

**Feasibility of Reducing Agricultural Protection:
Implications for Farm Households**

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Abstract

A special purpose version of the standard GTAP model is used to assess how reducing global agricultural protection affects farm households. The modified version of the model, nicknamed GTAP-AGR, is specifically tailored to include more realistic features of the food and farm economy. The purpose of this paper is to demonstrate how this model, in comparison with the standard GTAP model, promotes better understanding of how policy might affect the farm household. Major modifications include the segmentation of agricultural factor markets from nonagricultural markets, improved food demand, and incorporation of an explicit farm household. A comparison of results from the GTAP and GTAP-AGR models shows substantial difference in returns to land under a scenario reducing global tariffs. Real farm household income depends not only on the country's traded share of food output, but the share of household's income derived from farm activity. Farm and non-farm sources of income have implications for gains accruing to the farm household in both developed and developing countries.

Introduction

One of the main problems with global computable general equilibrium (CGE) models is the tendency to abstract from real world features of markets. The advent of special purpose CGE models provides a means of overcoming such criticisms. This is especially true for modeling energy and environmental factors where nonstandard production technology is often required. Food and agricultural markets have their own characteristics from the rest of the economy. Consumer food demand, farm labor supply, agricultural technology, and the farm household are all features characterizing the farm and food economy. Given the importance of agricultural policies and the high visibility given to debates on food policy and trade, there is a need for better representation of food and agricultural markets in global CGE models. This effort can also increase the policy relevance for the Global Trade Analysis Project (GTAP).

One of the main attractions for using CGE- based models is the ability to measure household welfare. There is growing need for policy analysis addressing farm households in both developed and developing countries. Currently, drawing a link between trade policy and farm households in individual countries is often dubious. This is because there is not a proper measure for assessing the well being of the farm household. Commonly, land rental rates are used as proxies for

gauging the economic well being of the farm household. This is done since land is the only factor specific to agriculture. One problem with this measure is that owners of land are not always operators of farms and vice versa operators are not always landowners. Furthermore there are major differences in the farm structure and land ownership rates across countries. In the United States there is enormous heterogeneity across farms, with a majority of farm households earning a substantial share of their income from nonagricultural activities (USDA 2002).¹ This is a problem that Hanson and Somwaru (2003) address using an innovative approach by exploring the distributional effects of U.S farm policy. It is common for a farm household in developing countries to earn a substantial share of their earnings from crop and livestock enterprises. Since the standard GTAP model does not explicitly represent a farm household, it is difficult to assess impacts from trade liberalization on farm households. The purpose of this paper is to demonstrate how a special purpose version of the GTAP standard model tailored for agricultural markets promotes a better understanding of how policies affect farm households.

Specific Reasons for Modifying GTAP

This section provides an overview of why specific modifications related to the food and agricultural markets are made. Details of how these changes were implemented such as the calibration of parameters as well procedures for conducting sensitivity analysis is documented in Keeney and Hertel (2004). Fortunately, previous investment towards improving agricultural modeling in general helped facilitate modifications that are made in this current effort.

The GTAP model like many other economy-wide models assume perfect mobility of labor and capital between agricultural and non-agricultural sectors. However, in reality perfect mobility of factors is not always the best assumption particularly in developing countries. If this were a valid assumption then wages paid to comparable workers in both agricultural and nonagricultural sectors would equalize. The same reasoning goes for capital mobility where returns to capital can differ between agriculture and non-agricultural sectors. There are barriers that limit mobility

¹ In the United States there are a large number small farms with a substantial non-farm income sources and few large commercial farms with a high share of income from farming.

as well as other factors that contribute to differences in factor returns. In the agricultural sector, family labor may not respond to market forces in same manner as labor in the general economy.

The explanations for imperfect factor mobility vary by individual countries. But more importantly we find that there are econometric based estimates of factor supply elasticities which vary by region. The estimates are provided by the OECD (2001) drawn from an extensive literature review of econometric estimates.² From this econometric evidence, it becomes clearer that the current treatment of factor markets has room for improvement with regards to how agricultural factors are affected by trade and domestic policies. The implications for segmenting factor market is that the farm output can become less responsive to price making more of the benefits of a subsidy accrue to the factors employed in the farm sector.

To handle imperfect labor mobility in the GTAP-AGR model a constant elasticity of transformation (CET) is adopted converting farm labor into non-farm labor.³ This allows wages between the farm and non-farm activities to diverge. The CET parameters are calibrated according to supply elasticity estimates. Similarly, the CET function is implemented in the model to segment capital between agriculture and non-agriculture. Land supply in the standard GTAP model is governed by the CET function making land imperfectly mobile across agricultural uses.

There are three CES substitution parameters introduced on the factor demand side of the model. The derived demands for factors employed in agriculture are also based on econometric estimates from the OECD (2001). A nested CES production function is calibrated to these estimated substitution elasticities. This provides greater substitution between land and other farm-owned inputs, land and purchased inputs, and between purchased intermediate inputs. Purchased intermediate inputs such as machinery and fertilizer are nested with a value added aggregate. In comparison to the standard GTAP model there is wider scope for input substitution possibilities within agriculture.

² For extensive review of farm level elasticities see: Abler 2001. "Elasticities of Substitution and Factor Supply in Canadian, Mexican, and U.S. Agriculture" Appendix A.1 Market Effects of Crop Support Measures. OECD, Paris, France.

Another modification is with livestock feed assumptions in the standard GTAP model. The problem in the standard GTAP model is that feed rations cannot respond to change in relative prices of feed ingredients. There is however evidence that feedstuff substitution occurs as differences in the price of alternative feed arise. As witnessed over time, crop prices for feed can diverge inducing livestock producers to use alternate rations. For example in East Asia, lower grade wheat is often used for livestock feed when prices for higher quality protein sources increase relative to wheat. The specification in the GTAP-AGR model follows that of Rae and Hertel (2000) where they use a single constant elasticity of substitution between alternative crops for feed use. The parameter estimates were derived from estimates made by Surry (1990). By allowing for greater feed substitution possibilities this can better capture the basic essence of cost-minimizing behavior in livestock production.

A third area that is modified in the GTAP-AGR model is in consumer demand. The standard GTAP model currently uses a Constant Difference Elasticity functional form using estimates of income and price elasticities taken from single country estimates. The main improvement is having elasticities estimated from international cross-sectional studies that estimate disaggregate food products. The current GTAP-AGR model recalibrates the CDE demand system in the standard GTAP model from nine consumption goods having eight disaggregated food products and a single aggregate non-food product. These estimates are based on Seale, Regmi, and Bernstein (2004) where price and income elasticity estimates are made from a two-stage budget by assuming separability between food and non-food. Total food expenditure is determined in the first level and with the second level allocating food expenditures across eight food categories including, beverages, bread and cereals, meats, fish, dairy, fats and oils, fruits and vegetables, and other food products. A drawback in the current version of the GTAP-AGR model specification is that it does not assume separability between food and nonfood, which can present a problem for studies addressing liberalization in non-food.

One of the most important new dimensions in GTAP-AGR model is incorporating an explicit farm household. A major problem with the standard GTAP model is there is not a good way of

³ Farm-owned labor is a term used in this paper as family labor supplied by the farm household.

assessing how farm households are affected by policy reforms. Land rental rates alone are not adequate for understanding changes of the economic well being of farm households. This is the primary motivation for incorporating a farm household in the GTAP-AGR model. What is often not realized is that farm household earnings may include income from agricultural and non-agricultural activities. In some cases non-farm income is greater than income from farming. In some countries the farm household may not be fundamentally different of households in the rest of the economy. In the GTAP-AGR model the farm household has a source of income and a use of income similar to the aggregate regional household in the standard GTAP model. The household maximizes utility subject to a budget constraint equating spending on consumption goods to income, net of taxes. Taxes are assumed to be the same rates as non-farm households. Sources of farm household income includes earnings from both agriculture and non-agriculture employment where the initial share of income is obtained from OECD (2003) estimates. For developing countries the share of income from farming is set to a default value of 100 percent. This however is not realistic since seasonal and off-farm employment is possible. The share of non-farm income for the farm household may differ from the initial share as changes in returns to farm and non-farm factors occur from policy reform. In this paper we alter the income shares using under four different cases to demonstrate the importance of farm and non-farm income in a trade liberalization scenario.

Trade expansion and trade dependency

This section describes why trade growth in agriculture is often viewed as the primary means for improving farm sector returns. For major exporting countries improved global market access for agricultural products is often viewed as the most important component for strengthening demand for farm commodities and farm income. For the United States because a large share of U.S. exports of processed foods use domestically produced raw materials the effect of tariff reductions on both farm goods and processed foods is seen as beneficial to returns to agriculture. Raising farm income through global market expansion is an important objective of multilateral trade negotiations both for developing and developed countries.

Over the past three decades foreign demand became an increasingly important outlet for the U.S. farm sector. However, the latter half of the past decade saw stagnant growth in food and agricultural trade accompanied by depressed commodity prices.⁴ The passage of the 2002 Farm Security and Rural Investment Act (FSRI) was, in part, a reaction to these conditions. The FSRI was designed to address various needs of the farm sector, including assuring an income safety net for producers and improving agricultural trade opportunities (Westcott, Young, and Price, 2002).

Wainio, et.al. demonstrate that tariff cuts from the Uruguay Round were, on average, deeper on raw commodities than on processed products. In some cases, this may have resulted in increased escalation of tariffs between raw and processed products. The presence of tariff escalation in agricultural trade is a frequently voiced concern of developing countries. However, tariff escalation is not confined to markets in industrial countries, but is present in many developing countries as well (Wainio, et.al.). Nor are developing countries the only ones that will gain from reducing tariff dispersion across agricultural goods.

Countries vary in their food trade orientation for numerous reasons. The size and diversity of a country's agricultural output is largely linked to its natural resource base (land, water, climate, etc.). However, the same is not necessarily true for the production of foods and beverages, where processing can often take place in countries miles distant from where raw materials are produced. As a result, while most of the production of processed foods and beverages is consumed domestically, a larger share of the production of raw materials crosses borders. And, the extent to which a country is either a net importer or exporter of processed foods and beverages is closely tied to both its own trade policies and those of its trading partners.

In many countries food processing benefits from both cheap inputs from foreign sources and high tariff protection from competing processed imports. For example, meat production is sometimes protected and supported by high tariffs on meat and low or zero tariffs on imports of animal feeds for the poultry and livestock sectors. Countries with this sort of escalating tariff structure range from those importing the bulk of their feed to those with traditional poultry and

⁴ In three years from 1996 to 1999 U.S. agricultural exports fell from \$60 billion to \$48 billion.

livestock sectors that use little or no grain or oilmeal as feed. The result is that the high tariffs on meat provide protection to cattle producers and the domestic meat processing industry, allowing the sector to capture value-added in the local market while denying meat-exporting countries market access.

The benefit to an exporting country's farm sector from increased trade in processed products depends largely on whether reductions in tariff escalation result in simply shifting the mix of exports from raw materials to finished products or whether they also result in an increase in production of raw materials. In our meat example above, for those countries importing animal feeds to sustain highly-protected domestic production, reducing or eliminating tariff escalation should result in a decrease in feed imports and in the production of animals, and thus, meat production. Meat imports, on the other hand, would be expected to increase. For a grain, oilseed, and meat exporter like the United States, this could result in a drop in animal feed exports, but an increase in meat exports, with the accompanying benefits of increased value-added. Production of feed grains and soybeans, however, might not change much. Quantities that were previously exported may now be used domestically to produce more meat for export. Alternatively, when meat tariffs are reduced in countries where production does not rely on imported feeds, an increase in meat imports as a result of tariff cuts would not be accompanied by a decrease in imports of animal feeds. This would be case if foreign and domestic meat are differentiated and are imperfect substitutes.

A characteristic of U.S. agriculture is the strong link between its food processing sector and the domestic farm sector.⁵ The livestock and food processing sectors in the United States are heavily dependent on domestic raw material. For example, the U.S. meat and poultry industry is almost entirely dependent on U.S. feed grains and oilseeds. Because of this, increased market access for U.S. processed foods and beverages will be expected to have a strong feedback effect on production of the raw materials.⁶

⁵ Of course, numerous exceptions exist. A good example of U.S. exports with a high content of imported raw materials are chocolates and chocolate products which may use imported cocoa, sugar, and butterfat.

⁶ The U.S. Meat Export Federation estimated that in 2001 the United States exported the equivalent of about 750,000 tons of soymeal and 7.5 million tons of coarse grains in the form of beef and pork. (Hinner).

Another characteristic of the U.S. farm sector is its increasing dependence on exports in both a direct and indirect way. A common indicator of trade dependency is the export share of production. For the United States, basic commodities such as grains and oilseeds are more trade-dependent than processed food and beverages. Such indicators however provide only a rough measure of trade dependency for the sector. In the past two decades a growing proportion of farm output is being used in processed products. To the extent that these products are exported, the trade dependency indicator will underestimate the export-orientation of basic commodities.

There are wide differences in export dependency ratios (exports as a share of production) for individual agricultural sectors and regions. Canada has relatively high export dependency ratios across a diverse set of agricultural commodities (appendix table 1). Canada exceeds the global average in all of the commodity sectors we analyzed, with the exception of dairy. Australia was the next most export dependent country, exceeding the global average in three bulk commodities (wheat, coarse grains, and oilseeds) and two semi-processed products (dairy and meats). The United States and Brazil, two other important exporters of agricultural goods, both exceeded the global average in four of the commodity groups, including in and meats. The United States was above the global average in three bulk commodities (wheat, coarse grains, oilseeds) and one semi-processed product, meat. Brazil exceeded the global average in three semi-processed products (meat, oils, and oilmeals) and one bulk commodity, oilseeds. The EU, while a major exporter of agricultural goods, tends to be minimally dependent on the export market. The share of EU exports destined for non-EU markets was below the global average in every category.

Oilseed products were the most heavily traded products internationally when compared against global production. The export dependency ratios for coarse grains and oilmeals would be higher if one took into account the proportion of these products that are used to produce meat and dairy products for export.

The export orientation in processed foods also differs across countries. Although the European Union and the United States have the world's largest food processing sectors their export share of output is relatively small in comparison to other developing regions. Some of these processed foods are imported from developing countries, while at the same time, these countries tend to

consume and import relatively small quantities of processed foods. The importance of processing for export in developing countries and benefits of trade liberalization for these countries were noted by Rae and Josling(2003).

Another striking difference between the developed and developing countries is the larger share of labor employed in agriculture and food processing in developing countries. The U.S. agriculture and food processing sectors account for a small share (2.3 percent) of economy-wide labor compared with many of the lower income developing countries in Sub-Saharan Africa and South Asia which have more than 20 percent of their labor employed in these sectors. Regions with a high labor share employed in export-oriented sectors are more likely to have higher returns to labor from improved market access.

Trade patterns and export dependency ratios are only part of the story of how policy and trade expansion might affect the farm household. Price and quantity responsiveness is also a factor must be considered. This is a topic we examine next.

Comparison of General Equilibrium Elasticities of Demand

The responsiveness of demand to changes in the supply price is crucial for policy analysis involving tariffs, farm subsidies, as well taxation policy. Modifications to a model either on the supply-side or demand-side can affects price and quantity responsiveness, thereby can lead to different policy implications. An indication summarizing how CGE models differ in this respect can be seen in differences in general equilibrium (GE) elasticities.

In a global CGE model GE demand elasticities capture the net effect of a one percent price increase on quantity demanded after all markets in the global economy reach equilibrium. The quantity demanded is a composite of many agent's collective response to a price change. When the production function parameters have been altered in any one country this will change demand responsiveness. The more elastic demand is, the more likely a greater share of the benefit of a subsidy accrues to producers. This is because a smaller price drop for a given quantity increase makes benefits the producer more than consumers. Subsidy incidence is of interest and a primary

motivation making the effort to improvements for an agricultural-based version of GTAP. The demand for a commodity depends on supply shifts taking place in the rest of the world as well as on income effects that might affect the quantity demanded. To generate general equilibrium demand elasticities a small perturbation to the price of each commodity is imposed with an output tax, change and allowing the model to reach a new equilibrium.

In this preliminary exercise, we compare the general equilibrium elasticities in the standard GTAP model with those of the GTAP-AGR model (table 3). Overall GE elasticities of demand are larger in the GTAP-AGR model with the exception of wool and silk sector. For example the simple average across all regions for wheat in the standard model is -1.08 , versus -1.26 for the GTAP-AGR model. This means that for a given output subsidy more of the benefit is captured by the producer since the price drop is less when output expands in the GTAP-AGR model. Alternatively one could surmise that subsidies are more effective than realized in the GTAP standard model and that a reduction in a subsidy could still deliver the same targeted benefit.

In global general equilibrium analysis the supplier does not face a single demand schedule. There are domestic demands as well export demands that affect the GE elasticity. Each country faces a different demand due to its unique trade orientation. Thus, it is not surprising to find wide differences in GE demand elasticities across countries and commodities for a number of reasons (table 4). The United States and Canada have higher GE demand elasticities for oilseeds than for South East Asia. However, for processed food products the United States faces a highly inelastic demand. In fact, the United States has the lowest elasticity among regions. Sub-Saharan Africa on the other hand faces an elastic demand. The reason for such differences is that each country faces different demand schedules stemming from both domestic and foreign demand. This can be seen by decomposing the contribution to the elasticity by both the domestic and export markets (table 5). A smaller country exporting a high share of their production generally faces a more elastic demand than a larger country with a similar export share. The contribution of Canada's domestic market (-0.73) and export market (-1.04) makes its demand for processed foods products elastic (-1.77). For the United States the contribution of the export market is noticeable lower (-0.17). This implies that an increase in processed food volume will have

greater benefit (elastic demand) for Canadian food manufactures and the input suppliers than it would for the United States since it faces an inelastic demand.

To illustrate further how destination markets contribute to the elasticity of demand we further decompose the export market into importing regions. This is done for processed food products for the United States and Sub-Saharan Africa (table 6). The contribution to the GE demand elasticity of exports for Sub-Saharan Africa is (-0.52). This is largely accounted for the region's exports to the European Union (-0.32), whereas the EU's contribution to the U.S. demand elasticity is (-0.03). Expansion Sub-Saharan African processed foods the EU leads to high returns for producers as price falls less than one percent for a given quantity change. A GE elasticity comparison provides some of the background for better understanding why factor markets might be affected differently in each region.

Scenario description

To determine how trade affects factor markets and the implications for farm households we perform, a common experiment with both versions of the GTAP model. A common tariff-reducing scenario is performed cutting all tariffs by a uniform 36 percent involving no domestic policy changes. Given what we learned from the GE elasticities in the GTAP AGR model we might expect factor prices to change less in the modified model. Our main interest is how will land rental rates change given that factor markets in the agricultural sector are now segmented from nonagricultural sectors. To demonstrate how the non-farm share affects farm households we look at four different cases from our base scenario by varying the assumption regarding the share of household income derived from farming activities. In the first case all regional farm households receive 100 percent of their income from farm related activities. In that case farm households are not diversified with respect to their source of income. In the second case we adopt a farm household for all regions similar to that of European Union where 60 percent of farm household earning are from farming activities according to OECD estimates. The third case is where the representative farm for all regions is a household receiving only 5 percent from farming activity. This is a case for a representative U.S. farm. The reason for the low share from farming is due to the large number of farms that earn off-farm income. Finally, in the fourth case

the income shares vary by region according to the estimates reported by OECD but with developing country households having 100 percent of household income from farming activity.

Results of tariff reduction: A comparison of two models

We first compare trade volume changes generated from the two models where tariffs were cut global tariffs by a uniform 36 percent. Global trade volume changes in both models are nearly identical for all sectors (table 7). This outcome, however is not a general outcome for all policy changes. If the policy reforms involved domestic subsidies, trade volume would likely be affected differently in each model. In this experiment our primary interest is how factor markets differ in two models that generate similar global trade volume changes. Table 8 presents the effects on primary factor returns. Most noticeable is the difference seen the returns to land. For example the Australia/New Zealand region shows the standard model produces higher returns to land (7.9) than the GTAP-AGR (3.2). Canada which is also a heavily export dependent country also shows a dramatic difference in the returns to land (15.4 versus 4.8). Regions that are more heavily protected experience a decline in returns to land. However the severity of the decline is much less in the GTAP-AGR model. This can be seen for Japan and Middle East/North Africa regions.

To better understand why returns to land differ in the two models we must view the input supply changes for a specific country and commodity. Table 9 shows how factor use changes differ in the two models in wheat production for Canada. In the standard model land use volume for wheat increases more in the GTAP-AGR model. The difference in the volume change of value-added is lower by 54 percent in the GTAP-AGR model. However inputs use of intermediate inputs increase in more in the GTAP-AGR model. This observation is the effect of greater substitution between intermediates and valued-added. This, in turn reduces the demand for land, thereby lessening the impact on the rental rate.

Since the total supply of land is fixed and not mobile across nonagricultural sectors, land is entirely allocated within agricultural sectors. If demand for total agricultural products rises with an increase in foreign demand, land rents rise but rise more when there is no substitute for land.

Assuming that land is owned by the farm household, and that the farm household receives 100 percent of their income from the farm sector, then change in farm household income will be reflected in returns to land. This result is shown in table 10. Under this scenario, we find that those regions where farm households gain from trade liberalization are countries that have a higher exports share of their total production. These include Australia/New Zealand, Canada, Latin America, and the United States. More heavily protected regions experience larger declines in their farm income similar to the declines in land rental rates. These include Japan, other East Asia, the EU15, and the Middle East/North Africa region. If, however, we assume income earned from farming is 60 percent, then the change in farm income drops substantially less for highly protected regions. In fact, for some of the same protected regions their household incomes actually experience an increase in household income from trade liberalization. The reason for this is that they now have income from the non-farm sector. As wages and returns to capital rise from trade liberalization, they benefit since the gains offset losses from income earned from farming.

In the third case where income from farming represents only 5 percent of household income, the agricultural-based countries experience small declines in farm household income. Surprisingly, the farm household in the EU15 gains from trade liberalization. In this case the overall the change in farm household income are mild in comparison to case one where 100 of income is derived from farming. The fourth case uses the OECD estimates of household income for each region. This demonstrates that farm households of less protected regions do not gain as much from trade liberalization since they earn less income from farming. Farm households income of heavily protected declines when the household receives a greater share of income from non-farm activity.

Conclusions

This paper demonstrates how a modified version of the GTAP model with a more agricultural-based specification can be used to provide richer information to policy makers. One improvement is that the new model, GTAP-AGR, now has a stronger econometric underpinning, which governs the supply and demand responsiveness. By having more segmented factor

markets between agricultural and non-agricultural sector this contributes to larger general equilibrium elasticities. The policy implications of more elastic GE elasticity is that for a given subsidy, more benefits go to producers than indicated by the standard GTAP model.

Of significance is that changes in returns to land are less severe in the GTAP-AGR model. This was shown with a trade liberalization scenario. This difference is directly related to a modification in the demand specification for agricultural inputs. With greater factor substitution between value-added and intermediate purchased inputs, it dampens the changes in returns to land. Since returns to land is often used as a proxy for determining impacts on the agricultural sector it would mean impacts on agriculture could be overstated in the standard model. However, we find this the change in returns to land may not be as important when we measure impacts on agriculture using an explicit farm household. One insight is that gains or losses from cutting agricultural tariffs are not confined to the agricultural sector. Non-farm income is also an important source of farm household income even in heavily protected countries. The nonagricultural sector can provide a source of benefit to the farm household under trade liberalization.

This exercise provides only a rudimentary understanding of the link between trade and the farm household. It demonstrates our ignorance as modelers how much we still do not know about the farm household. More work is needed in identifying sources and uses of farm household income in both developing and developed countries. Whether farm households are taxed differently from other non-farm households is another area for future research.

Creating models for the sake of modeling is not a good excuse for investing scarce resources in applied economic research. A good reason for modifying existing models is improving the quality of output and level of confidence for those demanding model-based analysis. Thus, it is worthwhile to place statistical levels of confidence on CGE results when parameters are less certain. This involves performing systematic sensitivity analysis on parameters for determining which model results are more sensitive to parameters. This is another direction the GTAP-AGR model should proceed.

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Table 1. GTAP-AG Agricultural Sectoral Detail

Sector identifier	Sector name description
PDR	Paddy Rice
WHT	Wheat
GRO	Cereal grains
V_F	Vegetable fruits, and nuts
OSD	Oil seeds
C_B	Sugar cane, sugar beets
PBF	Plant based fibers
OCR	Other crops
CTL	Bovine cattle sheep, goats horses
OAP	Animal products
RMK	Raw milk (non-traded)
WOL	Wool, silk-worm cocoons
FSH	Fishing
CMT	Bovine meat products
OMT	Other meat products
VOL	Vegetable oils and fats
MIL	Dairy products
PCR	Processed Rice
SUG	Sugar raw and refined
OFP	Other food products
B_T	Beverages and tobacco products
FSH	Fisheries
COGM	Coal, oil, gas, minerals
MNFS	Manufacturers
SERVS	Services

Aggregates from GTAP 5.3 database

Table 2. Regional Aggregation in GTAP-AGR model

ANZ	Australia and New Zealand
CHK	China and Hong Kong
JPk	Japan
OEASIA	Other East Asia
SEASIA	South East Asia
STHASIA	South Asia
CAN	Canada
USA	United States
MEX	Mexico
LAC	Latin America Caribbean
EU15	European Union 15
OEUR	Other Europe
EURFSU	Russia and Former SU, East Europe
MENA	Middle East and N. Africa
SSA	Sub-Saharan Africa
Aggregates from GTAP 5.3 database	

Table 3. General equilibrium elasticities, global averages for food and agricultural sectors

	GTAP-STD	GTAP-AGR	Difference from STD percentage
PDR	-0.486	-0.623	28.2
WHT	-1.081	-1.264	17.0
GRO	-0.527	-0.836	58.7
V_F	-0.603	-0.763	26.6
OSD	-1.079	-1.208	12.0
C_B	-0.193	-0.333	73.1
PBF	-1.420	-1.529	7.6
OCR	-1.431	-1.538	7.5
CTL	-0.369	-0.521	41.1
OAP	-0.506	-0.705	39.5
RMK	-0.143	-0.318	121.9
WOL	-0.999	-0.992	-0.7
FSH	-0.755	-0.947	25.5
CMT	-0.664	-0.795	19.7
OMT	-0.645	-0.816	26.4
VOL	-1.002	-1.077	7.5
MIL	-0.660	-0.828	25.5
PCR	-0.623	-0.764	22.6
SGR	-0.786	-0.936	19.1
OFP	-0.909	-1.106	21.7
B_T	-0.863	-0.960	11.3

Source: Authors simulations using GTAP 5.3 database

Table 4. General equilibrium elasticities for oilseed and processed food sectors

	Oilseeds	Processed Food
Australia/New Zealand	-0.89	-0.95
China/Hong Kong	-1.02	-1.17
Japan	-2.32	-0.57
Other East Asia	-1.83	-1.02
South East Asia	-0.63	-1.70
South Asia	-0.4	-1.96
Canada	-1.7	-1.77
United States	-1.14	-0.47
Mexico	-1.78	-0.97
Latin America Caribbean	-0.81	-0.78
European Union 15	-1.22	-0.71
Other Europe	-1.43	-1.64
Russia and Former SU, East Europe	-1.28	-1.01
Middle East and N. Africa	-1	-0.96
Sub-Saharan Africa	-0.81	-1.20

Source: Authors simulations using GTAP 5.3 database

Table 5. GE elasticity for processed food, decomposition by domestic and export demand

	Domestic demand	Export demand	Total
Australia/New Zealand	-0.53	-0.41	-0.95
China/Hong Kong	-0.72	-0.45	-1.17
Japan	-0.53	-0.05	-0.57
Other East Asia	-0.63	-0.39	-1.02
South East Asia	-0.66	-1.04	-1.7
South Asia	-0.46	-1.5	-1.96
Canada	-0.73	-1.04	-1.77
United States	-0.3	-0.17	-0.47
Mexico	-0.58	-0.39	-0.97
Latin America Caribbean	-0.48	-0.3	-0.78
European Union 15	-0.38	-0.33	-0.71
Other Europe	-0.75	-0.88	-1.64
Russia and Former SU	-0.73	-0.28	-1.01
Middle East and N. Africa	-0.76	-0.2	-0.96
Sub-Saharan Africa	-0.68	-0.52	-1.2

Source: Authors simulations using GTAP 5.3 database

Table 6. Further decomposition of GE elasticity for U.S. and Sub-Saharan African processed food

Importer region	U.S.	Sub-Saharan Africa
Australia/New Zealand	-0.01	-0.01
China/Hong Kong	-0.01	-0.02
Japan	-0.04	-0.07
Other East Asia	-0.01	0.00
South East Asia	-0.01	-0.01
South Asia	0.00	0.00
Canada	-0.03	0.00
United States	0.00	-0.03
Mexico	-0.01	0.00
Latin America Caribbean	-0.01	0.00
European Union 15	-0.03	-0.32
Other Europe	0.00	-0.01
Russia and Former SU, East Europe	0.00	-0.01
Middle East and N. Africa	-0.01	-0.01
Sub-Saharan Africa	0.00	-0.02
Total	-0.17	-0.52

Source: Authors simulations using GTAP 5.3 database

Table 7. Global trade volume changes from 36 percent cut in global tariffs

	GTAP- STD percent chg	GTAP-AGR percent chg
pdr	8.1	8.0
wht	5.5	5.2
gro	2.6	2.6
v_f	5.5	5.2
osd	3.1	2.8
c_b	7.0	7.8
pfb	1.0	1.0
ocr	3.4	3.2
ctl	5.3	5.1
oap	3.8	3.9
rmk	2.2	2.4
wol	1.8	1.4
fish	1.3	1.3
cogm	0.4	0.4
cmt	7.4	7.2
omt	6.0	6.1
vol	4.6	4.9
mil	6.5	6.8
pcr	11.9	11.6
sgr	8.7	8.7
ofd	8.7	8.8
b_t	12.2	12.1
mnfcs	2.8	2.8
svces	1.0	0.9

Source: Authors simulations using GTAP 5.3 database

Table 8. Returns to primary factors from 36 percent cut in global tariffs

GTAP Region	STD Model	AGR Model	STD Model	AGR Model	STD Model	AGR Model	STD Model	AGR Model
	Land		Unskilled labor		Skilled labor		Capital	
ANZ	7.9	3.2	0.2	0.4	0.1	0.2	0.1	0.2
CHK	-0.2	-0.3	1.6	1.6	1.8	2.0	1.7	1.9
JPN	-15.4	-11.1	0.5	0.5	0.6	0.6	0.5	0.5
OEASIA	-4.8	-4.5	1.9	1.8	1.9	2.0	1.9	2.0
SEASIA	1.0	0.5	1.5	1.5	1.4	1.5	1.5	1.5
STHASIA	0.8	0.4	1.3	1.3	1.4	1.7	1.3	1.5
CAN	15.4	4.8	0.0	0.0	0.0	0.0	0.0	0.1
USA	5.8	2.0	0.1	0.1	0.0	0.1	0.1	0.1
MEX	0.8	0.2	0.1	0.1	0.1	0.1	0.1	0.1
LAC	5.2	2.3	0.6	0.6	0.6	0.7	0.6	0.6
EU15	-6.6	-2.5	0.2	0.2	0.3	0.3	0.2	0.2
OEUR	-7.6	-2.9	2.1	2.0	2.2	2.2	2.1	2.1
EURFSU	-0.7	-0.3	0.9	0.9	1.0	1.1	0.9	1.0
MENA	-13.7	-5.6	2.3	2.2	3.1	3.3	2.6	2.7
SSA	3.8	1.4	1.2	1.2	1.3	1.4	1.1	1.2

Source: Authors simulations using GTAP 5.3 database

Table 9. Factor usage change in Canadian wheat production from 36 percent cut in global tariffs

	GTAP STD \$ millions	GTAP-AGR \$ millions	change from STD percent chg
Land	48	22	-54.2
Unskilled labor	95	72	-24.2
Skilled labor	8	6	-25.0
Capital	120	90	-25.0
Manufactures	91	96	5.5
Services	112	118	5.4

Source: Authors simulations using GTAP 5.3 database

Value changes are calculated with prices fixed to reflect volume change

Table 10. Impact on farm households using alternative farm income shares in farm household income

	Case 1 uniform farm share = 1.0	Case 2 uniform farm share = 0.6	Case 3 uniform farm share = 0.05	Case 4 share varies by region farm share = OECD estimates
Australia/New Zealand	2.6	0.14	-0.12	0.13
China/Hong Kong	-1.4	0.37	0.56	-1.36
Japan	-8.9	-0.61	0.23	0.18
Other East Asia	-4.6	0.06	0.59	0.28
South East Asia	-0.8	0.09	0.18	-0.75
South Asia	-0.4	0.55	0.65	-0.37
Canada	3.5	0.19	-0.13	-0.12
United States	1.4	0.09	-0.04	-0.04
Mexico	0.0	-0.08	-0.09	0.02
Latin America Caribbean	1.6	0.06	-0.09	1.58
European Union 15	-2.7	-0.18	0.08	-0.18
Other Europe	-4.0	0.3	0.74	-0.07
Russia and Former SU	-1.0	0.11	0.23	-0.96
Middle East and N. Africa	-6.5	0.33	1.01	-6.46
Sub-Saharan Africa	0.2	-0.01	-0.03	0.23

Estimates of farm share of farm household income provided by OECD 2003

Appendix table A1: Export shares of production for major agricultural producing countries

	USA	Canada	Australia	Brazil	EU	World
Total Oils	9.4	49.9	11.2	37.7	18.6	36.3
Total Meals	17.3	37.6	2.1	60.3	10.0	29.4
Oilseeds	36.8	48.1	62.6	37.4	6.8	21.3
Wheat	48.3	68.3	73.1	0.1	14.1	18.5
Coarse grains	20.2	13.0	41.9	9.0	7.6	11.9
Meat	11.5	35.6	47.2	17.4	8.2	8.5
Dairy	3.1	9.4	30.2	0.1	4.7	10.1

Source: USDA PS&D database

Appendix Table A2. General equilibrium elasticities from GTAP-AGR model

	ANZ	CHK	JPN	CAN	USA	MEX	LAC	EU15
pdr	-0.44	-0.26	-0.18	-2.00	-0.82	-0.65	-0.19	-1.30
wht	-1.47	-0.68	-1.90	-2.49	-1.38	-1.11	-0.82	-0.97
gro	-0.53	-0.91	-1.43	-1.27	-0.58	-0.55	-0.77	-1.08
v_f	-0.71	-0.50	-0.39	-1.49	-0.74	-0.92	-0.51	-0.99
osd	-0.89	-1.02	-2.33	-1.67	-1.14	-1.65	-0.81	-1.22
c_b	-0.26	-0.65	-0.08	-0.65	-0.28	-0.28	-0.36	-0.19
pfb	-2.51	-0.26	-2.14	-1.09	-1.01	-0.86	-0.66	-1.56
ocr	-0.85	-1.51	-0.44	-3.31	-1.13	-3.21	-1.41	-0.96
ctl	-0.60	-0.20	-0.46	-1.37	-0.40	-0.78	-0.26	-0.43
oap	-0.86	-0.65	-0.38	-1.49	-0.51	-0.55	-0.48	-0.54
rmk	-0.53	-0.08	-0.15	-0.33	-0.10	-0.45	-0.26	-0.24
wol	-0.67	-0.16	-0.37	-4.19	-0.67	-0.17	-0.22	-3.25
fish	-0.95	-0.53	-0.42	-1.46	-2.26	-0.57	-0.53	-0.51
cogm	-1.90	-0.52	-2.01	-2.15	-0.85	-1.87	-1.39	-2.12
cmt	-1.40	-0.37	-0.65	-1.02	-0.33	-0.66	-0.57	-0.56
omt	-0.62	-0.90	-0.60	-1.24	-0.38	-0.64	-0.74	-0.48
vol	-0.86	-0.91	-0.47	-0.91	-1.18	-0.63	-1.12	-0.65
mil	-1.35	-0.76	-0.51	-0.58	-0.24	-0.88	-0.62	-0.49
pcr	-0.60	-0.30	-0.20	-1.87	-1.51	-0.77	-0.41	-1.19
sgr	-0.72	-1.53	-0.26	-2.55	-0.65	-0.54	-0.79	-0.81
ofd	-0.95	-1.18	-0.57	-1.55	-0.45	-0.84	-0.79	-0.71

Source: Authors simulations using GTAP 5.3 database