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of APEC Trade Liberalization**

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## Computational Analysis of APEC Trade Liberalization

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### Abstract

In this study, we use the Michigan Model of World Production and Trade to analyze the economic welfare effects of APEC free trade, unilateral free trade for individual APEC members, and global free trade for all countries/regions covered in the Michigan Model. The Michigan Model is a multi-country, multi-sectoral computational general equilibrium (CGE) model of the global trading system. The version of the model used includes 31 countries/regions plus the rest-of-world and 27 sectors in each country/region. Nineteen APEC members are covered. The computational results suggest that APEC free trade would result in sizable increases in the economic welfare of the individual APEC members in both absolute terms and as a percentage of GDP. There would be trade diversion effects for non-APEC countries, except for the Rest of Middle East. Unilateral free trade for the APEC members would result in larger welfare gains as compared to APEC free trade for 7 of the 19 APEC members. The welfare benefits of APEC free trade are thus larger for more APEC members than unilateral free trade. Finally, global (multilateral) free trade by all of the countries/regions covered in the Michigan Model suggests much larger benefits for all APEC members compared to APEC free trade and APEC unilateral free trade. While global free trade is a limiting case, the computational results presented are testimony to the significant welfare benefits that could be realized from successful pursuit of future multilateral trade liberalization.

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## **I. Introduction**

In this study, we calculate the economic welfare effects for 19 APEC members of APEC free trade, unilateral free trade for individual APEC members, and global free trade for all countries/regions covered in the Michigan Model of World Production and Trade. The Michigan Model is a multi-country, multi-sectoral computational general equilibrium (CGE) model of the global trading system. The version of the model used includes 31 countries/regions plus the rest-of-world and 27 sectors in each country/region. The main data source used is “The GTAP-6.0 Database” of the Purdue University Center for Global Trade Analysis Project (Dimaranan and McDougall, 2005).

We begin in Section II following with an overview of the Michigan Model and a description of the benchmark data. The computational results for the three liberalization scenarios are presented in Section III. Conclusions are presented in Section IV.

## **II. The Michigan Model of World Production and Trade**

### **Overview of the Michigan Model**

The version of the Michigan Model used in this study covers 27 economic sectors, including agriculture, manufactures, and services, in each of 31 countries/regions. The distinguishing feature of the Michigan Model is that it incorporates some aspects of trade with imperfect competition, including increasing returns to scale, monopolistic competition, and product variety. Some details follow.<sup>1</sup> A more complete description of the formal structure and equations of the model can be found online at [www.Fordschool.umich.edu/rsie/model/](http://www.Fordschool.umich.edu/rsie/model/).

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<sup>1</sup> See also Deardorff and Stern (1990, esp. pp. 9-46) and Brown and Stern (1989a, b). Some readers may wish to skip the technical discussion and move directly to the section on interpreting the model results.

### ***Sectors and market structure***

As mentioned, the version of the model used in this study consists of 27 production sectors and 31 countries/regions (plus rest-of-world). The country/region coverage is indicated in the tables below. Agriculture is modeled as perfectly competitive with product differentiation by country of origin, and all other sectors covering manufactures and services are modeled as monopolistically competitive. Each monopolistically competitive firm is assumed to produce a differentiated product and to set price as a profit-maximizing mark-up of price over marginal cost. Free entry and exit of firms then guarantees zero profits.

### ***Expenditure***

Consumers and producers are assumed to use a two-stage procedure to allocate expenditure across differentiated products. In the first stage, expenditure is allocated across goods without regard to the country of origin or producing firm. At this stage, the utility function is Cobb-Douglas, and the production function requires intermediate inputs in fixed proportions. In the second stage, expenditure on monopolistically competitive goods is allocated across the competing varieties supplied by each firm from all countries. In the perfectly competitive agricultural sector, since individual firm supply is indeterminate, expenditure is allocated over each country's sector as a whole, with imperfect substitution between products of different countries.

The aggregation function in the second stage is a Constant Elasticity of Substitution (CES) function. Use of the CES function and product differentiation by firm imply that consumer welfare is influenced both by any reduction in real prices brought about by trade liberalization, as well as increased product variety. The elasticity of substitution among different varieties of a good is

assumed to be three, a value that is broadly consistent with available empirical estimates. The parameter for the sensitivity of consumers to the number of product varieties is set at 0.5.<sup>2</sup>

### ***Production***

The production function is separated into two stages. In the first stage, intermediate inputs and a primary composite of capital and labor are used in fixed proportion to output.<sup>3</sup> In the second stage, capital and labor are combined through a CES function to form the primary composite. In the monopolistically competitive sectors, additional fixed inputs of capital and labor are required. It is assumed that fixed capital and fixed labor are used in the same proportion as variable capital and variable labor so that production functions are homothetic. The elasticities of substitution between capital and labor vary across sectors and were derived from a literature search of empirical estimates of sectoral supply elasticities. Economies of scale are determined endogenously in the model.

### ***Supply prices***

To determine equilibrium prices, perfectly competitive firms operate such that price is equal to marginal cost, while monopolistically competitive firms maximize profits by setting price as an optimal mark-up over marginal cost. The numbers of firms in sectors under monopolistic competition are determined by the zero profits condition. The free entry condition in this context is also the basic mechanism through which new product varieties are created (or eliminated). Each of the new entrants arrives with a distinctly different product, expanding the array of goods available to consumers.

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<sup>2</sup> If the variety parameter is greater than 0.5, it means that consumers value variety more. If the parameter is zero, consumers have no preference for variety. This is the same as the Armington assumption according to which consumers view products as distinguished by country of production.

<sup>3</sup> Intermediate inputs include both domestic and imported varieties.

Free entry and exit are also the means through which countries are able to realize the specialization gains from trade. In this connection, it can be noted that in the commonly used GTAP-type model based on nationally differentiated products and the so-called Armington assumption, production of a particular variety of a good cannot move from one country to another. In such a model, there are gains from exchange but no gains from specialization. However, in the Michigan Model with differentiated products supplied by monopolistically competitive firms, production of a particular variety is internationally mobile. A decline in the number of firms in one country paired with an expansion in another essentially implies that production of one variety of a good is being relocated from the country in which the number of firms is declining to the country in which the number of firms is expanding. Thus, we have both an exchange gain and a specialization gain from international trade.<sup>4</sup>

### ***Capital and labor markets***

Capital and labor are assumed to be perfectly mobile across sectors within each country. Returns to capital and labor are determined so as to equate factor demand to an exogenous supply of each factor. The aggregate supplies of capital and labor in each country are assumed to remain fixed so as to abstract from macroeconomic considerations (e.g., the determination of investment), since our microeconomic focus is on the inter-sectoral allocation of resources.

### ***World market and trade balance***

The world market determines equilibrium prices such that all markets clear. Total demand for each firm or sector's product must equal total supply of that product. It is also assumed that trade

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<sup>4</sup> The international relocation of a particular variety of a good can be understood in the context of the ongoing outsourcing debate. Domestic firms require intermediate inputs, in addition to capital and labor. To the extent that tariff reduction leads a firm to substitute toward traded intermediate inputs, domestic firms can be thought of as outsourcing some component of production. This is particularly the case if there is a decline in the number of domestic firms in the sector from which intermediate inputs are purchased and an expansion in the supplier country.

remains balanced for each country/region, that is, any initial trade imbalance remains constant as trade barriers are changed. This is accomplished by permitting aggregate expenditure to adjust to maintain a constant trade balance. Thus, we abstract away from the macroeconomic forces and policies that are the main determinants of trade imbalances. Further, it should be noted that there are no nominal rigidities in the model. As a consequence, there is no role for a real exchange rate mechanism.

### ***Trade policies and rent/revenues***

We have incorporated into the model the import tariff rates and export taxes/subsidies as policy inputs that are applicable to the bilateral trade of the various countries/regions with respect to one another. These have been computed using the “GTAP–6.0 2001 Database” provided in Dimaranan and McDougall (2005). The export barriers have been estimated as export-tax equivalents.<sup>5</sup> We assume that revenues from both import tariffs and export taxes, as well as rents from NTBs on exports, are redistributed to consumers in the tariff- or tax-levying country and are spent like any other income.

Tariff liberalization can affect economic efficiency through three main channels. First, in the context of standard trade theory, tariff reductions both reduce the cost of imports for consumers and for producers purchasing traded intermediate inputs, thus producing an *exchange* gain. Second, tariff removal leads firms to direct resources toward those sectors that have the greatest value on the world market. That is, we have the standard *specialization* gain. Third, tariff reductions have a pro-competitive effect on sellers. Increased price pressure from imported varieties forces incumbent firms to cut price. Surviving firms remain viable by expanding output, thereby moving

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<sup>5</sup> Export tax equivalent includes the export quotas on textiles and clothing (wearing apparel) exports under the Agreement on Textiles and Clothing (ATC). For more detail about the protection data in GTAP-6.0 2001 Database, See Dimaranan and McDougall (2005, Section 16).

down their average total cost (ATC) curve. The consequent lower ATC of production creates gains from the *realization of economies of scale*.

### ***Model closure and implementation***

We assume in the model that aggregate expenditure varies endogenously to hold aggregate employment constant. This closure is analogous to the Johansen closure rule (Deardorff and Stern, 1990, pp. 27-29). The Johansen closure rule consists of keeping the requirement of full employment while dropping the consumption function. This means that consumption can be thought of as adjusting endogenously to ensure full employment. However, in the present model, we do not distinguish consumption from other sources of final demand. That is, we assume instead that total expenditure adjusts to maintain full employment.

The model is solved using GEMPACK (Harrison and Pearson, 1996). With the introduction of policy changes into the model, the method of solution yields percentage changes in sectoral employment and certain other variables of interest. Multiplying the percentage changes by the absolute levels of the pertinent variables in the database yields the absolute changes, positive or negative, which might result from the various liberalization scenarios.

### ***Interpreting the modeling results***

To help the reader interpret the modeling results, it is useful to review the features of the model that serve to identify the various economic effects to be reflected in the different applications of the model. Although the model includes the aforementioned features of imperfect competition, it remains the case that markets respond to trade liberalization in much the same way that they would with perfect competition. That is, when tariffs or other trade barriers are reduced in a sector, domestic buyers (both final and intermediate) substitute toward imports and the domestic competing industry contracts production while foreign exporters expand. Thus, in the case of



multilateral liberalization that reduces tariffs and other trade barriers simultaneously in most sectors and countries, each country's industries share in both of these effects, expanding or contracting depending primarily on whether their protection is reduced more or less than in other sectors and countries.

Worldwide, these changes cause increased international demand for all sectors. World prices increase most for those sectors where trade barriers fall the most.<sup>6</sup> This in turn causes changes in countries' terms of trade that can be positive or negative. Those countries that are net exporters of goods with the greatest degree of liberalization will experience increases in their terms of trade, as the world prices of their exports rise relative to their imports. The reverse occurs for net exporters in industries where liberalization is slight – perhaps because it may already have taken place in previous trade rounds.

The effects on the welfare of countries arise from a mixture of these terms-of-trade effects, together with the standard efficiency gains from trade and also from additional benefits due to the realization of economies of scale. Thus, we expect on average that the world will gain from multilateral liberalization, as resources are reallocated to those sectors in each country where there is a comparative advantage. In the absence of terms-of-trade effects, these efficiency gains should raise national welfare measured by the equivalent variation for every country,<sup>7</sup> although some factor owners within a country may lose, as will be noted below. However, it is possible for a particular country whose net imports are concentrated in sectors with the greatest liberalization to lose overall, if the worsening of its terms of trade swamps these efficiency gains.

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<sup>6</sup> The price of agricultural products supplied by the rest of the world is taken as the numeraire in the model, and there is a rest-of-world against which all other prices can rise.

<sup>7</sup> The equivalent variation is a measure of the amount of income that would have to be given or taken away from an economy before a change in policy in order to leave the economy as well off as it would be after the policy change has taken place. If the equivalent variation is positive, it is indicative of an improvement in economic welfare resulting from the policy change.

On the other hand, although trade with imperfect competition is perhaps best known for introducing reasons why countries may lose from trade, actually its greatest contribution is to expand the list of reasons for gains from trade. Thus, in the Michigan Model, trade liberalization permits all countries to expand their export sectors at the same time that all sectors compete more closely with a larger number of competing varieties from abroad. As a result, countries as a whole gain from lower costs due to increasing returns to scale, lower monopoly distortions due to greater competition, and reduced costs and/or increased utility due to greater product variety. All of these effects make it more likely that countries will gain from liberalization in ways that are shared across the entire population.<sup>8</sup>

The various effects just described in the context of multilateral trade liberalization will also take place when there is unilateral trade liberalization, although these effects will depend on the magnitudes of the liberalization in relation to the patterns of trade and the price and output responses involved between the liberalizing country and its trading partners. Similarly, many of the effects described will take place with the formation of bilateral or regional FTAs. But in these cases, there may be trade creation and positive effects on the economic welfare of FTA-member countries together with trade diversion and negative effects on the economic welfare of non-member countries. The net effects on economic welfare for individual countries and globally will thus depend on the economic circumstances and policy changes implemented.<sup>9</sup>

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<sup>8</sup> In perfectly competitive trade models such as the Heckscher-Ohlin Model, one expects countries as a whole to gain from trade, but the owners of one factor – the “scarce factor” – to lose through the mechanism first explored by Stolper and Samuelson (1941). The additional sources of gain from trade due to increasing returns to scale, competition, and product variety, however, are shared across factors, and we routinely find in our CGE modeling that both labor and capital gain from multilateral trade liberalization.

<sup>9</sup> It may be noted that, in a model of perfect competition, bilateral trade liberalization should have the effect of contracting trade with the excluded countries, thereby improving the terms of trade for the FTA members vis-à-vis the rest of world. But in a model with scale economies, the pro-competitive effect of trade liberalization can generate a cut in price and increase in supply to excluded countries. The terms of trade of FTA members may therefore deteriorate in this event.

In the real world, all of the various effects occur over time, some of them more quickly than others. However, the Michigan Model is static in the sense that it is based upon a single set of equilibrium conditions rather than relationships that vary over time.<sup>10</sup> The model results therefore refer to a time horizon that depends on the assumptions made about which variables do and do not adjust to changing market conditions, and on the short- or long-run nature of these adjustments.<sup>11</sup> Because the supply and demand elasticities used in the model reflect relatively long-run adjustments and it is assumed that markets for both labor and capital clear within countries,<sup>12</sup> the modeling results are appropriate for a relatively long time horizon of several years – perhaps two or three at a minimum. On the other hand, the model does not allow for the very long-run adjustments that could occur through capital accumulation, population growth, and technological change. The modeling results should therefore be interpreted as being superimposed upon longer-run growth paths of the economies involved. To the extent that these

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It should also be mentioned that rules of origin may offset some of the potential welfare benefits of FTAs insofar as they may lead to higher input costs and consequent reduction of FTA preference margins. In this connection, see Krishna (2006).

<sup>10</sup> As noted above, macroeconomic closure in the model involves the equivalent of having expenditure equal to the sum of earned incomes plus redistributed net tax revenues. However, the actual solution is attained indirectly, but equivalently, by imposing a zero change in the trade balance. Since the model allows for all net tax and tariff revenues to be redistributed to consumers, when tariffs are reduced with trade liberalization, the model implicitly imposes a non-distorting tax to recoup the loss in tariff revenues.

<sup>11</sup> It is important to understand that CGE modeling simulation results provide indications of the potential economic changes involved. In this respect, they are not meant to be empirical forecasts or predictions of the changes since they are not derived from econometric methods that can yield statistically-based estimations. Further, because they are microeconomic in character, CGE models of necessity abstract from the macroeconomic forces at work at the aggregate level in individual countries. As a consequence, it may be very difficult to compare CGE modeling results with the actual changes that occur in the economic variables over given periods of time. A further important consideration is that CGE models used to analyze the effects of trade liberalization may differ because of the assumptions that characterize their framework. In any event, CGE modeling results are therefore to be interpreted as the potential effects of trade liberalization at the microeconomic level, holding macroeconomic influences constant. The magnitudes and directions of change indicated by the CGE models are thus very useful in their own right, subject to the caveats just mentioned.

<sup>12</sup> The analysis in the model assumes throughout that the aggregate, economy-wide, level of employment is held constant in each country. The effects of trade liberalization are therefore not permitted to change any country's overall rates of employment or unemployment. This assumption is made because overall employment is determined by macroeconomic forces and policies that are not contained in the model and would not themselves be included in a negotiated trade agreement. The focus instead is on the composition of employment across sectors as determined by the microeconomic interactions of supply and demand resulting from the liberalization of trade.

growth paths themselves may be influenced by trade liberalization, therefore, the model does not capture such effects.

### ***Benchmark Data***

Needless to say, the data needs of this model are immense. Apart from numerous share parameters, the model requires various types of elasticity measures. Like other CGE models, most of our data come from published sources.

The main data source used in the model is “The GTAP-6.0 Database” of the Purdue University Center for Global Trade Analysis Project (Dimaranan and McDougall, 2005). The reference year for this GTAP database is 2001. From this source, we have extracted the following data, aggregated to our sectors and countries/regions:

- Bilateral trade flows among 31 countries/regions, decomposed into 27 sectors. Trade with the rest-of-world (ROW) is included to close the model.
- Input-output tables for the 31 countries/regions, excluding ROW.
- Components of final demand along with sectoral contributions for the 31 countries/regions, excluding ROW.
- Gross value of output and value added at the sectoral level for the 31 countries/regions, excluding ROW.
- Bilateral import tariffs by sector among the 31 countries/regions.
- Elasticity of substitution between capital and labor by sector.
- Bilateral export-tax equivalents among the 31 countries/regions, decomposed into 27 sectors.

The monopolistically competitive market structure in the nonagricultural sectors of the model imposes an additional data requirement of employment and the numbers of firms at the sectoral level. These data have been adapted from a variety of published sources as will be noted below.

The GTAP-6.0 2001 database has been projected to the year 2020, which is when we assume that the Doha Round will have been completed and fully implemented. In this connection, we extrapolated the labor availability in different countries/regions by an annual-average, weighted-population growth rate that varies by country/region.<sup>13</sup> All other major variables have been projected, using an average weighted growth rate of GDP of 3.1 percent. In the computational scenarios to be presented below, we use these extrapolated data as the starting point to carry out our liberalization scenarios.

In the GTAP-6.0 2001 database, the barriers on agricultural products consist of import tariffs, export subsidies/taxes, and domestic support. Tariffs on food and agriculture come from the Agricultural Trade Policy Database of the Economic Research Service in the US Department of Agriculture. Domestic support data are based on the producer support estimates for OECD countries and input-output tables for non-OECD countries if data are available. Tariffs on merchandise come from the World Integrated Trade Solutions system of the World Bank and UNCTAD. The GTAP-6.0 2001 database has been adjusted using the tariff-cutting scenario provided by GTAP that incorporates the assumed implementation of the Doha Round.<sup>14</sup> Developed countries are assumed to cut agricultural protection by the percentages specified in the Doha Development Agenda, and all countries are assumed to adopt 50 percent tariff cuts for non-agricultural goods and manufactures.

The services barriers are based on financial data on average gross (price-cost) margins constructed initially by Hoekman (1995, 2000) and adapted for modeling purposes in Brown, Deardorff, and Stern (2002, 2003). The gross operating margins are calculated as the differences

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<sup>13</sup> The growth projection of labor force from 2001 to 2020 is obtained from U.S. Census Bureau, IDB Summary Demographic Data for Taiwan and United Nations, World Population Prospects (The 2004 Revision, medium variant, <http://esa.un.org/unpp>) for other countries/regions. For a more elaborate and detailed procedure for calculating data extrapolations, see van der Mensbrugge (2005) and related documents.

<sup>14</sup> For more detail, see [https://www.gtap.agecon.purdue.edu/databases/v6/V6\\_dohascen.asp](https://www.gtap.agecon.purdue.edu/databases/v6/V6_dohascen.asp)

between total revenues and total operating costs and are presumed to reflect the barriers on the various modes of services transactions. Some of these differences are presumably attributable to fixed costs. Given that the gross operating margins vary across countries, a portion of the margin can be attributed in particular to barriers to FDI. For this purpose, a benchmark is set for each sector in relation to the country with the smallest gross operating margin, on the assumption that operations in the benchmark country can be considered to be freely open to foreign firms. The excess in any other country above this lowest benchmark is then taken to be due to barriers to establishment by foreign firms.

That is, the barrier is modeled as the cost-increase attributable to an increase in fixed cost borne by multinational corporations attempting to establish an enterprise locally in a host country. This abstracts from the possibility that fixed costs may differ among firms because of variations in market size, distance from headquarters, and other factors. It is further assumed for computational purposes in the Michigan Model that this cost increase can be interpreted as an ad valorem equivalent tariff on services transactions generally. The services barriers based on Hoekman (2000) are considerably higher than the import barriers on manufactures and reflect the fact that many services sectors are highly regulated and therefore may restrain international services transactions considerably. Nonetheless, as noted, because of the variations that exist in fixed costs, it is possible that the Hoekman services barriers may be overstated. We have accordingly reduced these barriers by 50 percent for modeling purposes.

Employment data, defined as labor force ( $LF_i$ ), were obtained from Ministry of Home Affairs (2003) for India, Council for Economic Planning and Development (2006) for Taiwan, and World Bank (2006) for other countries or regions. Since employment data are not available at the sectoral level, we estimated the sectoral employment share  $s_{ij}$ , using the latest available

data from UNIDO (2006) for manufacturing and from ILO (2006) for non-manufacturing sectors. Multiplying the share by the total labor force (i.e.,  $LF_i \times s_{ij}$ ), we estimated the sectoral employment data. Employment in the agricultural sector was further decomposed into 10 detailed agricultural sectors, using the labor endowment data in the GTAP-6.0 2001 database (i.e., the employment was decomposed by the labor endowment shares).

Data on the number of firms were obtained from UNIDO (2006). If the number of firms was not available, we used the data for the number of establishments. Since the latest available years are different among countries and regions, we adjusted the number of firms, using the per-capita GDP growth rate. For instance, if the latest available year was 2000, we multiplied the per-capita GDP growth rate from 2000 to 2001 by the number of firms. When the number of firms was not available, we first estimated the total number of firms in the manufacturing sectors and then decomposed this total to the sectoral level, using the sectoral employment shares. In some cases, the total number of firms was estimated from the number of firms and the relative per capita GDP in comparable, neighboring countries.<sup>15</sup>

The sectoral data that we have used for our modeling purposes are available on request. These data cover the Post-Doha Round tariff rates on agricultural and natural resource products and manufactures, tariff equivalents on services, the values and percentage distribution of exports and imports for the world and the OECD countries, and employment.

### **III. Computational Scenarios and Results for the APEC Economies**

We ran three scenarios: (1) APEC members free trade; (2) APEC members unilateral free trade; and (3) global free trade for all of the countries/regions covered in the Michigan Model. In all three scenarios, the existing tariff and related barriers in agricultural products, manufactures, and

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<sup>15</sup> The details of the various adjustments are available from the authors on request.

services are assumed to be removed. The aggregate results are contained in Tables 1 and 2.

=== Tables 1 and 2 ===

The effects of APEC free trade (scenario 1) are shown in Table 1 for the individual APEC countries and for the non-APEC countries. In the first two columns, global trade would increase by \$419.1 billion, reflecting increases in exports and imports for all of the APEC countries and declines for all of the non-APEC countries except the Rest of Middle East. The declines in trade for the non-APEC countries are thus indicative of the trade diversion that would occur with APEC free trade. Terms-of-trade effects are shown in column (3) of Table 1. It is interesting that the terms of trade improve somewhat in particular for the APEC industrialized countries and Hong Kong and decline for most of the other APEC countries. But these terms-of-trade effects are all comparatively small.<sup>16</sup> It can be seen in columns (4) and (5) of Table 1 that APEC free trade would increase global economic welfare by \$780.4 billion. The largest absolute increases in welfare are for the United States (\$217.4 billion) and Japan \$209.7 billion. While the absolute increases are smaller for the other APEC countries, the percentage increases in welfare are sizable, ranging from 1.74% of GDP for Peru to 12.36% of GDP for Malaysia.

The final right-hand columns in Table 1 show the percentage changes in real wages and the return to capital in the APEC and non-APEC countries. It is evident that real wages and the return to capital both increase in all APEC countries by sizable percentages, except for Peru. As noted earlier, the additional sources of gain from trade due to increasing returns to scale, competition, and product variety in the Michigan Model are shared across factors, so that, in contrast to what the Stolper-Samuelson theorem suggests, both labor and capital gain from

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<sup>16</sup> These terms-of-trade results are in contrast to those based on GTAP models in which products are distinguished by country of production and provide countries with elements of monopoly power, which when reduced or eliminated with trade liberalization often yields very sizable terms-of-trade changes.



multilateral trade liberalization. The changes in real wages and the return to capital are all comparatively small for the non-APEC countries.

Table 2 contains the welfare effects for the nineteen APEC members of scenarios 1-3. The welfare effects for APEC free trade (scenario 1) are shown in the left-hand columns of Table 2 and correspond to those shown in columns (4) and (5) in Table 1. The middle columns of Table 2 contain the welfare results for unilateral free trade (scenario 2) for each of the APEC member countries taken one by one.<sup>17</sup> Here again, the largest increases in welfare are for the United States (\$362.0 billion) and Japan (\$156.3 billion). In comparing the welfare increases of unilateral free trade with APEC free trade, it can be seen that the unilateral welfare increases are larger for 7 out of the 19 APEC countries shown. This suggests that many of the APEC countries would experience larger welfare increases from APEC free trade as compared to unilateral APEC free trade.

The right-hand columns in Table 2 show the welfare increases that would be experienced if there were global free trade (scenario 3), that is, with all of the countries/regions covered in the Michigan Model assumed to remove all of their trade barriers on agricultural products, manufactures, and services. The United States and Japan remain the largest gainers in welfare, but their welfare gains and those of the other APEC members are considerably larger with global free trade as compared to APEC free trade and APEC unilateral free trade. While global free trade is a limiting case, the computational results presented are testimony to the significant welfare benefits that could be realized from successful pursuit of multilateral trade liberalization.<sup>18</sup>

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<sup>17</sup> If the APEC countries acted in concert to undertake unilateral liberalization, the welfare effects would differ from those shown for scenario 2 in which the APEC countries act unilaterally one by one.

<sup>18</sup> Decomposition of the global free trade results indicates that most of the total welfare gains comes from the elimination of services barriers and manufactures tariffs.

Because of space constraints, we do not report the detailed sectoral results for the 19 APEC member countries. As mentioned, the Michigan Model is designed to focus on the intersectoral shifts in output and employment. Thus, in the individual scenarios, depending on the changes in the patterns of protection, some sectors in each country will expand output and employment and other sectors will contract. There will be no changes in employment overall since full employment is assumed and labor markets will clear. Broadly speaking, with assumed trade liberalization in the individual scenarios, the sectoral changes will mirror the comparative advantage of the emerging economies/developing countries in agricultural, natural resource, and mineral products and labor-intensive manufactures, and the comparative advantage of the major industrialized countries in capital-intensive manufactures and services.

#### **IV. Conclusions and Implications for Policy**

The computational analysis that we have presented has been based on the Michigan Model of World Production and Trade, which is a multi-country/multi-sector computable general equilibrium (CGE) model that has been used for over three decades to provide estimates of the economic effects of multilateral, regional, and bilateral trade negotiations and other aspects of changes in trade policies of the world's major trading countries/regions. The version of the model used covers 27 economic sectors, including agriculture, manufactures, and services, in each of 31 countries/regions. The distinguishing feature of the Michigan Model is that it incorporates elements of imperfect competition, including increasing returns to scale, monopolistic competition, and product variety. The data for the model are based on Version 6.0 of the GTAP database for 2001 together with data derived from other sources.

While it is likely that the removal of trade barriers would be phased in over time for some products and sectors, it is assumed for modeling purposes that all of the barriers are removed at

the same time and entered as inputs into the model for the policy changes involved. The model is then solved computationally to represent the percent changes in the variables of interest and to calculate the absolute changes in trade, output, and employment by sector. There will be positive and negative shifts in sectoral employment, but, because full employment is assumed, there will be no overall change in employment.

Our computational results suggest that APEC free trade would result in sizable increases in the economic welfare of the individual APEC members in both absolute terms and as a percentage of GDP. There would be trade diversion effects for non-APEC countries, except for the Rest of Middle East. Unilateral free trade for the APEC members would result in larger welfare gains as compared to APEC free trade for 7 of the 19 APEC members. The welfare benefits of APEC free trade are thus larger for more APEC members than unilateral free trade. Finally, global (multilateral) free trade by all of the countries/regions covered in the Michigan Model suggests much larger benefits for all APEC members compared to APEC free trade and APEC unilateral free trade. While global free trade is a limiting case, the computational results presented are testimony to the significant welfare benefits that could be realized from potential future multilateral trade liberalization.

## References

- Brown, Drusilla K. and Robert M. Stern. 1989a. "Computational Analysis of the U.S.-Canadian Free Trade Agreement: The Role of Product Differentiation and Market Structure," in R.C. Feenstra (ed.), *Trade Policies for International Competitiveness*. Chicago: University of Chicago Press.
- Brown, Drusilla K. and Robert M. Stern. 1989b. "Computable General Equilibrium Estimates of the Gains from U.S.-Canadian Trade Liberalization," in D. Greenaway, T. Hyclak, and R. J. Thornton (eds.), *Economic Aspects of Regional Trading Arrangements*, London: Harvester Wheatsheaf.
- Brown, Drusilla K., Alan V. Deardorff, and Robert M. Stern. 2002. "CGE Modeling and Analysis of Multilateral and Regional Negotiating Options," in R. M. Stern (ed.), *Issues and Options for U.S.-Japan Trade Policies*. Ann Arbor: University of Michigan Press.
- Brown, Drusilla K., Alan V. Deardorff, and Robert M. Stern. 2003. "Multilateral, Regional, and Bilateral Trade-Policy Options for the United States and Japan," *The World Economy* 26(6): 803-828.
- Council for Economic Planning and Development. 2006. *Taiwan Statistical Databook 2006*. Taipei: R.O.C. (Taiwan), Council for Economic Planning and Development.
- Deardorff, Alan V., and Robert M. Stern. 1990. *Computational Analysis of Global Trading Arrangements*. Ann Arbor: University of Michigan Press.
- Dimaranan, Betina V. and Robert A. McDougall. 2005. *Global Trade, Assistance, and Protection: The GTAP 6 Data Base*. West Lafayette, IN: Center for Global Trade Analysis, Purdue University.
- Harrison, W. J. and Ken Pearson. 1996. "Computing Solutions for Large General Equilibrium Models using GEMPACK," *Computational Economics* 9:83-127.
- Hoekman, Bernard. 1995. "Assessing the Agreement on Trade in Services," in Will Martin and L. Alan Winters (eds.), *The Uruguay Round and the Developing Economies*. Washington, D.C.: World Bank.
- Hoekman, Bernard. 2000. "The Next Round of Services Negotiations: Identifying Priorities and Options," *Federal Reserve Bank of St. Louis Review*, 82: 31-47.
- International Labor Organization. 2006. LABORSTA [<http://laborsta.ilo.org/cgi-bin/brokerv8.exe>].
- Krishna, Kala. 2006. "Understanding Rules of Origin," in Antoni Estavadeoral, Akiko Suwa Eisenmann, Thierry Verdier, and Olivier Cadot (eds.), *The Origin of Goods : Rules of Origin in Regional Trade Agreements*. New York: Oxford University Press.
- Ministry of Home Affairs. 2003. *Census of India*. New Delhi: Ministry of Home Affairs.
- Stolper, W. and P. A. Samuelson. 1941. "Protection and Real Wages," *Review of Economic Studies* 9(1): 58-73.

United Nations Industrial Development Organization (UNIDO). 2006. *Industrial Statistics Database, 3-digit Level of ISIC Code (Revision 2) on CD-ROM*. Vienna, Austria: UNIDO.

Van den Mensbrugghe, Dominique. 2005. *Linkage Technical Reference Document*, World Bank.

World Bank. 2006. *World Development Indicators on CD-ROM*. Washington, D.C.: World Bank.

**Table 1. Global Welfare Effects of APEC Free Trade**

(Millions of U.S. dollars and Percentages)

	Exports (U.S.\$)	Imports (U.S.\$)	Terms of Trade (%)	Welfare (U.S.\$)	(% of GDP)	Real wage (%)	Return to capital (%)
<b>APEC countries</b>							
Japan	73,916	73,916	0.7	209,736	2.8	1.2	1.3
United States	69,547	69,547	0.2	217,438	1.2	0.3	0.3
Canada	5,691	5,691	0.1	17,855	1.4	0.5	0.6
Australia	11,924	11,924	1.8	15,427	2.4	1.7	1.7
New Zealand	2,930	2,930	2.6	5,042	5.7	2.9	2.7
China	88,937	88,937	-2.3	77,988	3.8	3.5	3.0
Hong Kong	25,663	25,663	3.0	27,820	10.1	8.7	9.0
Indonesia	11,439	11,439	0.4	16,929	6.6	3.1	2.5
Korea	35,710	35,710	-0.5	47,814	6.5	5.2	5.1
Malaysia	13,236	13,236	-0.5	18,860	12.4	10.2	8.2
Philippines	6,463	6,463	-0.9	8,632	6.8	3.5	3.1
Singapore	10,415	10,415	0.7	9,216	6.5	6.3	6.7
Taiwan	23,848	23,848	-0.1	37,779	7.6	3.9	3.5
Thailand	17,094	17,094	-0.7	16,885	8.3	7.4	5.1
Vietnam	7,321	7,321	-5.1	3,225	5.6	10.9	4.5
Russia	7,461	7,461	-0.7	17,909	3.3	1.7	2.0
Mexico	5,066	5,066	-0.5	23,408	2.1	0.3	0.4
Chile	2,111	2,111	0.1	4,189	3.6	1.7	1.9
Peru	2,895	2,895	-2.4	3,877	1.7	-0.0	1.0
<b>Non-APEC countries</b>							
EU and EFTA	-1,708	-1,708	0.1	-6,377	-0.0	0.1	0.1
India	-918	-918	-0.2	-699	-0.1	-0.1	0.1
Rest of Asia	-509	-509	-0.3	-347	-0.1	0.1	0.2
Turkey	-405	-405	-0.0	1	0.0	0.1	0.1
Rest of Middle East	4,039	4,039	0.4	7,197	0.6	0.3	0.4
Argentina	-461	-461	-0.2	-1,105	-0.2	0.0	-0.0
Brazil	-1,065	-1,065	-0.2	80	0.0	0.1	0.2
Colombia	-21	-21	0.1	148	0.2	0.1	0.1
Uruguay	-58	-58	-0.0	-28	-0.1	0.1	0.1
Rest of Central and Latin America	-993	-993	-0.0	162	0.0	0.2	0.1
South Africa	-7	-7	0.0	748	0.4	0.3	0.4
Africa	478	-478	0.1	562	0.1	0.1	0.1
<b>Total</b>	<b>419,084</b>	<b>419,084</b>		<b>780,371</b>			