FTA.

Alongside this surge in interest in FTAs, there has been a corresponding increase in the number of quantitative analyses of such agreements. Most of these employ Applied General Equilibrium (AGE) models.[1] There are several reasons for this. In evaluating alternative models of NAFTA, Francois and Shiells (1994) conclude that AGE models are preferable to partial equilibrium approaches because the latter fail to capture the economy-wide nature of FTAs, in which some sectors expand while others contract due to competition for a common pool of labor and capital. The alternative of macro-econometric models for FTA analysis is less appealing because they generally lack sufficient sectoral detail. Additionally, since FTAs involve multiple countries by definition, it is natural to use a multi-region AGE model in these studies.

AGE-based FTA studies are not without criticism, however. For example, Kehoe (2002) has recently evaluated the AGE-based studies in the Francois and Shiells volume. He finds that they greatly underestimated the increases in trade resulting from NAFTA. This raises the question of whether there are important mechanisms that promote trade growth which are missed by AGE models. One recurring theme is that AGE models under-predict the changes associated

[1] These are also known as Computable General Equilibrium (CGE) models.

with FTAs because they ignore effects related to productivity linkages, procompetitive effects, and investment dynamics.

Many of these linkages are currently being studied in the empirical international trade literature, and we focus on three of them here. First, it is well known that more openness to *imports* may result in a reduction in firm's price-cost markups, and a movement of firms down their average total cost curve. This is often referred to as the "procompetitive effect" of trade liberalization (Markusen, 1981; Hertel, 1994).[2] Levinsohn (1993) offers evidence on such market disciplinary effects for Turkey, and a recent study by Ianchovichina et al. (2000) provides econometric evidence regarding the procompetitive effects of trade liberalization in Australia.

Second, *exporting* may also be associated with improvements in productivity (Bernard and Jensen, 2001). Newly opened foreign markets may enable domestic firms to expand such that they move down their average total cost curve. Overall productivity may also increase because only the most efficient firms survive in the new environment. Furthermore, there can be "learning by exporting", which relates to productivity improvements resulting from the knowledge and experience gained in export markets (Aw, Chung, Roberts, 2000). Although there is less theoretical literature to draw on than in the case of procompetitive effects, there is a great deal of new empirical work in this area. For example, a recent study by Bernard and Jensen (2001) provides statistical evidence of export-productivity links for U.S. firms.

Third, *foreign direct investment* (FDI) is another important channel through which trade liberalization can lead to increases in firm productivity (Blalock, 2001).[3] For example, a multinational may share new ideas and processes with the local firm, and try to improve the efficiency and quality of local upstream input suppliers. In addition to "vertical" technology spillovers of this type, there exist the possibility of "horizontal" spillovers, in which local firms copy the processes or hire away the staff of a competing firm acquired by a multinational (Blalock, 2001). A recent study by Chuang and Lin (1999) provides econometric evidence regarding FDI-productivity relationships of this sort in Taiwan. In addition, Hallward-Driemeier, Iarossi, and Sokoloff (2002) find strong correlations between FDI, exports, and firm productivity in five ASEAN nations, using detailed data from 2,700 manufacturing enterprises.

Since conventional AGE analyses of trade liberalization miss these potentially important effects, the purpose of our study is to explore their contribution in the context of one of the most important East Asian FTAs currently under negotiation, the Japan-ASEAN FTA. We carry this out with a suitably modified dynamic AGE model, and using the most recent econometric work in the burgeoning field of empirical international trade. However, given the uncertainty surrounding many of these studies as well as the difficulty in applying their findings to a specific FTA, our paper must be viewed as an exploratory effort aimed at understanding the *potential* impacts of these additional mechanisms. By identifying which of these effects is likely to be most important in determining the overall impact of a Japan-ASEAN FTA, we hope to provide a set of priorities for future policy-oriented econometric work aimed at refining the estimates used in this paper.

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[2] Another import-productivity channel relates to foreign intermediate inputs, which may be cheaper, of a different variety, higher quality, or more technologically advanced, thereby improving local firm productivity (Sjöholm, 1999).

[3] So-called "new age" FTAs tend to include measures designed to facilitate FDI among member countries. Furthermore, by reducing the cost of investment goods and boosting rental rates on capital, FTAs often increase FDI independent of any facilitation measures (Hertel, Walmsley, Itakura, 2001).

The remainder of this paper is organized as follows. In the next section, we outline the theoretical aspects of our methodology, including a description of the Dynamic GTAP model used in this study, and our implementation of the above productivity effects. We then describe the data used in this study as well as some key structural characteristics of the focus countries in the East Asia region. Following that is a brief description of the baseline projection and experimental design. We then proceed to an analysis of the importance of each new mechanism incorporated into this study. The final section summarizes and concludes.

I. EMPIRICAL FRAMEWORK

I.A Dynamic GTAP Model

Global AGE models account for intersectoral linkages within regions while capturing inter-regional trade flows, both of which are critical for the analysis of FTAs. The GTAP model of global trade, production and consumption (Hertel, 1997) is a relatively standard, applied general equilibrium model, in which products are differentiated by origin, firms operate under constant returns to scale, and perfect competition is assumed. Consumer demands are modeled with a Constant Difference of Elasticity (CDE) functional form that has been calibrated to own-price and income elasticities of demand from the literature. The GTAP data underlying the model feature extensive regional and sectoral coverage including disaggregation of service sectors and explicit treatment of international transport margins (Dimaranan and McDougall, 2002).

The Dynamic GTAP model was developed by Ianchovichina and McDougall (2001), and is a recursive-dynamic extension of the standard multi-region comparative static GTAP model. This dynamic formulation preserves the salient features of the standard GTAP model while incorporating international capital mobility and tracking cross-country asset ownership. In this way it captures important FTA effects on investment and wealth that are missed by purely static analyses. To track these components, the Dynamic GTAP model supplements the standard GTAP data base with foreign income data from the IMF *Balance of Payments* statistics.

A disequilibrium approach is used to model international capital mobility, which permits reconciliation of the theory of investment with observed reality. Economic theory suggests that saving is allocated across regions to those investments with the highest rate of return. With perfect capital mobility, rates of return must be equalized across regions, but in reality we do not observe this. Therefore we assume perfect mobility applies only in the very long run. Investment is the result of the gradual movement of rates of return to equality across regions.

A corollary of capital mobility theory is that if rates of return in a particular country are very low, investment will fall, and vice versa. Implementation of this theory with real world data leads to a dilemma, however. In many cases actual investment, as reported in the national statistics, does not correspond to that predicted by this theory. For example, observed rates of return may be low in some countries (e.g., China) while observed investment is high. Such discrepancies can be rectified in one of two ways: first, the data can be altered so that theory and data are consistent, or alternatively, the theory can be modified to more accurately reflect the real world. In the Dynamic GTAP model the latter method has been used, by incorporating errors in expectations about the actual rate of return. Thus, investment is the result of a gradual movement of expected rates of return to equality across regions, but the expected rate of return may differ from the actual rate of return due to errors in expectations.

In the Dynamic GTAP model, regional capital is owned by both domestic households and by foreign households via a "global trust". The saving of each regional household is then allocated either to domestic investment or to foreign investment. This allocation assumes that the shares of domestic and foreign investments are held constant, subject to the adding-up constraints required to ensure regional saving and investment constraints. This is consistent with empirical evidence that investors tend to invest in their home economies first, and then abroad. Explicit modeling of the ownership of regional investment allows for determination of the accumulation of wealth by foreigners. In addition, the ownership of domestic and foreign assets can also be tracked. Income accruing from the ownership of these foreign and domestic assets can then be appropriately incorporated into total regional income.

In this section we have seen that the Dynamic GTAP model captures a number of mechanisms missed in conventional comparative static AGE analyses of FTAs. We now turn to a description concerning how we implement the three new linkages into the Dynamic GTAP model. We begin with the "procompetitive effects" linkage, since this is the area with the greatest amount of theoretical support.

I.B Procompetitive Effects

Ever since the path-breaking work of Rick Harris (1984), it has become increasingly common to incorporate imperfect competition and scale economies into AGE models. Harris' work on the Canada-US FTA emphasized the potential gains in scale economies from disciplining domestic markups, forcing exit of many Canadian manufacturers and pushing the remaining firms down their average total cost curve. The potential importance of introducing these features in the context of the Japan-ASEAN FTA follows from the high degree of concentration in some of the ASEAN manufacturing sectors, as well as the inefficient scale of production in the import-competing manufacturing sectors of most developing countries (Devarajan and Rodrik, 1991).

A survey of the issues that arise in modeling imperfect competition in AGE models is offered by Francois and Roland-Holst (1997).[4] Once one chooses to move this direction, there is a bewildering array of choices that must be confronted: (a) entry or no-entry? (b) Bertrand or Cournot oligopoly, or perhaps Monopolistic Competition? (c) product differentiation by firm (Dixit-Stiglitz) or by nation (i.e. Armington)?, (d) market segmentation or integration? Empirical work to date offers very little basis for discriminating between these alternative specifications. Compounding this problem is the fact that, depending on the assumptions invoked, the findings can be reversed (e.g., Markusen and Venables, 1988). Once one has determined the appropriate market structure, there still remains the non-trivial task of model calibration to observed markups and unexploited scale economies. Finally, once scale economies enter the picture, computational problems loom large, with multiple equilibria becoming much more likely.

Of course, just because it is hard does not mean that such work should be avoided. It does mean, however, that work in this area requires careful theoretical consideration, and it must

[4] Francois (1998) has also made a wide variety of these approaches readily available within the GTAP framework.

be tailored to the issue at hand. In light of our overall objective, we choose to focus on those industries where there is the greatest likelihood of procompetitive effects stemming from the reduction of bilateral tariff under a Japan-ASEAN FTA. We first observe that a Japan-ASEAN FTA is likely to have little procompetitive effect on Japanese manufacturing, since Japanese tariffs are already very low, excepting for light manufactures where scale economies are unlikely to be significant, particularly given the size of the domestic market in Japan. On the other hand, manufactures tariffs in ASEAN are considerably higher (Table 3), domestic markets are smaller, and the presence of Japanese imports is quite important (Table 2). Thus we focus our attention in this paper on the potential for procompetitive effects in the ASEAN manufacturing sectors.

Within the ASEAN manufacturing sectors, we believe that those sectors which are already heavily involved in exporting (e.g. textiles and apparel in Thailand, Indonesia, Malaysia and Philippines, see Table 1) are likely to have few remaining unexploited scale economies. On the other hand, in the case of those industries where most domestic consumption is supplied by imports (e.g. automobiles in Indonesia, Table 1) and which are also protected by substantial tariffs, we expect significant potential for procompetitive effects. Therefore, we adopt a model of import-competing domestic industries and apply this to all ASEAN manufacturing sectors with less than 95% self-sufficiency ratios (see the boldface entries in Table 1).

The theoretical framework that we use here is that of oligopolistic competition in the presence of firm-level product differentiation (Hertel, 1994). Foreign firms are assumed to leave their markups unchanged, so the import price falls by the full amount of the tariff cut. Domestic firms incur fixed costs to produce a new variety, after which production is subject to constant returns to scale, so that average total costs decline with output. Furthermore, we assume that displaced domestic varieties will be replaced by similar imported varieties such that the varietal impact on consumer welfare from the FTA is negligible (Case III, Hertel 1994)[5].

With this model in mind, and simplifying the analysis to a two-sector, small, open economy model of one of the ASEAN economies, it can be shown (Hertel, 1994, Proposition 5) that welfare is an increasing function of the elasticity of the domestic markup with respect to the foreign price (b_{MF}). This elasticity is itself a function of the nature of the oligopoly (e.g. b_{MF} is larger for Cournot than Bertrand oligopoly), as well as the substitutability among varieties and market shares (Hertel, 1994, Table 2). The mechanism by which this welfare gain arises is precisely that described above: lower foreign prices discipline domestic markups and cause output per firm to increase, with some domestic firms exiting the industry to restore market equilibrium.

To be more precise, we have the following relationship between output per firm (q) and the power of the domestic markup (M) in the presence of domestic entry/exit: $\hat{q} = -\Omega_F^{-1}\hat{M}$, where ^ denotes percentage change and Ω_F is the share of fixed in total costs. With the total number of varieties on offer fixed, the equation for markups as a function of relative foreign (p_F) and home (p_H) prices is simply: $\hat{M} = b_{MF}(\hat{p}_F - \hat{p}_H)$, where b_{MF} is the markup elasticity with respect to the foreign price, as discussed above. Combining these yields:

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[5] Due to the "home bias" observed in the trade data, if we assumed otherwise, welfare would fall with the tariff cuts due to the high value placed on domestic varieties (e.g., Markusen and Venables, 1988). We do not believe that to be realistic in the case of Indonesian versus Japanese autos, for example.

$$\hat{q} = -\Omega_F^{-1} b_{MF} (\hat{p}_F - \hat{p}_H) \quad (1)$$

which shows that output per firm is directly related to the markup elasticity, scaled by the inverse of the share of fixed costs in production.

The presence of fixed costs, in conjunction with constant returns to scale in variable costs means that the elasticity of output with respect to composite inputs (z) is greater than one. In particular, we have: $\hat{q} = (1 - \Omega_F^{-1})\hat{z}$, where Ω_F^{-1} may be shown to equal the Cost Disadvantage Ratio (CDR) (Francois and Roland-Holst, 1997). So a reduction in tariffs lowers the price of competing foreign goods and so lowers markups, thereby boosting output per firm. The resulting efficiency gain, expressed as a percentage of sectoral output, is given by $\Omega_F \hat{q}$. Multiplying both sides of (1) by Ω_F, we can write the sectoral efficiency gain as a function of the markup elasticity and the percentage change in relative prices[6]:

$$efficiency = -b_{MF} (\hat{p}_F - \hat{p}_H) .$$

This reduced-form expression is incorporated into the Dynamic GTAP model to capture the essence of the procompetitive effects that might be available under a Japan-ASEAN FTA. In order to keep the focus on the *counterfactual* FTA impacts, we do not implement this specification in the baseline itself. Rather it only applies to *deviations* of foreign (p_F) and home (p_H) prices from the baseline price path.

The key factor in our empirical implementation of this model will be the size of b_{MF}. This could be obtained by *assuming* something about the oligopoly structure and number of firms in each imperfectly competing industry in ASEAN. Alternatively we could refer to recent empirical estimates of b_{MF}. In the spirit of this econometrically-based study, the latter approach is taken.

One study which estimates b_{MF} is that of Ianchovichina et al. (2000), who utilize a partial equilibrium model corresponding to the theoretical model discussed above. These authors focus on the behavior of the Australian auto industry during a period of deep tariff cuts – similar to those faced by ASEAN members under the proposed FTA. They obtain a fairly precise estimate of b_{MF} = 0.44 for this industry using quarterly data. This means that nearly half of a 1% decline in tariffs will be absorbed by reduced markups, which is quite significant. Indeed, in some simple, partial equilibrium simulations of tariff cuts in the Australian auto sector, Ianchovichina et al. (2000) conclude that a perfectly competitive model of this industry would likely overstate the output decline by 80%. That is, by ignoring this procompetitive effect, one might erroneously predict nearly twice as great a decline in output as would actually take place following a tariff cut. If this is indicative of the kind of impact that tariff cuts on Japanese imports would have on markups on ASEAN, then we need to give it further consideration.

6 For this procompetitive effect (as well as the export and investment effects) the "*efficiency*" variable is represented as ao(j,r) in the Dynamic GTAP model, which is the percentage rate of Hicks-neutral technical change in sector j of region r.

Of course, the auto industry tends to be a special case in the ASEAN economies, with very high rates of protection.[7] Additionally, since the markup elasticity depends on a number of factors, many of which are unobservable, there is no reason to believe that other sectors will have the same value of b_{MF}. Indeed, this is what Ianchovichina (1994) finds for several other sectors in the Australian economy, where her estimates for this markup elasticity are as follows: chemical fertilizers: 0.38, plastic materials: 0.22, steel pipes: 0.19, clay bricks: 0.0 and heating systems: 0.0. The high markup elasticity for autos is not surprising, since this is a highly protected, highly concentrated sector, selling a highly differentiated product. The fact that chemical fertilizers exhibit such a high markup elasticity is more an indication of market power in an industry with very high entry costs, as opposed to a highly differentiated product. Evidence on markups across industries, worldwide (Francois, 1998) reinforces the point that the chemicals sector tends to be quite imperfectly competitive. The same is true for steel products. On the other hand, it is hardly surprising that clay bricks show no markup elasticity. These are undifferentiated products with low barriers to entry.

Our approach to estimating b_{MF} for the import-competing sectors in ASEAN relies on outside information about the relative size of markups across industries in non-OECD economies (Francois, 1998). Our theoretical model shows that b_{MF} is increasing in the size of the industry markup, so we use this as a guide for setting the relative values of this elasticity across sectors within the ASEAN region. We next restrict the range of values for b_{MF} in our model to the estimates obtained from Ianchovichina (1994), namely 0.0 to 0.44. We then distribute the values of b_{MF} over this range, according to the relative size of the sectoral markups. The resulting estimates are as follows: 0.44 for chemical products, 0.40 for paper and wood products, 0.29 for metal products, 0.19 for the automotive sector, 0.19 for textiles/apparel/leather products, 0.13 for the machinery sector, and 0.13 for electrical equipment. Thus, the highest markups, and hence the largest procompetitive effects are in the chemical and wood products industries, followed by metal products. The other manufacturing sectors show lower markups, and hence receive a negligible procompetitive effect.

I.C. The Exporting Productivity Effect

In the case of the export-productivity linkage, there is little theoretical literature to draw on, and one confronts a fundamental problem of causality. Are exporters more productive because they export, or are they exporting because they are more productive? Bernard and Jensen (2001) attempt to control for this problem by looking at individual firms over time. They use a panel data set covering 50,000-60,000 individual manufacturing plants in the U.S. for the years between 1983-1992. They find that plants that *always* export during this time period are 8 - 9 % more productive than plants that *never* export, a result similar to those found in other studies (p. 9). While they find that exporting does not necessarily increase plant productivity growth rates, exporting is associated with the shifting of resources from less efficient to more efficient plants.

Of particular interest to our purposes here, they find that firms that start exporting tend to have productivity levels above those that never export during the period, although significantly below those who export throughout the period. As soon as firms begin exporting, however, their

[7] The average rate of automobile protection in ASEAN is 32.2%, as opposed to 5.8% for all other manufactures.

productivity grows until they nearly reach the level of firms that were exporting throughout the period (Bernard and Jensen, 2001, Fig. 1). At the same time, firms that were exporters at the beginning of the period, then *stop* exporting at some point, start out with high productivity but converge downward to the level of firms that never exported at all. This indicates that there may be some degree of *reversibility*, such that firm's relative productivity can diminish if they cease to export. Based on these findings, if we assume that the number of firms in an industry remains fixed, we have a situation in which the overall technological prowess of the industry will rise as exports rise, but will fall in concert with decreases in overall industry exports.

We incorporate this export-productivity linkage into our global AGE model as follows. Let $d > 1$ be the ratio of the technology index used for export-oriented firms relative to that of firms specializing in the domestic market only. Let s_X be the share of output that is exported, and s_D be the share of output that used domestically (note that $s_D + s_X = 1$). Furthermore, let $\hat{q}_X$ be the percentage change in output that is exported, and $\hat{q}_D$ be the percentage change in output that is used domestically. Then, as shown in Appendix 1, we can obtain an equation for the rate of change in overall productivity in the industry as a function of the productivity differential between exporters and domestic firms, and the differential growth in these two output markets:

$$efficiency = \frac{(d-1)s_X s_D(\hat{q}_X - \hat{q}_D)}{s_D + d\, s_X}.$$

Based on Bernard and Jensen's (2001) calculations and our definition of d, we calibrate the exporting sector to be 8% more productive, giving rise to $d = 1.08$. Therefore, when the rate of change in exported output exceeds that of output for domestic consumption ($\hat{q}_X > \hat{q}_D$), the average level of technology in the industry rises (i.e., the *efficiency* variable is positive). Note that this formulation can also induce efficiency losses when exported output declines relative to output for domestic consumption, since technological gains are reversible (as was found by Bernard and Jensen). As with the procompetitive effect, this efficiency effect is incorporated into the Dynamic GTAP model as a reduced form representation of the more complex underlying process by which exporting affects firm level productivity. Furthermore, this export-productivity linkage only applies to the export and output *deviations* from the baseline, not to the baseline itself.

I.D The FDI-Productivity Effect

Increased levels of foreign direct investment (FDI) have the potential to transfer technology and managerial skills to a host country, thereby enhancing productivity (Blalock, 2001). Some authors, such as Rodrik (1999), point out that there is little hard evidence for the more extravagant claims linking FDI and productivity. However, an increasing number of studies confirm that there are indeed significant, positive technological spillovers, even if we cannot always identify the precise mechanism through which this works. For example, in a study of FDI, research and development (R&D), and spillover efficiency in Taiwan, Chuang and Lin (1999) use firm level data to confirm the existence of beneficial spillovers from FDI. Specifically they find that a 1.0% increase in an industry's FDI ratio produces a 1.40% to 1.88% increase in domestic firm productivity.

As indicated earlier, in the Dynamic GTAP model regional capital is owned by domestic and foreign households via a global trust. This relationship is: $V = V_H + V_F$, where V is the equity value of firms in a given country, and V_H and V_F are the domestic- and foreign-held components of V, respectively. Thus we can write the foreign equity share as: $q_F \equiv V_F / V$. We use this as a proxy for the share of FDI in total capital stock. Since we want to relate productivity changes to changes in q_F, we totally differentiate this to get: $\hat{q}_F = \hat{V}_F - \hat{V}$. Using Chuang and Lin's (1999) lower bound estimate, we can write the percentage change in productivity associated with a capital inflow from abroad as:

$$efficiency = 0.014(\hat{V}_F - \hat{V}).$$

As with Chuang and Lin's study, we implement this reduced form relationship only for manufacturing sectors and incorporate it into the Dynamic GTAP model an additional equation determining the change in efficiency endogenously as a function of changes in the share of foreign ownership, owing to the FTA. We do not incorporate this productivity effect into the dynamic baseline. It only plays a role in the FTA counterfactual, and efficiency changing as a function of changes in the share of FDI, relate to the baseline.

II. DATA AND PROCEDURES

II.A Data and Aggregation

In this analysis we employ the GTAP Version 5 database, which has a base year of 1997 and distinguishes 57 sectors and 66 regions (Dimaranan and McDougall, 2002). Among its notable features are disaggregation of service sectors, and explicit treatment of international transport margins. We aggregate the GTAP data up to 23 sectors and 19 regions (see Appendices 2 and 3, respectively).[8] Our regional aggregation emphasizes the individual countries involved in the proposed Japan-ASEAN FTA. The GTAP data distinguish six ASEAN nations (Singapore, Indonesia, Malaysia, Philippines, Thailand, Vietnam), and when we refer to "ASEAN" below, we refer to these six only. While the GTAP data do not disaggregate Brunei, Cambodia, Laos, and Myanmar, these four nations comprise only 3.25% of ASEAN GDP (ASEAN, 2002).

II.B Trade Flows and Tariffs

In this section we use the aggregated GTAP data to provide an overview of the current trade and tariff relationships between Japan and ASEAN nations. The data indicate that while ASEAN depends on Japan for about 19% of overall imports, Japan gets only about 11% of its imports from ASEAN.[9] So despite their proximity, and dissimilarities in terms of endowments and technology (which may be a source of comparative advantage), these economies are not

[8] In certain tables of this paper, we use higher sector aggregates (e.g., Food & agriculture) to save space. Definitions are in Appendix 2. The analysis is otherwise done in terms of the 23 sectors.

[9] Japan's imports of goods and services from ASEAN nations totaled $52.3 billion in 1997, while Japan's imports from the rest of world (ROW) were $395.1 billion. ASEAN imported $81.2 billion from Japan, $276.2 billion from the ROW, and had $79.4 billion worth of trade within itself.

highly integrated, especially when compared to other regions such as Europe or North America. A deeper view of the current Japan-ASEAN trade relationship can be gained from Table 2, which breaks down the relative importance of merchandise trade with Japan for individual ASEAN members. The top half refers to the percent of ASEAN merchandise imports that originate in Japan. Clearly, Japan is not an important supplier of agriculture, resources, or light manufactures for ASEAN, as it supplies less than 10% of total imports in nearly all cases (Table 2). However, Japan is quite important as a source of high-technology manufactures. In the automotive sector Japan plays a particularly dominant role, with an import share of 60.9% for ASEAN overall. The bottom half of Table 2 depicts the relative importance of Japan as an export destination for the different ASEAN countries. Although this varies to a great degree across ASEAN countries, Japan generally plays a fairly large role as an export destination for ASEAN food and natural resource sectors. To the extent that comparative advantage is a driver of trade, it would appear that Japan and ASEAN are natural trading partners. Japan can play a role as a high-tech supplier, while the ASEAN countries as a group are presently well suited to meet Japan's need for resources, agriculture, and light manufactures.

Average tariff rates for all sectors are reported in Table 3. Japan is quite notable for its protection of food and agriculture (52.7% average tariff), which is driven to a large extent by protection of its rice market (rice has a tariff equivalent of 409%), and to a relatively lesser extent, its service sector (22.4% tariff equivalents). In contrast, Japan is fairly open with regard to light manufacturing (7.8% tariff), and its average tariff on high-tech manufactures is only 0.8%. ASEAN, on the other hand, is more open in food and agriculture compared to Japan, and more protective with regard to manufacturing. This is particularly the case for the automotive sector, where tariff equivalents range from 38% to 48% for Vietnam, Indonesia, Malaysia, and Thailand. So there appears to be a large degree of complementarity between the two regions in terms of the benefits that can accrue from reducing tariffs.

An alternative view of the level of protection is provided in Table 4, which reports a matrix of trade-weighted, bilateral tariffs across all commodities traded between country pairs. Looking first at Japan's column, its 1997 tariffs on goods and services from the ASEAN nations ranged from 1.3% for Singapore to 13.4% for Thailand. On the other hand, the top row reports ASEAN tariffs on Japanese exports. While Thailand's and Vietnam's tariffs on Japanese exports were relatively higher, other ASEAN nations appear to be fairly open, at least as far as the trade-weighted average tariff goes. Note that in our FTA simulation, all Japan-ASEAN tariffs are eliminated.[10] Clearly there will be a fair amount of Japan-Thailand and Japan-Vietnam trade response on the basis of the relatively large tariffs in place on both sides.

II.C Baseline Simulation

Our policy simulation results are obtained by comparing the counterfactual FTA policy scenario to our baseline. In order to have meaningful results, the baseline should reflect as closely as possible the changes in the world economy expected to occur over the period under study: 1997 to 2020. The baseline used in this paper is built upon the work of Walmsley, Dimaranan, and McDougall (2002). It contains information on macroeconomic variables as well

[10] Table 4 also displays intra-ASEAN tariffs for 1997. As shown in Appendix 4, these are reduced in our baseline scenario in the manner prescribed by ASEAN's Common Effective Preferential Tariff (CEPT) reduction program.

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. These projected macroeconomic variables were obtained for 211 countries over the period for 1997 to 2020. These projections for population, investment, skilled labor, and unskilled labor were aggregated, and growth rates were calculated to obtain the macro shocks describing the baseline. Changes in capital stocks were not imposed exogenously, but rather 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 (these are summarized in Appendix 4). The policies included in the baseline are those which are already agreed upon and legally binding (e.g. Uruguay Round commitments and China's WTO accession). Uruguay Round tariff commitments are assumed to be honored by all countries. China and Taiwan's accession to the WTO is phased in two periods: a period of pre-WTO tariff reduction for 1997-2001, and the period from 2002-2020. This accession also gives them quota free access to the North American and European textile and apparel markets by 2007. However, the liberalization of these quotas is assumed to be heavily back-loaded with most of the liberalization occurring after 2002. The CEPT preferential tariff reduction program among ASEAN members, and the Japan-Singapore FTA have also been incorporated in the baseline.

II.D Experimental Design

Once the baseline has been established, we are able to explore the impact of counterfactual policy simulations. Our simulations of the Japan-ASEAN Free Trade Agreement involve four different model specifications, aimed at identifying the most important potential sources of productivity gain. Simulation (a) involves complete elimination of tariffs among all countries involved in the Japan-ASEAN FTA (as well as removal of service trade barriers), but does not allow for the three new linkages described earlier. As such, it represents the standard types of effects that a conventional, dynamic AGE model would capture, including allocative efficiency, investment reallocation, and accumulation of capital stocks, as well as terms of trade effects. The remaining three simulations extend the first simulation (a) by adding the three additional modeling effects one at a time. Simulation (b) adds export-productivity effects, simulation (c) adds procompetitive effects, and simulation (d) adds FDI-productivity effects. These additions are cumulative in nature, and therefore simulation (d) includes all three additional effects.

III. RESULTS

We begin this section by introducing some shorthand notation regarding the productivity linkages we incorporate into our analysis. In the tables discussed below, columns labeled "STD" are meant to represent the difference between the baseline simulation, and simulation (a). As such, "STD" refers to the effects normally captured by standard dynamic AGE models, including allocative, investment, and terms of trade effects. Next, "EXP" is the difference between simulations (a) and (b), and captures productivity effects related to the potential expansion of export-oriented firms under an FTA. "IMP" is the difference between simulations (b) and (c), and captures procompetitive effects related to the exposure of local, imperfectly competitive firms to foreign competition. Finally, "FDI" is the difference between simulations (c) and (d), and refers to productivity effects related to foreign investment in local firms.

III.A Welfare and GDP Impacts of the FTA

Table 5 reports regional welfare changes in the year 2020 resulting from the hypothesized Japan-ASEAN free trade agreement. "Welfare" is defined as the percentage change in utility of a representative regional household in 2020 owing to the FTA. Consider first the change in welfare with all effects in place (i.e., the results of simulation (d)). These are reported in the "Total" column of Table 5. It is seen that all of the member nations experience an increase in welfare relative to the baseline. In relative terms, Thailand has the most to gain from a Japan-ASEAN FTA, with a welfare level that is 3.32 percentage points above the baseline scenario. For ASEAN nations as a whole, the welfare gain is 1.04 percentage points over the baseline, with Japan having a lower figure of 0.23 percentage points. The nations that face relatively low barriers in Japan prior to the FTA, including Indonesia, the Philippines, and particularly Singapore (Table 4), tend to experience smaller improvements in welfare (0.26, 0.24, and 0.46 percentage points, respectively).

We can also examine how these results would differ had we not incorporated the additional productivity linkage effects. Refer to the following columns in Table 5: "STD" (standard AGE modeling effects resulting from the tariff cuts), "EXP" (the export-productivity effect), "IMP" (the procompetitive effect), and "FDI" (the FDI-productivity effect). In terms of utility, the contributions of these extra effects are generally significant. In fact, we see that only 25% of the welfare change in ASEAN is related to standard AGE modeling effects (see values within parenthesis in the STD column). This figure is higher for Japan (86%), due to the absence of procompetitive and FDI effects for that country. Thailand shows the largest overall relative gains. Here, the most important channel for welfare change is the FDI-productivity effect (1.34 out of 3.32 percentage points), in which higher levels of foreign ownership following the FTA led to improvements in domestic firm productivity.

We now move on to other macroeconomic results presented in Table 6. Like Table 5, these changes are given as percentage point differences from the baseline, allowing us to gauge differences in relative terms. We first focus on the total change in GDP (the other variables in Table 6 will be discussed in later sections). While Japan's 2020 GDP is only 0.14 percentage points higher than in the baseline scenario, ASEAN's overall change is significantly higher (3.66 percentage points), with Thailand having the largest change by far (12.41 percentage points).[11] In Thailand, most of the change is due to conventional AGE modeling effects (STD), followed by the FDI-productivity effect and the procompetitive effect. This is because Japan has notably high overall tariffs with respect to Thailand, and Thailand also displays relatively high tariffs with respect to Japan (Table 4).

Figure 1 offers a temporal perspective regarding the changes in Thailand's GDP. Here, deviations from the baseline attributed to each effect are provided separately. Begin by looking at the year 2006, the first year of the prospective FTA. There we see that without the procompetitive effect (IMP), we would have underestimated Thailand's GDP change from the

[11] The small change in Singapore's GDP (0.18 percentage points) reflects the fact that it has already formed an FTA with Japan, and thus does not benefit to the extent that other ASEAN nations do.

baseline by 0.8 percentage points. While initially the procompetitive effect is the most important driver of Thailand's GDP difference, by 2007 conventional AGE effects (STD) in the form of added investment take over as the most important contributor. Also observe that the FDI-productivity link (FDI) is unimportant in the first several years after implementation of the FTA, but continuously grows in importance along with the increased foreign investment until it is the second largest contributor to the growth in GDP by 2020. The sum contribution of all three additional productivity effects to GDP is 5.45 percentage points over Thailand's baseline level in 2020, compared to 6.96 percentage points from the standard effects alone. On this basis it would appear that the productivity effects that are normally ignored in AGE analysis may indeed be important in the analysis of the Japan-ASEAN FTA, although one must bear in mind that these effects were somewhat more pronounced in Thailand than in the other nations (recall Table 6).

III.B Effects on Trade and Foreign Capital Ownership

Looking back at Table 6 we see that a Japan-ASEAN FTA results in higher overall imports and exports for all ASEAN nations, as well as Japan. Thailand has the largest increases, which are 15.44 and 23.96 percentage points over the baseline for imports and exports, respectively. In ASEAN most of the changes in trade volumes are due to conventional AGE modeling effects (STD). Thus relatively little is missed by ignoring effects on productivity arising from increased exports, imports, and foreign ownership of firms.

Table 7 presents a sectoral decomposition of the changes in Japan-ASEAN trade resulting from the FTA. The upper half reports the differences over the baseline regarding exports from ASEAN to Japan.[12] Not surprisingly, the FTA leads to a great deal more trade in nearly every category. In relative terms, the biggest boost comes from increased exports of leather products (159 percentage points over the baseline, or $709 million). In absolute terms, the biggest trade increase is in the Food and agricultural products, which increases by $5,064 million (77.5 percentage points) over the baseline, followed by Electrical equipment ($4,537 million, 15.7 percentage points) and Machinery ($2,789 million, 24.7 percentage points). In all of these cases the increases are related mainly to standard AGE modeling effects (STD).

Exports from Japan to ASEAN are given a big boost in general (lower half of Table 7). In absolute terms, the largest change derives from an increase in chemical exports by $12,018 million (33.0 percentage points). In relative terms, exports of textile and apparel products have the largest increase, at 187.5 percentage points ($1,264 million). In both cases, the majority of the change results from standard effects relating to the tariff cuts. This is related to the fact that Thailand and Vietnam had particularly large initial tariffs in these particular sectors (Table 3). (For a disaggregation of Table 7, see also Reviewer Appendix Table 1 and Table 2.)

Recall from Table 6 that implementation of the Japan-ASEAN FTA results in higher capital stocks for all the countries involved in the FTA. For these increased capital stocks, it is of interest to focus on the change in foreign ownership since this is hypothesized to drive the efficiency gain. Table 8 reports the change in share of foreign capital ownership by 2020, compared to the baseline. A free trade agreement between Japan and ASEAN attracts investment from abroad to all the countries involved in the FTA, resulting in higher share of foreign capital

[12] Of course, changes involving ASEAN exports to Japan coincide exactly with changes involving Japanese imports from ASEAN.

ownership. For Thailand the share of capital owned by foreign investor increases by 5.29 percentage points, relative to the baseline. The figure for Vietnam is 1.4 percentage points, while the remaining changes in foreign ownership share are all less than one percent. The conventional AGE modeling effects (STD) account for the majority of the increase, but the procompetitive effects (IMP) and FDI-productivity effects (FDI) also contribute at considerable amount, particularly in Thailand and Vietnam.

III.C Effects on Efficiency

Table 9 reports the sectoral efficiency gains in the manufacturing sectors for ASEAN countries by 2020. These values reflect the combined impact of the export-productivity, procompetitive, and the FDI-productivity effects (they are decomposed in Reviewer Appendix Table 3). Here we see that the automotive industries of Thailand and Vietnam have the largest gains, at 4.50 and 3.44 percentage points over the baseline, respectively. Recall in Table 1 that the self-sufficiency ratios for these sectors were well below 95%, so the procompetitive effects were active and indeed account for the largest source of efficiency gain in these cases (Reviewer Appendix Table 3). While most ASEAN manufacturing industries attain higher efficiency levels due to the Japan-ASEAN FTA, some countries have sectors for which the agreement has no impact. Interestingly, there are even slight reversals in efficiency for a few cases. This happens, for example, in Vietnam's electrical equipment sector (Table 9). In this case, it is the import-productivity (IMP) linkage coupled with the FDI-productivity linkage that gives rise to the technology reversal. Following the FTA, a drop in foreign investment in the Vietnamese electrical equipment sector, and a re-orientation of the existing firms toward the domestic market, both contribute to a slight loss in overall sectoral productivity (Reviewer Appendix Table 3).

III.D Effects on Sectoral Output

Finally, we move on to consider changes in sectoral output relating to the hypothesized Japan-ASEAN FTA. Table 10 provides this information for ASEAN in both absolute and relative terms, for the final year of the simulation, 2020. In general, there are output increases in every sector in ASEAN. Electrical equipment shows the largest increase in output over the baseline: $44,451 million, or 10.2 percentage points under the total column. Moving across the columns of Table 10, we see that more than half of this increase is related to conventional AGE modeling effects (almost $30 billion, 6.85 percentage points), with the procompetitive effect contributing a difference of $6.4 billion from the baseline (1.46 percentage points), and the FDI-productivity effect contributing $7.9 billion (1.8 percentage points). Chemical products and the automotive sector offer two interesting cases. Here, we observe negative impacts under the standard AGE closure (STD) (-$568 million or -0.32 percentage points, and -$1,805 million or -2.95 percentage points, respectively). In both of the sectors, the procompetitive effects (IMP) together with the FDI-productivity effects (FDI) are positive and large enough to reverse the overall output changes. While these additional effects are important particularly for Chemical products and automotive, it is nevertheless the conventional AGE effects related to Japan's tariffs that are the most important reason for the increase in output for most of the sectors.

Outside of the manufacturing sectors, output by ASEAN's Food and agricultural sector grows by $3.6 billion (0.96 percentage points) over the baseline, and the corresponding value for the Service sector is $32.7 billion (2.04 percentage points) over the baseline. ASEAN's Natural Resources sectors have much smaller changes. As with the manufacturing sectors, it is generally the conventional AGE effects (STD) that drive most of the changes in output related to implementation of the FTA. (For a disaggregation of Table 10, see also Reviewer Appendix Table 4.)

IV. SUMMARY AND CONCLUSIONS

Applied general equilibrium (AGE) models are extensively used in the evaluation of free trade agreements (FTAs), but they have often under-predicted the increases in trade and economic growth that followed FTA implementation (Kehoe, 2002). Meanwhile, there have been a surge of new empirical trade studies demonstrating that there are strong correlations between firm productivity, on the one hand, and exporting, importing, and investment, on the other. Since increasing these flows is a key objective of most FTAs, this raises the question: Might these additional productivity linkages have a significant impact on AGE-based analyses of FTAs? To test this hypothesis, we generalize the Dynamic GTAP model to allow for the productivity enhancing effects of import competition, increased exports, as well as FDI-productivity linkages. We then incorporate the best econometric evidence currently available and proceed to examine one of the most important FTAs currently under consideration, namely the Japan-ASEAN FTA.

In general, we find that this FTA will result in increases in trade for most sectors of the countries involved, and that the welfare of all participating countries will improve. By far the largest proportional gains accrue to Thailand which currently has rather high bilateral tariffs on its trade with Japan. Importantly, we find that the effects normally captured by standard AGE models still play a key role in driving the results. Our conventional, dynamic AGE model captures more than half of the ensuing GDP and trade changes. Overall, we find that the procompetitive and FDI-productivity linkages were the most important, with the export-productivity linkage playing a minor role. These added effects generally serve to reinforce the direction predicted by the standard AGE model. However, addition of the procompetitive effects does lead to aggregate output increasing instead of falling in the case of the two most imperfectly competitive sectors in the ASEAN region: chemicals and automobiles. Therefore, further refinements of the associated econometric estimates would be very worthwhile.

We can think of several ways that our results could be changed by future research. For example, the elasticity of productivity response to FDI employed was only 1.4 percent, and the estimate concerning the higher productivity of exporting firms was only 8 percent. It seems likely that these figures may be higher for the specific countries examined in this study, particularly those within ASEAN. Future econometric research concerning these parameters for the specific countries examined would facilitate the analysis of FTAs using the framework developed in this paper. Additionally, sensitivity analysis concerning these parameters (perhaps based on econometric standard errors) would also aid in the progression of this literature.

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Figure 1. Effect of Japan-ASEAN FTA on GDP, Thailand, Relative to Baseline

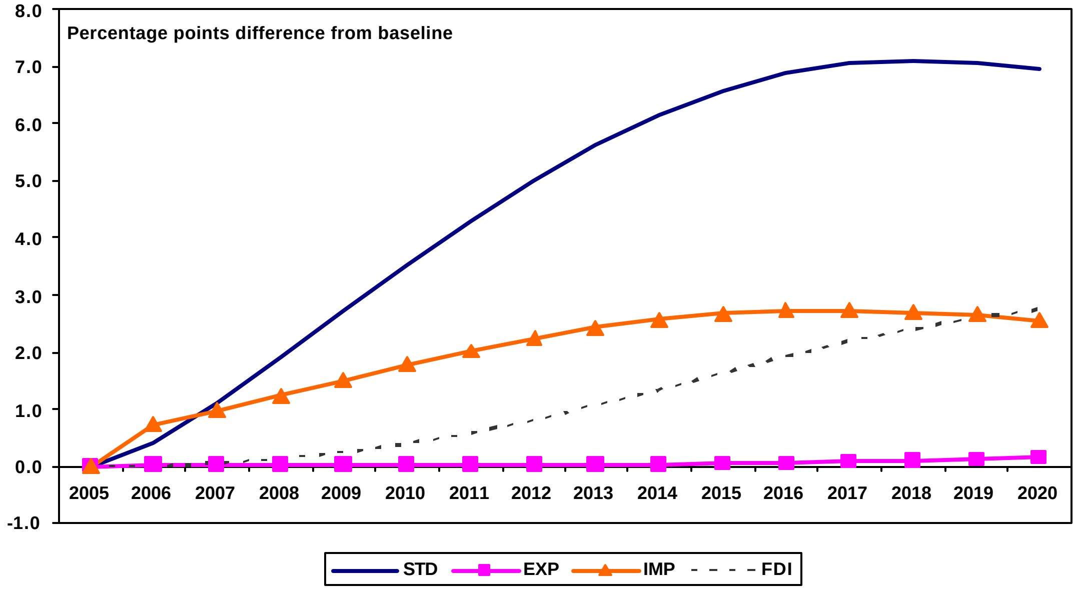

Table 1. Self Sufficiency Ratios, 1997

Sector	Thailand	Indonesia	Malaysia	Philippines	Vietnam	Singapore
Textiles/apparel	122	154	124	113	**77**	**51**
Leather	180	573	**60**	143	367	**39**
Paper/wood	100	170	144	**90**	99	**87**
Chemical products	**93**	**87**	**91**	**70**	**38**	97
Metal products	**52**	**68**	**58**	**59**	**36**	**56**
Automotive	**75**	**39**	**63**	**27**	**5**	**50**
Machinery	**71**	**39**	**55**	**36**	**36**	**60**
Electrical equipment	134	100	158	116	**53**	130

Notes: Values represent the percent that domestic production has of total use. Boldface entries indicate self sufficiency below 95%.

Table 2. Relative Importance of Japan in ASEAN Merchandise Trade, 1997 (%)

	ASEAN	Singapore	Indonesia	Malaysia	Philippines	Thailand	Vietnam
	Percent of all ASEAN imports coming from Japan						
Food & agriculture	2.1	2.9	0.7	1.0	1.8	4.1	2.4
Nat. resources	0.3	0.1	1.1	0.8	0.1	0.3	3.9
Textiles/apparel	9.5	6.0	12.3	8.3	8.2	12.7	10.7
Leather	2.0	1.4	1.0	0.8	4.1	4.5	1.3
Paper/wood	8.6	7.1	9.2	11.1	6.6	9.3	5.1
Chemical products	16.4	14.1	15.7	15.9	18.8	24.4	8.2
Metal products	25.8	21.5	26.1	27.9	18.9	33.0	11.0
Automotive	60.9	33.6	59.8	61.1	64.6	74.1	59.8
Machinery	28.5	26.1	32.0	25.6	27.5	34.2	19.9
Electrical equip.	21.0	18.3	25.1	18.2	31.4	24.7	18.4
	Percent of all ASEAN exports going to Japan						
Food & agriculture	18.2	7.9	20.5	6.5	22.8	26.0	22.9
Nat. resources	37.5	19.2	39.8	34.0	68.8	8.0	37.2
Textiles/apparel	9.9	2.7	8.6	7.8	5.8	9.7	34.8
Leather	6.0	9.3	6.4	1.7	4.5	3.9	8.2
Paper/wood	25.7	7.8	29.1	24.9	19.2	30.1	27.8
Chemical products	9.0	5.2	11.1	8.5	17.2	15.1	11.2
Metal products	15.6	6.0	35.8	11.3	16.9	19.0	20.6
Automotive	11.9	0.7	25.6	4.6	31.3	16.1	40.0
Machinery	11.7	5.7	19.2	10.4	23.0	15.6	16.9
Electrical equipment	9.2	7.6	12.6	7.5	13.5	13.9	8.8

Table 3. Average Sectoral Tariff Rates, 1997 (%)

	Japan	ASEAN	Indonesia	Malaysia	Philippines	Thailand	Vietnam	Singapore
Food & agriculture	52.7	15.8	9.0	21.0	17.5	31.3	32.3	4.3
Natural resources	-1.0	0.7	2.8	1.1	1.0	0.8	4.6	0.0
Light mnfcs	7.8	11.5	11.3	12.5	12.9	19.9	29.0	0.0
High-tech mnfcs	0.8	5.4	8.7	5.3	5.6	13.1	14.1	0.0
Merchandise total	7.0	5.2	6.9	5.5	5.3	11.5	16.5	0.2
Services	22.4	6.0	6.9	5.2	6.0	5.9	6.2	0.0

Note: Average tariffs on service sectors are estimated tariff equivalents.

Table 4. Average Trade Weighted Bilateral Tariffs, 1997 (%)

	Japan	Singapore	Indonesia	Malaysia	Philippines	Thailand	Vietnam
Japan	..	0.0	9.6	8.4	6.2	16.8	17.5
Singapore	1.3	..	4.5	5.1	4.5	11.2	15.3
Indonesia	5.4	0.2	..	11.0	7.8	15.4	9.4
Malaysia	1.9	0.2	7.9	..	5.5	11.4	18.6
Philippines	5.5	0.2	3.6	2.3	..	8.3	4.4
Thailand	13.4	0.2	8.3	7.4	3.9	..	23.6
Vietnam	11.4	0.6	3.5	24.8	19.0	10.9	..

Table 5. Overall Welfare Effects, 2020

Region	Total	STD (% of total)	EXP	IMP	FDI
ASEAN	1.04	0.26 (25)	0.05	0.35	0.38
Indonesia	0.26	0.11 (42)	0.04	0.07	0.05
Malaysia	0.47	-0.06 (-12)	0.06	0.32	0.14
Philippines	0.24	0.13 (54)	0.02	0.07	0.03
Thailand	3.32	0.82 (25)	0.10	1.06	1.34
Vietnam	0.62	0.22 (36)	0.01	0.25	0.14
Singapore	0.46	0.15 (33)	0.01	0.14	0.16
Japan	0.23	0.20 (86)	0.01	0.01	0.02

Note: These values represent percentage point differences from the baseline scenario in 2020. Figures in parenthesis are percentage contribution of standard AGE model effects to overall welfare change. Abbreviations are as follows: Standard AGE modeling effects (STD), Export-productivity effect (EXP), Procompetitive effect (IMP), FDI-productivity effect (FDI).

Table 6. Effect of Japan-ASEAN FTA on Selected Macro Variables, 2020

Effect	GDP	Imports	Exports	Capital	GDP	Imports	Exports	Capital
	Japan				**ASEAN**			
Total	0.14	2.83	1.54	0.27	3.66	4.03	6.24	5.71
STD	0.15	2.73	1.54	0.29	2.06	2.79	4.46	3.61
EXP	0.01	0.02	0.02	0.01	0.08	0.07	0.07	0.08
IMP	-0.01	0.02	-0.03	-0.02	0.77	0.43	0.98	1.08
FDI	0.00	0.06	0.02	-0.01	0.75	0.73	0.73	0.93
	Indonesia				**Philippines**			
Total	0.53	1.27	3.28	1.23	0.99	2.35	2.84	2.23
STD	0.33	1.10	2.92	0.93	0.83	2.21	2.62	1.93
EXP	0.06	0.07	0.12	0.10	0.03	0.04	0.04	0.03
IMP	0.08	0.04	0.13	0.11	0.10	0.06	0.14	0.19
FDI	0.06	0.05	0.11	0.08	0.04	0.05	0.04	0.07
	Malaysia				**Thailand**			
Total	1.56	2.46	3.36	2.26	12.41	15.44	23.96	16.22
STD	0.73	1.91	2.59	1.26	6.96	10.15	16.44	10.19
EXP	0.12	0.07	0.09	0.14	0.15	0.21	0.09	0.12
IMP	0.47	0.20	0.34	0.55	2.56	1.77	4.11	3.03
FDI	0.24	0.29	0.35	0.30	2.75	3.31	3.33	2.88
	Singapore				**Vietnam**			
Total	0.18	0.99	0.58	0.30	2.72	4.93	11.11	4.62
STD	-0.10	0.38	0.19	-0.23	2.04	4.98	8.27	3.10
EXP	-0.02	0.01	0.00	-0.01	0.06	-0.04	0.43	0.01
IMP	0.18	0.30	0.22	0.32	0.50	-0.45	3.22	1.28
FDI	*0.12*	*0.30*	*0.17*	*0.21*	*0.12*	*0.44*	*-0.81*	*0.23*

Note: These values represent percentage point differences from the baseline scenario in 2020.

Table 7. Change in Trade Volume Between ASEAN and Japan Due to Japan-ASEAN FTA, 2020

	Total	STD	EXP	IMP	FDI
	Exports from ASEAN to Japan				
Food and ag.	5,064 (77.5)	5,250 (80.3)	-13 (-0.2)	-73 (-1.1)	-99 (-1.5)
Nat. resources	-613 (-4.0)	-512 (-3.3)	-9 (-0.1)	-51 (-0.3)	-41 (-0.3)
Textiles/apparel	1,458 (73.3)	1,362 (68.5)	13 (0.7)	50 (2.5)	34 (1.7)
Leather	709 (159.0)	687 (153.9)	3 (0.6)	19 (4.2)	1 (0.3)
Paper/wood	1,149 (16.2)	1,087 (15.4)	19 (0.3)	19 (0.3)	25 (0.3)
Chemical products	359 (14.3)	221 (8.8)	3 (0.1)	114 (4.5)	21 (0.8)
Metal products	635 (18.8)	476 (14.1)	16 (0.5)	109 (3.2)	33 (1.0)
Automotive	261 (45.3)	157 (27.3)	1 (0.2)	90 (15.6)	12 (2.1)
Machinery	2,789 (24.7)	2,234 (19.8)	51 (0.5)	238 (2.1)	266 (2.4)
Electrical equip ment	4,537 (15.7)	3,327 (11.5)	25 (0.1)	539 (1.9)	645 (2.2)
Services	1,206 (11.6)	1,151 (11.1)	-5 (-0.0)	114 (1.1)	-54 (-0.5)
	Exports from Japan to ASEAN				
Food and ag.	532 (52.9)	491 (48.9)	1 (0.1)	18 (1.8)	22 (2.2)
Nat. resources	170 (21.3)	132 (16.5)	1 (0.1)	19 (2.4)	17 (2.2)
Textiles/apparel	1,264 (187.5)	1,258 (186.5)	4 (0.6)	12 (1.7)	-10 (-1.4)
Leather	32 (118.0)	32 (116.3)	0 (0.2)	0 (1.2)	0 (0.3)
Paper/wood	550 (62.7)	541 (61.7)	-1 (-0.1)	5 (0.6)	4 (0.5)
Chemical products	12,018 (33.0)	11,926 (32.7)	32 (0.1)	-161 (-0.4)	221 (0.6)
Metal products	7,524 (47.8)	6,972 (44.3)	24 (0.2)	184 (1.2)	343 (2.2)
Automotive	8,850 (70.1)	8,993 (71.3)	15 (0.1)	-348 (-2.8)	191 (1.5)
Machinery	11,474 (36.5)	10,690 (34.0)	56 (0.2)	243 (0.8)	485 (1.5)
Electrical equip ment	3,446 (18.1)	3,245 (17.1)	2 (0.0)	106 (0.6)	93 (0.5)
Services	312 (8.2)	258 (6.8)	2 (0.1)	12 (0.3)	40 (1.0)

Notes: Values represent differences in 1997 US$ million from baseline scenario in 2020. Values in parenthesis represent the corresponding percentage point differences.

Table 8. Change in Share of Foreign Capital Ownership, 2020
(percent of total capital ownership)

	Total	STD	EMP	IMP	FDI
Indonesia	0.003	0.002	0.001	0.00	0.00
Malaysia	0.05	0.03	0.00	0.01	0.01
Philippines	0.82	0.71	0.01	0.08	0.03
Thailand	5.29	3.15	0.05	0.96	1.14
Vietnam	1.40	0.98	0.00	0.36	0.07
Singapore	0.03	-0.08	0.00	0.06	0.04
Japan	0.07	0.08	0.00	-0.01	0.00

Table 9. ASEAN Sectoral Efficiency Gains, 2020 (%)

Sector	Thailand	Indonesia	Malaysia	Philippines	Vietnam	Singapore
Textile/apparel	0.86	0.08	0.15	0.05	0.06	-0.01
Leather	0.93	0.08	0.08	0.08	-0.02	0.02
Paper/wood prod.	0.83	0.15	0.19	0.28	0.04	0.13
Chemical products	2.40	0.32	0.78	0.20	0.50	-0.05
Metal products	1.33	0.43	0.27	0.16	0.00	0.04
Automotive	4.50	0.73	2.02	0.78	3.44	-0.02
Machinery	0.73	0.22	0.11	0.12	0.14	0.04
Electrical equipment	0.94	0.21	0.10	0.02	-0.06	0.00

Note: These changes are due solely to the EXP, IMP, and FDI effects.

Table 10. Sectoral Output Changes in ASEAN, 2020

	Total	STD	EXP	IMP	FDI
Food and ag.	3,595 (0.96)	3,539 (0.95)	2 (0.00)	143 (0.04)	-89 (-0.02)
Nat. resources	311 (0.22)	228 (0.16)	14 (0.01)	46 (0.03)	23 (0.02)
Textiles/apparel	6,436 (9.14)	4,505 (6.40)	84 (0.12)	824 (1.17)	1,024 (1.45)
Leather	1,515 (12.50)	1,199 (9.89)	20 (0.17)	185 (1.53)	111 (0.91)
Paper/wood	4,051 (3.92)	2,635 (2.55)	145 (0.14)	570 (0.55)	701 (0.68)
Chemical products	4,226 (2.38)	-568 (-0.32)	185 (0.10)	3,127 (1.76)	1,483 (0.83)
Metal products	4,673 (5.90)	1,839 (2.32)	195 (0.25)	1,622 (2.05)	1,016 (1.28)
Automotive	2,228 (3.64)	-1,805 (-2.95)	163 (0.27)	2,445 (4.00)	1,425 (2.33)
Machinery	24,300 (10.45)	15,632 (6.72)	668 (0.29)	3,495 (1.50)	4,505 (1.94)
Electrical equipment	44,451 (10.20)	29,865 (6.85)	347 (0.08)	6,380 (1.46)	7,860 (1.80)
Services	32,702 (2.04)	19,083 (1.19)	714 (0.04)	6,540 (0.41)	6,364 (0.40)

Notes: Values represent differences in 1997 US$ million from baseline scenario in 2020. Values in parenthesis represent the corresponding percentage point differences.

Appendix 1. Derivation of the Exports-Productivity Expression

We begin with the identity: $A_O Q_O \equiv A_D Q_D + A_X Q_X$, where A_O is an index of an industry's technology, A_D represents technology used by local market firms, and A_X is technology used by export firms. Q_O, Q_D, and Q_X indicate the total output, the output for the domestic market, and output for export. Normalize such that $A_D \equiv 1$, and let $d \equiv A_X / A_D$. We then re-write the above identity as: $A_O Q_O = Q_D + dQ_X$. Totally differentiate to get: $A_O dQ_O + Q_O dA_O = dQ_D + ddQ_X$. Divide through by $A_O Q_O$, let $s_D \equiv Q_D / Q_O$ and $s_X \equiv Q_X / Q_O$, and multiply both sides by 100 to get:

$$\hat{q}_O + \hat{a}_O = \frac{\hat{q}_D s_D}{A_O} + d\left(\frac{\hat{q}_X s_X}{A_O}\right), \quad (1)$$

where the lower case symbols with hats refer to percentage changes (e.g., $\hat{q}_O = (dQ_O / Q_O) \times 100\%$). Based on the earlier identity we can also derive: $A_O = s_D + d\, s_X$. Using this we can restate (1):

$$\hat{a}_O = \frac{s_D \hat{q}_D + d s_X \hat{q}_X}{s_D + d\, s_X} - \hat{q}_O \quad (2)$$

Using the identity $Q_O \equiv Q_D + Q_X$ we can totally differentiate and show that $\hat{q}_O = s_D \hat{q}_D + s_X \hat{q}_X$, which can be plugged into (2). With algebraic manipulation and the fact that $s_D + s_X = 1$, we obtain the equation for the rate of change in overall productivity as a function of the productivity differential between exporters and domestic firms and the differential growth in these two markets for output:

$$efficiency = \hat{a}_O = \frac{(d-1) s_X s_D (\hat{q}_X - \hat{q}_D)}{s_D + d\, s_X}.$$

Appendix 2. Aggregation of GTAP Version 5 Database Sectors

.Table A.2.1 Aggregation of GTAP Version 5 Database Sectors

No.	Sectors in this study	57 GTAP sectors
1	Rice	Paddy rice, Processed rice
2	Grains	Wheat, Cereal grains nec
3	Othcrops	Veg., fruit, nuts; Oil seeds; Sugar; Fibers; Crops nec; Wool, silk-worm cocoons
4	Meat	Cattle,sheep,goats; Animal products nec; Meat products nec
5	Othfood	Raw milk; Veg. oils and fats; Dairy; Sugar; Food products nec; Bev & tobacco
6	Forestry	Forestry
7	Fish	Fishing
8	Extract	Coal, Oil, Gas, Minerals nec
9	Texwap	Textiles, wearing apparel
10	Leather	Leather products
11	Paperwood	Wood products; Paper products, publishing
12	Chemical	Petroleum, coal products; Chemical,rubber,plastic prods; Mineral products nec
13	Metal	Ferrous metals; Metals nec; Metal products
14	Auto	Motor vehicles and parts
15	Machinery	Transport equipment nec, Machinery and equipment nec, Manufactures nec
16	Electrequip	Electronic equip.
17	Othservice	Electricity; Gas; Water; Business services nec; Recr. and oth. services; Dwellings
18	Construction	Construction
19	Trade	Wholesale/retail trade
20	Transport	Transport nec, Sea transport, Air transport
21	Comm	Communication
22	Insfinance	Financial services nec, Insurance
23	Pubservice	PubAdmin/Defence/Health/Educat

Notes: "Food & agriculture" is 1-5, "Natural resources" is 6-8, "Light manufactures" is 9-11, and "High tech" is 12-16.

Appendix 3. Aggregation of GTAP Version 5 Database Regions

Table A.3.1 Aggregation of GTAP Version 5 Database Regions

No.	Regions	66 GTAP regions
1	Japan	Japan
2	Korea	Korea
3	Malaysia	Malaysia
4	Philippines	Philippines
5	Indonesia	Indonesia
6	Vietnam	Vietnam
7	Thailand	Thailand
8	Singapore	Singapore
9	Taiwan	Taiwan
10	HongKong	Hong Kong
11	China	China
12	USA	USA
13	Canada	Canada
14	Mexico	Mexico
15	AusNzl	Australia, New Zealand
16	CSAmerica	Central Am., Carib, Colombia, Peru, Venezuela, Argentina, Brazil, Chile, Uruguay, Rest of South America
17	WEuro	Austria, Belgium, Denmark, Finland, France, Germany, United Kingdom, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, Switzerland, Rest of EFTA
18	SAsia	Bangladesh, India, Sri Lanka, Rest of South Asia
19	ROW	Hungary, Poland, Rest of Cent. Eur., Former S.U., Turkey, Rest of Mid-East, Moroc., Rest of N. Africa, Bots., Rest of SACU, Malawi, Moz., Tanz., Zam., Zimb., Other S. Africa, Uganda, Rest of Sub-Saha. Afr., Rest of World

Appendix 4. Baseline Policy Shocks

Table A.4.1 Baseline Policy Shocks

Period	Import tariff adjustments	Export tax adjustments
1997 – 2000	1. UR tariff reductions for all regions except China and Taiwan (no shocks to agriculture). 2. Pre-WTO tariff reductions undertaken by China prior to 2002.	
1997 – 2005	ASEAN's Common Effective Preferential Tariff (CEPT) reduction program (1997-2003), and Japan-Singapore Free Trade Agreements (2002).	USA and EU quotas increased on exports of textiles and wearing apparel for all regions except Taiwan and China.
2002 – 2007	UR tariff reductions for all regions. China and Taiwan's WTO agreement included (no shocks to agriculture, except for China and Taiwan).	USA and EU quotas increased on exports of textiles and wearing apparel for all regions (including Taiwan and China).

Notes: Japan-Singapore FTA and CEPT are added to the baseline originally developed by Walmsley, Dimaranan, and McDougall (2002). Their study is otherwise the source that should be consulted concerning the baseline.