Global Agricultural Trade and the Doha Round: What Are the Implications for North and South?

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Abstract

The next three-year World Trade Organization round has been set in motion by recent negotiations in Doha, Qatar. Among the most contentious issues in that meeting, and probably over the course of the next round, is direct and indirect producer support for agricultural exporters in the North and forgone production, employment, and trading opportunities for farmers in the South. Our results indicate that real commitments to reduce agricultural support in high-income countries will induce substantial changes in world food prices and domestic agricultural rates of return and output and will cause dramatic shifts in agricultural trade patterns. Total trade expands and real output, wages, and incomes in developing countries, especially among the rural poor, increase substantially. In particular, rural incomes in low- and middle-income countries increase by over $60 billion, a figure that comfortably exceeds even the most ambitious goals for increased development assistance and represents a substantial savings to Organization for Economic Cooperation and Development (OECD) taxpayers. At the same time, European Union and Japanese agricultural exports fall sharply and their imports rise. Other OECD countries see more balanced aggregate trade growth, but a number of strategic sectors are still adversely affected. These facts are likely to complicate negotiations in the Doha Round significantly.

Key words: agricultural trade liberalization, Doha Round.

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Introduction

Following the Uruguay Round of the World Trade Organization (WTO), many developing countries voiced their concerns and frustration during the agricultural agenda debate (Kennedy et al. 2001; WTO 2001). These concerns have shaped the WTO's November 2001 Doha Ministerial Declaration. This frustration has at least two components. First, there is a lack of market access in high-income countries. Tariff rate quotas (TRQs) and other trade barriers block access to markets in which developing economies are competitive (Anderson et al. 2001; Martin and Winters 1996). The lack of market access constrains trading opportunities for exporting developing-country members. Second, large agricultural subsidies in high-income countries via domestic farm and trade policies of high-income countries lead to depressed world market prices. Exports from some of the high-income countries are subsidized explicitly or implicitly through production subsidies.

The Doha Declaration states that the agricultural negotiations should try to achieve "substantial improvements in market access; reductions of, with a view to phasing out, all forms of export subsidies; and substantial reductions in trade-distorting domestic support" (WTO 2001, para. 13). Despite the progress achieved with the Uruguay Round Agreement on Agriculture, the heterogeneous structure of market interventions in high-income countries distorts resource allocation and trade in agriculture. European countries still rely heavily on export subsidies and domestic support, while the United States has been increasing domestic production subsidies to implicitly subsidize crop exports. Both the European Union and the United States have kept a few protectionist bastions with high-tariffs (e.g., sugar and dairy). High-income Asian countries, which tend to be net importing countries, rely on high tariffs and/or TRQs with prohibitive out-of-quotas tariffs in many agricultural and food sectors (e.g., Korea and Japan).

In this paper, we assess these claims and elucidate the empirical evidence contested between the developing-country members and the high-income members of the WTO. Using a dynamic global computable general equilibrium (CGE) model (van der Mensbrugghe 2001), we quantify the impact of trade and domestic agricultural distortions of high-income countries on terms of trade, welfare, and trade flows of developing economies and their partners. We consider the removal of all export subsidies, tariffs, TRQ schemes, and output and input subsidies affecting production decisions in high-income countries. We look at eleven agricultural activities and six food sectors (including two meat sectors, vegetable oils, dairy products, sugar, and other food). Our country coverage includes countries and aggregates with high-income economies, including Western Europe (EU-15 and European Free Trade Association [EFTA] countries), the United States, Canada, Australia, New Zealand, and High-Income Asia (Japan, South Korea, Taiwan, Singapore, and Hong Kong). Among developing and transition economies, we include Argentina, Brazil, China, India, the Rest of East Asia, the Rest of Latin America and the Caribbean, Eastern Europe and Central Asia, Sub-Saharan Africa and South African Customs Union (SACU) (including South Africa, Botswana, Lesotho, and Swaziland), and the Rest of the World.

Our paper is part of the new literature analyzing agricultural negotiation issues in the Doha Round of the WTO (Burfisher 2001; Diao, Roe and Somwaru 2002; Francois 2000; Hoekman and Anderson 2000; World Bank 2001). The contribution of our paper resides in its focus on policies in high-income countries and the quantification of their effects on the relative competitiveness of the United States, the European Union, and exporting developing economies for a large set of commodities and food industries. These policies affect the developing world's terms of trade in agricultural markets, its trade patterns, and its welfare for a large set of products and food industries. In light of the policy asymmetries among countries noted above, how can agricultural trade patterns, as well as induced income and employment effects, be expected to evolve in the course of further globalization? In particular, will WTO action against export subsidies confer an international competitive advantage on U.S. agriculture? And what would be the consequences for the

United States and its trading partners? We evaluate two major scenarios, elucidating the detailed adjustments that would take place in trade, world prices, national welfare, and domestic economic structure.

We find that the world welfare cost of agricultural distortions in high-income countries amounts to about $82 billion annually at 1997 prices, while the developing world would gain about $26 billion per year at 1997 prices from the removal of the same distortions. Organization for Economic Cooperation and Development (OECD) agricultural policies are a huge tax on developing country agriculture. Rural value-added could increase by more than $60 billion (per annum, not cumulatively) in low- and middle-income countries. This figure, incidentally, exceeds the most ambitious target for increased aggregate development assistance by over 20 percent. Ironically, realizing poverty alleviation in this way would occasion substantial savings for OECD taxpayers. Reduced OECD support would raise world food prices, causing real wages in developing countries to rise across the board and increase more than capital returns. In other words, removal of OECD agricultural protection is pro-poor on average, with the possible caveat that wage gains among urban poor would be offset by rising food prices.

Though world food prices rise, the changes in terms of trade are positive for all developing regions on aggregate. Terms-of-trade effects induced by domestic programs are substantial, especially for meat products. Further, there will be a significant reorientation of agricultural trade because the current structure of production and trade is highly distorted. Trade in agriculture would increase by 17 percent at the global level, with agricultural and food exports increasing by 24 percent for low- and middle-income countries. This gives the latter an opportunity to purchase needed manufactured imports and capital goods.

In the next section, we provide a brief overview of global agricultural support patterns. This is followed by the results section of the paper, including policy scenarios, estimates, and interpretation. Then, we offer concluding remarks, followed by the model documentation and bibliography.

Agricultural and Trade Policies in High-Income Countries

This section provides stylized facts on current domestic and border distortions in the key high-income countries we previously identified as they relate to our aggregation in the model. We focus on distortions relevant to agriculture and to food industries. Although the GTAP database used in the model refers to 1998, we provide a characterization of current policies based on the most recent data published by the OECD (OECD 2001) and the most recent country notifications to the WTO.

Australia and New Zealand

Australia and New Zealand have few distorting policies. Agricultural producers in these two countries are the least supported among OECD countries. The total producer subsidy equivalent (PSE) for Australian agriculture was 6 percent in 2000. The corresponding PSE for New Zealand was 0 percent in 2000 (OECD 2001).

Until recently, the Australian dairy industry was heavily distorted. The dairy program, which set milk prices and a system of production quotas, was the last sector price support scheme in Australian agriculture. It was eliminated in 2000. An adjustment program replaced it, which is financed by a levy on consumers for eight years. Australia still has state-trading entities in charge of exports for wheat, barley, rice, and sugar. State trading does not seem to distort price signals for consumers or producers (OECD 2001).

Canada

As shown in Figure 1, Canadian agriculture is moderately protected in aggregate, with a PSE of 19 percent in 2000. A few sectors are heavily protected however, such as dairy, which constituted about 40 percent of the support received by Canadian agriculture in 2000 as measured by the OECD PSE (OECD 2001). The Canadian dairy program combines price supports with production quotas to increase domestic prices. In recent years, the production quotas have been binding and the price supports have been redundant. TRQ schemes at the border limit dairy imports with prohibitive out-of-quota tariffs, which allow for the raising of prices internally. The other sectors being supported are oilseeds and meat production, but at a much lower level than dairy. Canada has been moving away from commodity-specific policy toward an income safety net approach to

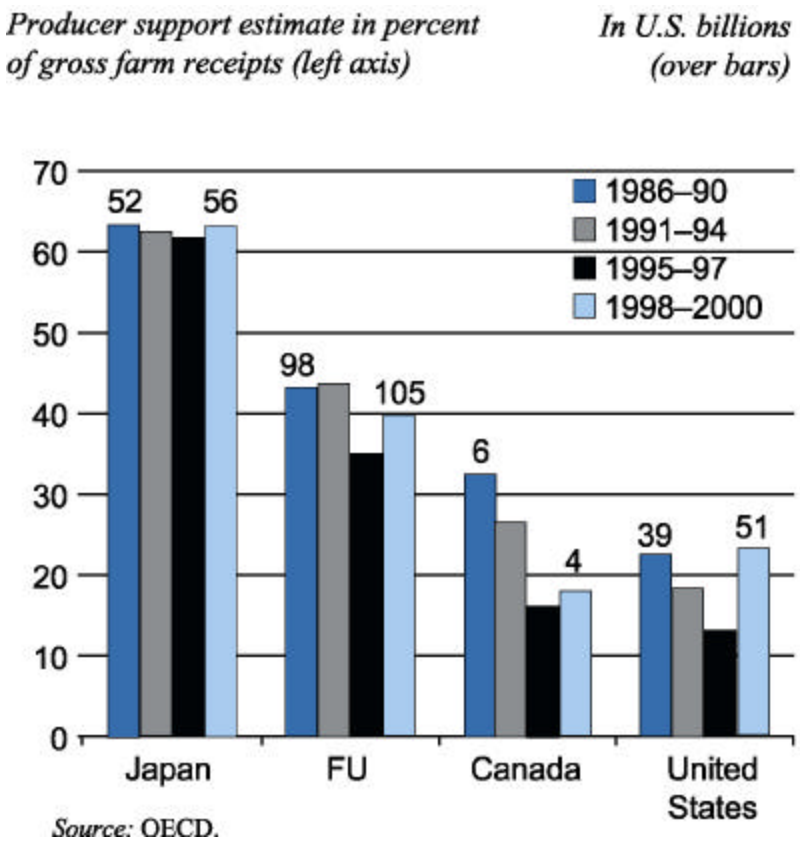

FIGURE 1. Producer support estimates in some OECD countries

farm subsidies. With the exception of dairy, producer prices for most commodities are just slightly above the corresponding world prices.

The European Union

As suggested in Figure 1, European agriculture is heavily subsidized using various combinations of import restrictions, price supports, area payments, and export subsidies. The most protected industries are sugar, dairy, and beef; sugar and dairy receive price supports constrained by production quotas, while import restrictions and export subsidies complement domestic support and facilitate exports of excess production. Cattle and beef producers enjoy price supports, headage premia based on a fixed number of animals, TRQs on import and export subsidies, and aid for private storage. Pigmeat production benefits from the same kind of assistance and protection, although the European Union does export substantial quantities of high-quality pork without subsidies. Grain produc-

tion benefits from export subsidies and receives price support and area payments but faces a set-aside requirement associated with the latter. Oilseeds receive area payments associated with a set-aside but do not have an intervention price.

Although the European Union remains a major distorting force in world agricultural markets, the Common Agricultural Policy (CAP) has evolved dramatically since 1992, with a series of reforms culminating with the Berlin Accord of the European Commission's Agenda 2000. The reforms have modified the sources of income support by lowering price supports, offsetting these with compensatory payments that are linked to historical production and that impose set-aside requirements (crops) and with headage payments combined with fixed production quotas (livestock, dairy). Area payments to oilseed producers are being reduced progressively to the level for cereals by the 2002/03 marketing year. The base rate for compulsory set-aside is 10 percent through the 2006/07 marketing year.

These CAP reforms and the devaluation of the euro vis-à-vis the U.S. dollar have helped decrease the support level of European farmers as measured by the PSE (about 38 percent of aggregate farm income in 2000). Agricultural and food export subsidies amounted to US$2.6 billion (European Currency Unit [ECU] 2.763 billion) in 2000-01 according to official notifications (WTO various), a sharp decline from the 1999-2000 level of ECU 5.6 billion. The total direct payments amounted to about ECU 20 billion in 1998-99, and the Aggregate Measure of Support (AMS) for Europe was in excess of ECU 46 billion for 1998-99, the most recent notification to the WTO (WTO various).

EFTA countries subsidize and protect their agriculture even more than the EU-15 countries do. They rely on trade restrictions, domestic subsidies, and export subsidies to get rid of production surpluses (Norway). Their aggregate PSE was 63 percent for Iceland, 66 percent for Norway, and 71 percent for Switzerland in 2000.

High-Income Asia

The High-Income Asia aggregate is made up of net-importing countries, characterized by their restrictive trade policies, which are used to support domestic agriculture. WTO commitments achieved under the Uruguay Round have opened some of these markets, such as the feed market (corn and soybeans). Nevertheless, food grain markets (rice in particular), dairy, and meat markets remain virtually closed. Minimum imports

for these products under TRQs are anemic because of prohibitive tariffs on out-of-quota imports. The Korean government uses price supports, which are sustained by trade restrictions and limited government purchases (less than 5 percent of production for rice, soybeans, and corn), and direct payments. The trade restrictions include a quota on rice (a WTO exemption until 2004 and TRQs on most other commodities). State trading in beef was abolished in 2001. Korea is virtually self-sufficient in rice. The Korean government also provides a few direct payments for environmental practices and some input subsidies (fertilizers and interest subsidies). Self-sufficiency remains a policy objective, particularly in the rice sector, because of the cultural content of this good (Beghin, Bureau, and Parks 2001). The PSE for Korean agriculture was 73 percent in 2000, the highest among OECD countries.

The objectives of Japan's agricultural policies have much in common with those of Korea. Food self-sufficiency is an official policy, with a target of 45 percent of total caloric intake to be domestically produced. This policy target has affected most commodities, including rice, dairy, and meat production. Support to agriculture is accomplished through administrative prices and state purchases, trade protection, and production limits. The government buys about 10 percent of rice production for "strategic" reserves. TRQs are in place for meat and all major grains, including rice. The import quota on rice was abolished in 1999. Under minimum access requirements dictated by the Uruguay Round Agreement on Agriculture (URAA), a state trading agency controls rice imports, about half of which are re-exported as food aid. Another state trading agency controls dairy imports and administers dairy prices. There are supply controls for dairy via production quotas and for rice via compulsory diversion to other crops. Rice farmers receive direct compensation when market prices fall below some historical average level. Production subsidies also are received for calves and dairy manufacturing (OECD 2001). Special safeguard duties frequently are used to increase the border protection of various food industries. As shown in Figure 1, the overall PSE of Japanese agriculture was 63 percent for the 1998-2000 period. Producer prices were about three times world prices in 2000 (OECD 2001).

Taiwan has large livestock and meat production industries, mostly geared to export pork to Japan. This trade collapsed because of several foot-and-mouth disease outbreaks

since 1997. Taiwan has had high trade barriers on pork and beef, which became TRQs with WTO membership in January 2002. Feed grains and protein crops enter the country with low duties since Taiwan does not produce enough feed domestically. No PSE information is available for Taiwan. Hong-Kong and Singapore have no agricultural production.

The United States

The United States has a myriad of policies affecting agriculture. We focus on the key policy instruments relevant to our trade liberalization analysis. Since 1997, the United States has been following an opposite route to that of the European Union, increasing farm support levels to most commodities, including exportable crops, through three major instruments. First, decoupled payments, the "production flexibility contracts" of the 1996 farm bill, subsidize farming activities, although they have no production requirements but they inflate land prices. These payments are linked to historical production and land use for contract crops (corn, wheat, rice, cotton, sorghum, barley, and oats). Second, program crops (contract crops, oilseeds, sugar, and tobacco) benefit from producer price subsidies known as marketing assistance loans and/or loan deficiency payments, essentially the difference between the market price and the loan rate which acts as a price floor. Finally, "countercyclical" emergency payments under the "market loss assistance" program have been taking place since 1998 for contract crops and dairy. Loan deficiency payments are contentious because they are directly linked to output and are trade distorting. They depress world prices. Like the European Union, the United States has a few well-established bastions of protectionism relying on restrictive TRQs (sugar, dairy, and peanuts) and countervailing duties (lamb). In 2000, dairy had a PSE of 50 percent, which was the highest PSE among all U.S. commodities in that year. TRQs are in place for virtually all dairy products, raw and refined sugar, peanut-based products, and some meat products.

The United States resorts to small, explicit export subsidies for dairy products (US$78 million in 1999) and for poultry, although the latter is marginal according to WTO notifications (WTO various). The United States also subsidizes exports via export credit guarantees, which help foreign countries to buy U.S. products. This subsidy covers about US$3 billion of export guarantees per year. U.S. farmers also enjoy heavily

subsidized crop and revenue insurance. The net subsidy of this insurance program was in excess of US$1 billion in 2000.

The aggregate PSE for U.S. agriculture was 22 percent in 2000, right at the OECD average. The aggregate PSE has been rising, reaching $51 billion annually for 1998-2000 (see Figure 1). The AMS, which is used by the WTO to monitor commitments to reduce distorting assistance to agriculture, has been increasing dramatically compared to 1996-97 levels. Abstracting from de minimis and counting the marketing loss assistance as amber box payments, the total U.S. AMS for 2000 was above US$21 billion, exceeding the U.S. WTO commitment of US$19.1 billion for 2000 (Hart and Babcock).

Policy Coverage in GTAP

The GTAP database (release 5.3) provides a realistic description and parameterization of actual agricultural and trade policies, which rely largely on the agricultural policy information collected by the OECD (OECD 2001). The database maps domestic policies into four categories (output subsidies, input subsidies, payments to land, and payments to capital). The GTAP database also accounts for agricultural trade distortions (tariffs and export subsidies). TRQ schemes are not explicitly accounted for, although tariff estimates reflect trade-weighed averages over in-quota and out-of-quota tariffs.

A few shortcomings constrain the accuracy of our analysis. The database refers to 1998 and hence is behind on important developments that have since taken place, such as the entry of China and Taiwan into the WTO. As a result, the GTAP database significantly overstates China's tariffs on oilseeds and grains, which does not reflect the current situation. A similar problem arises with the European Union because new policies have been put in place in 2000 with the Berlin Accord on Agenda 2000. The latter increases direct payments and reduces crop intervention prices. Finally, in the case of U.S. policy, the GTAP database maps production flexibility contract payments received by a subset of crops into subsidies to land devoted to these crops. The general view is that these subsidies benefit all crops because most farms grow more than one crop, and these payments do not require any specific crop to be grown.

The GTAP data do not distinguish between raw and refined sugar uniformly across countries, which leads to much raw sugar being accounted for as refined sugar, especially in the trade data. Hence, the refined sugar sector provides information for the

aggregate sugar industry (raw and refined), whereas the results for the raw sugar sector should be discounted.

These shortcomings are significant but not radical enough to invalidate our policy analysis exercise. Production and trade flows would be different under a more accurate policy description but the key messages emerging from our analysis remain unaltered.

Scenarios and Simulation Results

To assess the global consequences of liberalizing agricultural markets, we developed a variety of scenarios with the dynamic CGE model (documented in the Appendix). Initial simulation results with the model were based on a calibrated business-as-usual baseline and eleven counterfactual policy scenarios. The latter group was designed to reflect liberalization of various individual and combined forms of agricultural support with respect to both domestic and external markets. Table 1 indicates the scenarios considered, where an x denotes abolition of the type of support in the respective column of the schematic chart.

For the present discussion, we have restricted ourselves to impart results from scenarios 1 and 5, representing the removal of all agricultural distortions and trade distortions only. These two capture the effects of domestic and external liberalization, both individually and collectively, and should, in a reliable manner, indicate the efficiency losses associated with both kinds of market bias. Results for the other scenarios are available from the authors.

The simulations assume that liberalizations are phased in stepwise between 2005 and 2010. In each of these years, one-sixth of the relevant benchmark policy is eliminated, while the simulations provide identical results between 1997 and 2004. The model is allowed to settle down for five years after the final year of phase-in. Policy reductions are only implemented in the high-income regions defined as Australia and New Zealand, Canada, the European Union and EFTA countries, High-Income Asia, and the United States. In the case of tariffs, only positive tariffs are reduced. In the case of all other instruments, they are only reduced when they are negative, that is, acting as subsidies.

Table 2 presents the aggregate effects of the two scenarios. In the first column, aggregate income changes are given in 1997 U.S. billion dollars. More precisely, this is

TABLE 1. Hypothetical agricultural liberalization scenarios

Name	Scenario by Instrument Liberalized	Output Subsidies	Input Subsidy	Land Subsidy	Capital Subsidy	Export Subsidies	Import Tariffs
Scenario 1	All instruments	X	X	X	X	X	X
Scenario 2	No output subsidy		X	X	X	X	X
Scenario 3	No output and input subsidies			X	X	X	X
Scenario 4	No output, input, land subsidies				X	X	X
Scenario 5	Only tariffs and export subsidies					X	X
Scenario 6	Only tariffs						X
Scenario 7	Only export subsidies					X	
Scenario 8	Only subsidies on capital use				X		
Scenario 9	Only subsidies on land use			X			
Scenario 10	Only input subsidies		X				
Scenario 11	Only output subsidies	X					

measured as the change in the expenditure function at baseline and post-shock prices; that is, it is a measure of Hicksian equivalent variation (EV). The second column provides the levels of EV income change as a percentage of baseline expenditures. As is usual with neoclassical growth models, aggregate shifts in production possibilities are limited by resource constraints, but it is noteworthy that, under both domestic and international agricultural liberalization, EV income increases for every country except China. On current trends, by 2015, the latter country will be facing some constraints on agricultural supply and slightly higher, though still modest, levels of dependence on imported food. Higher world prices negatively affect imports of food items such as dairy and grains. Clearly, removing price distortions confers efficiency on most of the economies under consideration, and the result is output expansion in nearly every country.

TABLE 2. Real income impacts from agricultural reform in high-income regions

	(1997 billion $)		(percent)	
	Removal of All Protection	**Removal of Border Protection**	**Removal of All Protection**	**Removal of Border Protection**
United States	5.0	4.3	.05	.04
Western Europe	17.0	21.4	.17	.21
High-Income Asia	22.1	25.8	.34	.40
Canada	4.2	3.0	.55	.39
Australia and New Zealand	7.7	6.2	.12	.98
Argentina	3.6	2.0	.79	.44
Brazil	3.2	1.8	.32	.17
China	-0.7	1.5	-.04	.07
India	1.6	1.1	.23	.16
Rest of East Asia	0.6	0.5	.07	.06
Rest of Latin America and the Caribbean	9.2	8.2	.72	.65
Eastern Europe and Central Asia	3.2	2.2	.22	.15
Sub-Saharan Africa and SACU	1.8	1.6	.57	.52
Rest of the World	3.6	3.4	.22	.20
Low- and middle-income countries	26.0	22.3	.27	.23
High-income countries	56.1	60.6	.20	.21
World total	82.1	82.9	.21	.22
Cairns Group	28.5	21.6	.57	.43

Small aggregate changes, dictated by resource constraints in the basic model, are not the most important message of this analysis, however. Whether the aggregate moves up a little or more substantially, there are very dramatic adjustments taking place under the smooth veneer of the aggregate production possibilities frontier. In particular, as relative prices shift in response to the removal of preferential agricultural price distortions, factor returns in these sectors adjust dramatically and resources are pulled toward other activities. At the same time, removal of support takes a subsidy burden off the international price system, as OECD agricultural prices must rise to offset the loss of government support. This in turn will raise rates of return for farmers with support below the prior levels, especially those in developing countries with no support, and the lowest rural incomes can rise sharply.

To get a more precise impression of these agricultural linkage effects, consider the sectoral output adjustments presented in Table 3. Here we express sectoral output changes in 2015 as a percentage of their corresponding baseline levels, the counterfactual being scenario 1 (removal of all agricultural support). For the economies with relatively high prior protection, the adjustments can be relatively dramatic. While the rice sector is relatively small in the United States and in Australia and New Zealand, removal of Japanese and other High-Income Asian country support triggers significant competitive responses from these countries. As one might reasonably expect, heavily subsidized (raw and refined) sugar output contracts sharply in the United States and European Union. The main beneficiaries are Latin American farmers.

Important disparities emerge between United States and Western Europe, however, especially in cereals and meat. Wheat has significantly higher prior protection in Europe, and the result of liberalization is significant contraction of Western European output, offset largely by expansion in the United States and elsewhere. The same thing happens with bovine, other meat, and dairy products, with Western European output declining sharply against more competitive sources.

It is also worth noting that similar, but more dramatic, effects occur in High-Income Asia. Rice output falls by about two-thirds, while wheat drops more than three-quarters and meats fall by about one-half. The main beneficiaries of this market diversion are the low- and middle-income countries and the Cairns Group.

Overall (see last row), the Agriculture and Food aggregate contracts sharply in Western Europe and High-Income Asia, and this is offset by expansion in the United States, Australia and New Zealand, and a wide variety of low-income countries in Latin America, Africa, and Asia. Indeed, one of the most salient features of these results is redistribution between OECD farmers in the prior group and farmers in poor countries. Our results appear to support the inference that wealthy taxpayers are undermining incomes of the rural poor across the developing world.

While Western European protection appears to be sustaining artificially high aggregate agricultural protection, U.S. support actually represses agriculture by comparison to open multilateralism. If all support were removed multilaterally, aggregate U.S. agricultural output would be 0.7 percent higher annually from 2015.

TABLE 3. Change in output from full removal of agricultural protection in high-income regions (percentage change from baseline in 2015)

	United States	Western Europe	High-Income Asia	Canada	Australia and New Zealand	Argentina	Brazil	China	India
Paddy rice	473.5	-71.4	-63.7	..	1285.7	-1.4	0.6	0.9	8.6
Wheat	4.2	-44.0	-77.1	43.3	12.0	3.8	5.2	3.8	0.4
Other cereal grains	-0.1	-51.2	-60.8	-0.9	-6.4	30.9	2.7	5.9	-0.0
Vegetable and fruits	4.6	-11.3	-5.0	-2.4	-5.2	-0.9	0.1	-0.2	0.6
Oil seeds	-9.9	-31.2	-44.3	17.9	10.2	-2.7	13.2	3.4	0.3
Raw sugar	-45.4	-43.3	-58.6	23.5	-2.2	0.4	3.8	0.6	-0.1
Plant based fibers	1.9	19.1	104.0	..	-18.6	-3.3	0.0	0.4	0.1
Other crops	-10.7	1.6	-12.0	-3.3	10.0	-6.9	2.4	0.3	0.6
Bovine cattle etc	5.3	-39.8	-27.2	12.7	30.9	38.5	11.3	0.1	0.4
Other livestock	1.3	-15.6	-2.4	-14.8	-7.6	-4.6	4.2	-0.2	-0.2
Raw milk	1.0	-15.7	-40.9	-12.1	73.3	14.7	0.2	-0.0	0.3
Fossil fuels	0.6	3.2	2.4	0.8	-6.1	-5.9	-1.3	0.2	-0.3
Other natural resources	0.3	1.8	1.7	-0.3	-5.5	-2.1	-1.2	0.1	0.1
Bovine meat products	3.1	-36.4	-8.8	9.8	57.2	40.0	12.3	0.2	11.3
Other meat products	2.4	-18.5	-20.5	-10.5	3.7	-0.1	3.5	2.0	..
Vegetable oils and fats	-3.2	-7.0	45.5	-1.7	-5.6	-3.5	2.4	-2.2	-0.5
Dairy products	1.1	-16.1	-50.5	-16.6	82.0	0.6	0.4	2.2	-0.3
Refined sugar	-45.6	-65.4	-59.0	32.0	-2.2	0.4	5.3	2.3	4.7
Oth Proc Food, Bev, Tob	-0.4	-0.7	3.5	-1.9	-4.0	-1.0	-0.2	-0.7	-3.2
Text, Leath, and Apparel	0.3	2.7	1.6	-0.4	-7.2	-1.2	-0.4	-0.3	-1.0
Chem, Plastic, Rubber	-0.1	1.3	0.4	-0.6	-4.1	-2.0	-0.6	-0.3	-0.5
Other manufacturing	-0.1	1.4	0.6	-0.6	-4.2	-2.1	-1.1	-0.1	-0.5
Electricity and gas	0.2	0.4	0.3	-0.1	-0.6	0.4	-0.3	0.1	0.3
Construction	-0.0	0.1	0.0	0.3	1.0	0.2	-0.1	0.1	0.2
Other services	-0.0	0.5	0.2	0.1	-0.2	0.0	-0.1	-0.0	-0.0
Agriculture	2.7	-22.3	-24.4	6.4	26.2	8.0	3.8	0.6	1.5
Processed foods	-0.2	-10.1	-0.9	-3.4	24.8	3.9	2.1	-0.5	0.1
Manufacturing	-0.1	1.2	0.5	-0.3	-3.2	-1.6	-0.8	-0.1	-0.3
Services	-0.0	0.5	0.2	0.1	-0.2	0.0	-0.1	-0.0	-0.0
Total	0.0	-0.0	0.1	-0.1	0.6	0.3	0.0	-0.1	0.1
Agriculture and food	0.7	-13.4	-6.7	0.2	25.4	5.5	2.9	0.2	1.3

TABLE 3. Extended

	Rest of East Asia	Rest of Latin America and the Caribbean	Eastern Europe and Central Asia	Sub-Saharan Africa x SACU	Rest of the World	Low- and Middle-Income Countries	High-Income Countries	World Total	Cairns Group
Paddy rice	-1.4	6.1	0.6	-0.6	0.2	1.9	-32.3	-3.5	6.0
Wheat	28.7	22.0	12.7	7.0	8.5	7.0	-15.1	0.5	17.9
Other cereal grains	1.8	10.6	19.7	6.4	8.7	8.5	-13.2	0.4	9.0
Vegetable and fruits	0.3	3.1	2.7	1.9	3.1	1.1	-4.3	0.0	0.9
Oil seeds	5.0	11.2	8.6	25.8	2.4	5.1	-11.5	1.0	9.1
Raw sugar	2.3	18.8	7.7	36.7	3.8	6.1	-42.1	-1.5	6.7
Plant based fibers	0.7	-1.6	0.8	-2.4	0.1	-0.2	-1.9	-0.4	-3.4
Other crops	2.4	4.7	5.6	-0.7	1.3	1.7	-5.1	-0.7	3.6
Bovine cattle etc	2.6	9.3	34.6	3.5	9.7	9.5	-11.0	-1.4	13.7
Other livestock	0.7	31.2	5.7	-1.7	2.7	2.9	-8.9	-0.4	9.3
Raw milk	4.5	9.3	12.0	2.5	4.7	5.7	-8.6	-0.7	13.5
Fossil fuels	1.2	-3.2	-0.9	-3.3	-0.4	-0.9	0.7	-0.5	-1.8
Other natural resources	0.5	-1.3	-0.9	-0.4	-0.4	-0.3	0.4	-0.0	-1.3
Bovine meat products	2.2	9.2	10.2	39.5	11.1	12.8	-10.1	-1.4	20.1
Other meat products	8.7	49.8	8.6	1.2	11.3	14.3	-11.4	-1.1	19.6
Vegetable oils and fats	4.1	0.7	3.8	1.1	2.6	0.6	-1.2	-0.1	0.7
Dairy products	9.7	9.7	41.7	16.4	15.8	15.2	-9.4	-2.4	15.7
Refined sugar	2.6	26.0	8.5	73.2	9.3	13.2	-54.2	-4.5	11.8
Oth Proc Food, Bev, Tob	-1.7	-0.8	-0.5	-1.2	-0.7	-0.9	0.4	-0.1	-1.2
Text, Leath, and Apparel	0.3	-2.1	-2.0	-2.0	-1.6	-0.8	1.4	0.0	-1.1
Chem, Plastic, Rubber	-0.7	-1.7	-1.7	-0.3	-1.1	-0.8	0.5	0.0	-1.3
Other manufacturing	-0.2	-2.9	-1.7	-2.1	-1.2	-0.8	0.5	0.1	-1.5
Electricity and gas	0.1	-0.8	-0.2	-0.2	0.1	-0.0	0.3	0.1	-0.3
Construction	0.1	0.4	-0.1	-0.1	0.1	0.1	0.1	0.1	0.3
Other services	-0.0	-0.2	-0.3	-0.4	-0.2	-0.2	0.2	0.1	-0.1
Agriculture	0.4	10.0	8.9	3.1	4.5	3.6	-10.3	-0.6	6.8
Processed foods	0.1	8.4	6.2	5.5	3.3	3.2	-3.8	-0.7	5.1
Manufacturing	-0.0	-2.0	-1.3	-1.5	-0.8	-0.6	0.5	0.1	-1.1
Services	-0.0	-0.2	-0.3	-0.4	-0.2	-0.2	0.2	0.1	-0.1
Total	0.0	0.6	0.0	0.5	0.1	0.1	0.0	0.0	0.2
Agriculture and food	0.3	9.1	7.4	4.0	3.9	3.4	-5.7	-0.6	5.8

Given the huge fiscal burden of this protection, this indicates that U.S. protection is justifiable only on a defensive basis and that (apart from relatively narrow sectoral interests like sugar) the United States should rationally take the developing countries' side in the Doha Round.

Finally, note the aggregate agriculture output effect for the regional aggregates in the latter columns of Table 3. Here again, the progressive nature of the implied income distribution is immediately apparent. According to our results, the prevailing regime of global agricultural support is repressing output and incomes in most low-income continents, including Africa, Latin America, and low-income Eastern Europe and Asia. This trend is particularly ironic because the support budgets in question comfortably exceed development assistance budgets exerting themselves in the opposite direction.

The results shown in Table 4 enable us to better understand the microeconomics of the adjustment process for the high-income countries and the regional aggregates. As one would expect from a producer support program, abolition leads to direct and indirect increases in the cost of capital, and this is particularly evident in Western Europe where direct producer support is quite high. Even on an average basis, high-income capital costs rise quite significantly when support is removed multilaterally. Returns to capital fall uniformly within countries because the current model specification assumes perfect domestic capital mobility.

In the case of land, we see the expected result that a factor's rate of return falls sharply while its price declines to partially offset this as output is reduced. Land prices fall dramatically in the United States under scenario 1 for all tariff 1 simulations. Our model treats land as being imperfectly substitutable among agricultural activities. Land devoted to grains production experiences the steepest decrease, with a 45, 74, and 63 percent reduction for land devoted to rice, wheat, and other coarse grains, respectively. Generally speaking, the interactions between expanding and contracting sectors and land intensity are relatively complex, but, at the regional aggregate level, the net burden of protection determines the direction of the adjustment in rate of return, land values, and rural incomes. Again, richer farmers are the losers and poorer ones are the winners.

TABLE 4. Factor returns in agriculture (percentage change from baseline in 2015)

	United States	Western Europe	High-Income Asia	Canada	Australia and New Zealand	Low- and Middle-Income Countries	High-Income Countries	World Total	Cairns Group
					Cost of Capital Inclusive of Subsidies				
Paddy rice	2.5	-1.1	10.3	0.0	3.4	0.9	17.7	7.5	1.5
Wheat	2.7	121.2	10.0	3.1	3.4	1.9	48.8	20.6	1.2
Other cereal grains	3.1	145.3	14.2	5.8	3.4	1.8	30.6	16.1	2.6
Vegetable and fruits	0.6	-0.6	0.3	0.5	3.4	2.0	-0.8	1.3	2.4
Oil seeds	2.8	136.7	21.9	3.5	3.4	3.2	26.5	10.8	3.3
Raw sugar	2.0	-0.6	8.6	0.5	3.4	2.4	1.6	3.3	2.1
Plant based fibers	0.6	-0.7	0.3	0.0	3.4	1.2	1.0	1.1	2.2
Other crops	0.6	-0.6	0.3	0.5	3.4	1.8	0.9	1.8	2.3
Bovine cattle etc	4.1	442.5	42.9	4.4	4.7	2.2	200.6	85.5	2.5
Other livestock	3.4	19.3	21.5	11.0	3.4	2.1	13.3	4.4	2.7
Raw milk	18.9	13.2	13.0	13.7	3.4	1.9	13.0	6.9	2.6
					Returns to Capital Exclusive of Subsidies				
Paddy rice	0.6	-1.1	0.3	0.0	3.4	0.9	7.7	4.8	1.5
Wheat	0.6	-0.6	0.3	0.5	3.4	2.0	-5.6	0.5	0.7
Other cereal grains	0.6	-0.6	0.3	0.5	3.4	1.8	-3.7	0.4	2.1
Vegetable and fruits	0.6	-0.6	0.3	0.5	3.4	2.0	-0.8	1.3	2.4
Oil seeds	0.6	-0.6	0.3	0.5	3.4	3.2	-2.5	2.1	3.0
Raw sugar	0.6	-0.6	0.3	0.5	3.4	2.5	0.5	3.1	2.2
Plant based fibers	0.6	-0.7	0.3	0.0	3.4	1.2	1.0	1.1	2.2
Other crops	0.6	-0.6	0.3	0.5	3.4	1.8	0.9	1.8	2.3
Bovine cattle etc	0.6	-0.6	0.3	0.5	3.4	2.3	-4.2	-0.4	1.9
Other livestock	0.6	-0.6	0.3	0.5	3.4	2.2	-1.0	1.1	2.4
Raw milk	0.6	-0.6	0.3	0.5	3.4	1.9	-0.5	1.0	1.9
					Cost of Land Inclusive of Subsidies				
Paddy rice	80.8	-59.9	-65.5	0.0	180.1	2.0	-19.4	2.3	4.1
Wheat	4.6	-53.2	-70.2	22.2	27.3	5.1	42.4	36.3	12.5
Other cereal grains	3.1	-55.5	-63.7	7.9	19.6	5.0	23.5	23.2	9.4
Vegetable and fruits	4.6	-42.1	-51.6	7.6	20.2	2.9	-31.6	-2.1	5.0

TABLE 4. Continued

	United States	Western Europe	High-Income Asia	Canada	Australia and New Zealand	Low- and Middle-Income Countries	High-Income Countries	World Total	Cairns Group
Oil seeds	-0.5	-49.6	-60.0	14.5	26.6	4.4	22.5	16.5	7.8
Raw sugar	-15.8	-49.9	-63.9	0.0	21.5	3.8	-25.2	5.0	5.7
Plant based fibers	3.7	-35.5	-36.0	0.0	14.2	2.4	3.3	2.5	3.3
Other crops	-0.9	-39.1	-53.2	7.0	26.3	4.3	-22.7	-2.7	6.8
Bovine cattle etc	5.9	-45.6	-55.6	12.2	33.7	4.3	-2.9	3.9	9.8
Other livestock	4.2	-38.5	-52.6	3.0	19.4	2.0	-24.6	-0.1	6.6
Raw milk	4.6	-39.9	-58.7	4.0	46.7	5.7	-20.1	0.1	14.9
				Returns to Land Exclusive of Subsidies					
Paddy rice	0.2	-77.8	-68.4	0.0	180.1	2.0	-27.8	0.8	4.1
Wheat	-73.2	-95.8	-79.3	-31.6	15.2	5.4	-72.8	-27.0	1.0
Other cereal grains	-62.3	-95.7	-68.0	-36.3	6.1	5.8	-62.5	-19.8	7.4
Vegetable and fruits	4.6	-42.1	-51.6	7.6	20.2	2.9	-31.6	-2.1	5.0
Oil seeds	-23.4	-96.5	-61.6	-19.7	26.6	4.4	-46.1	-3.7	4.9
Raw sugar	-29.5	-66.3	-63.9	0.0	12.7	3.8	-40.2	2.9	5.5
Plant based fibers	3.7	-35.5	-36.0	0.0	14.2	2.4	3.3	2.5	3.3
Other crops	-0.9	-39.1	-53.2	7.0	26.3	4.3	-22.7	-2.7	6.8
Bovine cattle etc	-3.6	-50.6	-56.3	-8.4	20.0	4.3	-11.8	1.2	7.5
Other livestock	-3.7	-47.9	-53.3	-14.0	4.8	2.1	-31.6	-1.0	5.8
Raw milk	-5.0	-47.7	-58.7	0.6	38.6	5.7	-28.1	-2.4	14.3

Most agricultural economists believe that the rental rate paid by producers would fall by the amount (rents to landlords) corresponding to the rate of return. The rental rate paid should fall because the rental rate was inflated by the farm programs formerly received by producers/renters. This may be a limitation of the GTAP database: all subsidies go to the factor owner, not to the user of the factor.

Now we examine, in Tables 5 and 6, the most dynamic adjustments: exports and imports by sector and country. There are many interesting individual adjustments. Note for example that world rice exports expand by 800 percent. Trade of cattle meat products expands substantially (70 percent for cattle, 69 percent for beef, and 48 percent for other meats). Global grain trade expands by 20 to 25 percent despite an expansion of livestock output in major grain producing countries (Argentina, the United States, and Australia). The European Union experiences a major surge in meat and grain imports (130 percent for wheat and coarse grains, 129 and 176 percent for cattle and beef), and a collapse of its exports of the same products (-87 and 94 percent for coarse grains and wheat, -77 percent for cattle; –82 percent for beef). Dairy and sugar trade expands significantly. The GTAP database does not track raw sugar trade separately and it is difficult to disentangle changes in trade patterns in refined and raw sugar. Nevertheless, it is clear that Brazil, India, China, and Sub-Saharan Africa benefit from sugar trade liberalization, as their exports increase substantially.

While the tables reward this kind of close inspection, we now focus on the last row of aggregate agricultural exports and imports by exporter and importer, respectively. On the export side, the story mirrors sectoral output adjustments in Table 3. For example, the United States expands agricultural exports by 16 percent more per year by 2015 under multilateral liberalization, while the Cairns Group manages a 26 percent increase. Even more dramatic are the Rest of Latin America (31 percent), Eastern Europe and Central Asia (45.2 percent), the Rest of the World (36.1 percent), and Australia and New Zealand (with a sensational 58 percent increase). Some of this trade growth displaces Western European exporters, whose shipments decline 14.2 percent, but the vast majority is driven by economic growth in a less distorted market environment. Again, the burden and opportunity cost of agricultural protection is far greater than simple market defense could justify.

TABLE 5. Change in exports from full removal of agricultural protection in high-income regions (percentage change from baseline in 2015)

	United States	Western Europe	High-Income Asia	Canada	Australia and New Zealand	Argentina	Brazil	China	India
Paddy rice	2543.5	-94.3	..	..	8268.5	-5.1	..	5776.8	398.0
Wheat	13.4	-40.5	..	55.5	12.4	6.1	45.6	678.1	24.5
Other cereal grains	-12.5	-86.7	..	2.0	-19.4	46.3	28.3	238.1	..
Vegetable and fruits	31.9	-10.1	133.9	8.1	-15.6	-4.3	12.8	34.7	12.4
Oil seeds	-15.6	-51.3	-77.0	54.5	23.2	-1.5	35.1	60.5	12.9
Raw sugar	..	-43.3	..	..	..	..	..	..	..
Plant based fibers	4.7	20.0	148.3	..	-23.2	-11.1	-1.0	..	1.2
Other crops	15.1	20.0	73.5	-3.5	-21.7	-14.3	5.0	9.9	4.1
Bovine cattle etc	212.4	-77.2	1069.5	20.8	-12.6	-6.2	..	212.0	..
Other livestock	-1.3	-4.6	57.0	-16.5	-25.2	-25.4	33.5	-5.1	-27.1
Raw milk	..	-22.1	..	..	..	..	..	..	-11.3
Fossil fuels	1.6	3.9	3.6	1.6	-8.2	-10.8	-5.8	3.1	-1.6
Other natural resources	1.4	4.9	5.0	0.8	-10.8	-13.8	-5.2	1.7	-0.2
Bovine meat products	47.8	-82.5	196.4	77.0	106.6	231.7	387.9	-3.6	11.3
Other meat products	27.6	-33.4	188.0	50.2	30.6	2.8	17.2	69.3	..
Vegetable oils and fats	-4.8	-10.3	247.2	1.8	-34.6	-6.5	4.7	-29.0	-2.4
Dairy products	150.0	-36.8	399.8	311.8	146.2	13.4	..	-43.6	-41.7
Refined sugar	213.7	-93.6	82.3	152.7	-10.4	60.3	19.5	20.2	97.2
Other processed foods incl beverages and tobacco	-7.8	2.7	40.8	-4.3	-23.4	-19.1	-10.0	-12.8	-7.8
Textiles clothing and leather	1.1	4.0	2.9	-0.8	-15.1	-15.9	-6.6	-0.2	-3.4
Chemicals plastics and rubber	-0.4	2.5	1.9	-1.5	-13.5	-14.7	-6.0	-1.1	-3.6
Other manufacturing	-0.5	2.3	1.2	-1.0	-11.2	-11.8	-5.5	-0.4	-2.8
Electricity and gas	-0.4	1.4	0.9	-0.2	-6.4	-9.4	..	0.0	..
Construction	-1.1	1.1	0.0	-1.4	-7.9	-8.5	-4.3	-1.1	-1.9
Other services	-0.6	3.3	2.3	-1.4	-13.0	-13.9	-6.7	-0.6	-2.5
Agriculture	24.3	-21.5	97.4	31.0	23.9	14.9	19.0	92.8	41.0
Processed foods	8.2	-13.0	80.5	27.7	76.9	27.2	18.5	-5.6	0.5
Manufacturing	-0.4	2.4	1.4	-0.8	-11.1	-12.4	-5.6	-0.4	-3.0
Services	-0.6	3.3	2.3	-1.4	-13.0	-13.9	-6.7	-0.6	-2.5
Total	0.5	1.9	2.1	0.8	0.6	4.3	2.4	-0.2	0.8
Agriculture and food	16.0	-14.2	82.3	29.5	57.9	21.8	18.8	12.7	15.3

TABLE 5. Extended

	Rest of East Asia	Rest of Latin America and the Caribbean	Eastern Europe and Central Asia	Sub-Saharan Africa x SACU	Rest of the World	Low- and Middle-Income Countries	High-Income Countries	World Total	Cairns Group
Paddy rice	31.9	38.0	..	..	53.0	282.6	2919.4	804.1	617.3
Wheat	33.4	240.5	67.4	..	125.9	60.1	13.4	25.6	41.4
Other cereal grains	-16.4	102.4	136.1	146.5	121.5	89.1	-24.9	20.0	32.9
Vegetable and fruits	8.9	6.3	20.9	10.5	20.9	11.3	7.2	10.2	4.9
Oil seeds	-2.5	19.9	18.3	115.1	5.2	30.3	-8.4	13.4	31.8
Raw sugar	..	..	..	..	..	..	-43.3	-43.3	..
Plant based fibers	3.1	-6.1	2.0	-3.0	0.5	-1.1	-1.0	-1.1	-15.5
Other crops	7.0	6.3	13.1	-1.2	2.1	3.7	17.3	5.4	5.2
Bovine cattle etc	..	16.8	295.0	18.7	295.4	180.8	2.6	70.0	10.7
Other livestock	-21.2	-7.3	4.3	-24.0	7.2	-1.5	-5.7	-3.7	-11.1
Raw milk	..	..	-17.1	..	-16.2	-15.6	-22.1	-16.0	..
Fossil fuels	2.0	-3.7	-0.8	-3.5	-0.3	-1.1	1.3	-0.6	-2.0
Other natural resources	2.5	-5.0	-1.5	-4.2	-1.1	-1.5	-1.4	-1.5	-4.4
Bovine meat products	57.3	168.0	118.1	639.1	500.3	209.9	21.4	68.9	149.5
Other meat products	65.3	1247.2	45.7	48.6	275.7	166.5	-7.5	47.9	191.5
Vegetable oils and fats	7.5	1.7	10.1	33.9	28.9	2.9	7.8	4.5	2.1
Dairy products	24.1	180.0	553.1	36.9	310.6	315.1	13.6	43.8	146.3
Refined sugar	13.6	91.7	44.4	200.8	165.9	81.5	-56.4	61.5	48.8
Other processed foods incl beverages and tobacco	-9.0	-12.1	-7.8	-14.5	-9.3	-10.4	1.5	-3.3	-11.4
Textiles clothing and leather	0.5	-6.7	-3.6	-7.1	-3.4	-1.8	3.0	0.3	-3.5
Chemicals plastics and rubber	-1.2	-6.4	-4.0	-6.0	-3.4	-2.9	1.5	0.5	-3.7
Other manufacturing	-0.2	-5.6	-3.4	-5.9	-2.7	-2.2	1.1	0.3	-2.8
Electricity and gas	0.1	-2.4	-0.8	-1.8	-1.0	-1.1	1.1	0.1	-1.2
Construction	-0.7	-4.4	-2.5	-3.5	-1.7	-2.2	0.6	0.0	-3.6
Other services	-0.3	-7.3	-2.5	-5.8	-2.6	-2.7	1.6	0.4	-4.7
Agriculture	2.7	11.0	41.4	5.2	30.3	19.2	12.6	16.9	15.6
Processed foods	0.2	62.7	48.2	62.6	44.8	28.5	3.5	14.0	34.9
Manufacturing	-0.0	-5.4	-3.1	-4.5	-1.9	-2.0	1.3	0.3	-2.9
Services	-0.3	-7.3	-2.5	-5.8	-2.6	-2.7	1.6	0.4	-4.7
Total	-0.0	1.1	0.2	1.9	0.4	0.5	1.5	1.2	0.8
Agriculture and food	0.6	31.0	45.2	16.1	36.1	23.8	6.1	15.1	25.9

TABLE 6. Change in imports from full removal of agricultural protection in high-income regions (percentage change from baseline in 2015)

	United States	Western Europe	High-Income Asia	Canada	Australia and New Zealand	Argentina	Brazil	China	India
Paddy rice	101.5	55.7	6568.0	-0.0	..	..	-6.1	..	..
Wheat	33.1	130.6	14.0	459.8	..	..	-8.2	-17.9	-21.6
Other cereal grains	16.8	133.5	-13.9	18.5	..	17.1	-11.1	-18.1	..
Vegetable and fruits	2.7	12.1	39.3	2.5	10.2	3.9	-5.5	-4.1	-2.0
Oil seeds	64.4	17.1	40.5	-5.5	-4.5	-1.7	-3.4	-7.9	..
Raw sugar	..	-43.3	..	..	..	..	..	..	..
Plant based fibers	-3.0	1.8	0.8	-0.6	..	..	-0.3	-2.8	-2.8
Other crops	27.1	-1.7	9.0	1.9	27.8	3.8	-0.4	-0.4	3.0
Bovine cattle etc	11.4	129.0	305.1	6.4	33.9	55.1	5.8	..	..
Other livestock	-0.6	-0.2	-19.9	52.2	13.1	5.0	-0.2	-5.3	-1.3
Raw milk	18.9	-12.9	-51.8	..	..	..	..	..	..
Fossil fuels	-1.3	0.0	-0.2	-0.5	1.1	3.2	-0.4	-1.6	-0.6
Other natural resources	-1.5	-1.7	-1.5	-0.8	3.2	3.1	1.0	-2.9	-0.5
Bovine meat products	16.5	176.1	21.9	32.8	8.7	9.2	-4.2	-3.9	..
Other meat products	6.5	73.6	59.6	172.4	13.9	7.7	6.7	-4.2	..
Vegetable oils and fats	15.2	14.7	-24.9	12.7	13.2	4.3	-1.3	2.3	0.9
Dairy products	92.4	39.3	245.7	797.6	16.0	4.0	-6.7	-14.4	-10.6
Refined sugar	133.0	163.7	114.1	-0.4	0.4	7.9	..	-2.1	-3.9
Other processed foods incl beverages and tobacco	0.5	-3.3	-16.4	-0.8	9.5	8.1	1.4	1.8	2.6
Textiles clothing and leather	-0.2	-0.1	-0.6	0.4	3.0	8.1	3.3	0.7	1.0
Chemicals plastics and rubber	0.4	-0.3	-0.9	0.6	5.3	7.1	3.9	0.6	1.4
Other manufacturing	0.1	0.1	-0.2	0.2	3.6	5.3	2.5	0.5	1.4
Electricity and gas	0.2	-0.2	-0.1	0.2	..	3.1	1.3	..	1.1
Construction	0.4	-0.5	0.0	1.2	5.2	4.9	2.1	0.7	1.2
Other services	0.5	-1.4	-0.9	1.2	8.2	8.6	4.0	0.4	1.7
Agriculture	15.9	21.0	51.5	7.3	20.8	3.9	-4.1	-6.8	-3.9
Processed foods	13.2	28.5	9.5	29.7	10.3	7.6	-0.8	0.4	0.8
Manufacturing	-0.0	-0.0	-0.4	0.2	3.7	5.7	2.6	0.4	1.1
Services	0.5	-1.4	-0.9	1.2	8.2	8.6	4.0	0.4	1.7
Total	0.6	1.5	1.3	1.2	4.9	6.2	2.5	0.1	1.1
Agriculture and food	14.4	25.4	24.9	22.0	12.7	6.1	-2.7	-3.2	-1.7

TABLE 6. Extended

	Rest of East Asia	Rest of Latin America and the Caribbean	Eastern Europe and Central Asia	Sub-Saharan Africa x SACU	Rest of the World	Low- and Middle-Income Countries	High-Income Countries	World Total	Cairns Group
Paddy rice	-1.5	-10.5	-2.5	-41.1	-1.3	-6.2	1241.1	787.4	-7.3
Wheat	-0.5	-8.3	-0.5	-18.6	-14.1	-10.0	89.1	25.1	-3.0
Other cereal grains	-19.4	-3.8	1.2	-0.1	-14.1	-11.6	44.7	18.7	-7.8
Vegetable and fruits	-3.4	3.1	0.2	4.3	-0.2	-1.2	13.7	10.5	0.7
Oil seeds	-4.2	-0.1	3.7	3.6	-3.3	-4.3	25.3	13.4	-2.1
Raw sugar	..	..	..	..	..	..	-43.3	-43.3	..
Plant based fibers	-3.1	3.7	-0.4	-0.8	-0.9	-1.7	1.3	-1.1	-1.3
Other crops	-0.9	6.5	4.1	1.3	1.0	2.1	6.2	5.4	5.0
Bovine cattle etc	-15.6	1.0	-3.6	5.0	-4.8	-5.7	92.0	71.6	-1.3
Other livestock	-3.0	36.9	4.7	3.4	2.3	0.6	-5.5	-3.8	23.0
Raw milk	..	..	..	..	..	..	-16.0	-16.0	..
Fossil fuels	-1.0	-2.7	-0.9	-0.3	-1.2	-1.1	-0.4	-0.6	-0.9
Other natural resources	-1.3	1.2	-0.8	2.7	-0.6	-1.3	-1.6	-1.5	-0.0
Bovine meat products	-3.2	-4.2	-13.4	-11.7	-13.4	-8.6	102.0	71.8	4.4
Other meat products	-3.7	4.0	-0.1	-3.9	0.2	-1.0	67.4	46.8	47.0
Vegetable oils and fats	1.1	-1.4	1.5	17.6	3.1	2.1	8.4	4.7	1.6
Dairy products	-8.3	-13.0	-15.8	-21.9	-11.7	-12.5	74.6	44.5	20.1
Refined sugar	-2.3	1.5	-1.1	-2.8	-7.0	-3.6	139.7	62.9	-0.5
Other processed foods incl beverages and tobacco	2.4	3.9	3.3	5.1	2.3	2.9	-5.8	-3.4	3.0
Textiles clothing and leather	0.1	2.7	0.9	2.2	0.8	1.2	-0.1	0.3	2.0
Chemicals plastics and rubber	0.2	2.6	1.3	3.5	1.6	1.6	-0.1	0.5	2.2
Other manufacturing	0.1	1.3	1.0	1.8	0.9	0.9	0.1	0.3	1.1
Electricity and gas	0.9	1.3	0.1	0.7	0.8	0.5	-0.1	0.1	1.2
Construction	0.6	2.8	1.3	1.7	0.8	1.0	-0.3	0.0	1.3
Other services	0.3	4.3	1.7	3.6	1.5	1.9	-0.6	0.1	2.9
Agriculture	-4.3	1.1	1.7	-6.8	-6.9	-3.8	26.2	16.4	-0.1
Processed foods	-0.1	0.3	0.2	1.8	-0.9	0.0	21.6	14.2	6.1
Manufacturing	0.1	1.5	0.8	2.0	0.9	0.9	-0.0	0.3	1.2
Services	0.3	4.3	1.7	3.6	1.5	1.9	-0.6	0.1	2.9
Total	-0.0	1.8	0.9	2.4	0.7	0.9	1.3	1.2	1.6
Agriculture and food	-2.1	0.6	0.7	-0.0	-2.8	-1.4	23.4	15.1	3.6

On the import side, we see rising world food prices inducing greater food self-sufficiency in some poor countries, including Brazil, China, India, Rest of (low income) East Asia, and Rest of the (non-OECD) World. For richer countries, income effects and lower relative prices for foreign agricultural products drive significant increases in imports. Generally speaking, a Doha-style approach to more balanced abolition of agricultural price distortions would greatly increase global agricultural trade, improving the livelihoods of a significant and underprivileged majority of the world's farmers.

A final insight from these scenarios concerns world food prices. Table 7 presents these by sector under the two scenarios, scenario 1 (removal of domestic and trade support) and scenario 5 (removal of trade support only). These results clearly indicate that most of the burden of agricultural support on international food trade is indirect. When only tariff and export subsidies are removed, world food prices for these product categories never change by 10 percent or more. If domestic and external supports are abolished together, however, the percentage increase in global food prices can be up to

TABLE 7. Changes in world prices (percentage change from baseline in 2015)

	Removal of All Protection	Removal of Border Protection
Paddy rice	5.5	4.1
Wheat	12.0	1.9
Other cereal grains	14.5	2.7
Vegetable and fruits	0.3	0.1
Oil seeds	8.1	1.0
Raw sugar	-1.7	-2.2
Plant based fibers	1.8	1.4
Other crops	0.9	0.6
Bovine cattle etc	18.2	-0.5
Other livestock	2.2	-0.9
Raw milk	2.4	0.1
Bovine meat products	10.4	1.9
Other meat products	1.7	-0.9
Vegetable oils and fats	2.2	-0.2
Dairy products	8.3	5.9
Refined sugar	9.0	8.4
Other processed foods incl beverages and tobacco	-0.2	-1.0
Agriculture (weighted average)	4.3	0.7
Processed foods (weighted average))	2.1	0.3

two orders of magnitude greater by 2015. Cattle prices, for example, would drop 0.5 percent if only external distortions were removed, indicating that the existing pattern of external policy toward this sector is withholding supply for world markets. If domestic support were removed, however, an 18 percent world price increase would be necessary to offset this and restore equilibrium in world beef markets. Clearly, it is not conventional protectionism or export promotion that is most responsible for the dysfunction of today's agricultural markets—it is direct producer support. It should also be noted that, upon inspection of trade-weighted world prices for all product categories, we find that, although world food prices rise significantly, overall terms of trade improve for developing countries.

What would be the global distributional consequences of abolishing OECD agricultural protection? This can be inferred from the market linkages in question; that is, rising global food prices improve incomes among farmers without prior support. But more detailed estimates are available directly from the simulation model and presented in Table 8. These changes in national rural value-added indicate that the big losers would be farmers in Western Europe and High-Income Asia (mainly Japan), while low- and middle-income farmers would benefit more in absolute terms (but less in relative terms). Indeed, OECD agricultural policies represent a huge tax on developing country agriculture. Removing all OECD subsidies would increase rural value-added by more than $60 billion (per annum, not cumulatively) in low- and middle-income countries.

This figure, incidentally, exceeds by over 20 percent the most ambitious target for increased aggregate development assistance. Unlike development assistance by conventional means, realizing poverty alleviation in this way would also occasion substantial savings for OECD taxpayers. Perhaps most significant, this real net $63.4 billion would be delivered directly to the doorstep of poor households in the developing world by the marketplace, bypassing local, regional, and national governments and a variety of other mediating institutions. At the heart of these policies lies a potent catalyst for global poverty alleviation. For those who believe, as we do, that globalization has been beneficial to the poor, it would be doubly ironic if, as the new U.S. farm bill threatens to do, OECD agricultural protection were to break the Doha Round.

TABLE 8. Impact on nominal rural value added from agricultural reform in high-income regions (in 2015 compared to baseline)

	(1997 billion $)		(percent)	
	Removal of All Protection	**Removal of Border Protection**	**Removal of All Protection**	**Removal of Border Protection**
Western Europe	-28.8	-34.4	-15.5	-18.6
United States	5.5	7.6	4.8	6.6
High-Income Asia	-34.4	-35.0	-36.6	-37.2
Canada	2.1	1.5	15.4	11.1
Australia and New Zealand	7.8	6.6	41.5	34.9
Argentina	6.6	3.8	15.5	8.9
Brazil	5.7	3.3	7.0	4.0
China	7.9	4.6	2.0	1.1
India	4.9	3.6	3.3	2.4
Rest of East Asia	1.5	0.4	1.4	0.4
Rest of Latin America and the Caribbean	15.3	12.3	15.2	12.2
Eastern Europe and Central Asia	7.7	4.4	10.8	6.2
Sub Saharan Africa x SACU	3.4	2.6	6.3	4.8
Rest of the World	10.3	6.2	6.8	4.1
Low- and middle-income countries	63.4	41.2	5.5	3.6
High-income countries	-47.7	-53.7	-11.2	-12.6
World total	15.7	-12.5	1.0	-0.8
Cairns Group	39.1	27.9	10.8	7.7

Note: Loss in value is net of agricultural subsidies.

Conclusions and Extensions

Global agricultural trade is the centerpiece of the next round (Doha Round) of multilateral trade relations. This focus is eminently sensible since agriculture is one of the largest and most stubborn areas of government market intervention remaining after thirty years of determined progress toward open multilateralism. Agricultural protection is also seen as an important source of market bias between rich and poor nations, and reconciling this has special significance in the context of recent multilateral commitments to attack more aggressively the causes of global (largely rural) poverty.

In this paper, we use a new dynamic simulation model and global database to assess the efficiency and welfare burdens of today's agricultural support programs. Our results

indicate that these burdens are quite substantial, that their abolition would lead to dramatic shifts in domestic and international resource allocation, and that the result would be a more progressive distribution of farm income. In particular, our results give strong empirical support to the idea that current agricultural support in high-income countries is repressing output and incomes in low-income farm households across the developing world. Thus, for example, taxpayers in OECD countries are paying twice for development assistance: once to reduce the incomes of poor farmers and again to alleviate the same poverty.

Abolition of OECD agricultural support would be a potent catalyst for global poverty alleviation and at the same time would induce substantial savings for OECD taxpayers. Today, these policies reduce rural value-added by more than $60 billion (per annum, not cumulatively) in low- and middle-income countries, a figure 20 percent higher than the most ambitious goals for increased development assistance. If they were also to undermine the Doha Round, as the new U.S. farm bill portends, it would be a doubly regressive blow to North-South economic relations.

Among our more specific conclusions are the following:

- Though world food prices would rise with the abolition of agricultural support programs, the overall terms of trade would appreciate for developing regions as a group.
- There would be significant growth and reorientation of global agricultural trade; that is, the current structure of production and trade is highly distorted. Trade in agriculture would increase by 17 percent at the global level, with agricultural and food exports increasing by 24 percent for low- and middle-income countries. This would give the latter an essential opportunity to purchase more manufactured imports and capital goods.
- Real wages in developing countries would rise across the board, increasing more than capital returns; that is, removal of agricultural protection in OECD countries is pro-poor on average and, more than likely, equitable.[1]
- The Cairns Group would be a clear beneficiary of this liberalization.[2]

The results reported here are preliminary in the sense that we would like to calibrate existing support patterns in greater detail and also because this support may change

significantly in the near future. The new U.S. farm bill has, in light of our results, momentous implications for the Doha Round. The bill not only threatens escalation to unprecedented support levels but also repudiates, in its present form, one of the important tenets of Doha: decoupling support from output levels. To reduce the distortionary impact of agricultural support, it has been argued that it should be converted from output-based assistance to lump sum income transfers. The new farm bill thus represents two steps backward from a more liberal global trade stance: it imposes higher absolute subsidy burdens and it creates more direct distortion of market incentives. In subsequent work, we hope to evaluate this policy and the potential for retaliation, including a breakdown of the Doha Round.

Endnotes

1. One caveat to this is rising food prices faced by the urban poor.

2. The Cairns Group includes Australia and New Zealand, Argentina, Brazil, the Rest of East Asia, and the Rest of the Latin American Countries.

Appendix: Model Overview and Assumptions

The LINKAGE Model is a dynamic applied general equilibrium model that is global, multi-regional, and multi-sectoral. It is currently implemented in GAMS10 and its specification is virtually free of references to specific dimensions (region, sector, or time). The model is accompanied by an aggregation facility, which is used to aggregate the extensive GTAP dataset into a tractable dataset for simulation purposes. The sectoral and regional disaggregations are presented in Tables A.1 and A.2. The output of the aggregation facility is the primary input for the model. The aggregation facility also produces some auxiliary data, such as population, and the model user is expected to provide values for all key elasticities. The dynamic version of the model also requires a series of assumptions, which are to be provided independently of the aggregation facility. The remainder of this section briefly outlines the main characteristics of supply, demand, the dynamics and the policy instruments of the model.

Production

All sectors are assumed to operate under constant returns to scale and cost optimization. Production in each sector is modeled by a series of nested constant elasticity of substitution (CES) production functions, which are intended to represent the different substitution and complementarity relations across the various inputs in each sector. There are material inputs that generate the input/output table, as well as factor inputs representing value-added. Three different production archetypes are defined in the model: crops, livestock, and all other goods and services. The CES nests of the three archetypes are graphically depicted in Figures A.1 through A.3. Sectors are differentiated by different input combinations (share parameters) and substitution elasticities within each one of the main production archetypes. The former are largely determined by base-year data and the latter are given values by the modeler. The key feature of the crop production structure is the substitution between intensive cropping versus extensive cropping, i.e., between

TABLE A.1. Sectoral concordance

Modeled sectors	
Acronym	**Description**
	Paddy rice
WHEAT	Wheat
OGRNS	Other cereal grains
VGFRT	Vegetable and fruits
OLSDS	Oil seeds
RWSGR	Raw sugar
PBFBR	Plant based fibers
OCROP	Other crops
CATTL	Bovine cattle etc
OLVST	Other livestock
RWMLK	Raw milk
FSNRG	Fossil fuels
ONTRS	Other natural resources
CTTMT	Bovine meat products
OMEAT	Other meat products
VGOIL	Vegetable oils and fats
DAIRY	Dairy products
RFSGR	Refined sugar
OTHFD	Other processed foods including beverages and tobacco
TXTCL	Textiles clothing and leather
CHEMS	Chemicals plastics and rubber
OMANU	Other manufacturing
ELGAS	Electricity and gas
CONST	Construction
OSRVS	Other services
Aggregate sectors	
AGRIC	Agriculture
PRCFD	Processed foods
MANUF	Manufacturing
SRVCS	Services
TOTAL	Total
AGRFD	Agriculture and food

fertilizer and land (see Figure A.1). Livestock production captures the important role played by feed versus land, i.e., between ranch- versus range-fed production (see Figure A.2). Production in the other sectors more closely matches the traditional role of capital/labor substitution, with energy introduced as an additional factor of production (see Figure A.3).

TABLE A.2. Regional concordance

Modeled regions	
Acronym	**Description**
eur	Western Europe
usa	United States
hya	High-income Asia
can	Canada
anz	Australia and New Zealand
arg	Argentina
bra	Brazil
chn	China
ind	India
rea	Rest of East Asia
rlc	Rest of Latin America and the Caribbean
eca	Eastern Europe and Central Asia
ssx	Sub Saharan Africa x SACU
row	Rest of the World
Aggregate regions	
lmy	Low- and middle-income countries
hiy	High-income countries
wld	World total
cns	Cairns group

Labor can have three different skill levels: unskilled, skilled, and highly skilled. The first two are substitutable and combined in a CES aggregation function as a single labor bundle. Highly skilled labor is combined with capital to form a physical plus human capital bundle.

In each period, the supply of primary factors—capital, labor, and land—is usually predetermined. However, the supply of land is assumed to be sensitive to the contemporaneous price of land. Land is assumed to be partially mobile across agricultural sectors Thus, rates of return are sector specific, but sectoral land supply does react to changes in relative rates of return. Some of the natural resource sectors also have a sector-specific factor whose contemporaneous supply is price sensitive. The model includes adjustment rigidities. An important feature is the distinction between old and new capital goods. In addition, capital is assumed to be partially mobile, reflecting differences in the marketability of capital goods across sectors. Labor and population growth are exogenous. Labor within each skill category is perfectly mobile across sectors.

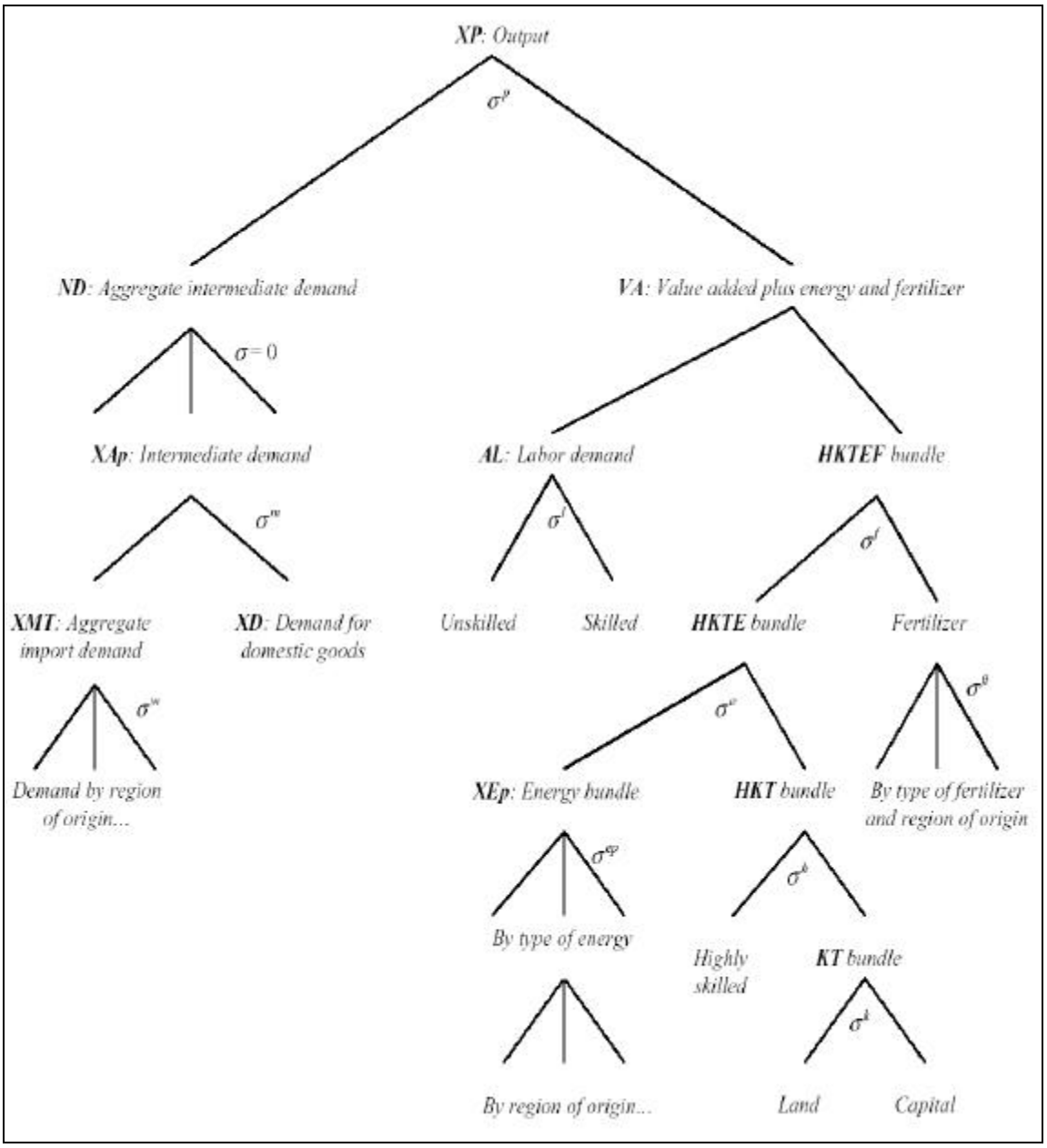

FIGURE A.1. Production structure in the crop sectors

Once the optimal combination of inputs is determined, sectoral output prices are calculated assuming competitive supply (zero-profit) conditions in all markets. (A fixed markup has been introduced in the model allowing for an assessment of the impacts of greater competitiveness.)

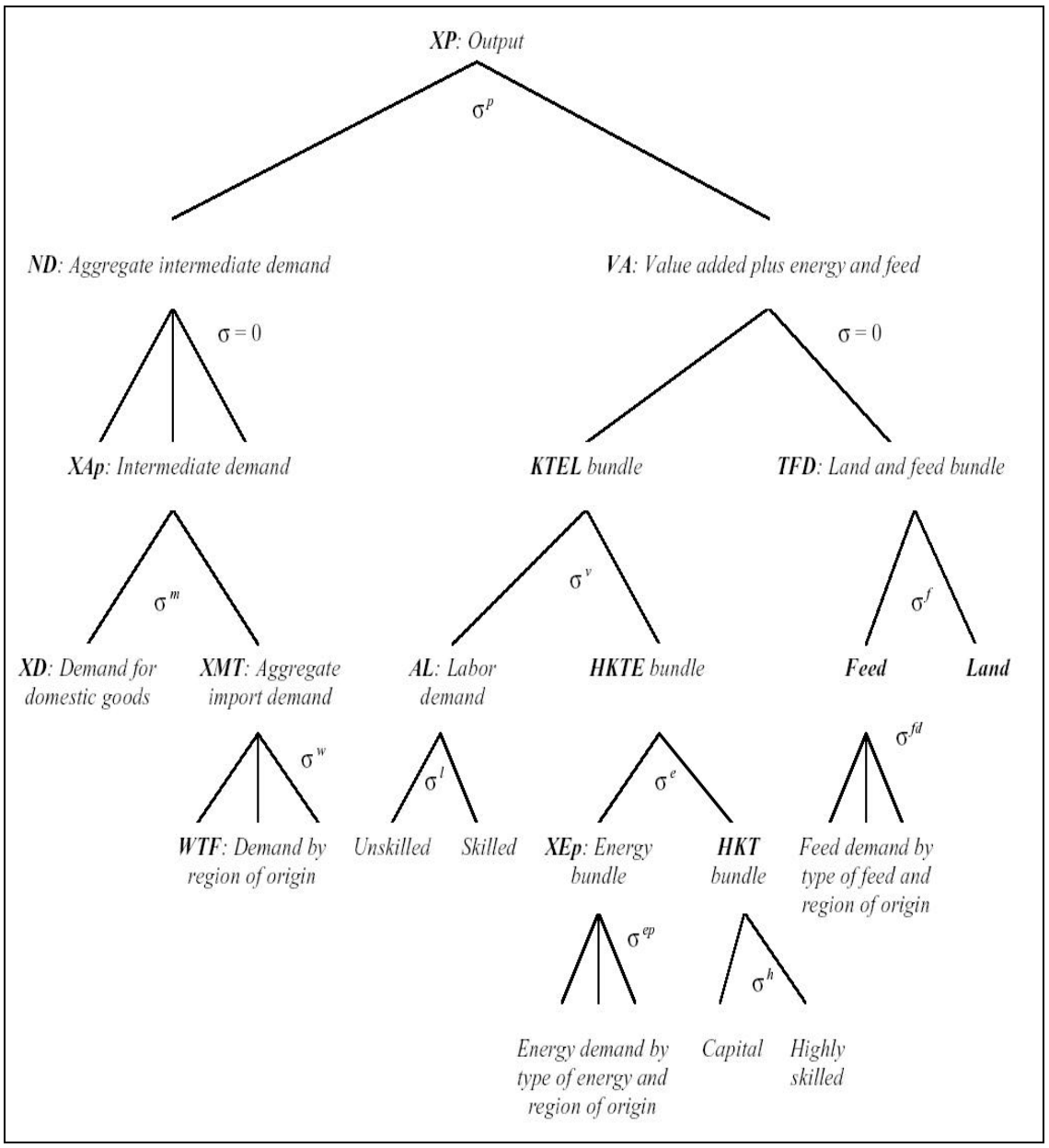

FIGURE A.2. Production structure in the livestock sectors

Consumption and the Closure Rule

All income generated by economic activity is assumed to be distributed to consumers. A single representative consumer allocates optimally his/her disposable income among the consumer goods and saving. The consumption/saving decision is completely static: saving is treated as a "good" and its amount is determined simultaneously with the

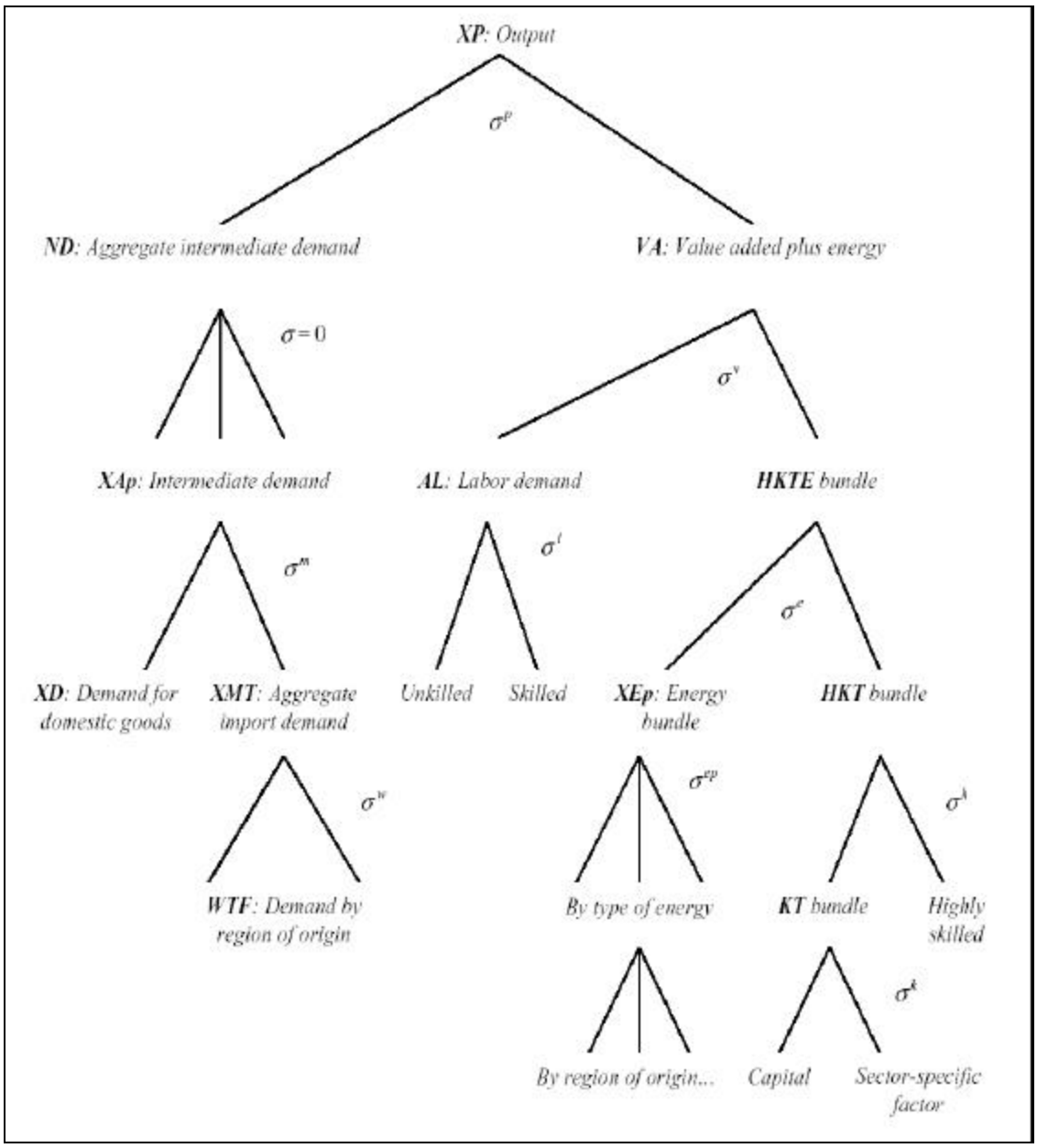

FIGURE A.3. Production nesting in the manufacturing and service sectors

demands for the other goods, the price of saving being set arbitrarily equal to the average price of consumer goods.

Government collects income taxes, indirect taxes on intermediate and final consumption, production taxes, tariffs, and export taxes/subsidies. Aggregate government expenditures are linked to changes in real GDP. The real government deficit is exogenous. Closure therefore implies that some fiscal instrument is endogenous in order to

achieve a given government deficit. The standard fiscal closure rule is that the marginal income tax rate adjusts to maintain a given government fiscal stance. For example, a reduction or elimination of tariff rates is compensated by an increase in household direct taxation, *ceteris paribus*.

Each region runs a current-account surplus (deficit), which is fixed (in terms of the model *numéraire*). The real exchange rate adjusts to achieve external balance. The counterpart of these imbalances is a net outflow (inflow) of capital, which is subtracted from (added to) the domestic flow of savings. In each period, the model equates gross investment to net savings (equal to the sum of savings by households, the net budget position of the government and foreign capital inflows). This particular closure rule implies that investment is driven by savings. Government savings and foreign savings are fixed in any given time period and, by default, are held constant throughout the horizon. At a minimum, this ensures sustainability since as a percentage of GDP (gross domestic product) both are declining. The household direct tax schedule shifts to ensure the fiscal target.

Foreign Trade

The world trade block is based on a set of regional bilateral flows. The basic assumption in LINKAGE is that imports originating in different regions are imperfect substitutes (see Figure A.4). Therefore, in each region, total import demand for each good is allocated across trading partners according to the relationship between their export prices. This specification of imports—commonly referred to as the Armington specification—implies that each region faces a downward-sloping demand curve for its exports. The Armington specification is implemented using two CES nests. At the top nest, domestic agents choose the optimal combination of the domestic good and an aggregate import good consistent with the agent's preference function. At the second nest, agents optimally allocate demand for the aggregate import good across the range of trading partners. The bilateral supply of exports is specified in parallel fashion using a nesting of constant-elasticity-of-transformation (CET) functions. At the top nest, domestic suppliers optimally allocate aggregate supply across the domestic market and the aggregate export market. At the second nest, aggregate export supply is optimally allocated across each trading region as a function of relative prices.

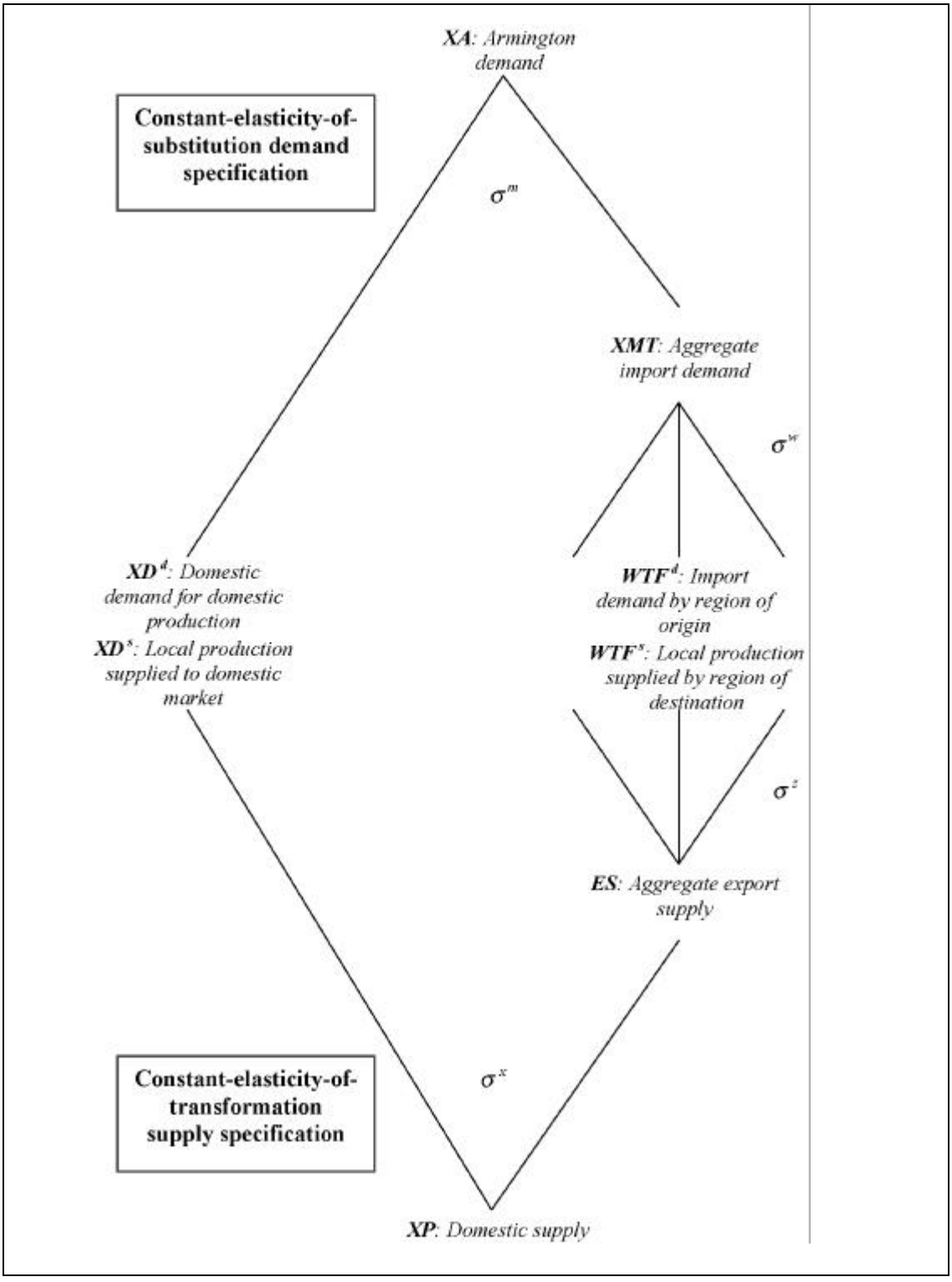

FIGURE A.4. Armington and CET structure

Trade measures are fully bilateral and include both export and import taxes/subsidies. Trade and transport margins are also included; therefore, world prices reflect the difference between FOB (free on board) and CIF (cost, insurance, and freight) pricing.

Prices

The LINKAGE model is fully homogeneous in prices, i.e., it solves for only relative prices. The price of a single good, or of a basket of goods, is arbitrarily chosen as the anchor to the price system. The price (index) of OECD manufacturing exports has been chosen as the *numéraire*, and is set to 1 in the base year and all subsequent years. From the point of view of the model specification, this has an impact on the evaluation of international investment flows. They are evaluated with respect to the price of the *numéraire* good. Therefore, one way to interpret the foreign investment flows is as the quantity of foreign savings that will buy the average bundle of OECD manufacturing exports.

Dynamic Features and Calibration

The LINKAGE model has a simple recursive dynamic structure, as agents are assumed to be myopic and to base their decisions on static expectations about prices and quantities. Dynamics in LINKAGE originate from three sources: (*i*) accumulation of productive capital; (*ii*) the putty/semi-putty specification of technology; and (*iii*) productivity changes.

Capital Accumulation

In the aggregate, the basic capital accumulation function equates the current capital stock to the depreciated stock inherited from the previous period plus gross investment. However, at the sectoral level, the specific accumulation functions may differ because the demand for (old and new) capital can be less than the depreciated stock of old capital. In this case, the sector contracts over time by releasing old capital goods. Consequently, in each period, the new capital vintage available to expanding industries is equal to the sum of disinvested capital in contracting industries plus total savings generated by the economy, consistent with the closure rule of the model.

The Putty/Semi-Putty Specification

The substitution possibilities among production factors are assumed to be higher with the new than with the old capital vintages; technology has a putty/semi-putty specification. Hence, when a shock to relative prices occurs (e.g., tariff removal), the demands for production factors adjust gradually to the long-run optimum because the substitution effects are delayed over time. The adjustment path depends on the values of the short-run elasticities of substitution and the replacement rate of capital. As the latter determines the pace at which new vintages are installed, the larger is the volume of new investment, the greater is the possibility to achieve the long-run total amount of substitution among production factors.

Dynamic Calibration

The model is calibrated on exogenous growth rates of population, GDP per capita, and an autonomous energy efficiency improvement in energy use (known as the AEEI factor). There are various alternatives for calibrating the key growth parameters in the baseline scenario. The model does need some unique instrument per region to achieve a desired per capita GDP growth. The current strategy has three components. First, agricultural productivity is fixed in the baseline using results from recent empirical studies. Second, productivity in the manufacturing and services sector is divided intro three components. The first component is a uniform shifter. This component is in essence the instrument used to achieve the given per capita GDP growth target. The second component is a sectoral shifter which permits constant deviations across sectors, for example, imposing manufacturing productivity some 2 percent higher than in services. The third component is a shifter determined by sectoral openness. This latter shifter is sensitive to the sectoral export/output ratio. The degree of sensitivity is measured by elasticity.

The model is calibrated to a given baseline from 1997 to 2015. The per capita GDP growth rates are broadly consistent with The World Bank's long-term forecast. Productivity is calibrated in the baseline to achieve the desired GDP trends. Several assumptions underline the calibration of productivity. Agricultural productivity is exogenous, user-determined, and varies across regions. An economy-wide productivity factor is calibrated to achieve the given GDP target with the assumptions previously described. Productivity growth is assumed to be labor augmenting.

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