An Inquiry on General Equilibrium Effects of MERCOSUR—An Intertemporal World Model

Xinshen Diao, International Food Policy Research Institute
Agapi Somwaru, U.S. Department of Agriculture, Economic Research Service

A multiregion dynamic computable general equilibrium model is constructed to analyze effects of the Southern Common Market (MERCOSUR) on the member countries as well as third-party nonmember countries. The model is based on intertemporal optimization behaviors of consumers and firms with eight endogenously specified regions. By taking into account dynamic general equilibrium adjustments, we observe significant shifts of trade diversion away from the nonmember trading partners to the member countries. We also find that, following the MERCOSUR’s common external tariffication, growth of intraregional trade would likely be accompanied by increases in trade between MERCOSUR and other countries. In this case, not only MERCOSUR member countries gain more, but also the nonmember countries are better off in terms of their production, consumption, and consumer welfare. © 2000 Society for Policy Modeling. Published by Elsevier Science Inc.

1 AFTA, ASEAN Free Trade Agreement, came into effect in January 1993 to cover 330 million people, with an aggregate GNP of over US$ 300 billion. The ASEAN consists of Brunei, Indonesia, Malaysia, the Philippines, Singapore, and Thailand (Bowles and MacLean, 1996).

2 European Union-Extended Free Trade Agreement includes, in addition to the regular 12 members, Finland, Austria, and Sweden.

Address correspondence to Dr. Xinshen Diao, Trade and Macroeconomics Division, International Food Policy Research Institute, 2033 K St., NW, Washington, DC 20006. E-mail: x.diao@cgiar.org

We are grateful to Jean Mercenier, Erinc Yeldan, and Terry Roe for their helpful comments and critical suggestions.

Received May 1997; final draft accepted September 1997.

© 2000 Society for Policy Modeling
Published by Elsevier Science Inc.
1. INTRODUCTION

There is a growing interest on the economics of formation of customs unions and trade blocs, given the second wave of regional integrations with the emergence of NAFTA, AFTA, EU-EFTA, MERCOSUR (Southern Common Market including four South American countries), and negotiation on APEC (Asian Pacific Economic Association) in the recent years. Most studies to assess the effects of these regional integration agreement (RIAs) on trade and welfare have generally focused on the participated member countries. Examples are Francois and Shiells (1994) on NAFTA, Mercenier (1995) on EU, Adams and Park (1995) on ASEAN, and Behar (1995) on MERCOSUR. The formation of regional trading blocs, however, will not solely affect trade flows and welfare of the member countries, it will likely substantiate significant trade diversion from the nonmember trading partners and affect nonmember countries’ welfare. In this paper, we study such third party spillover effects in the context of a newly created commodity trade bloc, the Southern Common Market, and its previous major trading partners.

MERCOSUR was launched by the Treaty of Asuncion signed in March 1991, with the purpose of creating a free trade area and a custom union among Brazil, Argentina, Uruguay, and Paraguay. Before that in 1960, countries in South America established the Latin American Free Trade Association (LAFTA), the largest and most ambitious integration scheme. The failure of LAFTA to attain its main objective, namely, the complete elimination of trade barriers among the member countries, led to its reorganization into a more flexible scheme, the Latin American Integration Association (LAIA) in 1980. The LAIA agreements included provisions for negotiating reductions in tariffs on intraregional trade on a global basis, the regional preferential tariff, but at the same time, they allowed the liberalization of tariff barriers among members on a bilateral basis. An example of the bilateral basis of trade liberalization is provided by the 1988 economic cooperation agreement between the two largest South American countries, Argentina and Brazil, which stipulated the elimination of all barriers to reciprocal trade over a 10-year period. The advancements in economic integration made by these two countries, as well as the importance they have for the entire region compelled Uruguay and Paraguay to join the Argentine–Brazilian trade agreement in March 1991. The new cooperation treaty, the Treaty of Asuncion,
was signed by the four countries, and the time schedule for achieving tariff-free trade established by Brazil and Argentina was maintained. At the same time, the countries committed themselves to initiating a process of tariff alignment. The objectives include to eliminate tariff and non-tariff barriers for trade among member countries and to converge toward a low common external tariff (CET) between zero and 20 percent for third-country imports with some exceptions.

The agreement of MERCOSUR represents the nature of the recent RIAs, which is different from earlier wave of postwar RIAs, as it is “more defensive than integrationist in nature, with smaller countries seeking “safe-haven” trade agreement with larger countries” (Srinivasan et al., 1994, p. 52). The newly formed MERCOSUR comprises 200 million people, who generated a GDP of US$670 billion in 1996 and accounted for about 50 percent of Latin American industrial output and total exports. In the period of 1990–94, the value of intra regional trade nearly tripled, from US$4.1 billion to US$10.7 billion. This growth partly reflects the progress made under the trade liberalization program, as well as the gradual elimination of non-tariff restraints on reciprocal trade. As the second largest trading bloc in the western hemisphere after NAFTA, MERCOSUR will not only affect its member countries’ economies, but also nonmember countries that have high trade shares with it.

Discussion of welfare and trade effects of custom unions has been one of the staples of trade theorists over the postwar years. The seminal contribution to the literature on the effects of RIAs is that of Viner (1950). He distinguishes between the effects of trade creation in which trade between partner countries expands in accordance with international comparative advantage, and trade diversion in which trade between countries expands as a result of the preferential treatment given to imports from within the region as compared to those from the rest of world. While this categorization is a useful description of the effects of customs-union formation, it is inappropriate as a basis for measuring the welfare effects of a RIA. In this paper we employ a global model to analyze both trade effects and welfare effects of MERCOSUR on the member

---

3 For example, from Viner (1950), through Meade (1955) and Lipsey (1957), to Berglas (1979), Wonnacott and Wonnacott (1981), and Wooton (1986).
countries, and on the nonmember trading regions alike. The welfare effects are not only measured by changes in trade, but also by other macroeconomic indicators.

Previous CGE modeling work on regional integration and trade reform has been generally done within a static framework. Gains from trade in static models stem from the increased efficiency of resource allocation and improved consumption possibilities. However, such traditional CGE analysis fails to account for the positive relationship between trade, investment, and growth, a linkage that is fairly well established empirically and theoretically. On the later, neoclassical growth theory suggests the potential for a medium-run growth or accumulation effect through induced changes in savings and investment patterns. But, the incorporation of saving and investment decisions by way of fixed parameters and ad hoc closure roles in the traditional CGE approaches often led to nonrobust policy results with arbitrary dependence on modeling specification (Devarajan and Go, 1996; Srinivasan, 1982). In the current model, we incorporate explicit intertemporal optimizing behavior on the part of rational agents and explore the interaction between trade policy and capital accumulation in a multisector, multiregion setting. As expected, we are able to investigate dynamic gains or losses in production or welfare.

Our model draws in many ways upon the recent contributions of dynamic CGE modeling by Ho (1989), McKibbin (1993), Mercenier and SampaõÉo de Souza (1994), Mercenier (1995), and Go (1994). We utilize the model to simulate both the short-run (upon impact) and the medium-run, interregional transitional dynamic effects of trade reforms in the context of a global economy. We base our simulation experiments on the recent version of the Global Trade Analysis Project database (GTAP).4 The paper is organized as follows: Section 2 presents the structure of the model. In Section 3, we analyze the dynamic effects of alternative MERCOSUR tariff reform scenarios on MERCOSUR member countries, and as well as on the third-party trading partners. Finally, Section 4 summarizes the conclusions.

2. THE MODEL

2A. Overview

The model is based on the intertemporal general equilibrium theory with multiregion specification. There are eight regions,
each of which produces six commodities from the same number of production sectors. The eight regions include: (1) the United States, (2) Argentina, (3) Brazil, (4) Chile, (5) the Rest of the Western Hemisphere countries, (6) European Union, (7) all Asian countries, and (8) the Rest of the World; while the six aggregate production sectors are: (1) agriculture, (2) processing food, (3) textile, (4) intermediates, (5) manufacturing, and (6) services. All these eight regions, including the Rest of World, are fully endogenous in the model. In a multiregion multisector framework, it is necessary to keep track of the trade flows by their geographical and sectoral origin and destination. Following the traditional CGE specification structure, countries are linked by an Armington system so that commodities are differentiated in demand by their geographical origin.

Firms in each region produce goods and install capital so as to maximize firm’s valuation. Infinitely-lived households consume home produced and imported goods to maximize an intertemporal utility function. Household’s income is consumed or saved in the form of equity in domestic firms or foreign bonds. Home firm equities and foreign bonds are assumed to be perfect substitutes. Through equity purchases by households, the world “pool” of savings is channeled to profitable investment projects without regard to the national origin of savings. The detailed description of the each agent within this framework is as follows.

2B. Firms and Investment

We assume that firms within each sector of every region can be aggregated into a representative firm. The representative firm operates with constant returns to scale technologies. The value added production function for labor and capital is of Cobb-Douglas, while the intensities of intermediate goods are fixed. The representative firm chooses, at each time period, the input levels of labor and intermediate goods and makes investment decision to maximize the value of the firm. We assume that the firm finances all its investment outlays by retaining profits so that the number of equities issued by the private sector remains unchanged.

A starting point for specifying the firm’s optimizing behavior is the condition of asset market equilibrium, i.e., the expected returns from holding the equity in the firms must be in line with those from holding a “safe” asset, such as foreign bonds, at any time period:
\[ r = \frac{\text{div}_i}{V_i} + \frac{\Delta V_i}{V_i}, \]

where \( r \) is the world interest rate, \( V_i \) is the market value of firm \( i \), \( \text{div}_i \) is the current dividend payments, and \( \Delta V_i = V_{i+1} - V_i \) is the expected annual capital gain on the firm equity. Assuming an efficient world financial capital market, each region faces the same world interest rate.

Firm’s intertemporal decision problem can be restated more rigorously as follows: in each region’s sector \( i \), \( i = 1, 2, \ldots, 6 \), the representative firm chooses the optimal investment and labor employment strategies, \( \{I_{i,t}, L_{i,t}\}_{t=1,\ldots,\infty} \) to maximize the present value of all future dividend payments, taking into account expected future prices of output and sectoral specific capital equipment, and labor wage, \( \{P_{i,t}, PI_{i,t}, w_{i,t}\}_{t=1,\ldots,\infty} \), and the capital accumulation constraint. Formally:

\[
\text{Max } V_i = \sum_{t=1}^{\infty} R_t \text{div}_{i,t} = \sum_{t=1}^{\infty} R_t[P_{i,t}(L_{i,t},K_{i,t}) - w_{i,t}I_{i,t} - \varphi \frac{P_{i,t}}{K_{i,t}}] - PI_{i,t},
\]

subject to:

\[
K_{i,t+1} = (1 - \delta_i)K_{i,t} + I_{i,t},
\]

where \( R_t = \Pi_{s=1}^{i}1/(1 + r_s) \), represents the discount factor, and \( \delta_i \) is a positive capital depreciation rate. The term, \( \varphi \frac{P_{i,t}}{K_{i,t}} \), represents the capital adjustment costs. Because of the presence of adjustment costs on capital, marginal products of capital differ across sectors, resulting in unequal although optimal rates of investments. We assume that labor is perfectly mobile across sectors (but immobile internationally), and firms never face any quantity constraints. Also, the structure of investment goods, in terms of sectoral origin, is of Cobb-Douglas form. Hence, \( PI_i \) is a function of Armington composite good prices:

\[
PI_i = \Pi_{j=1}^{6}PC_{ij}, \quad i = 1, 2, \ldots, 6,
\]

where \( PC_i \) is the price for the composite good \( i \), \( 0 < d_i < 1 \), and \( \sum d_i = 1 \).

2C. The Households and Consumption/Savings

In each region the representative household owns labor and all financial assets, namely, the equity in domestic firms and foreign bonds, and allocates income to consumption and savings to maximize an intertemporal utility function over an infinite horizon:
subject to the following budget constraint:

\[ SAV_t = w_tL_t + T_l + div_t + rB_{t-1} - PtctTC_t, \]

where \( \rho \) is the positive rate of time preference, \( TC_t \) is the aggregate consumption, \( SAV_t \) is household savings, \( B_{t-1} \) is foreign assets and \( rB_{t-1} \) is interest earnings from foreign bond, \( Ptct \) is the consumer price index, and \( Tl_{nt} \) is the lump sum transfer of government revenues. We assume no independent government saving–investment behavior. "Government" spends all its tax revenues on consumption or transfer to households and, hence, fiscal deficit is ignored.\(^5\) \( TC_t \), the instantaneous aggregate consumption, is generated from the consumption of final goods by maximizing a Cobb-Douglas function:

\[ TC_t = \Pi(cit), \]

subject to

\[ \sum_{i=1}^{n} PC_itcit = PtctTC_t, \]

where \( cit \) is the final consumption for good \( i \), \( 0 < b_i < 1 \), and \( \sum b_i = 1 \).

The flow of savings, \( SAV_t \), is the demand for foreign new bonds issued by the other regions, which, in the equilibrium, reflects current account imbalance of this region:

\[ SAV_t = B_t - B_{t-1} = rB_{t-1} + FBOR_t, \]

where a positive \( FBOR_t \) implies a surplus in this region's foreign trade.

2D. Equilibrium

Intratemporal equilibrium requires that at each time period, (1) in each region, demand for production factors equal their

\(^5\) Government budget deficits in some countries of MERCOSUR, such as Brazil and Argentina, are high, and any drastic reduction of tariff protection will have important fiscal effects on their economies. Because we will focus our attention on the future borrowing behavior of the aggregated national economy as a whole, the behavior of the government of each country and, hence, government budget deficit are ignored by the analysis.

\(^6\) Because we assume that the number of equities of the firms in each region remains constant.
supply; (2) in the world, total demand for each sectoral good equal to its total supply; (3) in the world, the aggregate household savings equal zero. In the steady state equilibrium, the following constraints must also be satisfied for each region:

\[ r_{sa} = \frac{div_{sa}}{V_{sa}} \]

\[ I_{sa} = \delta K_{sa} \]

\[ FBOR_{sa} + r_{sa}B_{sa} = 0. \]

3. ANALYSIS OF ALTERNATIVE SIMULATIONS

3A. An Overview of MERCOSUR Trade and Protection in 1992

The data for the calibration and the base-run are drawn primarily from the Global Trade Analysis Project (GTAP) version 3 database. Initial trade protection data, for the present application, are representative of the world as of 1992 (i.e., pre-Uruguay Round). A closer look at the data of trade flows indicates that MERCOSUR has a comparative advantage in the trade of agricultural goods and agricultural related goods. In 1992, MERCOSUR exports 13 to 22 percent of its different agricultural commodities to the world markets, and its world market shares for these commodities vary from 6.2 to 12.5 percent.

The two important trading partners of MERCOSUR are U.S. and EU. In 1992, MERCOSUR shipped 16 and 31 percent of its total exported goods to the U.S. and EU, respectively, and its imports from U.S. and EU account for 25 of 24 percent of its total imported goods. Some Asian countries, such as Japan and China, are also important trading partners for MERCOSUR. MERCOSUR’s exports to Asia account for 16 percent of its total exports, and its imports from Asia amount to 11 percent. In the model, the Rest of the Western Hemisphere ranks fourth from MERCOSUR’s export point of view, and fifth regarding its imports (see Table 1 for detail).

Table 1a,b,c also presents MERCOSUR’s import/export shares of each commodity from different regions. While the Rest of the Western Hemisphere countries are major suppliers of MERCOSUR’s imports of agricultural and processing food products, EU is an important supplier regarding nonagricultural commodities.
Table 1a: (Mercosur Sectoral Import and Export Shares (Total Sectoral Imports/Exports Are 100, 1992))

1. Mercosur import shares by regions

<table>
<thead>
<tr>
<th>Exporting countries</th>
<th>Agriculture</th>
<th>Food processing</th>
<th>Textile</th>
<th>Intermediates</th>
<th>Manufacturing</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>7.9</td>
<td>8.4</td>
<td>14.6</td>
<td>19.8</td>
<td>33.4</td>
<td>26.5</td>
</tr>
<tr>
<td>ARG</td>
<td>31.5</td>
<td>9.1</td>
<td>9.0</td>
<td>1.9</td>
<td>2.1</td>
<td>2.9</td>
</tr>
<tr>
<td>BRA</td>
<td>6.5</td>
<td>8.1</td>
<td>11.7</td>
<td>8.1</td>
<td>8.9</td>
<td>4.3</td>
</tr>
<tr>
<td>CHL</td>
<td>3.0</td>
<td>7.2</td>
<td>3.9</td>
<td>4.2</td>
<td>1.2</td>
<td>2.5</td>
</tr>
<tr>
<td>RWH</td>
<td>26.3</td>
<td>26.3</td>
<td>17.5</td>
<td>12.5</td>
<td>3.8</td>
<td>8.8</td>
</tr>
<tr>
<td>E_U</td>
<td>9.8</td>
<td>26.1</td>
<td>16.7</td>
<td>18.5</td>
<td>29.4</td>
<td>26.8</td>
</tr>
<tr>
<td>ASA</td>
<td>6.7</td>
<td>3.5</td>
<td>24.4</td>
<td>3.4</td>
<td>16.8</td>
<td>12.7</td>
</tr>
<tr>
<td>ROW</td>
<td>8.3</td>
<td>11.2</td>
<td>2.2</td>
<td>31.7</td>
<td>4.3</td>
<td>15.5</td>
</tr>
</tbody>
</table>

2. Mercosur export shares by regions

<table>
<thead>
<tr>
<th>Importing countries</th>
<th>Agriculture</th>
<th>Food processing</th>
<th>Textile</th>
<th>Intermediates</th>
<th>Manufacturing</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>9.7</td>
<td>11.8</td>
<td>40.4</td>
<td>14.8</td>
<td>19.8</td>
<td>12.4</td>
</tr>
<tr>
<td>ARG</td>
<td>1.8</td>
<td>1.1</td>
<td>3.8</td>
<td>6.6</td>
<td>16.6</td>
<td>6.6</td>
</tr>
<tr>
<td>BRA</td>
<td>8.6</td>
<td>1.2</td>
<td>2.9</td>
<td>1.5</td>
<td>4.0</td>
<td>4.5</td>
</tr>
<tr>
<td>CHL</td>
<td>1.5</td>
<td>1.3</td>
<td>2.6</td>
<td>3.4</td>
<td>6.0</td>
<td>3.2</td>
</tr>
<tr>
<td>RWH</td>
<td>6.6</td>
<td>7.5</td>
<td>11.7</td>
<td>13.7</td>
<td>24.6</td>
<td>8.9</td>
</tr>
<tr>
<td>E_U</td>
<td>45.3</td>
<td>43.4</td>
<td>26.0</td>
<td>25.8</td>
<td>16.5</td>
<td>31.6</td>
</tr>
<tr>
<td>ROW</td>
<td>14.1</td>
<td>22.9</td>
<td>5.5</td>
<td>10.3</td>
<td>7.0</td>
<td>12.2</td>
</tr>
</tbody>
</table>
Asia, the Rest of the Western Hemisphere, and the U.S. have relative large shares in MERCOSUR’s textile imports.

Regarding to sectoral exports, EU absorbed the largest shares of MERCOSUR’s exports for agricultural, food processing, intermediate goods, and services, and is the second largest demander for MERCOSUR’s textile exports. MERCOSUR’s agricultural and processing food products shipped to EU account for 45.3 and 43.4 percent of MERCOSUR’s total exports in the respect commodities.

Turning into intraregional trade in MERCOSUR, this can only be partially captured by the trade between Argentine and Brazil due to data limitation. In aggregate terms, intraregional trade accounts for 11.4 and 10 percent of MERCOSUR’s total imports and exports, respectively. Shares of the intraregional trade vary by sectors, but intraregional imports of agricultural and agricultural-related goods dominate total intraregional trade in MERCOSUR, with the highest share of 55 percent.

Even though Argentina and Brazil started their tariff reforms before the establishment of MERCOSUR, their 1992s tariff levels were still high compared with other regions recognized in the model. In 1992, the weighted average tariff rates for Argentina and Brazil were 21.3 and 19.2 percent, respectively, which are the highest two among the eight regions.

Following the formation of MERCOSUR, two important policies that would affect both the member countries and the third-party economies are: (a) elimination of all restrictions to the free trade among the member countries; and (b) gradual specification of a common external tariff (CET) in the range of zero and 20 percent on imports from third countries. We now turn to an analysis of MERCOSUR tariff reform policies from the point of view.

---

Table 1b: MERCOSUR Total Import and Export Shares by Regions (Total Imports/Exports Are 100, 1992)

<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th>ARG</th>
<th>BRA</th>
<th>CHL</th>
<th>RWH</th>
<th>E_U</th>
<th>ASA</th>
<th>ROW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imports</td>
<td>25.1</td>
<td>4</td>
<td>7.4</td>
<td>2.7</td>
<td>9.7</td>
<td>24.1</td>
<td>11.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Exports</td>
<td>15.8</td>
<td>6.4</td>
<td>3.5</td>
<td>3.1</td>
<td>12.5</td>
<td>30.8</td>
<td>15.7</td>
<td>12.2</td>
</tr>
</tbody>
</table>

---

1. Each country/region’s tariff rates on the goods imported from different countries are calculated from GTAP database. For the average sectoral or total import tariff rates, the weights used are the values of 1992’s sectoral imports from different countries/regions.
of adjustment processes of trade creation and trade diversion and welfare gains/losses of the countries inside and outside MERCOSUR. For this objective, we consider the following two alternative tariff reduction scenarios: under experiment EXP-1, we focus on the trade liberalization among MERCOSUR member countries by fully eliminating all internal tariffs of them; while under experiment EXP-2, we combine EXP-1 with MERCOSUR’s external policy. Here, in addition to EXP-1, we harmonize MERCOSUR’s external tariffs for the third-country imports, with the common external tariff rates lowered than the base levels are chosen roughly at the world average rates for comparable goods.

Our discussion strategy of the two experiments is as follows: we first analyze the adjustment processes of trade and production among MERCOSUR member countries in response to their tariff reforms; then we analyze the spillover effects of MERCOSUR tariff reforms on its major nonmember trading partners. Facing a newly formed trade bloc, third countries’ interests mainly reflect concern with potential trade and investment opportunities. Hence, our investigation will be focused on the effects on those countries’ terms of trade, real exchange rates, and sectoral exports.

3B. Effects on MERCOSUR Member Countries

In general, a trade union in which tariffs are lowered or eliminated among its member countries creates trade opportunity for the members. Our simulation for “zero-tariff” among MERCOSUR member countries does capture this result. We observe that upon impact (the first year in the simulation), Argentine and Brazilian total exports (in 1992 prices) increase by 33 and 9 percent, respectively, from their base-run levels (1992). When the new steady state is approached, the aggregate exports rise by 39 and 12 percent in Argentina and Brazil, respectively. In the second

<table>
<thead>
<tr>
<th>Agriculture</th>
<th>Food processing</th>
<th>Textile</th>
<th>Intermediates</th>
<th>Manufacturing</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imports</td>
<td>1.7</td>
<td>1.3</td>
<td>0.7</td>
<td>1.9</td>
<td>1.7</td>
</tr>
<tr>
<td>Exports</td>
<td>6.3</td>
<td>10.1</td>
<td>2.2</td>
<td>2.3</td>
<td>0.9</td>
</tr>
</tbody>
</table>
experiment where not only tariffs are eliminated among the member countries, but also MERCOSUR’s external trade policy (Common External Tariff) is fully implemented, aggregate exports grow more in the member countries (40 and 20 percent in year 1, and 50 and 30 percent in the steady state for Argentina and Brazil, respectively).

In the conventional static approach, an increase in the member countries’ trade is generated from a once-and-for-all reallocation of factors of production. As tariff elimination among the member countries correct price distortion partially, current production factors start to be reallocated relatively more efficiently. However, the process of resource reallocation continues over time, i.e., the new trade policy would also affect firms’ investment decision through its impact on firms’ expected returns of capital investments. The intertemporal property of our model directly capture the capital accumulation effects. The reduction of tariffs stimulates investment (Figure 1a,b), and capital flows into MERCOSUR countries (under the assumption of a perfect world financial capital.

Figure 1. Aggregate Investment in MERCOSUR Countries (Ratios to Base-Run Steady State). a) Argentina, b) Brazil.
Table 2: Dynamic Results of Alternative Mercosur Tariff Policies on the Member Countries (% Changes from Base-Run Steady State)

<table>
<thead>
<tr>
<th></th>
<th>Experiment 1</th>
<th></th>
<th>Experiment 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 1</td>
<td>New steady state</td>
<td>Year 1</td>
<td>New steady state</td>
</tr>
<tr>
<td><strong>Argentina</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer welfare</td>
<td></td>
<td>0.318</td>
<td></td>
<td>0.171</td>
</tr>
<tr>
<td>(equivalent variation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross domestic product</td>
<td>0.000</td>
<td>1.357</td>
<td>-0.002</td>
<td>2.098</td>
</tr>
<tr>
<td>Private consumption</td>
<td>0.792</td>
<td>1.996</td>
<td>0.255</td>
<td>2.099</td>
</tr>
<tr>
<td>Aggregate investment</td>
<td>3.928</td>
<td>2.754</td>
<td>6.017</td>
<td>4.275</td>
</tr>
<tr>
<td>Aggregate exports</td>
<td>32.741</td>
<td>39.319</td>
<td>39.757</td>
<td>50.426</td>
</tr>
<tr>
<td>Aggregate imports</td>
<td>27.824</td>
<td>26.403</td>
<td>32.071</td>
<td>30.413</td>
</tr>
<tr>
<td>Foreign trade deficit</td>
<td>10.638</td>
<td>-14.090</td>
<td>15.728</td>
<td>-21.352</td>
</tr>
<tr>
<td><strong>Brazil</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer welfare</td>
<td></td>
<td>0.311</td>
<td></td>
<td>0.406</td>
</tr>
<tr>
<td>(equivalent variation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross domestic product</td>
<td>0.000</td>
<td>0.759</td>
<td>0.000</td>
<td>2.259</td>
</tr>
<tr>
<td>Private consumption</td>
<td>0.838</td>
<td>1.501</td>
<td>0.940</td>
<td>2.662</td>
</tr>
<tr>
<td>Aggregate investment</td>
<td>1.663</td>
<td>1.409</td>
<td>5.278</td>
<td>4.213</td>
</tr>
<tr>
<td>Aggregate exports</td>
<td>9.222</td>
<td>12.129</td>
<td>21.099</td>
<td>31.039</td>
</tr>
<tr>
<td>Aggregate imports</td>
<td>18.000</td>
<td>17.820</td>
<td>34.366</td>
<td>32.427</td>
</tr>
</tbody>
</table>

Thus, the regional economy experiences growth along the transition path. Of course, if MERCOSUR’s tariffs on the nonmember countries are reduced (as in EXP-2), growth of the regional economy will be more pronounced. We document part of our simulation results in Table 2, in which changes in MERCOSUR member countries' macroeconomic indicators are presented for both year 1 and the steady state. Real GDP and aggregate trade are reported in the base year (1992) prices. Equivalent variation is used to measure both transitional and long-term effects of the policy on the household’s well-being (see for instance, Mercenier, 1995, for detail).

MERCOSUR significantly expands trade among its member countries. In our simulations, increase in trade between Argentina and Brazil is observed to be higher than the increase in two countries' total trade. Compared with the base year, under EXP-1, Argentine exports to Brazil increase by almost 200 percent in the first year and more than 200 percent in the new steady state, while exports from Brazil to Argentina are more than doubled. As
Intraregional trade grows faster than the total trade, shares of intraregional trade with respect to MERCOSUR’s total trade increase significantly. Compared with the base year’s shares (in Table 1), shares of intraregional exports/imports in MERCOSUR’s total exports and imports rise from 10 and 11 percent to 30 and 33 percent in the new steady state, respectively.

When the common external tariff rates are reduced in EXP-2, MERCOSUR’s total exports rise more than that in EXP-1 (see Table 2). However, its intraregional trade rises less than that in case of EXP-1, i.e., compared with the increases in the intraregional trade between Argentina and Brazil observed in EXP-1, in EXP-2, exports from Argentina to Brazil and from Brazil to Argentina fall by 35 and 30 percent, respectively. The comparison of simulation results suggest that, if MERCOSUR’s both internal and external trade policies are fully implemented, trade opportunity for MERCOSUR member countries enlarges more. Increases in the member countries’ exports are not limited by the rise in intraregional trade alone. Furthermore, the growth of MERCOSUR’s real GDP and welfare gains are more pronounced (Table 2).

3C. Spillover Effects on Non-MERCOSUR Member Countries

Regional trading bloc will not be limited solely to the trade creation effects between member countries, but also leads to spillover effects over the third-party trading countries as well. During the processes of gradual transition due to regional integration, the impact of initial adjustment on all parties involved may give rise to international retaliation by those stayed outside the group, but nevertheless affected. The possible counteractions may even be strong enough to halt the future of the bloc. In this subsection, we focus our study on the effects of MERCOSUR tariff reforms on its major trading partners.

An important phenomenon observed from our simulations is that spillover effects on third-country are quite different under the different scenarios. We use changes in nonmember countries/regions’ consumer welfare index, total consumption, and real GDP to illustrate this (see Table 3). As most regions recognized in our model are either highly aggregated or much larger than MERCOSUR, trade between them and MERCOSUR only accounts for less than 1 percent of their total trade (except for Chile). Thus,
the aggregate effects on the large nonmember regions due to MERCOSUR, no matter positive or negative, cannot be expected to be large. If MERCOSUR only eliminates tariffs among its member countries, the aggregate effects on the other regions are mainly negative, i.e., total consumption and real GDP fall, and consumer welfare deteriorates. If MERCOSUR eliminates internal tariffs together with the reductions of its common external tariffs on all imports from nonmember countries, consumer welfare improves, total consumption and real GDP rise in the new steady state for the nonmember regions, except for the Rest of the World.

Reasons used to explain the difference in the spillover effects on the third country can be mainly drawn on the dynamic changes in these countries’ terms of trade. In general, a country’s terms of trade are defined as the price of its exports in terms of its imports. Simulation results indicate that terms of trade deteriorate in EXP-1 and improve in EXP-2 for all non-MERCOSUR countries along the transitional paths (see Figure 2a-d). Similarly, these countries’ real exchange rates (price index of import goods in terms of home produced commodities) appreciate in EXP-1, and depreciate in EXP-2. Consequently, in response to the different changes in terms of trade and real exchange rates, firms reduce investment, when the terms of trade deteriorate, and increase investment, when the terms of trade improve. Simulation results do reveal that investments slightly fall in EXP-1 and rise in EXP-2 for most nonmember regions (Figure 3a,b).
Figure 2. Terms of Trade in Selected Non-Member Regions (Ratios to Base-Run Steady State). a) USA, b) EU, c) Rest of West Hemisphere, d) Asia.
In response to the deteriorated terms of trade in EXP-1, third countries’ trade situation worsens. When tariffs among MERCOSUR member countries are eliminated, nonmember countries’ total exports fall along the transitional path. Among all nonmember regions, the total exports decline more in the new steady state than upon impact. Such negative effect is larger for the small nonmember countries, such as Chile, than that for the large regions. Chile is experienced a decline in its total exports ranging from 0.14 percent upon impact to 0.55 percent in the steady state; while for the large regions, such declines rank from less than 0.05 percent upon impact to 0.1 percent in the steady state.

Drastic declines in the exports to MERCOSUR are the reason that causes nonmember countries’ total exports to fall (Table 4a, and Figure 4a,b for U.S.). Under scenario EXP-1, exports from

---

The Rest of World total exports rise slightly (by 0.01 percent) in the first year, but fall by 0.02 percent in the new steady state.
<table>
<thead>
<tr>
<th></th>
<th>Experiment 1</th>
<th></th>
<th>Experiment 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 1</td>
<td>Steady state</td>
<td>Year 1</td>
<td>Steady state</td>
</tr>
<tr>
<td>USA</td>
<td>−0.0237</td>
<td>−8.8232</td>
<td>0.1547</td>
<td>11.9044</td>
</tr>
<tr>
<td>CHL</td>
<td>−0.1412</td>
<td>−7.3707</td>
<td>0.3208</td>
<td>9.8441</td>
</tr>
<tr>
<td>RWH</td>
<td>−0.0217</td>
<td>−6.5350</td>
<td>0.1127</td>
<td>7.8240</td>
</tr>
<tr>
<td>E_U</td>
<td>−0.0475</td>
<td>−9.0253</td>
<td>0.1961</td>
<td>22.2101</td>
</tr>
<tr>
<td>ASA</td>
<td>−0.0089</td>
<td>−13.0058</td>
<td>0.1446</td>
<td>46.5588</td>
</tr>
<tr>
<td>ROW</td>
<td>0.0126</td>
<td>−0.2077</td>
<td>0.0458</td>
<td>−9.4897</td>
</tr>
</tbody>
</table>
Table 4b: Spillover Effects of Mercosur on Third-Country Sectoral Exports in the New Steady States (% Changes from base-run steady state)

<table>
<thead>
<tr>
<th></th>
<th>All non-Mercosur countries</th>
<th></th>
<th>U.S.</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXP-1</td>
<td>EXP-2</td>
<td>EXP-1</td>
<td>EXP-2</td>
<td>EXP-1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>to Merc.</td>
<td>Total</td>
<td>to Merc.</td>
<td>Total</td>
</tr>
<tr>
<td>Agriculture</td>
<td>-0.35</td>
<td>-17.14</td>
<td>0.19</td>
<td>-19.23</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>Processing food</td>
<td>-0.35</td>
<td>-7.89</td>
<td>0.92</td>
<td>-0.14</td>
</tr>
<tr>
<td>Textile</td>
<td>-0.30</td>
<td>-38.96</td>
<td>0.55</td>
<td>51.81</td>
<td>-0.44</td>
</tr>
<tr>
<td>Intermediates</td>
<td>-0.11</td>
<td>-2.22</td>
<td>0.28</td>
<td>4.23</td>
<td>0.07</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>-0.37</td>
<td>-22.38</td>
<td>0.56</td>
<td>31.09</td>
<td>-0.32</td>
</tr>
<tr>
<td>Services</td>
<td>0.03</td>
<td>3.48</td>
<td>-0.01</td>
<td>-5.27</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                | Chile                      |                | The rest of the Western hemisphere |                |
|                | EXP-1                      | EXP-2          | EXP-1          | EXP-2          |
|                | Total                      | to Merc.       | Total          | to Merc.       |
| Agriculture    | 0.22                       | -12.50         | -0.65          | -8.50          |
|                | Processing food            | 0.00           | 1.76           | 30.06          |
| Textile        | -8.52                      | -36.56         | 6.21           | 23.45          |
| Intermediates  | -0.17                      | -4.55          | -0.17          | -8.66          |
| Manufacturing  | -19.37                     | -35.43         | 37.11          | 66.48          |
| Services       | 0.67                       | 3.74           | -0.22          | -5.01          |

(Continued)
Table 4b: Continued

<table>
<thead>
<tr>
<th>European Union</th>
<th>Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXP-1</td>
</tr>
<tr>
<td>Agriculture</td>
<td>-0.01</td>
</tr>
<tr>
<td>Processing food</td>
<td>0.15</td>
</tr>
<tr>
<td>Textile</td>
<td>-0.13</td>
</tr>
<tr>
<td>Intermediates</td>
<td>0.08</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>-0.40</td>
</tr>
<tr>
<td>Services</td>
<td>0.09</td>
</tr>
</tbody>
</table>

The rest of the world

<table>
<thead>
<tr>
<th>EXP-1</th>
<th>EXP-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>to Merc.</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.08</td>
</tr>
<tr>
<td>Processing food</td>
<td>0.24</td>
</tr>
<tr>
<td>Textile</td>
<td>-0.04</td>
</tr>
<tr>
<td>Intermediates</td>
<td>0.02</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>-0.26</td>
</tr>
<tr>
<td>Services</td>
<td>0.01</td>
</tr>
</tbody>
</table>

X. Diao and A. Somwaru
the nonmember regions (except for the Rest of World) to MERCOSUR fall between 6.5 percent (for EU) and 13 percent (for Asia) in the first year, and fall between 8 percent (for the Rest of the Western Hemisphere) and 15 percent (for Asia) in the steady state. To compensate for the losses in MERCOSUR markets, the nonmember countries raise trade among themselves. However, increases in exports to the non-MERCOSUR countries are smaller than the decreases in the exports to MERCOSUR and, hence, we observe that total exports fall in the nonmember countries.

In contrast, when MERCOSUR combines its common external tariff policy with its internal trade policy, terms of trade improve for the nonmember countries (in EXP-2). Thus, four non-MERCOSUR regions raise their aggregate exports either along the transition or in the new steady state. Besides these four regions, U.S. and Rest of the World raise their exports during first few years after tariff reduction in MERCOSUR. Also, we observe that
increases in the exports from nonmember regions to MERCOSUR are larger than the increases in their total exports, except for the Rest of the World (Table 4a). For example, Asia and EU raise their exports to MERCOSUR by 47 and 22 percent, respectively, in the first year, and 41 and 18 percent, respectively, in the steady state.

Now we turn to analyze MERCOSUR’s effects on third-countries’ sectoral trade. We first calculate changes in sectoral exports of the nonmember countries as a group, and report the results in the first columns of Table 4b. We notice that under EXP-1, sectoral exports of all nonmember countries as a group fall between 0.1 and 0.4 percent (except for services). Similar as the changes in total exports, declines in sectoral exports are caused by the significant decreases in the exports to MERCOSUR. Nonmember countries’ exports to MERCOSUR fall as high as 40 percent for the textile sector to 2 percent for the intermediate sector in the steady state. However, if MERCOSUR implements its lower common external tariff policy, sectoral exports of the nonmember countries rise from 0.2 percent in agriculture to almost 1 percent in processing foods. Increases in the exports of textile, intermediates, and manufacturing can be explained by the increases in trade with MERCOSUR. We observed that exports of nonmember countries to MERCOSUR significantly rise in these three sectors (52, 30, and 4 percent for textile, manufacturing, and intermediates, respectively; see Table 4b). However, exports of agricultural and processing foods of nonmember countries to MERCOSUR fall by 19 and 0.14 percent, respectively. Thus, increases in nonmember countries’ total exports of these two sectors are the results of trade expansion among themselves.

In general, the spillover effects of MERCOSUR on third-country textile and manufacturing sectors are much greater than those on the other sectors, regardless of such effects being positive or negative. This is due to the different levels of trade protection rates among MERCOSUR’s sectors. The data (of 1992) indicate that, for Argentina and Brazil, the textile and manufacturing import tariff rates are almost 100 percent higher than other sectors’ tariff rates. Hence, when the internal tariffs are eliminated between these two countries, or MERCOSUR’s common external tariff on third-country are reduced to the world average levels, textile and manufacturing sectors are affected the most. These results imply that, for the sectors with higher levels of protection
in MERCOSUR, trade-diverting effects are larger when MERCOSUR only eliminates the internal tariffs. However, when MERCOSUR also reduces its external tariffs, opportunities for the nonmember countries to raise their exports to MERCOSUR are also higher in those sectors where MERCOSUR has higher levels of trade protection.

Even though the sectoral exports fall in the nonmember countries as a group under the scenario EXP-1, changes in their sectoral exports vary across regions. Table 4b also presents changes in each nonmember region’s sectoral exports and exports to MERCOSUR and such variation can be easily observed.

4. CONCLUSIONS

In this paper we employ a dynamic global general equilibrium model to analyze trade effects and welfare effects of MERCOSUR on both its member countries and as well as on the nonmember trading regions. The model is global in the sense that all regions, including the rest of world, are fully endogenous. The model is characterized by the nature of dynamics in the sense that we incorporate explicit intertemporal optimizing behavior of consumption, savings, and investment for the agents in each region.

The simulation results indicate that the regional trade agreement raises MERCOSUR member countries’ welfare by stimulating their investment, production, and consumption. While trade opportunities of the member countries increase, growth of intraregional trade is much faster than that of the total trade for the member countries. Furthermore, lowering MERCOSUR common external tariff for third-country import allows MERCOSUR member countries to benefit more from their trade agreement than that if they only eliminated their internal tariffs. In this case, the member countries’ real GDP grows more and their welfare gains more. Also the total exports increases more, and the fast growth of their intra regional trade is accompanied by the increases in trade with their major third-country trading partners.

The negative spillover effects on the third-country trading partners are observed in terms of third-country’s investment, consumer welfare, and national products, when MERCOSUR only carries out internal trade reforms. However, as trade with MERCOSUR has a relative small share with respect to the large third-region’s total trade, such negative effects are small. If trade agreements
only involve trade liberalization among the member countries, for a large trade bloc, such as NAFTA or EU, we would expect relatively greater negative spillover effects on the third party. Furthermore, the perspectives of emerging large trade blocs or regional integration agreements, such as APEC or WHFTA, makes the results obtained in this study from MERCOSUR internal zero-tariff policy simulation relatively important for policy analysis.

Third-countries benefit when MERCOSUR reduces its common external tariff rates. Production, consumption, and trade opportunities rise, and consumer welfare improves in the non-member countries. If MERCOSUR countries can further reduce their external trade protection rates, both member and non-member trading partners would be expected to benefit more.

However, MERCOSUR’s further trade policy reform calls for a reciprocal action between MERCOSUR and nonmember trading partners. Hence, if regional integration can stimulate further international cooperation and multilateral trade liberalization, then a more conducive economic environment for all countries can be anticipated.

REFERENCES


APPENDIX I: EQUATIONS AND VARIABLES IN THE DYNAMIC CGE MODEL

A.1. List of Equations

The time-discrete intertemporal utility:

\[ U_{n,t} = \sum_{s=0}^{\infty} \left( \frac{1}{1 + \rho} \right)^s \ln(TC_{n,t}) \]

\[ TC_{n,t} = \Pi_i CD_{n,it} \]

Intertemporal value of firms:
\[ V_{n,i} = \sum_{v=1}^{n} \frac{1}{\gamma_v} (1 + r_T) [PVA_{n,i} L_{n,i}^{0.5} K_{n,i}^{0.5}] \\
- w_{l,a} I_{n,i} - \Phi_n PVA_{n,i} E_{n,i} - P I_{n,i} I_{n,i} \]

\[ K_{n,i+1} = (1 - \delta_n) K_{n,i} + I_{n,i} \]

Within period equations (time subscript \( t \) is skipped).

A.1.1. Armington functions:

\[ PMM_{n,i} = \frac{1}{Y_{n,i}} \left[ \sum_{m} \theta_{m,n,i} \left( \frac{1 + t m_{n,i}}{1 - t m_{n,i}} \right) \right]^{1 - \theta_{m,n,i}} \]

\[ PC_{n,i} = \frac{1}{A_{n,i}} \left[ \beta_{n,i}^{\theta_{m,n,i}} PMM_{n,i} \left( \frac{1}{1 - t m_{n,i}} \right) \left( \frac{1 + t m_{n,i}}{1 - t m_{n,i}} \right) \right]^{1 - \theta_{m,n,i}} + \frac{1}{\lambda_{n,i}} \]

\[ M_{n,i} = Y_{n,i}^{1+\theta_{m,n,i}} \left[ \frac{\theta_{n,i}^{\theta_{m,n,i}} PMM_{n,i}^{\theta_{m,n,i}} \left( \frac{1}{1 - t m_{n,i}} \right) \left( \frac{1 + t m_{n,i}}{1 - t m_{n,i}} \right)}{1 + t m_{n,i}} \right] \]

\[ MM_{n,i} = \lambda_{n,i}^{1+\theta_{m,n,i}} \left[ \frac{\theta_{n,i}^{\theta_{m,n,i}} PC_{n,i}^{\theta_{m,n,i}} \left( \frac{1}{1 - t m_{n,i}} \right) \left( \frac{1 + t m_{n,i}}{1 - t m_{n,i}} \right)}{1 + t m_{n,i}} \right] \]

\[ D_{n,i} = \Lambda_{n,i}^{1+\theta_{m,n,i}} \left[ \frac{\theta_{n,i}^{\theta_{m,n,i}} PC_{n,i}^{\theta_{m,n,i}} \left( \frac{1}{1 - t m_{n,i}} \right) \left( \frac{1 + t m_{n,i}}{1 - t m_{n,i}} \right)}{1 + t m_{n,i}} \right] \]

A.1.2. Value added and output prices:

\[ PVA_{n,i} = \frac{1}{A_{n,i} \alpha_{n,i}^{\alpha_{n,i}} (1 - \alpha_{n,i})^{1+\alpha_{n,i}}} \left( \frac{w_{l,a}^{\alpha_{n,i}} \alpha_{n,i}^{\alpha_{n,i}}}{1 + \alpha_{n,i}} \right) \]

\[ PX_{n,i} = PVA_{n,i} + \sum_{n} PC_{n,i} J O_{n,i} \]

A.1.3. Factor market equilibrium:

\[ \sum_{n} \alpha_{n,i} PVA_{n,i} X_{n,i} = w_{l,a} L B_{n} \]

\[ (1 - \alpha_{n,i}) PVA_{n,i} X_{n,i} = w_{k,n} K_{n,i} \]

A.1.4. Demand system:

\[ CD_{n,i} = \frac{b_{n}(Y_{n} - S A V_{n})}{PC_{n,i}} \]

\[ GD_{n,i} = \frac{c_{n} \left( \sum_{n} \frac{t e_{n,i}^{\alpha_{n,i}} P X_{n,i}^{\alpha_{n,i}}}{1 - t e_{n,i}} M_{n,i} + \sum_{n} \frac{t m_{n,i}^{\alpha_{n,i}} P X_{n,i}^{\alpha_{n,i}}}{1 - t e_{n,i}} M_{n,i} \right)}{PC_{n,i}} \]
\[ INTD_{n,i,j} = IO_{n,i,j}X_{n,j} \]
\[ INVD_{n,i,j} = \frac{d_{n,i,j}PI_{n,i,j}}{PC_{n,i,j}}. \]

A.1.5. Household income:
\[ Y_n = w_nLB_n + \sum div_{n,i} + rB_n \]
\[ div_{n,i} = wk_nK_{n,i} - PVA_{n,i}\Phi_n\frac{I_{n,i}}{K_{n,i}} - PI_{n,i}r_n. \]

A.1.6. Commodity market equilibrium:
\[ C_{n,i} = CD_{n,i} + GD_{n,i} + \sum INVD_{n,i,j} + \sum INTD_{n,i,j}. \]

A.1.7. Trade surplus:
\[ FB_n = \sum \sum \left( \frac{PX_{n,i}M_{n,i,j} - PX_{n,i}M_{n,i,j}}{1 - \epsilon_{n,i,j}} \frac{PX_{n,i}M_{n,i,j}}{1 - \epsilon_{n,i,j}} \right) \]

Dynamic Difference Equations

A.1.8. Euler equation for consumption:
\[ \frac{Y_{n,t+1} - SAV_{n,t+1}}{Y_{n,t} - SAV_{n,t}} = \frac{1 + r_{n,t+1}}{1 + r} \]

A.1.9. No-arbitrage condition for investment:
\[ q_{n,i} = PI_{n,i} + 2PVA_{n,i}\Phi_n\frac{I_{n,i}}{K_{n,i}} \]
\[ (1 + r)q_{n,i,t-1} = wk_{n,i} + PVA_{n,i}\Phi_n\left( \frac{I_{n,i}}{K_{n,i}} \right)^{\frac{1}{2}} + (1 - \delta_n)q_{n,i} \]

A.1.10. Capital accumulation:
\[ K_{n,i,t+1} = (1 - \delta_n)K_{n,i,t} + I_{n,i} \]

A.1.11. Foreign assets:
\[ B_{n+1} = (1 + r)B_{n,t} + FB_{n,t} \]

A.1.12. Terminal conditions (steady-state constraints):
\[
\begin{align*}
\delta_n \mathcal{K}_{n,ss} &= I_{n,ss} \\
\alpha_n \mathcal{V}_{n,ss} &= \text{div}_{n,ss} \\
\alpha_n B_{n,ss} + FB_{n,ss} &= 0 \\
\alpha_n &= \rho
\end{align*}
\]

A.1.13. Welfare criterion (equivalent variation index):
\[
\sum_{t=0}^{\infty} \left( \frac{1}{1 + \rho^t} \ln(\hat{T}C_n(1 + \varphi_n)) \right) = \sum_{t=0}^{\infty} \left( \frac{1}{1 + \rho^t} \ln(TC_n) \right)
\]
where \( \hat{T}C_n \) is base year’s total consumption. That is, welfare gain resulting from the policy change is equivalent from the perspective of the representative household to increasing the reference consumption profile by \( \varphi_n \) percent.

A.2. Glossary
A.2.1. Parameters:
\[
\begin{align*}
\gamma_{ni} & \quad \text{shift parameter in Armington import function for good } i \text{ in region } n \\
\Lambda_{ni} & \quad \text{shift parameter in Armington composite function for good } i \text{ in region } n \\
A_{ni} & \quad \text{shift parameter in value added function for sector } i \text{ in region } n \\
A_{nik} & \quad \text{shift parameter in capital good production function for sector } i \text{ in region } n \\
b_{ni} & \quad \text{share parameter in household demand function for good } i \text{ in region } n \\
c_{ni} & \quad \text{share parameter in government demand function for good } i \text{ in region } n \\
\alpha_{ni} & \quad \text{share parameter in value added function of sector } i \text{ for labor in region } n \\
\theta_{ni} & \quad \text{share parameter in Armington import function for good } i \text{ in region } n \text{ imported from } s \\
\beta_{ni} & \quad \text{share parameter in Armington function for composite good } i \text{ imported by region } n
\end{align*}
\]
A.2.2. Exogenous variables:

- $LB_{nt}$: labor supply in region $n$
- $tm_{nt}$: tariff rate for good $i$ imported by region $n$ from region $s$
- $te_{nt}$: export tax rate for good $i$ in region $n$ exporting to region $s$

A.2.3. Endogenous variables:

- $PMM_{nt}$: composite import price for good $i$ in region $n$
- $PX_{nt}$: producer price for good $i$ in region $n$
- $PC_{nt}$: composite good price for good $i$ in region $n$
- $PVA_{nt}$: price of value added for good $i$ in region $n$
- $Pl_{nt}$: unit price of investment quantity in sector $i$ region $n$
- $q_{nt}$: shadow price of capital in sector $i$ region $n$
- $div_{nt}$: dividend in sector $i$ region $n$
- $wl_{nt}$: wage in region $n$
- $wk_{nt}$: marginal product of capital in sector $i$ region $n$
- $r_{t}$: world interest rate
- $X_{nt}$: output of good $i$ in region $n$
- $C_{nt}$: total absorption of composite good $i$ in region $n$
- $D_{nt}$: own good $i$ in region $n$
- $M_{nt}$: trade flow of good $i$ exported from region $n$ to the destination region $s$
- $MM_{nt}$: composite import good $i$ in region $n$
- $TC_{nt}$: household aggregate consumption in region $n$
- $CD_{nt}$: household demand for composite good $i$ in region $n$
- $GD_{nt}$: government demand for composite good $i$ in region $n$
- $INVD_{njt}$: investment demand for composite good $j$ in sector $i$ region $n$
\[ INTD_{ni} \] intermediate demand for composite good \( j \) in sector \( i \) region \( n \)

\[ Y_{nt} \] household income in region \( n \)
\[ SAV_{nt} \] household savings in region \( n \)
\[ K_{nit} \] capital stock in sector \( i \) region \( n \)
\[ I_{nit} \] investment quantity in sector \( i \) region \( n \)
\[ FB_{nt} \] trade surplus of region \( n \)
\[ B_{nt} \] foreign assets in region \( n \)

**APPENDIX II. DATA AND CALIBRATION STRATEGY**

The GTAP database used for the calibration and the base-run are aggregated into an eight region, six sector data set. The six aggregate production sectors/commodities are: (1) agriculture, (2) processing food, (3) textile, (4) intermediates, (5) manufacturing, and (6) services; while the eight aggregate regions include: (1) the United States, (2) Argentina, (3) Brazil, (4) Chile, (5) the Rest of West Hemisphere countries, (6) European Union, (7) all Asian countries, and (8) the Rest of World. Due to data limitation for the other two member countries (Uruguay and Paraguay), MERCOSUR is represented approximately by the Argentine and Brazilian data, which, in terms of national domestic product, comprises 97 percent of the total MERCOSUR’s economy. All regions, including the ROW, are fully specified, in the sense that production, consumption, investment, and trade decisions are the result of well-defined optimization problems.

Calibration of the model involves specifying values for certain parameters based on outside estimates, and deriving the remaining ones from restrictions posed by the equilibrium conditions. As in a static CGE model where calibration begins with the assumption that data obtained for the domestic economy reflect-period equilibrium, we assume that the world is evolving along a balanced (equilibrium) growth path.\(^9\) Hence, some of the assumptions on the model calibration concerning the economy’s exogenous environment are arbitrary. However, as we are interested in deviations with respect to a reference path in our counterfactual experiments, this specification can be regarded as robust.

\(^9\) The steady-state assumption, though questionable for most developing economies, is systematically adopted in applied intertemporal general equilibrium models due to its extreme convenience for calibration. For example, Goulder and Summers (1989), Go (1994), and Mercenier and Yeldan (1997).
The method used to calibrate parameters or initial values of variables associated with intratemporal economic activities are quite standard as that used in most static CGE models. We only sketch the more subtle dynamic calibration. Starting from the steady-state assumption, the household time discount rate, $\rho$, equals the world interest rate, $r$, which can be chosen from outside data. GTAP database further provides both the values of each region’s stock of capital and the flows of capital. Thus, with the data of the value of total investment, including capital adjustment costs, it is easy to calculate the initial level of total dividend payments ($\text{div} = \text{value of capital flows} - \text{value of total investment}$). The aggregate steady state value of the firms, $V$, and hence the marginal value of capital, Tobin’s $q$, are then obtained, i.e., $V = \text{div}/r; q = V/K$. The values of capital depreciation rate, $\delta$, and the coefficient in the capital adjustment costs, $\varphi$, have to be chosen consistently with the steady-state condition. We can first either choose $\delta$ or $\varphi$ and then calculate the other one from the steady-state equations presented in Section 2. If $\varphi$ is chosen first, then $\delta$ is calculated from the following equation derived from the steady-state conditions:

$$
\delta = \frac{q}{2P\varphi} - \frac{r q - w k}{P\varphi} + \left(\frac{q}{2P\varphi}\right)^{1/2}.
$$

The quantity of total investment, $I$, can be determined via $I = \delta K$. The capital adjustment costs, and the price for investment, $P_I$, then can be easily obtained.

In a dynamic general equilibrium model the analyst is typically interested in the adjustments generated in the finite time periods in response to parametric changes of selected exogenous variables. Hence, imposition of a terminal condition becomes pertinent for a discrete time dynamic model when there are out-of-steady state transitional paths for the endogenous variables. Since the so-called terminal conditions are, in fact, conditions for the steady state, an ideal terminal period should be chosen when a steady state is asymptotically approached. In administering the dynamic experiments, two criteria can be adhered to select the “convergence” of a steady state: the first is the time horizon when 99.99 percent of the transitional life of the main variables is realized; and the second is the time period when all endogenous variables cease to change by less than 0.000001 percent. However, for a large size global model, the computation ability of the software or computer
used may restrict the application of these two criteria. Implement-
ing the time-aggregation techniques of Mercenier and Michel
(1994) reduces required aggregate number of time periods and,
hence, reduce the size of the numerical model. This method is
applied in our simulation experiments.