

**Economic Impact Analysis of the Reduction in Sugar Tariffs
Under the ASEAN Trade in Goods Agreement:
The Case of the Philippine Sugar Sector[¶]**

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Executive Summary

The members of the Association of South East Asian Nations (ASEAN) signed and implemented in 2010 the ASEAN Trade in Goods Agreement (ATIGA) that aims at establishing the region as a single market by 2015. In the agreement, the original six ASEAN nations (Brunei, Indonesia, Malaysia, the Philippines, Singapore and Thailand) placed zero-duty on 99 percent of all their products in an inclusion list. However, they also put up a list of sensitive/highly sensitive products in which certain tariffs can be maintained. In the case of the Philippines, tariffs on rice and sugar were initially maintained at 40 percent and 38 percent. But in the ATIGA, the Philippines has committed to reduce its rice tariffs to 35 percent and its tariffs on sugar to 5 percent in 2015. In particular, through the Executive Order (EO) 892 signed by the Philippine president in 2010, the Philippines committed to reduce tariffs on sugar imports from the area from 38 percent in 2011 to 28 percent in 2012, 18 percent in 2013, 10 percent in 2014 and finally to 5 percent in 2015.

The Philippine sugar industry is the second most highly protected sector in the country. It is second to rice where imports are still being controlled by quantitative restrictions. In 2007-2011, the average domestic price of sugar was more than 100 percent higher than world sugar prices. The high sugar protection prevented the inflow of lower priced sugar imports and resulted in high domestic sugar prices.

The reduction in sugar tariffs in the Philippines and in the rest of the ASEAN may potentially increase the flow of sugar trade within the region because some countries are net sugar exporters while others are net importers. Thailand for example is a major sugar exporter in the region, while the Philippines exports some of its sugar under preferential arrangements. Indonesia used to export significant amount of sugar, but it has become a net sugar importer over time.

The objective of this paper is to examine the potential effects on the Philippine economy as the government fulfills its sugar commitment. The paper utilizes three simulation models in the analysis: The GTAP model; a Philippine CGE model; and a Philippine poverty and income distribution microsimulation model. The GTAP model is used to analyze the trading interactions between the Philippines and the rest of the ASEAN member countries and the rest of the world. The Philippine CGE model, which provides details of the economy including several household groups, is used to analyze the effects on the local sugar and the sugar-using downstream industries and the rest of the production sector, while the poverty microsimulation model which utilizes data from the national household survey is used to analyze the effects on poverty and income distribution in the Philippines.

The simulation results indicate that sugar imports in the Philippines increase by an average of 40 percent with lower ASEAN sugar tariffs. This higher import sugar volume however has minimal impact on sugar production. The local production of sugar declines marginally by an average of 0.6 percent.

The composition of sugar imports in the Philippines changes as sugar tariffs are reduced. Philippine sugar imports from the ASEAN increase by an average of 136 percent while imports

from the rest of the world contract by an average of 0.6 percent. This is because sugar prices in the ASEAN region become cheaper relative to the price in the rest of the world as a result of the regional tariff reduction.

Philippine sugar exports increase by an average of 0.7 percent. Its sugar exports to the ASEAN increase by average of 4 percent while exports to the rest of the decline by an average of 0.8 percent. However, the increase in Philippine sugar export is not enough to offset displacement effects of higher sugar imports.

The reduction in sugar tariffs lowers the cost of production of several sugar-using downstream sectors. Their production increases as a result. Some of these sectors include the manufacturing of milk processing, cocoa chocolate, ice cream and animal feeds. The dynamic effects of the reduction in sugar tariffs on these sectors indicate that their growth continues to accelerate even after the reduction in output of sugarcane and sugar milling sectors stabilizes.

The reduction in sugarcane production generates reallocation effects wherein factor resources move to the rest of the agricultural sector. Thus, output of the rest of agriculture improves. The increase in output of the sugar-using sectors attracts factor resource movements from the sugar milling and the rest of the non-agricultural sectors.

Real income improves across household groups. The income improvement is not uniform across groups. Those between the fifth and the eighth decile benefit the most. As a result the poverty incidence declines from 26.34 percent to 26.27 percent, a decline of 0.29 percent which translates to 69 thousand people moving out of poverty based on a population of 92 million.

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1. Introduction

The Philippines is a member of the Association of South East Asian Nations (ASEAN)¹. In January 1992, the Association signed an agreement creating the ASEAN Free Trade Area (AFTA) which involved a region-wide tariff reduction program. To implement the program, the tariff reduction scheme called the Common Effective Preferential Tariff (CEPT) was adopted. In the CEPT, ASEAN as a group does not apply a common external tariff on import goods coming from outside the area, but each member may impose tariffs on non-ASEAN goods based on each member's national tariff schedule. The AFTA program, which became fully operational in January 2003, expanded its coverage to include initiatives to eliminate non-tariff barriers, to harmonize customs nomenclature, valuation and procedures, and to develop common standards for product certification within the area.

The AFTA, which was signed in Singapore, was originally composed of six nations (Brunei, Indonesia, Malaysia, the Philippines, Singapore and Thailand), but four additional nations (Viet Nam, Lao PDR, Cambodia, and Myanmar) joined the Association in the second half of the 1990s and were required to adhere to the AFTA agreement. However, the newcomer nations were given longer time periods to meet all of the liberalization commitments.

In 2009, the Association signed another agreement which consolidates all existing initiatives critical to the members' desire for establishing a single market and for deeper economic integration of production base by 2015. This agreement, which is called the ASEAN Trade in Goods Agreement (ATIGA), is consistent with the principles in the AFTA, and with the trade liberalization commitments in the CEPT-AFTA.

In the ATIGA, which was implemented in 2010, the original six ASEAN nations placed zero-duty on 99 percent of all their products in the inclusion list of each of the members. The members, however, were allowed a list of sensitive/highly sensitive products in which certain tariffs can be maintained. In the case of the Philippines, tariffs on rice and sugar were initially maintained at 40 percent and 38 percent. However, in the ATIGA the Philippines has committed to reduce its rice tariffs to 35 percent and its tariffs on sugar to 5 percent in 2015. In particular, through the Executive Order (EO) 892 signed by the Philippine president in 2010, the

¹ The ASEAN was formed in 1967.

Philippines committed to reduce tariffs on sugar imports from the area from 38 percent in 2011 to 28 percent in 2012, 18 percent in 2013, 10 percent in 2014 and finally to 5 percent in 2015².

Within the area, Thailand is the largest sugar exporter (Table 1). Its sugar exports have been increasing, reaching 4.7 million metric tons in 2012. Indonesia used to be a sugar-exporting nation in the region, but its sugar exports have dropped through time. The Philippines has also been exporting sugar under certain preferential arrangements. Thus, the reduction in the Philippine and the ASEAN sugar tariffs can potentially increase the sugar trade flows within the area.

Table 1. Sugar Exports from ASEAN Member Countries ('000 metric tons)

	Thailand	Indonesia	Philippines	Vietnam
2000	2,322.7	5,114.6	138.9	3.8
2001	2,230.3	4,934.9	57.1	4.1
2002	2,063.3	359.0	89.4	0.0
2003	2,551.3	220.7	145.4	1.9
2004	2,240.2	100.9	232.0	1.0
2005	1,583.6	575.4	221.2	0.4
2006	1,244.1	386.1	217.6	0.1
2007	2,082.3	197.6	236.7	0.5
2008	2,977.8	1,190.2	211.4	0.9
2009	2,348.1	668.6	247.4	1.2
2010	2,075.0	380.5	74.0	0.1
2011	4,122.7	282.4	580.9	na
2012	4,736.7	10.6	203.3	na

Source: United Nations Comtrade

na – not available

The objective of this paper is to examine the potential effects on the Philippine economy as the government fulfills its sugar commitments. Consistent with the agreements set in the ATIGA, the paper also allows for sugar tariff reduction in the rest of the ASEAN member countries. The paper utilizes three simulation models in the analysis: The GTAP model; a Philippine CGE model; and a Philippine poverty and income distribution microsimulation model. The GTAP model is used to analyze the trading interactions between the Philippines and the rest of the ASEAN member countries and the rest of the world. The Philippine CGE model, which provides details of the economy including several household groups, is used to analyze the effects on the local sugar and the sugar-using downstream industries and the rest of the

² http://tariffcommission.gov.ph/eo_892.htm

production sector, while the poverty microsimulation model which utilizes household income and expenditure data from the national household survey is used to analyze the effects on poverty and income distribution in the Philippines.

The paper is organized in five sections. After the introduction in the first section, the second section discusses key features of the sugar sector in the Philippines. The third section describes the framework adopted in the paper, including the three simulation models used in the analysis. The fourth section discusses the simulation results. Lastly, the fifth section gives a summary, conclusion and policy insights. The paper includes four appendixes which give a detailed discussion of the specification of the models used.

2. Industry Background

The sugar industry in the Philippines has long history. Long before Ferdinand Magellan discovered the different islands of the country in 1521, the cultivation of sugarcane in the Philippines was already widespread³. During the Spanish occupation since the discovery, the extraction of juice from the cane was done in a primitive manner. It was only during the turn of the 19th century when the industry started to prosper under the American occupation. During that time, sugar from the Philippines was allowed entry into the United States under a preferential treatment. Several laws in the United States and Philippine were enacted since then that allowed the continued flow of sugar imports from the Philippines to the United States under preferential arrangements.

Table 2 shows the current production and trade in the country. Between 2007-2011 sugarcane production grew by 6.3 percent. However, raw sugar production declined by 2.3 percent over the same period. In 2007-2011, more than 12 percent of raw sugar output is exported. Domestic sugar consumption however, is mainly supplied by local production because raw sugar imports are almost negligible, except in 2010 when sugar import totaled 46 thousand tons.

³ http://www.sra.gov.ph/aboutus_history1.html

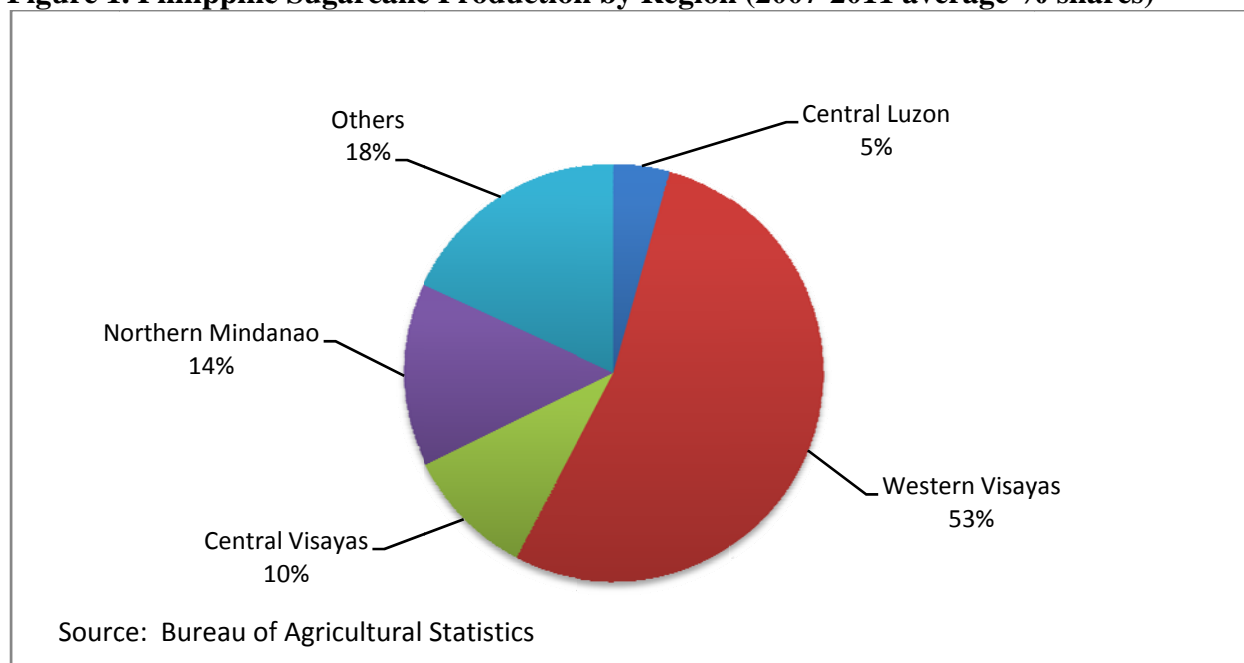
Table 2. Philippine Sugar Production and Trade ('000 tons)

	2007	2008	2009	2010	2011
Sugarcane	22,235	26,601	22,933	17,929	28,377
Raw sugar production	2,455	2,100	1,971	2,399	2,240
Exports of raw sugar	244	214	250	75	585
Imports of raw sugar	0.0	0.1	0.3	46.6	0.1

Source: Philippine Sugar Regulatory Administration, Bureau of Agricultural Statistics, United Nations Comtrade

At present, sugarcane production is concentrated in four regions: Central Luzon; Western Visayas; Central Visayas; and Northern Mindanao (Figure 1). The Western Visayas region produces 53 percent of sugarcane production, while the Northern Mindanao region produces less at 14 percent. The sugarcane production shares of the Central Visayas and Central Luzon regions are 10 percent and 5 percent, respectively. The remaining 18 percent of sugarcane production is spread across the Philippines.

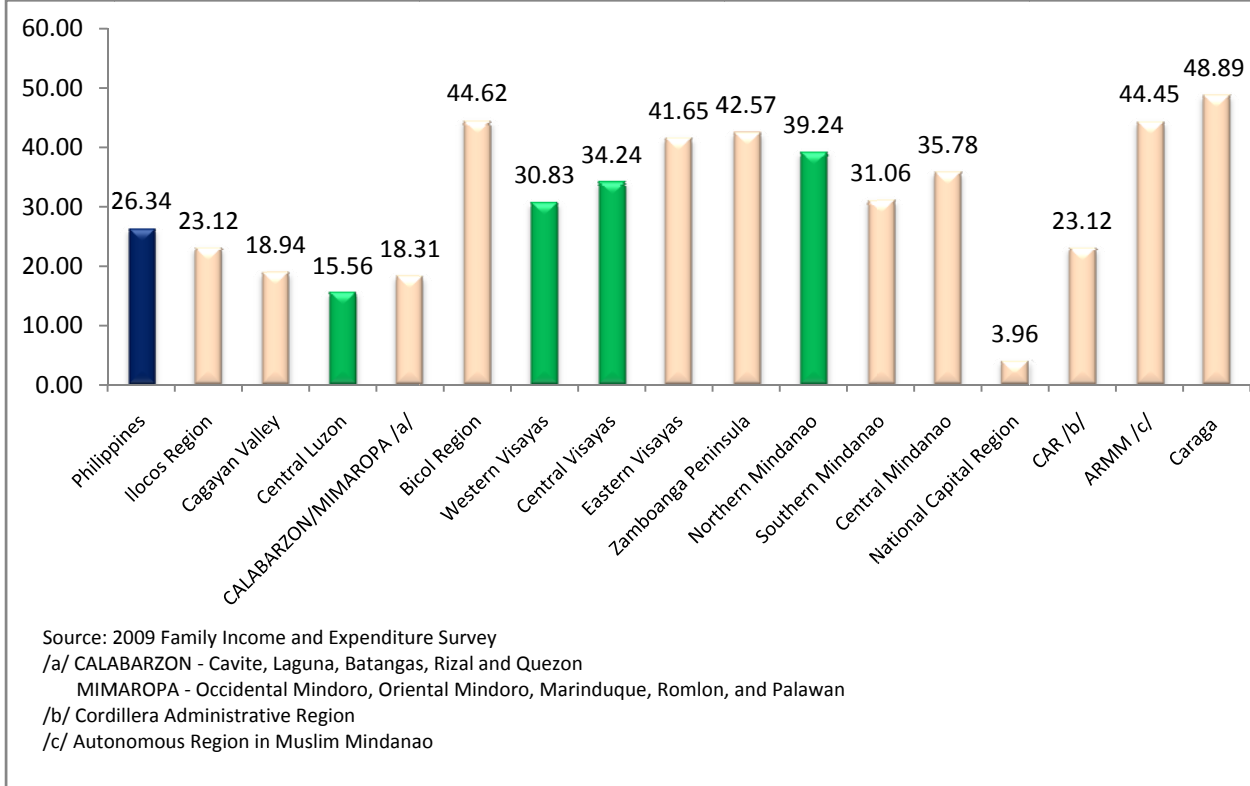
Figure 1. Philippine Sugarcane Production by Region (2007-2011 average % shares)



Except for the Central Luzon region which is located near Metro Manila, the National Capital Region where the sources of family income are diversified, the sugar-producing regions have relatively high incidence of poverty compared to the national average (Figure 2). The national poverty incidence in 2009 was 26.34 percent, while the poverty incidence in the

Western Visayas region was 30.83 percent, in the Central Visayas region 34.24 percent, and in the Northern Mindanao region 39.24 percent.

Figure 2. Philippine Regional Poverty Incidence (%)



In 2007-2011, about 76 percent of the country’s sugar export went to the United States (Table 3). This sugar export was the result of the United States sugar import quota allocation to the Philippines. The United States allocates its sugar import quota to several countries, and over the period 2008-2012, the Philippines was allocated about 13 percent of the total sugar import quota. The other two major recipients of the United States sugar import quota allocations are the Dominican Republic and Brazil. The other markets for Philippine sugar exports are Japan and Indonesia.

The sugar industry in the Philippine is the second most highly protected sector in the country. It is second to rice where imports are still being controlled by quantitative restriction (QR). The high protection on sugar resulted in high domestic sugar prices. Between 2007 and 2011, the average domestic sugar price in the Philippines was 111 percent higher than the world

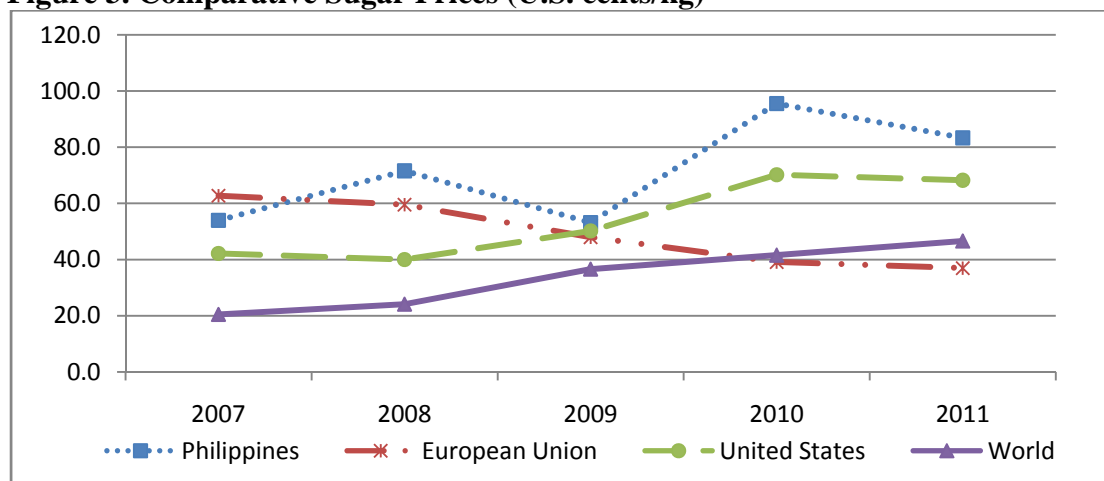
price, 32 percent higher than the United States price, and 45 percent higher than the European Union price (Figure 3).

Table 3. Philippine Sugar Exports

	2007	2008	2009	2010	2011
Philippine Sugar Exports ('000 m. tons)	244.2	214.2	250.2	75.2	584.7
Market Destination (%)	100.0	100.0	100.0	100.0	100.0
United States	72.2	86.9	72.0	84.3	62.2
Japan	9.2	3.0	16.1	12.2	15.7
Indonesia	14.7	0.0	7.6	0.0	10.0
Republic of Korea	0.0	0.1	0.2	0.4	3.5
China	0.0	0.0	0.0	0.0	5.1
Others	3.9	10.0	4.1	3.1	3.5

Source: Trade Map

Figure 3. Comparative Sugar Prices (U.S. cents/kg)



The high protection on the sugar sector can also be seen in the estimates of the nominal protection rate (NPR) in Table 4, computed using sugar world prices, wholesale prices, marketing margins, and the exchange rate. The estimates indicate that the protection reached a peak of 158 percent in 2008, but declined to 56 percent in 2011. These rates are prohibitively high which prevented the flow of lower priced sugar imports into the country as indicated in Table 2.

Table 4. Sugar Prices and Margins (U.S. cents/kg)

	Philippines			World price (c)	Nominal Protection Rate, % /2/ (a) vs (c)
	Wholesale price (a)	Farmgate price /1/ (b)	Marketing Margin,% (a) vs (b)		
2000	37.8	31.9	18.5	20.2	62.8
2001	37.8	33.5	12.8	22.4	46.5
2002	36.8	34.2	7.5	18.0	77.7
2003	33.4	30.7	9.0	17.3	67.7
2004	29.0	26.9	7.9	16.3	54.9
2005	41.2	30.9	33.3	21.8	64.5
2006	46.6	43.0	8.3	31.9	27.0
2007	53.9	47.1	14.5	20.5	129.1
2008	71.6	47.6	50.4	24.1	158.2
2009	53.1	40.4	31.5	36.6	26.3
2010	95.5	72.0	32.6	41.6	99.9
2011	83.3	71.2	17.0	46.6	55.5

Sources: IMF and Philippine Sugar Regulatory Administration

/1/ Raw sugar equivalent

/2/ Computed by increasing world prices by 15 percent to convert to CIF

The share of sugar expenditure in Filipino household consumption is relatively small compared to rice (Table 5). Poor households spend 1.3 percent of their consumption expenditure directly on sugar. Sugar is used as inputs in commodities such as soft drink, bread, and etc., which also have small shares in the consumption basket of households.

Table 5. Structure of Family Expenditure in the Philippines (%)

	Poor	Non-Poor
Rice	22.49	8.00
Sugar	1.30	0.50
Soft drink and bottled water	0.07	0.38
Bread, biscuits, cake, etc.	2.93	2.42
Others	73.22	88.70
Total	100.00	100.00

Source: 2009 Family Income and Expenditure Survey

3. Framework of Analysis

The paper adopts the modeling framework of Horridge and Zhai (2006) where a global model is linked with a country model to analyze the effects of changes in regional trade policies. In the present case, the effects on the Philippine economy of the reduction in sugar tariffs in the

ASEAN are analyzed using the GTAP model and the Philippine CGE model linked through external trade flows. The GTAP model is specified in such a way that the Philippines is treated as a separate trading region not included in the ASEAN. Thus, the Philippines trades with the ASEAN and the rest of the world. The reduction in tariffs in the ASEAN on imports of sugar from the Philippines is simulated using the GTAP model. The simulation is conducted with sugar tariffs in the rest of the world on imports from the Philippines, as well as sugar tariffs in the Philippines on all sugar imports into the country, held fixed. The reduction in sugar tariffs in the ASEAN generates relative price changes that result in shifts in the global demand for Philippine sugar in the ASEAN and in the rest of the world. These demand shifts are incorporated into the Philippine CGE model. The GTAP model was calibrated to the most recent 2008 GTAP database. In the Philippine model, sugar tariffs on imports from the ASEAN are reduced while holding fixed the corresponding tariffs on sugar imports from the rest of the world. This, together with the shifts in the global demand for Philippine sugar generated from the GTAP model, is simulated in the Philippine model. The rationale for adopting this framework in the analysis is discussed in Appendix A.

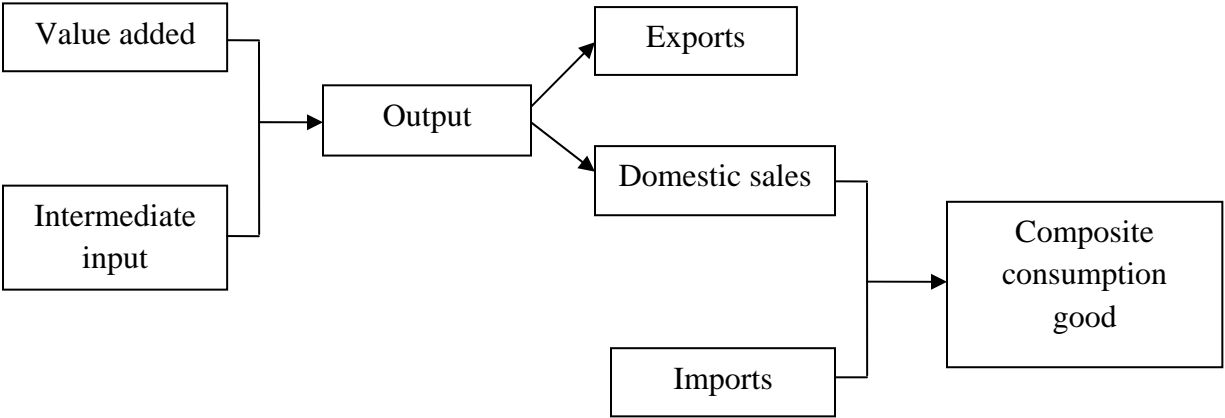
The changes in Philippine sugar tariffs and the shifts in the global demand for Philippine sugar generate changes in relative price changes within the economy. The Philippine model simulates these changes and generates detailed sectoral results, including results on factor prices, factor demand, commodity prices, commodity demand and household income. This information is inputted into a poverty and income distribution microsimulation model to analyze the poverty and distributional effects in the Philippines of changes in sugar tariff policies in the ASEAN region. The poverty and distributional model uses the 2009 Family Income and Expenditure Survey (FIES). The details of the microsimulation model are discussed in Appendix D.

The complete specification of the Philippine CGE model used is presented in Appendix B. The key relationships in the model are summarized in Figure 4.

Output (X) is a composite of value added (VA) and intermediate input. Output is sold either to the domestic market (D) or exports (E) or both. The model allows for some degree of substitution between E and D through a constant elasticity of transformation (CET) function. The substitution depends on the changes in relative prices of E and D and on the substitution

parameter. The model has upward sloping export supply curves and downward sloping world demand curves. The supply of goods and services in the economy is a composite (Q) of two variables: production sold to the domestic market (D) and imports (M). The model allows for substitution between D and M through a constant elasticity of substitution (CES) function. The substitution depends upon the changes in relative prices of D and M and on the substitution parameter. The composite good is consumed by households (consumption), purchased by the government (government expenditure), or demanded as investments.

Figure 4. Key Relationships in the Philippine CGE Model

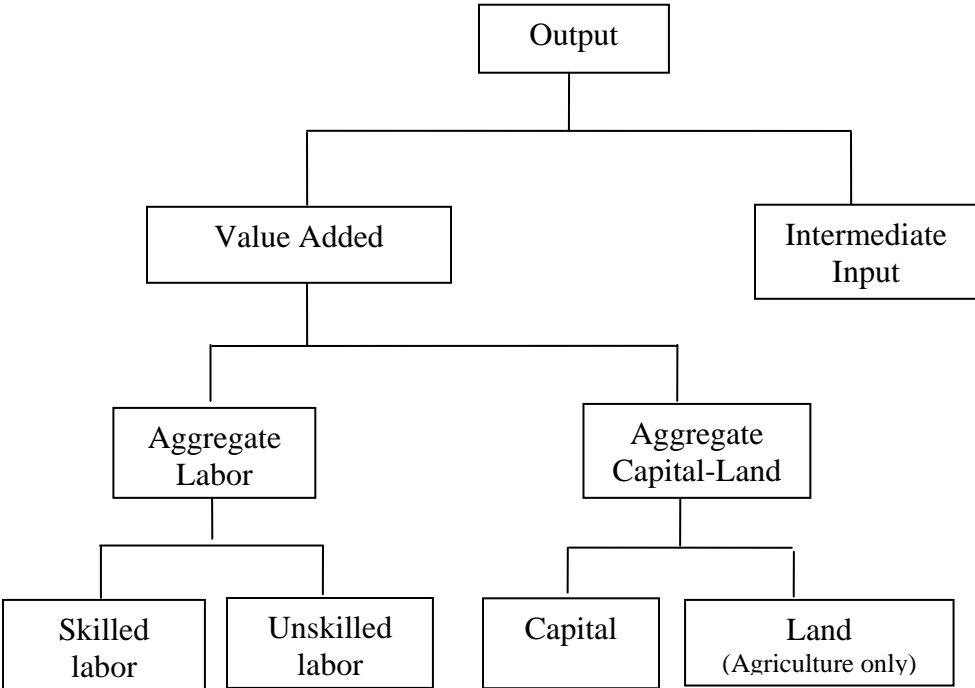


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Figure 5 shows how output is determined. Output is a composite of intermediate input and value added using fixed (Leontief) coefficients. Value added (VA) is specified as a CES

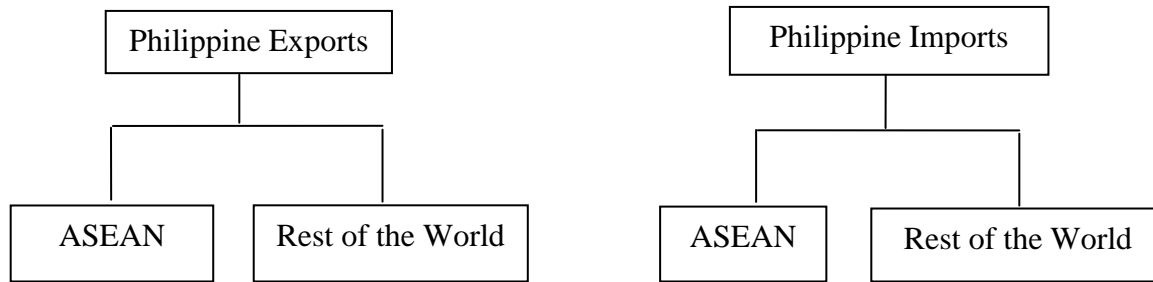
function. In agriculture, value added is a CES function of skilled labor, unskilled labor, capital and land. In non-agriculture, value added is a CES function of skilled labor, unskilled labor and capital. All factors are mobile across sectors where they are demanded. The factor demands are derived as the first order conditions for profit maximization.

Figure 5. Output Determination in the Philippine CGE model



The Philippine external trade in the Philippine CGE model is divided into ASEAN and the rest of the world (ROW). Through a CET function, Philippine goods are exported to the ASEAN and ROW (Figure 6). Through a CES function, the Philippines purchases imports from the ASEAN and ROW.

Figure 6. External Trade in the Philippine CGE Model



There are 40 sectors in the Philippine CGE model⁴ (Table 6). The model has separate sugarcane and sugar milling sectors, including detailed downstream industries that use sugar as inputs. The sources of household income are factor incomes (labor, capital, and land), transfers, foreign remittances, and dividends. Household savings are fixed proportions of disposable income. Households and enterprise pay direct taxes to the government. The sources of government income are tariffs, indirect taxes, direct taxes, and foreign grants. Household demand is represented by a linear expenditure system (LES). Households in the model are grouped in decile by income levels.

The Philippine CGE model is dynamic-recursive. Basically, it is a series of static CGE models which are linked between periods by updating equations for exogenous and endogenous variables. Within each period, government savings and government total income are both endogenous variables. Government consumption however, is fixed in real terms. Fixing government activities assures households to remain in their budget constraints, which is important in welfare analysis (McDougall, 2001). Household savings as well as household income are both endogenous variables. Foreign savings is fixed. The nominal exchange rate is the numeraire. The external account is cleared by changes in the real exchange rate, which is the ratio between the nominal exchange rate and endogenous prices in Philippine markets.

⁴ The model is an aggregated version of a model originally with 220 sectors.

Table 6. Sectors in the Philippine CGE model

1	Palay	21	Other food manufacturing *
2	Corn	22	Alcoholic liquors wine *
3	Coconut	23	Soft drinks carbonated water *
4	Banana	24	Tobacco
5	Sugarcane *	25	Textile clothing
6	Other crops	26	Wood paper printing
7	Livestock	27	Leather and rubber
8	Fishing	28	Chemicals
9	Other Agriculture	29	Non-Metallic
10	Mining	30	Metallic
11	Rice milling	31	Machineries
12	Corn milling	32	Electrical
13	Sugar milling *	33	Transportation vehicles
14	Milk processing *	34	Other Manufacturing
15	Ice cream *	35	Construction
16	Canning fruits and vegetables *	36	Utilities
17	Manufacture of bakery products *	37	Wholesale retail trade
18	Manufacture of cocoa chocolate *	38	Restaurants bars canteens
19	Manufacture of animal feeds *	39	Other Services
20	Manufacture of flavoring extracts *	40	Government Services

* Sugar and sugar-using sectors

Between periods, the model dynamics is driven by three factors: labor supply growth; capital accumulation; and productivity. The historical growth of labor in the Philippines is used to update the supply of labor. The aggregate capital stock in a given period is equated to the previous period capital stock, less capital depreciation, plus the volume of investment in the previous period. The volume of investment is affected by national savings, foreign savings, and the unit cost of investment.

The model adopts the steady-state growth framework of most neoclassical models where the capital-labor ratio grows at m , where m is the labor-augmenting productivity factor (Appendix C). Following van der Mensbrugge (2008), the labor-augmenting productivity factor in agriculture is treated differently from the non-agriculture sectors. Several studies in the Philippines have indicated zero or at best minimal improvement in Philippine agricultural productivity (Habito and Briones, 2005; Mundlak, Y. D. Larson, and R. Butzer, 2004; and Cororaton and Cuenca, 2002). The Philippine industrial sector has relatively higher productivity than the services sector. To account for these differences in sectoral labor-augmenting productivity factor in the model, the framework of van der Mensbrugge (2008) is adopted

where the labor-augmenting productivity factor in agriculture is fixed while the productivity factors in industry and service sectors differ by a constant. In the dynamic simulation, the labor-augmenting productivity factor is calibrated to achieve some target level of per capita GDP growth.

The Philippine CGE model was calibrated to a 2009 SAM. The 2009 SAM consists of 220 sectors, but in the analysis, the SAM was aggregated into 40 sectors with separate sugar sectors and downstream industries that use sugar raw materials. A summary of the 2009 macro SAM is presented in Appendix B.

4. Simulation Results

In the analysis, the Philippine CGE model is simulated from $t0$ to $t10$. In $t0$ the tariff rate on sugar imports from the ASEAN is set at 38 percent. Following the tariff schedule set in EO 892, the tariff rate is reduced gradually from 38 percent in $t0$ to 28 percent in $t1$, to 18 percent in $t2$, to 10 percent in $t3$, and finally to 5 percent in $t4$. The 5 percent tariff rate is maintained until $t10$ to capture the dynamic effects of the tariff reduction in the Philippines.

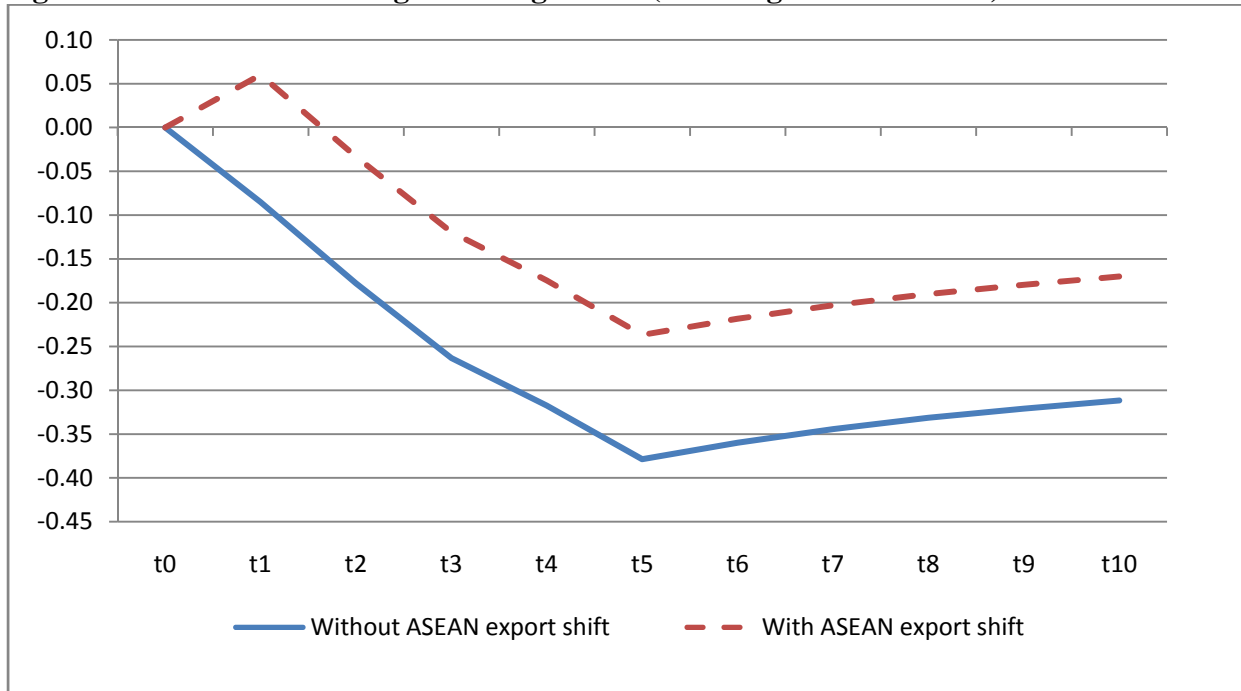
However, the GTAP model used to capture the sugar demand shifts following the reduction in sugar tariff rates within the ASEAN excluding the Philippines is static. In the absence of a dynamic GTAP model, the reduction in sugar tariffs in the rest of the ASEAN countries excluding the Philippines is simulated only in $t1$. The resulting demand shifts are applied throughout the simulation period, i.e. from $t1$ to $t10$ in the Philippine CGE model.

Effects on the Philippine Sugar Sector

The reduction in tariff rates on sugar imports lowers the price of sugar in the Philippines. The price effects on the sugar milling sector in the Philippines are depicted in Figure 7. There are two price effects shown: (a) without ASEAN export shift; and (b) with ASEAN export shift. The price effects without ASEAN export shift refer to the case of a unilateral reduction in Philippine tariff rates on sugar imports from the ASEAN, while the price effects with ASEAN export shift refer to the combined effects of the reduction in Philippine and ASEAN tariff rates on sugar traded within the region.

From the results one can observe that the negative price effects on the Philippine sugar sector are reduced under a regional tariff rate reduction. The price reduction reaches its peak in $t5$. Sugar prices begin to stabilize thereafter.

Figure 7. Price Effects on Sugar Milling Sector (% change from baseline)



The reduction in tariff rates increases the flow of sugar imports into the Philippines which displaces Philippine sugar production. Figure 8 shows that a unilateral reduction in Philippine tariff rates on sugar generates relatively higher displacement effects on the local sugar production than a regional tariff reduction. The reduction in sugar milling output reaches its peak in $t5$, and then stabilizes thereafter.

Figure 8. Output Effects on Sugar Milling Sector (% change from baseline)

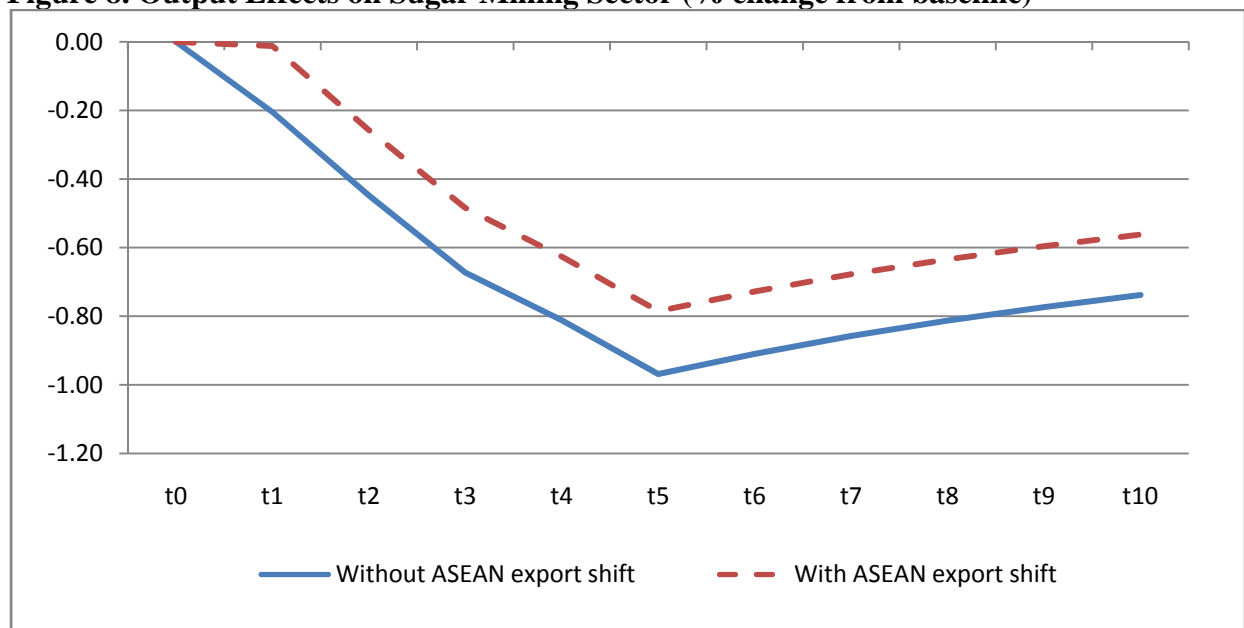


Table 7 summarizes the effects on sugar output and trade in the Philippines of the regional reduction in sugar tariffs. The output reduction in the sugar sector reaches its peak of -0.79 percent in *t5*. The decline continues after *t5* but at a reduced rate. The output reduction in the sugar milling sector translates to lower sugarcane production, but the reduction in sugarcane is slightly lower than the decline in the output of sugar milling.

The reduction in sugar milling can largely be attributed to the increased flow of sugar imports. Sugar imports increase by 10 percent in *t1* and continue to accelerate to more than 50 percent in *t5*. The flow of sugar imports however tends to stabilize after *t5*.

The composition of sugar imports in the Philippines change as sugar imports from the ASEAN increase and sugar imports from the rest of the world contract. This is due to the change in the relative price of sugar imports with sugar prices in the ASEAN becoming cheaper relative to the rest of the world as sugar tariffs within the region are reduced.

Table 7. Effects on Sugarcane and Sugar Milling Sectors in the Philippines (% change from baseline)

	t0	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10
<i>Output:</i>											
Sugarcane	0.000	-0.012	-0.244	-0.458	-0.592	-0.742	-0.687	-0.639	-0.598	-0.562	-0.530
Sugar milling	0.000	-0.012	-0.258	-0.484	-0.626	-0.785	-0.728	-0.677	-0.634	-0.596	-0.562
<i>Imports:</i>											
All											
Sugarcane	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sugar milling	0.000	10.151	21.368	32.998	41.918	52.433	52.554	52.657	52.745	52.823	52.891
From ASEAN											
Sugarcane	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sugar milling	0.000	29.837	65.562	104.162	134.607	171.383	171.599	171.780	171.937	172.079	172.198
From Rest of the World											
Sugarcane	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sugar milling	0.000	0.124	-0.226	-0.544	-0.742	-0.967	-0.888	-0.821	-0.764	-0.714	-0.668
<i>Exports:</i>											
All											
Sugarcane	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sugar milling	0.000	1.371	1.043	0.744	0.562	0.356	0.445	0.522	0.588	0.645	0.697
To ASEAN											
Sugarcane	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sugar milling	0.000	4.942	4.602	4.292	4.104	3.890	3.983	4.063	4.131	4.190	4.244
To Rest of the World											
Sugarcane	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sugar milling	0.000	-0.157	-0.480	-0.775	-0.953	-1.157	-1.069	-0.993	-0.928	-0.872	-0.821

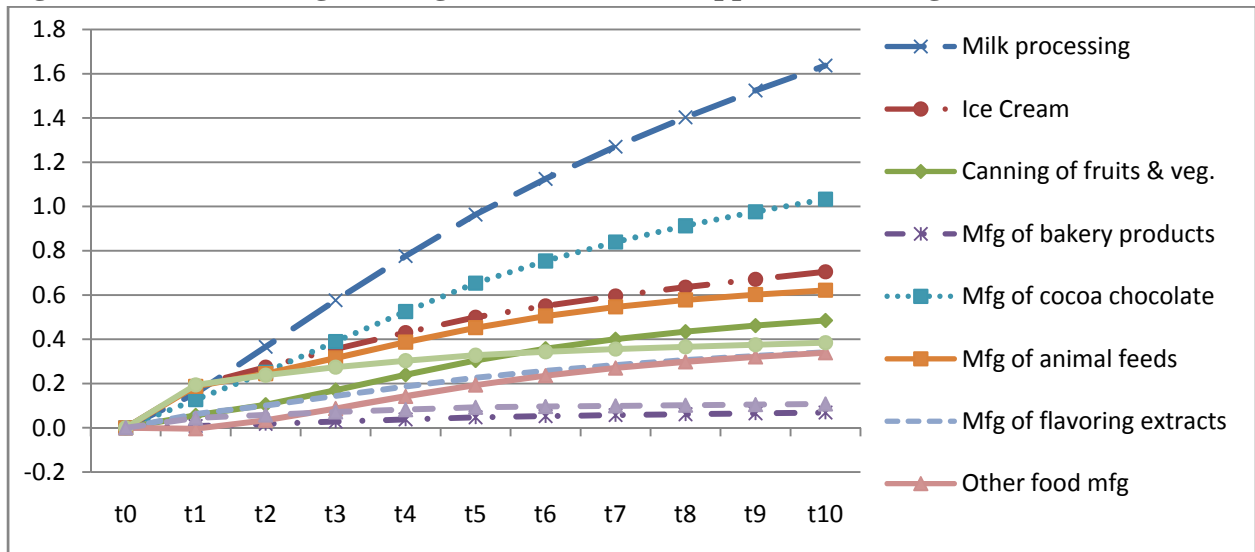
Philippine exports of sugar improve. Exports increase by 1.37 percent in *t1*. This is largely due to the increased demand for Philippine sugar within the ASEAN region as the countries in the area reduce their tariffs on Philippine sugar. Philippine sugar exports to the ASEAN grow by about 4 percent per year. However, Philippine sugar exports to the rest of the world (largely to the U.S. market) decline slightly by 0.2 percent in *t1*. The export drop accelerates to about 1 percent until *t5*, and then stabilizes thereafter.

On the whole, the increase in exports of Philippine sugar as sugar tariffs in the ASEAN are reduced is not enough to offset the displacement effects of increased sugar imports on the sugar milling sector in the country. However, sugar is an input in several sugar-using sectors, particularly in the food manufacturing sector. These downstream sectors benefit from reduced sugar prices and increased flow of sugar imports with lower prices as the next section shows.

Effects on Sugar-Using Downstream Sectors

There are several sectors which use sugar as raw materials. The increased availability of sugar imports at lower costs because of the elimination of the high, prohibitive sugar tariff rates in the Philippines reduces the cost of production of several sugar-using downstream sectors. Among these sectors, output of the manufacturing of milk processing and cocoa chocolate increases the most, followed by ice cream animal feeds (Figure 9). Furthermore, based on the results of the dynamic effects of the sugar tariff reduction, the growth in these sectors continues to accelerate even beyond $t10$ when the effects on both the sugarcane and sugar milling sectors tend to stabilize. Also, in the first year ($t1$) of the implementation of EO 892, a small negative effect output effect is seen on the other food manufacturing sector. However, beginning $t2$, the effect on the sector's growth becomes positive and accelerates thereafter.

Figure 9. Effects on Sugar-Using Sectors in the Philippines (% change from baseline)

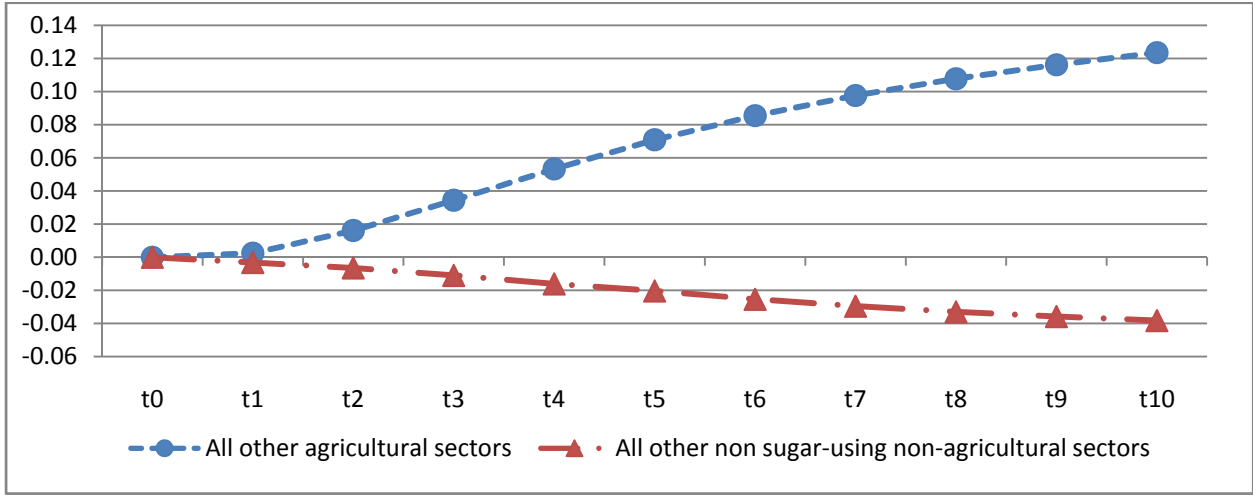


Economy-wide Effects

The decline in sugarcane output from the elimination of tariffs on sugar frees some of the factor resources used in sugarcane farming activities. The Philippine CGE model captures this factor resource movement to other agricultural crops, which is reflected in the improvement of the weighted output of all other sectors in agriculture (excluding sugarcane) in Figure 10.

However, the weighted output of all non sugar-using non-agriculture sector declines marginally over time. This can also be explained by the resource movements from this group of sectors to the sugar-using sectors. Furthermore, sugar milling is a sector under food manufacturing, and the decline in its production also triggers resource movements towards the sugar-using sectors.

Figure 10. Effects on Output of Other Agricultural and All Other Non Sugar-Using Non-Agricultural Sectors (% change from baseline)



Effects on Household Income, Distribution and Poverty

The sugarcane sector is negatively affected by the reduction in tariffs on sugar, but the rest of the other agricultural sector improves. The sugar milling sector declines as sugar imports increase, but several sugar-using sectors grow largely because of lower cost of sugar inputs. All this affect income of households. The results in Figure 11 show that the accumulated real income over the simulation years improves across household groups. The improvement in income is not uniform across households, but those between decile 5 and 8 tend to benefit more than the rest.

Figure 11. Accumulated Change in Household Real Income (% change from baseline)

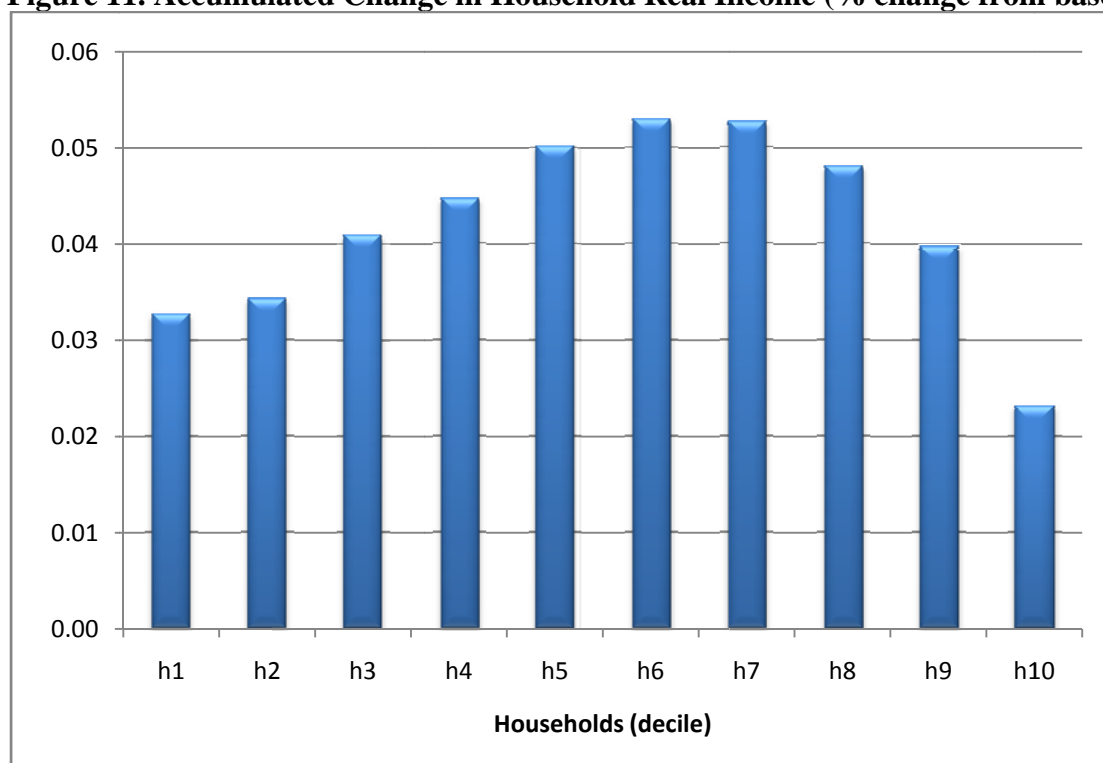


Table 8. Poverty and Income Distribution Effects in the Philippines of Sugar Tariff Reduction

	2009 FIES	Sugar Tariff Reduction	% change
Philippines			
P0 - poverty incidence	26.343	26.268	-0.285
P1 - poverty gap	7.238	7.214	-0.343
P2 - poverty severity	2.809	2.798	-0.384
Rural			
P0 - poverty incidence	40.282	40.165	-0.290
P1 - poverty gap	11.626	11.585	-0.352
P2 - poverty severity	4.635	4.617	-0.392
Urban			
P0 - poverty incidence	12.064	12.031	-0.269
P1 - poverty gap	2.744	2.736	-0.308
P2 - poverty severity	0.938	0.935	-0.347
GINI coefficient	0.47429	0.47411	-0.037

The elimination of tariffs on sugar is poverty-reducing as shown in Table 8. The reduction in the poverty indices is due to the improvement in real household income. The overall poverty incidence index declines from 26.342 to 26.268, a decline of 0.29 percent which

translates to 69 thousand people moving out of poverty based on a population of 92 million people. The decline in the poverty incidence index is relatively higher in rural areas than in urban areas.

5. Summary, Conclusion and Policy Insights

The sugar sector is the second most protected sector in the Philippines. It is second to rice where trade is still being controlled by quantitative restriction. Estimates of the net protection rate on sugar indicate extremely high rates of protection which peaked at 158 percent in 2008. The net protection rate declined to 56 percent in 2011.

Under the ATIGA, the ASEAN member countries agreed to place 99 percent of all products in the inclusion list at zero duty. The countries however agreed to maintain certain tariffs on selected items in their sensitive/highly sensitive list. The Philippines includes rice and sugar in this list. However, the Philippines, through Executive Order 892, commits to reduce gradually its sugar tariff from 38 percent in 2011 to 28 percent in 2012, to 18 percent in 2013, to 10 in 2014 and finally to 5 percent starting 2015.

The objective of this paper is to simulate the effects of this gradual tariff reduction on sugar traded within the ASEAN and to analyze the economic impact on the Philippine economy. The paper utilizes three simulation models in the analysis: The GTAP model; a Philippine CGE model; and a Philippine poverty and income distribution microsimulation model. The GTAP model is used to analyze the trading interactions between the Philippines and the rest of the ASEAN member countries and the rest of the world. The Philippine CGE model which provides details of the economy including several household groups, is used to analyze the effects on the local sugar and the sugar-using, downstream industries and the rest of the production sector, while the poverty microsimulation model which utilizes household income and expenditure data from the household survey is used to analyze the effects on poverty and income distribution in the Philippines.

In the analysis, the tariff rate on sugar is reduced gradually from 38 percent in the first period to 28 percent in the second period, to 18 percent in the third period, to 10 percent in the

fourth period, and finally to 5 percent in the fifth period. The 5 percent tariff is maintained until the tenth period to analyze the dynamic effects.

Sugar imports in the Philippines increase by an average of 40 percent as the regional sugar tariffs are reduced. Higher sugar imports have minimal effect on sugar production, with sugar output declining marginally by an average of 0.6 percent.

Sugar prices in the ASEAN region decline relative to the price in the rest of the world as sugar tariffs in the region are reduced. This changes the composition of sugar imports in the Philippines. Sugar imports from the ASEAN increase by an average of 136 percent while sugar imports from the rest of the world decline by 0.6 percent.

Philippine sugar exports to the ASEAN increase by 4 percent per year, while exports to the rest of the decline by 1 percent. The total Philippine sugar export increases following the reduction in tariffs, but the improvement is not enough to offset displacement effects of higher sugar imports.

Several sugar-using sectors benefit from the reduction in sugar tariffs. Their cost of production declines and their output improves. Some of these sectors include the manufacturing of milk processing, cocoa chocolate, ice cream and animal feeds. The dynamic effects of the reduction in sugar tariffs on these sectors indicate that their growth continues to accelerate even after the reduction in output of sugarcane and sugar milling sectors stabilizes.

The reduction in sugar tariffs generates several economy-wide effects. One of these effects is the resource reallocation from sugarcane farming activities to the rest of the agricultural sector. Thus, output of the rest of agriculture improves. The improvement in output of the sugar-using sectors attracts factor resource movements from the sugar milling and the rest of the non-agricultural sector.

Real income improves across household income groups. The improvement in income is not uniform across groups. Those between the fifth and the eighth decile benefit the most. As a result the poverty incidence declines from 26.34 percent to 26.27 percent.

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Appendix A: GTAP and Philippine CGE model

Goods produced in a country are either sold to the domestic market or exported. There is product differentiation (or quality differentiation) between goods for exports and goods for domestic consumption. This product differentiation is often reflected in price differences. Usually, product differentiation is modeled using a constant elasticity of transformation (CET) function production transformation frontier. The conditional supply functions for exports and the domestic market are the first order conditions for revenue maximization. Supply functions are upward sloping.

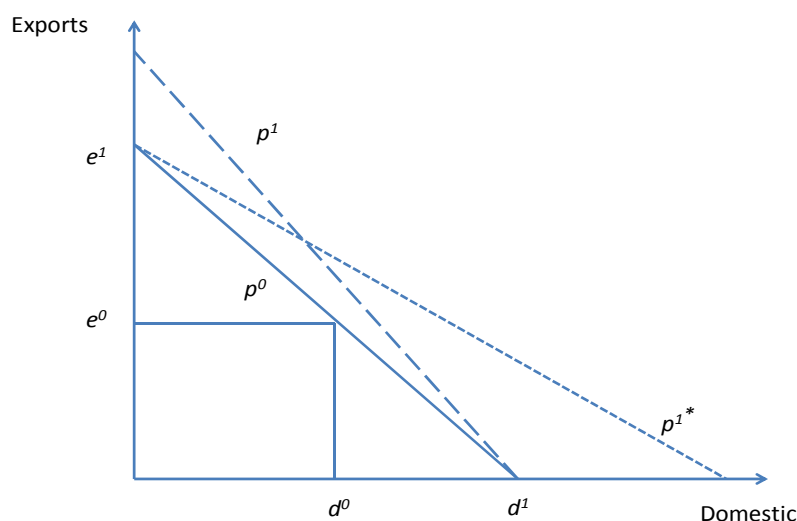
Within a single country embedded in the global GTAP model, there is no such transformation function between goods for exports and the domestic market. This implies they are perfect substitutes (Horridge and Zhai, 2006). Perfect substitutes can be characterized as goods with constant marginal rate of transformation. The supply functions of the products are not a function of relative prices. They are produced in different quantitative proportions. This may overestimate the effects in a single country that is embedded in the global GTAP model. In a perfect substitute case, a small change in the relative price between exports and the domestic market may result in wider fluctuations in quantities (over-specialization or flip-flop problem) as illustrated in Figure 11.

If the relative price of export increases to p^{l*} , everything will be exported at e^l and there will be zero supply to the domestic market. On the other hand, if the relative price of domestic goods increases to p^l , everything will be sold to the domestic market at d^l and there will be zero exports.

In the GTAP model bilateral trade is modeled using the Armington assumption where products are exogenously differentiated by origin. This means there is no single “world price” for a given product, but price varies with the origin of the product. Usually, the Armington assumption is specified as a constant elasticity of substitution (CES) function. Therefore, within a country the total demand for imports is a CES function of imports of products from different origins, each with a different price to reflect production and transportation costs, trade distortions, etc. The first order condition for expenditure minimization results in a downward-

sloping import demand curve. This is the demand curve facing a country for the product that it exports.

Figure 12. Goods for Exports and Domestic Market are Perfect Substitutes

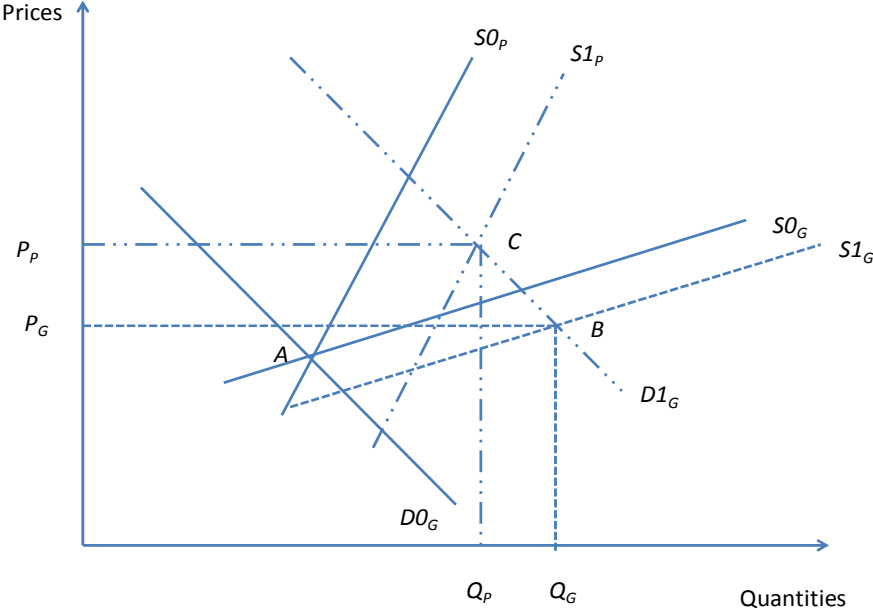


Given the structure of the global GTAP model, to analyze the impact on the Philippine economy of changes in trading arrangements between the ASEAN and the Philippines three models are utilized: (i) the global GTAP model which simulates the effects of the shocks to the export demand curve facing the Philippines, as well as changes in the import prices and demand of the country; (ii) a Philippine country computable general equilibrium (CGE) model which entails a transformation function between exports and goods sold to the domestic market; and (iii) a micro-simulation model that analyzes the distributional and poverty effects of trade policies. The first model generates the export demand shifts facing the Philippines; demand by the ASEAN and the rest of the world. The Philippine CGE model provides the Philippine upward-sloping export supply functions that capture the supply response to changes in the global export demand facing the country. The results from the Philippine CGE model are utilized in the third model are used to analyze the impact of changes in Philippine trade policies on poverty and distribution.

Linking the global GTAP model with the Philippine model has important implications on the simulation results as demonstrated in Hertel (2006). This is illustrated in Figure 12. Let DO_G

be the export demand facing the Philippines for a particular product, Q , which is determined in the global GTAP model. Let $S0_G$ be the global supply curve of the product. Let $S0_P$ be the supply curve of the Philippines, which is determined in the Philippine model. Note that $S0_G$ is flatter than the $S0_P$ because there are several production/resource constraints in the Philippines which are captured in the Philippine model but are not captured in the GTAP model. One such constraint is the CET function in the Philippine model between exports and domestic demand which has marginal rate of transformation along the frontier that is not constant, unlike in the global GTAP model which is constant.

Figure 13. Differences in the Effects in the Global GTAP and Country Models



Initially, both the global economy and the Philippine economy are in equilibrium at point A (global model). Assume a demand shock due, for example, to a tariff reduction on Q in the ASEAN. This shock shifts the demand curve outward to $D1_G$. This demand shift is due to substitution and income effects. Consumers in the ASEAN will be paying lower price for Q produced in the Philippines due to the reduction in tariff. This generates substitution effects in favor of Q produced in the Philippines. The reduction in tariff also increases the effective real income of ASEAN consumers, which effectively shifts the income line outwards to a higher indifference curve. Assuming normal good, the reduction in tariff generates substitution and

income effects that increase the demand for Q produced in the Philippines. In addition, there are cross effects on similar Q produced in other countries which may also be positive⁵.

In the Philippines, assuming limited production resources, the increase in the demand for Q releases the factors used in the production of other goods into the production of Q . This shifts the supply curve of the Philippines to SI_P . Similarly, it also shifts the global supply curve to SI_G as the world demand for Q increases because of the reduction in tariffs on Q in the ASEAN. The new Philippine equilibrium is at point $C (Q_P, P_P)$ while the new global equilibrium is at point $B (Q_G, P_G)$. Points B and C are different and they can only be captured if the Philippines has its own completely specified model. The difference between point C and point B was demonstrated by Hertel (2006) using the case of sugar in Brazil.

Horridge and Zhai (2006) have shown that in the global GTAP model the export demand curve can be written as

$$(1) \quad Q = \left(\frac{FP}{P}\right)^{ESUBM}$$

where FP is defined below, P is the price, and $ESUBM$ is the slope of the export demand curve, which is equal to the GTAP elasticity of substitution among imports. In proportional form (log-change, percent) equation (1) becomes

$$(2) \quad q = -ESUBM \cdot (p - fp) \text{ or } p = fp - \frac{q}{ESUBM}$$

where the lower case variables represent the percentage changes of the upper case variables. The change in FP represents the shift in the export demand curve which is

$$(3) \quad fp = p + \frac{q}{ESUBM}$$

Horridge and Zhai (2006) have suggested mimicking equation (1) and adding it to the country (Philippine) CGE model. The value of $ESUBM$ is the same as in the global GTAP model. The values of q and p are taken from the global GTAP model. Equation (3) can be computed at the first order, i.e.

⁵While these cross effects may be indeterminate without further restrictions, Chiang (1984) has shown that if a consumer chooses between two goods, the cross effects will be positive as well (pp. 406-408).

$$(4) \quad fp = 100 \cdot (a - 1), \text{ where } a = (1 + 0.01 \cdot p) \cdot (1 + 0.01 \cdot q)^{\frac{1}{ESUBM}}$$

This method was applied to various country applications in Hertel (2006) and in Anderson, Cockburn, and Martin (2010), in particular in Cororaton, Cockburn and Corong (2006), and Cororaton, Corong and Cockburn (2010) in the case of the Philippines, and in Cororaton and Orden (2010) in the case of Pakistan.

In the global GTAP model, the Philippines is embedded as one of the countries. When analyzing tariff changes between the ASEAN and the Philippines, ASEAN tariffs in the global GTAP model are changed. This generates a shift in global demand for Philippine products. To avoid double counting, Philippine tariffs in the GTAP model are help fixed. Philippine tariffs are changed within the Philippine CGE model.

Aside from the effects illustrated in Figure 12, there are other advantages of using interacting global model with a well specified country model to analyze country the effects of trade policies. The global GTAP model has only 1 representative household per country. The Philippine model has several household categories. The GTAP model has only one type of labor, but the Philippine CGE model disaggregates labor into skilled and unskilled categories.

Appendix B: Philippine CGE and Social Accounting Matrix

Specification of the CGE Model

Sectoral output is generated using primary factor inputs and intermediate inputs (raw materials). The sectoral primary factors generate the sectoral value added. There are three types of primary inputs in each sector: (a) labor with two labor types – skilled and unskilled; (b) capital; and (c) land. The sectoral value added is a CES function of these primary inputs. In all sectors, labor is a nested CES function of skilled and unskilled labor. In agriculture, capital is a nested CES function of capital and land. The non-agricultural sectors use capital only. Sectoral intermediate inputs are a fixed proportion (using Leontief coefficients) of sectoral output.

The cost-minimizing demand for aggregate labor is

$$(5) \quad l_i = \frac{pva_i va_i \theta_i^{va}}{\delta_{li} \left(\frac{w_i}{\delta_{li}} \right)^{\sigma_i^{va}} \left(\left(\frac{w_i}{\delta_{li}} \right)^{1-\sigma_i^{va}} (\theta_i^{va})^{\sigma_i^{va}} + \left(\frac{rkln_i}{\delta_{klni}} \right)^{1-\sigma_i^{va}} (1-\theta_i^{va})^{\sigma_i^{va}} \right)}$$

where pva_i is the value added price of sector i ; va_i the value added; θ_i^{va} the share parameter of aggregate labor in the value added function; δ_{li} the productivity factor in aggregate labor; w_i the wage of aggregate labor; σ_i^{va} the elasticity of substitution between aggregate labor and aggregate of capital-land (in agriculture); $rkln_i$ the returns to aggregate capital-land; and δ_{klni} the productivity factor of aggregate capital-land.

The cost-minimizing demand for aggregate capital-land in agriculture is

$$(6) \quad kln_i = \frac{pva_i va_i (1-\theta_i^{va})}{\delta_{klni} \left(\frac{rkln_i}{\delta_{klni}} \right)^{\sigma_i^{va}} \left(\left(\frac{w_i}{\delta_{li}} \right)^{1-\sigma_i^{va}} (\theta_i^{va})^{\sigma_i^{va}} + \left(\frac{rkln_i}{\delta_{klni}} \right)^{1-\sigma_i^{va}} (1-\theta_i^{va})^{\sigma_i^{va}} \right)}$$

For non-agricultural sectors there is no land input, thus equation (6) becomes the cost-minimizing demand for capital, k_i , with returns to capital rk and productivity factor δ_{ki} .

The unit cost function for value added is

$$(7) \quad pva_i = \left(\frac{1}{\alpha_i^{va}} \right) \left(\left(\frac{w_i}{\delta_{li}} \right)^{1-\sigma_i^{va}} (\theta_i^{va})^{\sigma_i^{va}} + \left(\frac{rkln_i}{\delta_{klni}} \right)^{1-\sigma_i^{va}} (1 - \theta_i^{va})^{\sigma_i^{va}} \right)^{\frac{1}{(1-\sigma_i^{va})}}$$

where α_i^{va} is a scale parameter in the CES function.

Aggregate labor is a CES function of skilled and unskilled labor. The cost-minimizing demand for skilled labor is

$$(8) \quad skl_i = \frac{w_i l_i \theta_i^l}{\delta_{skli} \left(\frac{wskl}{\delta_{skli}} \right)^{\sigma_i^l} \left(\left(\frac{wskl}{\delta_{skli}} \right)^{1-\sigma_i^l} (\theta_i^l)^{\sigma_i^l} + \left(\frac{wuskli}{\delta_{uskli}} \right)^{1-\sigma_i^l} (1-\theta_i^l)^{\sigma_i^l} \right)}$$

where θ_i^l is the share parameter of skilled labor; δ_{skli} the productivity factor of skilled labor; $wskl$ the wage of skilled labor; σ_i^l the elasticity of substitution in the CES function; $wuskli$ the wage of unskilled labor; and δ_{uskli} the productivity factor of unskilled labor

The cost-minimizing demand for unskilled labor is

$$(9) \quad uskli = \frac{w_i l_i (1-\theta_i^l)}{\delta_{uskli} \left(\frac{wuskli}{\delta_{uskli}} \right)^{\sigma_i^l} \left(\left(\frac{wskl}{\delta_{skli}} \right)^{1-\sigma_i^l} (\theta_i^l)^{\sigma_i^l} + \left(\frac{wuskli}{\delta_{uskli}} \right)^{1-\sigma_i^l} (1-\theta_i^l)^{\sigma_i^l} \right)}$$

The unit cost function of labor is

$$(10) \quad w_i = \left(\frac{1}{\alpha_i^l} \right) \left(\left(\frac{wskl}{\delta_{skli}} \right)^{1-\sigma_i^l} (\theta_i^l)^{\sigma_i^l} + \left(\frac{wuskli}{\delta_{uskli}} \right)^{1-\sigma_i^l} (1 - \theta_i^l)^{\sigma_i^l} \right)^{\frac{1}{(1-\sigma_i^l)}}$$

where α_i^l is a scale parameter in the CES function.

The cost-minimizing demand for capital in agriculture is

$$(11) \quad k_i = \frac{rkln_i kln_i \theta_i^{kln}}{\delta_{ki} \left(\frac{rk}{\delta_{ki}} \right)^{\sigma_i^{kln}} \left(\left(\frac{rk}{\delta_{ki}} \right)^{1-\sigma_i^{kln}} (\theta_i^{kln})^{\sigma_i^{kln}} + \left(\frac{rln_d}{\delta_{ln_d i}} \right)^{1-\sigma_i^{kln}} (1-\theta_i^{kln})^{\sigma_i^{kln}} \right)}$$

where θ_i^{kln} is the share parameter of capital; δ_{ki} the productivity factor of capital; σ_i^{kln} the elasticity of substitution between capital and land; $rlnd$ the returns to land; and δ_{lndi} the productivity factor of land.

The cost-minimizing demand for land in agriculture is

$$(12) \quad lnd_i = \frac{rkln_i kln_i (1 - \theta_i^{kln})}{\delta_{lndi} \left(\frac{rlnd}{\delta_{lndi}} \right)^{\sigma_i^{kln}} \left(\left(\frac{rk}{\delta_{ki}} \right)^{1 - \sigma_i^{kln}} (\theta_i^{kln})^{\sigma_i^{kln}} + \left(\frac{rlnd}{\delta_{lndi}} \right)^{1 - \sigma_i^{kln}} (1 - \theta_i^{kln})^{\sigma_i^{kln}} \right)}$$

The unit cost function of aggregate capital-labor is

$$(13) \quad rkln_i = \left(\frac{1}{\alpha_i^{kln}} \right) \left(\left(\frac{rk}{\delta_{ki}} \right)^{1 - \sigma_i^{kln}} (\theta_i^{kln})^{\sigma_i^{kln}} + \left(\frac{rlnd}{\delta_{lndi}} \right)^{1 - \sigma_i^{kln}} (1 - \theta_i^{kln})^{\sigma_i^{kln}} \right)^{\frac{1}{(1 - \sigma_i^{kln})}}$$

where α_i^{kln} is a scale parameter in the CES function.

Sectoral value added, va_i , is a fixed proportion of sectoral output, that is,

$$(14) \quad x_i = va_i \omega_i$$

where ω_i is a fixed coefficient.

Sectoral intermediate inputs, $intp_i$, are fixed proportion of sectoral output as well, i.e.,

$$(15) \quad intp_i = \varphi_i x_i$$

where φ_i is a fixed parameter. The matrix of intermediate inputs, mat_{ij} , is

$$(16) \quad mat_{ij} = a_{ij} intp_i$$

where a_{ij} is the input-output (IO) technical coefficients.

Sectoral output is sold in the domestic market, d_i , or exported, e_i . Using a constant elasticity of transformation (CET) function this relationship is

$$(17) \quad x_i = \alpha_i^e \left(\theta_i^e e_i^{\rho_i^e} + (1 - \theta_i^e) \cdot d_i^{\rho_i^e} \right)^{\frac{1}{\rho_i^e}}$$

where α_i^e is a scale parameter, θ_i^e share parameter. The elasticity of transformation between d_i and e_i is $\sigma_i^e = \frac{1}{1+\rho_i^e}$.

Revenue maximization will yield the conditional supply functions of d_i and e_i , whose ratio is given as

$$(18) \quad e_i = d_i \left(\frac{pe_i}{pd_i} \right) \left(\frac{1-\theta_i^e}{\theta_i^e} \right)^{\sigma_i^e}$$

where pe_i is the export price in local currency and pd_i the domestic price.

Sectoral exports are disaggregated into exports to the trading partner with special trade arrangements, the ASEAN, and to the rest of the world (ROW) using a CET function. Revenue maximization will yield a conditional export supply function to the ASEAN in the following form

$$(19) \quad e_i^{ASEAN} = \left(\frac{e_i}{\alpha_i^{eASEAN}} \right) \left(\frac{\theta_i^{eASEAN} \alpha_i^{eASEAN} pe_i}{pe_i^{eASEAN}} \right)^{-\sigma_i^{eASEAN}}$$

where α_i^{eASEAN} is a scale parameter in the CET function; θ_i^{eASEAN} the share parameter of exports to the ASEAN; pe_i^{eASEAN} domestic price of exports to the ASEAN; σ_i^{eASEAN} the elasticity of transformation of exports between the ASEAN and ROW.

The conditional export supply function to ROW has a similar form which is given by

$$(20) \quad e_i^{ROW} = \left(\frac{e_i}{\alpha_i^{eROW}} \right) \left(\frac{(1-\theta_i^{eASEAN}) \alpha_i^{eROW} pe_i}{pe_i^{eROW}} \right)^{-\sigma_i^{eASEAN}}$$

where pe_i^{eROW} is the domestic price of exports to ROW.

The overall export price is

$$(21) \quad pe_i = \left(\frac{1}{\alpha_i^{eASEAN}} \right) \left((\theta_i^{eASEAN})^{-\sigma_i^{eASEAN}} (pe_i^{ASEAN})^{(1+\sigma_i^{eASEAN})} + (1 - \theta_i^{eASEAN})^{-\sigma_i^{eASEAN}} (pe_i^{ROW})^{(1+\sigma_i^{eASEAN})} \right)^{\frac{1}{1+\sigma_i^{eASEAN}}}$$

There are two export demand functions facing the Philippines: the ASEAN and ROW demand for Philippine products. For the ASEAN the function is

$$(22) \quad e_i^{ASEAN} = \varepsilon_i^{ASEAN} \left(\frac{\overline{pwe_i^{ASEAN}}}{pwe_i^{ASEAN}} \right)^{\eta_i^{ASEAN}}$$

where ε_i^{ASEAN} is a scale constant; pwe_i^{ASEAN} the FOB export price to the ASEAN; $\overline{pwe_i^{ASEAN}}$ a shift factor in the demand function; and η_i^{ASEAN} the demand elasticity. The variable $\overline{pwe_i^{ASEAN}}$ shifts as the ASEAN demand for Philippine products changes as a result of changes in the bilateral trading arrangements.

The ASEAN export price relationship is

$$(23) \quad pe_i^{ROC} = pwe_i^{ROC} er$$

where er is exchange rate. The price variable that clears (19) and (23) is pwe_i^{ASEAN} .

The ROW demand has a similar form given by

$$(24) \quad e_i^{ROW} = \varepsilon_i^{ROW} \left(\frac{\overline{pwe_i^{ROW}}}{pwe_i^{ROW}} \right)^{\eta_i^{ROW}}$$

where ε_i^{ROW} is a scale constant; pwe_i^{ROW} the FOB export price to ROW; $\overline{pwe_i^{ROW}}$ represents vertical shift factor in the demand function; and η_i^{ROW} is demand elasticity.

The ROW export price relationship is

$$(25) \quad pe_i^{ROW} = pwe_i^{ROW} er$$

The price variable that clears (21) and (25) is pwe_i^{ROC} .

Imports, m_i , and domestic produced goods, d_i , are imperfect substitutes. They are specified using a CES function which is given as

$$(26) \quad q_i = \alpha_i^m \left(\theta_i^m m_i^{-\rho_i^m} + (1 - \theta_i^m) d_i^{-\rho_i^m} \right)^{-\frac{1}{\rho_i^m}}$$

where q_i is the composite of m_i and d_i ; α_i^m a scale parameter; θ_i^m a share parameter. The elasticity of substitution is $\sigma_i^m = \frac{1}{1+\rho_i^m}$. Cost minimization will yield the demand for m_i and d_i , whose ratio is given as

$$(27) \quad m_i = d_i \left(\frac{pd_i}{pm_i} \right) \left(\frac{\theta_i^m}{(1-\theta_i^m)} \right)^{\sigma_i^m}$$

where pm_i is the domestic price of imports and pd_i the domestic price of domestically produced goods which are specified as

$$(28) \quad pd_i = pl_i(1 + itx_i)$$

where pl_i is the local price of domestically produced goods before indirect taxes; and itx_i indirect taxes. pm_i is defined below.

Sectoral imports are disaggregated into imports from the ASEAN and ROW using a CES function. Cost minimization will yield an import demand from the ASEAN given as

$$(29) \quad m_i^{ASEAN} = \left(\frac{m_i}{\alpha_i^{mASEAN}} \right) \left(\frac{\theta_i^{mASEAN} \alpha_i^{mASEAN} pm_i}{pm_i^{ASEAN}} \right)^{\sigma_i^{mASEAN}}$$

where α_i^{mASEAN} is a scale parameter in the CES function; θ_i^{mASEAN} the share parameter of imports from the ASEAN; pm_i^{ASEAN} domestic price of imports from the ASEAN; σ_i^{mASEAN} the elasticity of substitution of imports between the ASEAN and ROW.

The demand for imports from ROW has a similar form which is given as

$$(30) \quad m_i^{ROW} = \left(\frac{m}{\alpha_i^{mROW}} \right) \left(\frac{(1-\theta_i^{mASEAN}) \alpha_i^{mROW} pm_i}{pm_i^{ROW}} \right)^{\sigma_i^{mASEAN}}$$

where pm_i^{ROW} is the domestic price of imports from ROW.

The overall import price is

$$(31) \quad pm_i = \left(\frac{1}{\alpha_i^{mASEAN}} \right) \left((\theta_i^{mASEAN})^{\sigma_i^{mASEAN}} (pm_i^{ASEAN})^{(1-\sigma_i^{mASEAN})} + (1 - \theta_i^{mASEAN})^{\sigma_i^{mASEAN}} (pm_i^{ROW})^{(1-\sigma_i^{mASEAN})} \right)^{\frac{1}{1-\sigma_i^{mASEAN}}}$$

The domestic price of imports from the ASEAN is

$$(32) \quad pm_i^{ASEAN} = pwm_i^{ASEAN} (1 + tm_i^{ASEAN})(1 + itx_i)er$$

where pwm_i^{ASEAN} FOB price of the ASEAN goods; and tm_i^{ASEAN} Philippine tariffs on goods from the ASEAN.

The domestic price of imports from ROW is

$$(33) \quad pm_i^{ROW} = pwm_i^{ROW} (1 + tm_i^{ROW})(1 + itx_i)er$$

where pwm_i^{ROW} FOB price of ROW goods; and tm_i^{ROW} Philippine tariffs on goods from ROW.

Consumption of households is specified using linear expenditure system (LES) given as

$$(34) \quad ch_{i,h} = \frac{(cmin_{i,h} \cdot pq_i + \Gamma_{i,h} \cdot (ct_h - \sum_j cmin_{i,h} \cdot pq_j))}{pq_i}$$

where $cmin_{i,h}$ is subsistence consumption, pq_i the price of the composite good q_i , $\Gamma_{i,h}$ is a set of parameters, and $(ct_h - \sum_j cmin_{i,h} \cdot pq_j)$ the supernumerary or residual income. The equation for ct_h is

$$(35) \quad ct_h = dy_h - s_h$$

where dy_h is household disposable income and s_h household savings.

Investment demand inv_i is specified as

$$(36) \quad inv_i = \frac{\kappa_i \cdot tinv}{pq_i}$$

where κ_i is a share parameter and $tinv$ total investment defined as

$$(37) \quad tinv = pinv \cdot rtinv$$

where $pinv$ is the price of investment and $rtinv$ total investment in real terms.

Intermediate demand is specified as

$$(38) \quad intd_i = \sum_j mat_{i,j}$$

Government consumption is given as

$$(39) \quad g = px_{ntrd} x_{ntrd}$$

where px_{ntrd} is the price of output of the government services sector ($ntrd$) and x_{ntrd} is the output of the government services sector.

Income from skilled labor is

$$(40) \quad yskl = \sum_i skl_i wskl$$

Income from unskilled labor is

$$(41) \quad yusk = \sum_i uskl_i wusk$$

Income from capital is

$$(42) \quad yk = \sum_i k_i rk$$

Income from land is

$$(43) \quad ylnd = \sum_i lnd_i rlnd$$

Household income y_h is

$$(44) \quad y_h = \delta_{h,sk} y_{skl} + \delta_{h,unsk} y_{usk} + yk(1 - \lambda_f - \lambda_{row})\delta_{h,unsk} + \delta_{h,lnd} y_{lnd} + y_{div_h} p_{index} + y_{gtrf_h} p_{index} + y_{row_h} er$$

where $\delta_{h,f}$ is household income share parameter; λ_f capital income share of firm; λ_{row} capital income share of foreign capital; y_{div_h} dividend income of households; y_{gtrf_h} government transfers to households; y_{row_h} foreign remittances to households; p_{index} general price index; and er nominal exchange rate.

The disposal income of households in equation (35) is

$$(45) \quad dy_h = y_h(1 - dtx_h)$$

where dtx_h is the rate of direct income tax on households.

Firm income is specified as

$$(46) \quad y_f = yk_{cap} \lambda_f$$

Firm income net of taxes is

$$(47) \quad dy_f = y_f(1 - dtxf)$$

where $dtxf$ is the rate of corporate tax on firm

The revenue from direct taxation is

$$(48) \quad dtxrev = \sum_h dtx_h y_h + y_f \cdot dtxf$$

The revenue from import tariff is

$$(49) \quad tmrev = \sum_i er(pwm_i^{ASEAN} m_i^{ASEAN} tm_i^{ASEAN} + pwm_i^{ROW} m_i^{ROW} tm_i^{ROW})$$

where tm_i tariff rate and pwm_i the CIF price of imports.

The revenue from indirect taxes is

$$(50) \quad itxrev = \sum_i \left((pl_i d_i + er(pwm_i^{ASEAN} m_i^{ASEAN} (1 + tm_i^{ASEAN}) + pwm_i^{ROW} m_i^{ROW} (1 + tm_i^{ROW}))) itx_i \right)$$

The total revenue of the government is

$$(51) \quad yg = dtxrev + tmrev + itxrev + er \cdot rowtrfg$$

where $rowtrfg$ is foreign transfers to the government.

Household savings is given as

$$(52) \quad s_h = aps_h dy_h$$

where aps_h is the average propensity to save of households.

Firm savings is specified as

$$(53) \quad sf = dyf - pindex \sum_h ydiv_h - divrow$$

where $divrow$ is dividend payments of firm to the rest of the world.

Savings of the government is

$$(54) \quad sg = yg - g - pindex \sum_h ygtrf_h - er \cdot gvtrow$$

where $gvtrow$ is payments of the government to the rest of the world.

The general price index is

$$(55) \quad pindex = \sum_i \mu_{va,i} pva_i$$

where $\mu_{va,i}$ is share parameter.

The price of investment is specified as

$$(56) \quad pinv = \sum_i \mu_{inv,i} pq_i$$

where $\mu_{inv,i}$ is share parameter.

The sectoral output price is

$$(57) \quad px_i = \frac{pl_i \cdot d_i + pe_i \cdot e_i}{x_i}$$

Total investment is the sum of all savings

$$(58) \quad tinv = \sum_h s_h + savf + savg \cdot pindex + er \cdot cab$$

where *cab* the current account balance which is

$$(59) \quad cab = \sum_i pwm_i^{ASEAN} m_i^{ASEAN} + pwm_i^{ROW} m_i^{ROW} + \frac{\lambda_{row} yk}{er} + divrow + gvtrow - \sum_i pwe_i^{ASEAN} e_i^{ASEAN} + pwe_i^{ROW} e_i^{ROW} - \sum_h yrow_h - rowtrfg$$

Real total investment is

$$(60) \quad rtinv = \frac{tinv}{pinv}$$

The zero-profit condition is given as

$$(61) \quad px_i x_i = pva_i va_i + \sum_j mat_{j,i} pq_i$$

Equilibrium in the product market is ⁶

$$(62) \quad q_i = \sum_h ch_{i,h} + inv_i + intd_i$$

Equilibrium in the skilled labor is

$$(63) \quad spskl = \sum_i skl_i$$

where *spskl* is the supply of skilled labor

Equilibrium in the unskilled labor is

$$(64) \quad spuskal = \sum_i uskl_i$$

⁶Note that (62) holds for all products less 1. Equilibrium in the i^{th} product is given as: $leon = q_{i^{th}} - \sum_h ch_{i^{th},h} - inv_{i^{th}} - intd_{i^{th}}$. The variable *leon* is always zero to satisfy the Walras law.

where $spusk_l$ is the supply of unskilled labor

Equilibrium in capital is

$$(65) \quad spk = \sum_i k_i$$

where spk is the supply of capital

Equilibrium in the land is

$$(66) \quad splnd = \sum_i lnd_i$$

where $splnd$ is the supply of land

The model is dynamic-recursive. Capital stock in the next period is

$$(67) \quad spk_{t+1} = (1 - dep)spk_t + rtinv_t$$

where t represent period.

Investment function is specified as

$$(68) \quad \frac{rtinv_t}{spk_t} = \Psi \left(\frac{rkt_t}{u_t} \right)^2$$

where Ψ is a constant; rkt_t the returns to capital in period t ; and u_t is the user cost of investment in period t which is given as

$$(69) \quad u_t = pinv_t(ir_t + dep_t)$$

where $pinv_t$ is the price of investment in period t defined in (56); ir_t real interest rate; and dep_t capital depreciation rate.

The supply of skilled labor in the next period $t+1$ is

$$(70) \quad spskl_{t+1} = spskl_t(1 + grspskl)$$

where $grspkl$ is the growth of skilled labor. The supply of unskilled labor in the next period has similar form

$$(71) \quad spusk_{t+1} = spusk_t(1 + gruspkl)$$

where $grspkl$ is the growth of skilled labor.

Social Accounting Matrix

The 240 sectors of the 2000 IO table were updated to 2009 levels using the 2009 Gross Domestic Product (GDP) in the input-output (IO) relationship: $x = (I - A)^{-1} \cdot d$, where x is the column matrix of sectoral output, I identity matrix, and A matrix of 2000 IO table technical coefficients, and d column matrix of final demand, which is the 2009 GDP. This updated 2009 IO provides a major source of information to construct the 2009 SAM. The other sources of information are the savings of households, firm and the government, which were taken from the 2009 Flow of Funds account of the Bangko Sentral ng Pilipinas (BSP). Information on the 2009 government accounts were taken from the Bureau of Treasury (BoC). The external accounts were taken from the balance of payments (BOP) accounts of the BSP. The 2009 FIES was use to update the structure of consumption across households and across commodities. The 2009 Labor force Survey (LFS) was used to update structure of labor inputs across sectors, including the breakdown of labor into skilled and unskilled, where unskilled labor is defined as labor without high school diploma.

This set of information is combined using a SAM framework. Because data come from various sources, initially the resulting SAM is not a balanced. Adjustments are needed to balance the SAM. There are several methods available in the literature to balance a SAM. In the present case, the SAM adjustments were made using an entropy method (Fofana, Lemelin and Cockburn, 2005)⁷. The resulting macro SAM is shown in Table 12⁸. In 2009, GDP of the Philippine economy was PhP 8,026 billion. The government-deficit-to-GDP was -2.62 percent.

⁷ "Balancing a Social Accounting Matrix: Theory and Application". (<http://www.pep-net.org/fileadmin/medias/pdf/sambal.pdf>)

⁸ Table 13 only shows the macro SAM. However, the updated 2009 SAM is very detailed in sectoral breakdown, comprising of 220 sectors. The list of these sectors is available upon request from the author.

Table 9. 2009 macro SAM of the Philippines, PhP billion

	Activities				Commodities				Factors			hhld	firm	govt	accum	row	Total	
	agr_a	ind_a	ser_a	ntrad_a	agr_c	ind_c	ser_c	ntrad_c	labor	land	capital							
agr_a					1,302												42	1,344
ind_a						5,197											2,248	7,445
ser_a							4,756										297	5,054
ntrad_a								791										791
agr_c	102	744	61	6								402					84	1,398
ind_c	193	3,160	1,053	114								2,089					1,174	7,783
ser_c	50	740	805	99								3,552					74	5,320
ntrad_c														791				791
labor	368	803	863	572														2,606
land	87																	87
capital	544	1,999	2,271															4,814
hhld									2,606	87	3,266		102	133			680	6,874
firm											1,327							1,327
govt					44	331	144					294	142				30	985
accum												537	463	-210			541	1,332
row					51	2,255	420				222		620	271				3,839
Total	1,344	7,445	5,054	791	1,398	7,783	5,320	791	2,606	87	4,814	6,874	1,327	985	1,332	3,839		

Check:

GDP: expenditure

GDP: gross value added

C	I	G	X	M	Total
6,042	1,332	791	2,587	2,726	8,026

Value added	Indirect taxes	Total
7,507	519	8,026

Government deficit/GDP ratio, %

-2.62

Where agr: agriculture; ind: industry; ser: service; ntrad: government services; hhld: households; govt: government; accum: accumulation; row: rest of the world; _a: activities; and _c: commodities.

Table 10. Elasticities Used in the Philippine CGE Model

	sigVa1	sigVa2	etaEU	sigE1	sigE2	sigM1	sigM2
Palay	1.65	1.67	10.61	-1.32	-1.39	2.75	2.78
Corn	1.65	1.67	2.73	-1.32	-1.39	2.75	2.78
Coconut	1.65	1.67	5.15	-1.32	-1.39	2.75	2.78
Banana	1.65	1.67	6.09	-1.32	-1.39	2.75	2.78
Sugarcane	1.65	1.67	5.67	-1.32	-1.39	2.75	2.78
Other crops	1.65	1.67	7.43	-1.32	-1.39	2.75	2.78
Livestock	1.65	1.67	3.23	-1.32	-1.39	2.75	2.78
Fishing	1.65	1.67	2.63	-1.32	-1.39	2.75	2.78
Other Agriculture	1.65	1.67	6.52	-1.32	-1.39	2.75	2.78
Mining	1.80	1.82	12.48	-1.44	-1.51	3.00	3.03
Rice milling	1.80	1.82	5.46	-1.44	-1.51	3.00	3.03
Corn milling	1.80	1.82	5.66	-1.44	-1.51	3.00	3.03
Sugar milling	1.80	1.82	5.67	-1.44	-1.51	3.00	3.03
Milk processing	1.80	1.82	7.67	-1.80	-1.89	4.25	4.29
Ice cream	1.80	1.82	7.67	-1.80	-1.89	4.25	4.29
Canning fruits and vegetables	1.80	1.82	5.66	-1.80	-1.89	4.25	4.29
Manufacture of bakery products	1.80	1.82	5.66	-1.80	-1.89	4.25	4.29
Manufacture of cocoa chocolate	1.80	1.82	5.66	-1.80	-1.89	4.25	4.29
Manufacture of animal feeds	1.80	1.82	5.66	-1.80	-1.89	4.25	4.29
Manufacture of flavoring extracts	1.80	1.82	5.66	-1.80	-1.89	4.25	4.29
Other food manufacturing	1.80	1.82	5.66	-1.80	-1.89	4.25	4.29
Alcoholic liquors wine	1.80	1.82	2.42	-1.80	-1.89	4.25	4.29
Softdrinks carbonated water	1.80	1.82	2.42	-1.80	-1.89	4.25	4.29
Tobacco	1.80	1.82	5.66	-1.44	-1.51	3.00	3.03
Textile clothing	1.80	1.82	7.83	-1.44	-1.51	3.00	3.03
Wood paper printing	1.80	1.82	6.66	-1.44	-1.51	3.00	3.03
Leather and rubber	1.80	1.82	8.51	-1.44	-1.51	3.00	3.03
Chemicals	1.80	1.82	6.21	-1.44	-1.51	3.00	3.03
Non_Metallic	1.80	1.82	6.09	-1.44	-1.51	3.00	3.03
Metallic	1.80	1.82	7.64	-1.44	-1.51	3.00	3.03
Machineries	1.80	1.82	7.52	-1.44	-1.51	3.00	3.03
Electrical	1.80	1.82	8.40	-1.44	-1.51	3.00	3.03
Transportation vehicles	1.80	1.82	9.03	-1.44	-1.51	3.00	3.03
Other Manufacturing	1.80	1.82	7.88	-1.44	-1.51	3.00	3.03
Construction	1.80	1.82	3.99	-1.44	-1.51	3.00	3.03
Uilities	1.80	1.82	5.88	-1.44	-1.51	3.00	3.03
Wholesale retail trade	3.75	3.79	3.99	-1.44	-1.51	3.00	3.03
Restaurants bars canteens	3.75	3.79	3.99	-1.44	-1.51	3.00	3.03
Other Services	3.75	3.79	3.99	-1.44	-1.51	3.00	3.03
Government Services	1.65	1.67	3.99	-1.20	-1.26	2.50	2.53

where:

sigVa1 - CES elasticities between aggregate capital and aggregate labor

sigVa2 - CES elasticities between skilled and unskilled labor, and between land and capital in agriculture

eta - Export demand elasticities the GTAP model

sigE1 - CET elasticities between exports and sale to domestic market

sigE2 - CET elasticities between exports to ASEAN and rest of the world

sigM1 - CES elasticities between imports and domestically produced goods

sigM2 - CES elasticities between imports from the ASEAN and rest of the world

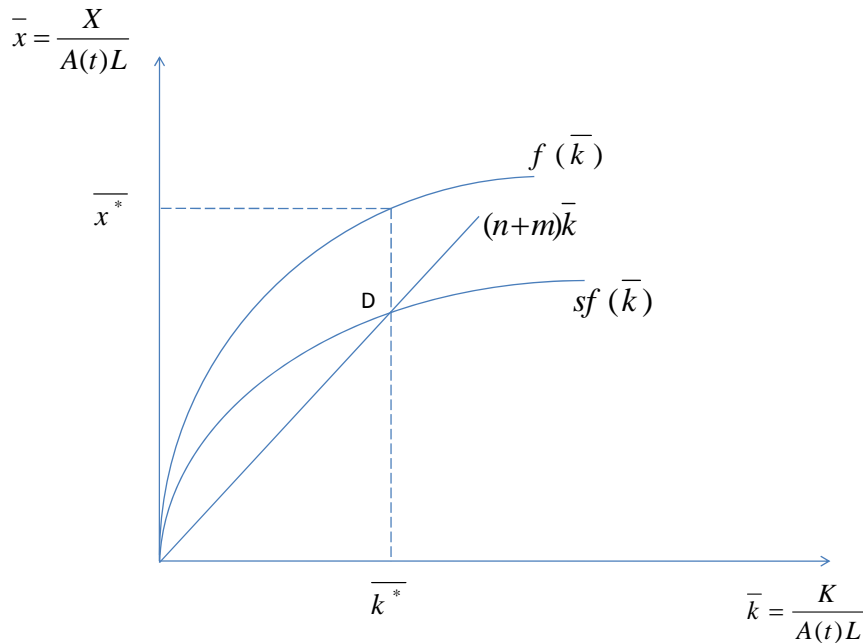
Appendix C: Long term dynamics of the CGE model

The long term dynamics of the CGE adopts the framework of the neoclassical growth model with technological progress⁹. To illustrate, let an aggregate production function be

$$(72) \quad X = F(K, A(t)L)$$

where X is the aggregate output; K the aggregate capital; L the aggregate labor; and $A(t)$ labor-augmenting technical progress. Labor is measured in efficiency units, i.e., ‘effective labor’. Let the output per labor in efficiency units be $\bar{x} = \frac{X}{A(t)L}$, and the capital per labor in efficiency units $\bar{k} = \frac{K}{A(t)L}$. The steady-state growth is illustrated in Figure 13

Figure 14. Neoclassical Growth Model Framework



where $\bar{x} = f(\bar{k})$ is the production function in terms of ‘effective labor’; s is saving rate per ‘effective’ worker (which is less than 1); $n = \frac{\dot{L}}{L}$ the growth of labor; and $m = \frac{\dot{A}(t)}{A(t)}$.

The fundamental equation of the neoclassical growth model is

⁹ A good summary of the neoclassical growth model is given in Jones (1976).

$$(73) \quad \dot{\bar{k}} = sf(\bar{k}) - (n + m)\bar{k}$$

At the steady-state growth $\dot{\bar{k}} = 0$. Graphically, this is at point D where output is at \bar{x}^* while capital at \bar{k}^* . This implies

$$(74) \quad \frac{sf(\bar{k})}{\bar{k}} = (n + m)$$

Given the definition above, (3) can also be expressed as

$$(75) \quad s \left(\frac{X}{A(t)L} \right) \left(\frac{A(t)L}{K} \right) = \frac{sX}{K} = (n + m)$$

Note that the aggregate savings is $S = sX$. In neoclassical economics, aggregate savings S is equal to aggregate investment I . Assuming zero depreciation, the aggregate investment is equal to the change in the aggregate capital stock, i.e. $I = \dot{K}$. Therefore,

$$(76) \quad \frac{I}{K} = \frac{\dot{K}}{K} = (n + m)$$

Let the simple capital-labor ratio be $k = \frac{K}{L}$. Its change can be written as¹⁰

$$(77) \quad \frac{\dot{k}}{k} = \frac{\dot{K}}{K} - \frac{\dot{L}}{L} = (n + m) - n = m$$

Thus, in neoclassical growth model with technological progress, the change in the capital-labor ratio is m , which is the labor-augmenting productivity factor. Also, at the steady-state growth, the rate of growth output per worker is also m as illustrated below.

$$(78) \quad \frac{\dot{x}}{x} = \frac{\dot{X}}{X} - \frac{\dot{L}}{L} = (n + m) - n = m$$

As discussed in the previous section, the CGE model incorporates several productivity-augmenting factors. To implement the neoclassical growth dynamics in the model, the labor-augmenting productivity factors are used: δ_{skli} for skilled labor in equation (8) and δ_{uskli} equation (9) for unskilled labor.

¹⁰ Take the logarithm of the ratio and differentiate with respect to t we get $\frac{1}{k} \frac{dk}{dt} = \frac{1}{K} \frac{dK}{dt} - \frac{1}{L} \frac{dL}{dt}$

The sectors in the CGE model are segmented into three major sectors: agriculture, industry and services. However, each of the major sectors is composed of detailed sub-sectors. It is assumed that the productivity factors for skilled labor and for unskilled labor in the sub-sectors within each of the three major sectors remain the same.

Following van der Mensbrugghe (2008), the productivity in agriculture is treated differently from the productivity in non-agriculture. Several studies in the Philippines have indicated zero or at best minimal improvement in Philippine agricultural productivity (Habito and Briones, 2005; Mundlak, Y. D. Larson, and R. Butzer (2004); and Cororaton and Cuenca, 2002). The Philippine industrial sector has relatively higher productivity than the services sector. To account for these differences in sectoral productivity in the CGE model, the framework of van der Mensbrugghe (2008) is adopted. The labor productivity in agriculture is assumed fixed, i.e. δ_{skli} and δ_{uskli} are fixed $\forall i = \text{agriculture}$. For industry and service sectors the following relationships are used

$$(79) \quad \delta_{skli,t+1} = (1 + \pi_{skl} + \gamma_{skl})\delta_{skli,t}$$

where $\delta_{skli,t+1}$ is the productivity of skilled labor in $t+1$; π_{skl} is a constant; and γ_{skl} is a uniform productivity factor; and

$$(80) \quad \delta_{uskli,t+1} = (1 + \pi_{uskl} + \gamma_{uskl})\delta_{uskli,t}$$

where $\delta_{uskli,t+1}$ is the productivity of unskilled labor in $t+1$; π_{uskl} is a constant; and γ_{uskl} is a uniform productivity factor. The model assumes $\gamma_{skl} = \gamma_{uskl}$ and $\pi_{skl} = \pi_{uskl}$. For industry π is positive, while for services it is zero. Thus π represents a wedge between industry and service sector labor productivity. The uniform productivity factor γ is calibrated to achieve some target level per capita GDP growth.

Appendix D: Poverty Microsimulation

There are several approaches to linking CGE models with data in the household survey to analyze poverty issues¹¹. One approach is a top-down method where the results of CGE models with representative households are applied recursively to data in the household survey with no further feedback effects. Within the top-down method there are wide variations. A popular one is to assume a lognormal distribution of income within household category where the variance is estimated from data in the survey (De Janvry, et al 1991). In this method, the change in income of the representative household generated in the CGE model is used to estimate the change in the average income for each household category, while the variance of this income is assumed fixed. Decaluwé et al (2000) argue that a beta distribution is preferable to other distributions such as the lognormal because it can be skewed left or right and thus may better represent the types of intra-category income distributions commonly observed. Instead of using an assumed distribution, Cockburn et al. (2006) apply the actual incomes from a household survey and use the change in income of the representative household generated in the CGE model to each individual household in that category.

There are recent more sophisticated microsimulation methods that link CGE models with household data to analyze poverty issues through the labor market transmission channel. Ganuza et al (2002) introduce a randomized process to simulate the effects of changes in the labor market structure. Random numbers are used to determine key parameters in the labor market such as: (i) which persons at working age change their labor force status; (ii) who will change occupational category; (iii) which employed persons obtain a different level of education; and (iv) how are new mean labor incomes assigned to individuals in the sample. The random process is repeated a number of time in a Monte Carlo fashion to construct 95% confidence intervals for the indices of poverty. The CGE model is used to quantify the effects of a macroeconomic shock on key labor market variables such as wages, employment, etc, and apply them to the microsimulation process. The advantage of this method is that it works through the labor market channel.

The top-down method usually uses CGE models with representative households. One criticism of this approach is that it does not account for the heterogeneity of income sources and

¹¹ There are several approaches and written papers that deal with CGE microsimulation. This appendix includes only a few of these approaches.

consumption patterns of households within each category. Intra-category income variances could be significant part of the total income variance. That is, there is increasing evidence that households within a given category may be affected quite differently according to their asset profiles, location, household composition, education, etc. To address this issue an integrated CGE microsimulation allows full integration of all households in the survey in the CGE model. As demonstrated by Cockburn (2001) and Cororaton and Cockburn (2007), this poses no particular technical difficulties because it involves constructing a standard CGE model with as many household categories as there are households in the household survey providing the base data. Decaluwé, et al (1999) constructed an integrated CGE micro-simulation model in which 150 households are directly modeled within a CGE model using fictional data from an archetypal developing country. They construct the model to allow comparisons with the earlier approaches with multiple household categories and fixed intra-category income distributions. They show that intra-category variations are important, at least in this fictional context.

In this paper we apply a simpler version of the Ganuza et al (2002) method. The idea is to allow a change in employment status after a policy change. Thus, if a household does not earn labor income initially because of unemployment, it will have a chance to gain employment after the policy shock. Similarly, if it earns labor income initially, it will have a chance of getting zero labor income after the policy change. Thus, household labor income is affected by changes in wages as well as the chance of getting unemployed after the policy shock. Similar to the Ganuza et al (2002) method we introduce a randomized process to simulate the effects of changes in sectoral employment. This approach has been applied in Cororaton and Corong (2009).

The step-by-step procedure given below adopts some features of the process in Vos (2005) and Sanchez (2004).

1. The household head represents the entire family. In the first phase of this procedure, household heads are distinguished by: (a) skill level; and (b) sector of employment. Sector of employment is differentiated into agriculture and non-agriculture whereas skill level is classified into unskilled (no education to non-high school graduates) and skilled (high school graduates and higher). There are 4 labor income sources/sectoral employment groups: unskilled agriculture, skilled agriculture, unskilled non-agriculture, and skilled non-agriculture.

2. Generate a dummy variable called *employed* where 1 = households with wage income and zero otherwise. Compute the total employment rate u^* for each of the four groups defined in step 5. The total employment rate for each group, u^* is the weighted mean of the dummy variable *employed* and weights in the household survey. Note that the dummy variable is only a subset of the survey as it only covers those with wage income (dummy variable =1) and those with zero wage income but unemployed (dummy variable = 0).
3. Update the total sectoral employment u^* in the household survey by using the variation in sectoral employment from the CGE model.
4. Assign a random number from a normal distribution to those identified as employed. This is called *random*. The variables *random* and *employed* are then sorted by descending order.
5. Compute the accumulated weight of *employed* in each group (by sector and by skill level as defined in 5).
6. Compute the over-all weight of each group. This is simply the sum of accumulated weight by sector and by skill level as defined in 5.
7. Take the ratio of accumulated weight and the overall weight of each group. This ratio is called r_{ij} .
8. Compare r_{ij} and u^* . If $r_{ij} \leq u^*$, then that household head is employed, and unemployed otherwise ($r_{ij} > u^*$).
9. Arrange each group in deciles. The decile grouping is based on the sum of labor income and capital income, where capital income is the sum of ‘total income from entrepreneurial activities’ and ‘net share of crops’ in the household survey. Other incomes such as dividends, interest income and others are not used in grouping households into deciles.
10. Assign the decile mean labor income to those who become newly employed (after a change in u^*), and reduce labor income of those who become unemployed¹² (after a change in

¹² In reducing labor income of those who become unemployed, that is, they will move to the area where $r_{ij} > u^*$ after the change in u^* . The one we adopted involves deducting the decile mean labor income from the labor income if the former is less than the latter. Otherwise, labor income is reduced to zero.

u^*), For those who become newly employed, and if they belong to the first decile for example, the mean labor income in the first decile will be assigned to them. Those with labor income, but not picked by the random process will retain their labor income. On the other hand, those with zero labor income but not picked by the random process will continue to have no labor income earnings.

11. Define total income. It is composed of three major items: labor income, capital income, and other income. Capital income is income derived from the various production sectors other than labor income, while other income includes income from dividends, government transfers, and remittances. Note that similar income sources are found in the CGE model and in the household survey.

12. Derive the change in capital and other income of each household in the survey using the average change in capital and other income per household category from the CGE model.

13. Derive the change in labor income in a two-step procedure: (a) use the change in labor income of each household in the survey from the average change in labor income per household category from the CGE model; (b) update the final labor income using the result of the random process carried in step 8.

14. Compute for the total household income by taking the sum of labor income, capital income, and other income.

15. Update the nominal value of the poverty line of each household in the survey by applying the variation in household specific consumer price index from the CGE model.

16. Calculate the GINI coefficient using the new column of income, as well as the FGT poverty indices using the income and new nominal poverty line.

17. The FGT poverty indices are calculated according to the demographic characteristics of the household head: (1) gender; (2) skill level; and (3) location, urban-rural. In total, the final FGT indices are derived for households both in decile and socio-economic categories.

18. The micro-simulation process is repeated 30 times¹³. Thus, there will be 30 estimates of GINI coefficient and FGT indices in each simulation. Confidence intervals of estimates from the 30 simulations/runs are derived.

¹³ Vos (2005) observes that 30 iterations are sufficient. Repeating this process additionally does not significantly alter the results.