Review of Agricultural Economics—Volume 28, Number 2—Pages 168–194
DOI:10.1111/j.1467-9353.2006.00280.x

Distortions to World Trade: Impacts on Agricultural Markets and Farm Incomes

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The latest versions of the Global Trade Analysis Project database and the LINKAGE model of the global economy (projected to 2015) are used to estimate the impact of removing all merchandise trade distortions (including agricultural subsidies). Results suggest that a move to free merchandise trade would increase farm employment, the real value of agricultural output and exports, real returns to farm land and unskilled labor, and real net farm incomes in developing countries. This would occur despite the decline in international terms of trade for some developing countries that are net food importers or are enjoying preferential access to agricultural markets of high-income countries.

To what extent do government trade and subsidy policies still distort agricultural markets and farmers' incentives around the world? Nearly two decades ago, a major World Bank study addressed that question to eighteen developing countries (Krueger, Schiff, and Valdes). The study found that farmers in those countries were discriminated against by their governments' policies, albeit indirectly (via restrictions on imports of industrial products and overvalued exchange rates). Anderson and Hayami focused on the time-series data for developed and newly industrializing countries and found that national governments tend to gradually change from taxing to subsidizing agricultural relative to industrial production (and from subsidizing to taxing food consumers) in the course of their economic development. The shift occurs at an earlier stage, the weaker an economy's comparative advantage in agriculture.

Support for farmers, for example, rose substantially during earlier post–World War II decades when manufacturing protection rates began falling to current very low levels. Estimates by the OECD Secretariat indicate that the aggregate degree

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of direct producer support by member governments is high and has not declined over the past fifteen years in U.S. dollar terms and has fallen only slightly in percentage terms (Legg; OECD).

In the past, developing countries' policies caused international prices of farm products to be above what they otherwise would have been, while the policies of high-income countries had the opposite effect. A partial equilibrium attempt to measure the net effect of those policies in the 1980s suggested that they almost exactly offset each other in terms of their impact on international prices of temperate foods, while more than halving the volume of international food trade (Tyers and Anderson, table 6.9). Hence, developing country farmers and agricultural production were clearly discriminated against by the patterns of distortions across sectors and regions.

Since the 1980s, however, a number of major policy changes have occurred. Many developing countries have been reforming their trade and subsidy regimes unilaterally. As a result, innumerable preferential trading arrangements (reciprocal and nonreciprocal) have led to the subglobal or discriminatory trade liberalization that may or may not have improved global welfare. The Uruguay Round of multilateral trade negotiations, begun in 1986, came to a successful conclusion in 1994 and by late 2004, the reforms were fully implemented. In addition, the World Trade Organization (WTO) began to subsume the General Agreement on Tariffs and Trade (GATT) in January 1995. WTO membership has grown by twenty to almost 150 customs territories, with new members (especially China) committing to significant reforms as the price of admission (Crawford and Fiorentino; World Bank 2002, 2004, 2005; Drabek and Bacchetta).

By the mid-1990s, Jensen, Robinson, and Tarp felt that the problem of an anti-agricultural bias in trade and sectoral policies had all but disappeared for a sample of fifteen developing countries. What about in other developing countries? Are some developing countries overshooting and adopting the potentially equally wasteful agricultural protectionist stance of more-advanced economies? Are rich-country policies still harming farmers in developing countries, notwithstanding the preferential access some developing countries enjoy in those markets?

The structure of current protection is also extremely important for the ongoing negotiations under the Doha Development Agenda (see WTO). The impact of multilateral trade reform on the agricultural sector is a particularly controversial issue. Negotiators must decide how much to focus on agriculture relative to other sectors. They also must pay particular attention to the impacts of reform on developing countries, since the majority of the poor in developing countries lives in rural areas. In this paper, we consider how agricultural markets and value added would change if, over the next decade, all merchandise trade barriers and agricultural subsidies were simultaneously removed (as in an ambitious WTO round).[1] While no one anticipates such a radical reform, the analysis serves as a benchmark to suggest what is at stake in the WTO's current round of multilateral trade negotiations and further unilateral reforms. It can also give a better indication of agricultural comparative advantages than indicators in the current distortion-ridden situation.

We use a recursive model of the global economy known as LINKAGE (van der Mensbrugghe). The model has formed the basis of the World Bank's standard decade-long projections of the global economy and its earlier trade analysis (e.g.,

World Bank 2002, 2004). Our welfare results distinguish between effects of moving to free trade by developing versus high-income countries, and in agriculture as compared with nonagricultural sectors. We also make use of the latest Global Trade Analysis Project (GTAP) database (Version 6.05, see www.gtap.org) which includes reciprocal and nonreciprocal preferential tariffs. The latter provide low-income exporters duty-free access to protected high-income country markets. This model allows us to take into account that reform may cause a decline in the international terms of trade for developing countries enjoying preferential access to the agricultural markets of high-income countries (in addition to those that are net food importers because their comparative advantage is in other sectors such as labor-intensive manufacturing).

Key Distortions in Global Markets

Governments distort prices in their domestic markets for products primarily with border measures. Interventions in the market for foreign exchange affect the price of tradables relative to nontradables, while trade taxes-cum-subsidies or quantitative trade restrictions influence the relative prices of the various tradables. Multiple exchange rates also alter relative prices among tradable products. Product-specific domestic producer or consumer subsidies have played a more limited role (because of their much greater cost to the treasury), with a few exceptions most notably in rich-country agriculture. Freeing up of most foreign exchange markets over the past two decades (Hinkle and Montiel), phasing out of most export taxes,[2] and converting many nontariff trade barriers into tariffs (Ingco) have made measuring the extent of distortions to goods markets much easier because attention can focus on import tariffs and agricultural subsidies. In principle, services trade and foreign investment distortion also could affect incentives in the agricultural and industrial sectors, but they are ignored here because much controversy still surrounds their measurement and how they should be modeled.[3]

The latest release (6.05) of the GTAP dataset includes estimates of bilateral tariffs and domestic and export subsidies as of 2001, for eighty-seven countries and country groups. The new protection data come from a joint CEPII (Paris)/ITC (Geneva) project. The product of this joint effort, known as MAcMaps, is a HS6 tariff-level detailed database on bilateral protection that integrates trade preferences, specific and compound tariffs, and a partial evaluation of nontariff barriers such as tariff rate quotas (TRQs).[4] The ad valorem equivalents of specific tariffs are evaluated using five different reference groups of exporters distinguished by income level to allow for the generally lower unit value of exports from developing countries, and the consequently higher ad valorem equivalents of the specific tariffs they face. Trade weights are used to obtain averages from the six-digit level of the Harmonized System up to the broader sectoral aggregates in the model. These weights introduce important differences in bilateral tariff rates at the model level, even between countries facing the same tariff rates at the tariff-line level, and tend to understate the protective impacts of protection because high-tariff items receive relatively low trade weights.[5]

The new GTAP database has lower tariffs than the previous database because bilateral trade preferences are included, as well as the major reforms between 1997 and 2001. These include continued implementation of the Uruguay Round

Table 1. Import-weighted average applied tariffs, by sector and region, 2001 (percent)

Importing Region	Agriculture and Processed Food	Other Primary Products[a]	Textiles and Clothing	Other Manufacturing	All Goods
High-income countries[b]	**16.0**	**1.0**	**7.5**	**1.3**	**2.9**
Developing countries	**17.7**	**6.5**	**17.0**	**8.3**	**9.9**
Middle-income countries	*16.5*	*4.6*	*16.8*	*7.3*	*8.9*
Low-income countries	*22.2*	*14.2*	*17.9*	*14.5*	*15.9*
East Asia and Pacific	26.3		17.8	8.6	10.5
South Asia	33.9		20.1	22.2	23.5
Europe and Central Asia	14.8		10.7	4.1	6.0
Middle East and North Africa	14.1		27.1	7.2	9.8
Sub-Saharan Africa	18.2		23.7	10.5	12.6
Latin America and Caribbean	10.3	5.1	11.3	7.1	7.7
World total	**16.7**		**10.2**	**3.5**	**5.2**

Source: Authors' compilations from the GTAP database Version 6.05.
[a]Forestry, fishing, fuels, minerals, and nonferrous metals.
[b]Intra-EU15 trade is ignored in calculating weights for determining tariff averages.

agreements and China's WTO accession commitments (which caused the ratio of global exports plus imports to GDP to rise from 44% to 46% over those four years).

According to this dataset, the average import-weighted applied tariff for agriculture and food in 2001, was 16.0% for high-income countries and 17.7% for developing countries. In contrast, the average import-weighted applied tariff for manufacturers other than textiles and clothing was 8.3% for developing countries and 1.3% for high-income countries (table 1).

The averages, of course, obscure large variations across countries and commodities, and are poor indicators of overall assistance to farming. For example, if high-income countries' tariffs on temperate farm products are at a near-prohibitive 100%, but zero on tropical products such as coffee, those countries' import-weighted average agricultural tariff could be quite low even though agricultural value added in those rich countries had been enhanced substantially. Consider also the case of a developing country with a strong agricultural comparative advantage in all but one small farming industry, and with high tariffs to stave off import competition for that industry and for all manufacturing industries. Overall, agricultural value added would be depressed, yet the import-weighted average tariff protection for agriculture would be high and possibly above that for manufactures. A third case is where the nonagricultural primary sector receives a similar level of import protection as the farm sector and less than manufacturing, but is much more export focused: trade reform may cause it to expand at the expense of manufacturing and farming.

Hence, it is not possible to say from the tariff data in table 1 whether developing country policies have overshot in terms of moving away from an antiagricultural bias, even though the ratio of agricultural to all goods tariffs is well above unity for each of the regions shown. A general equilibrium model is needed to estimate the net effects of all sectors' distortions on agricultural markets and net farm.

The Global LINKAGE Model for Assessing Sectoral and Welfare Effects of Trade Distortions

The World Bank's LINKAGE (van der Mensbrugghe) is a relatively straightforward global Computable General Equilibrium model but with some characteristics that distinguish it from the GTAP and other standard comparative static models (described in Hertel). A key difference is that it is recursive, so while it starts with 2001 as its base year, it can be solved annually through to 2015. The projected annual changes result from assumptions about exogenous population and labor supply growth, savings-driven capital accumulation, and labor-augmenting technological progress as assumed for the Global Economic Prospects report in World Bank (2005). In any given year, factor stocks are fixed, which means in the case of labor, that the extent of unemployment (if any) in the baseline remains unchanged.[6] Producers minimize costs subject to constant returns to scale production technology, consumers maximize utility, and all markets—including for labor—are cleared with flexible prices.

There are three types of production structures. Crop sectors reflect the substitution possibilities between extensive and intensive farming; livestock sectors, the substitution possibilities between pasture and intensive feeding; and all other sectors, standard capital/labor substitution (with two types of labor: skilled and unskilled). There is a single representative household per modeled region, allocating income to consumption using the extended linear expenditure system. Trade is modeled using a nested Armington structure in which aggregate import demand is the outcome of allocating domestic absorption between domestic goods and aggregate imports. Aggregate import demand then is allocated across source countries to determine the bilateral trade flows.[7]

There are several sources of protection in the model. The most important involves bilateral import tariffs, which differ across trading partners because of the world's myriad subglobal preferential trading arrangements, as documented in Bouët et al. There are also bilateral export subsidies.[8] The OECD's Producer Support Estimate (PSE) estimates (see OECD and Dimaranan and McDougall) indicate that agricultural subsidies that apply to intermediate goods, outputs, and payments to capital and land are important in numerous countries.

Government fiscal balances are fixed in any given year, with the objective being met by changing the level of lump sum taxes on households.[9] This implies that losses of tariff revenues are replaced by higher direct taxes on households. The current account balance also is fixed, primarily for convenience in this recursive dynamic model. However, this is also consistent with the Feldstein–Horioka finding of limited international capital mobility (Feldstein and Horioka; Ventura). Given that other external financial flows are fixed, this implies that *ex ante* changes to the trade balance are reflected in *ex post* changes to the real exchange rate. For example, if import tariffs are reduced, the propensity to import increases and these

additional imports are financed by higher export revenues. The latter typically is achieved by a depreciation in the real exchange rate.

Finally, with fixed public and foreign saving, investment comes from changes in the savings behavior of households and in the unit cost of investment. The latter can play a role in a dynamic model when imported capital goods are taxed. Because the capital account is exogenous, rates of return across countries can differ over time and across simulations. The model only solves for relative prices, with the *numéraire*, or price anchor, being the export price index of manufactured exports from high-income countries. This price is fixed at unity in the base year and throughout the projection period to 2015.

The version of the LINKAGE model used for this study is based on an aggregation of the GTAP database such that it solves with twenty-seven regions and twenty-five sectors. Agriculture and food comprise thirteen of the twenty-five sectors, and the model focuses on the largest commodity exporters and importers.

Effects of Current Protection Policies

The LINKAGE model provides a baseline projection of the world economy to 2005 and then to 2015, assuming no other policy changes. We examine deviations from that baseline in 2015, due to total liberalization in 2005. The first step requires a presimulation to bring the world as depicted in the GTAP dataset in 2001, up to the start of 2005. In terms of policy shocks, we include only key multilateral commitments in that presimulation, namely the final stages of Uruguay Round implementation, including the phase-out of the Multifibre Arrangement (MFA), the accession of China and Taiwan to the WTO, and the eastern enlargement of the European Union (EU) from fifteen to twenty-five members.[10] The impacts of these three reforms are not trivial; had they not been implemented, the gains in 2015, from freeing global merchandise trade would have been an extra $64 billion per year. Removal of MFA quotas accounts for nearly half of that difference and so should be considered part of the Uruguay Round's legacy. The effect of those reforms on tariffs can be seen by comparing the estimates at the start of 2005 in table 2 with those for 2001 in table 1.

The next step is to measure the prospective effects of removing all agricultural subsidies plus the tariffs summarized in table 2 over 2005–2010. This could be done for each economy in turn, so as to assess the impact of own-country policies as in Jensen, Robinson, and Tarp. However, each country's policies are a response to other countries', and are more likely to be reformed if other regions do the same (as following a multilateral trade negotiation such as the Doha Agenda). Therefore, a more appropriate question is how each region's welfare, agricultural markets, and farm incomes would change if all trade distortions were removed together.

Our LINKAGE model's answer is that it would lead to global gains of $287 billion per year by 2015. High-income countries would gain two-thirds of those dollars (table 3). However, as a share of national income, developing countries would gain more, with an average increase of 0.8% compared with 0.6% for high-income countries. The results vary widely across developing countries, ranging from little impact in Bangladesh and China to 4% or 5% increases in parts of East Asia.

The second column of table 3 shows the amount of welfare gain due to changes in the international terms of trade for each country. For developing countries, the

Table 2. Import-weighted average applied tariffs, by sector and country, 2005 (percent)

Importing Region	Agriculture and Processed Food	Primary Agriculture Only	Processed Food Only	Textiles and Clothing	Other Manufacturing
World	**15.2**			**9.3**	**3.1**
High income	**15.9**			**7.3**	**1.2**
Australia and NZ	2.6	0.3	3.3	13.9	4.1
EU25 + EFTA	13.9	13.2	14.7	5.1	1.7
United States	2.4	2.3	2.5	9.6	0.9
Canada	9.0	1.2	14.1	8.7	0.5
Japan	29.3	48.0	20.8	9.0	0.4
South Korea and Taiwan	53.0	84.5	22.4	9.2	3.6
Hong Kong and Singapore	0.1	0.0	0.2	0.0	0.0
Developing countries[a]	**14.2**			**14.3**	**7.1**
Middle income	***12.1***			***13.6***	***6.0***
Argentina	7.1	5.6	7.8	11.1	10.1
Brazil	5.0	2.4	9.0	14.7	9.7
China	10.3	9.9	11.0	9.6	5.5
Mexico	10.3	10.8	9.7	7.8	4.3
Russia	13.5	14.6	12.8	15.8	7.8
South Africa	8.6	5.9	10.6	21.9	5.4
Thailand	16.7	12.7	19.2	16.4	7.6
Turkey	16.6	16.4	17.0	3.8	1.2
Rest of East Asia	13.4	18.6	9.0	8.7	3.5
Rest of LAC	10.8	9.2	11.8	12.9	8.4
Rest of ECA	15.7	10.4	19.5	9.3	3.2
Middle East and North Africa	13.1	8.2	18.3	23.9	7.2
Low income	***22.0***			***17.9***	***14.1***
Bangladesh	12.7	7.4	21.2	29.9	16.2
India	49.9	25.7	75.6	26.5	24.2
Indonesia	5.0	4.3	6.2	8.0	4.3
Vietnam	37.1	13.1	44.8	29.1	12.3
Rest of South Asia	21.1	14.2	32.0	6.6	14.3
Selected sub-Saharan Africa[b]	11.8	10.2	13.0	12.5	7.5
Rest of sub-Saharan Africa	21.2	18.0	23.6	26.2	14.0
Rest of the world	11.8	1.9	18.7	5.6	8.9

Source: Authors' projections from the GTAP database Version 6.05 using the World Bank's LINKAGE model.

[a]Numbers in parentheses are the averages at the start of 2005 following WTO accession by China and end of MFA.

[b]The selected sub-Saharan African countries (for which national modules are available in the LINKAGE model) include Botswana, Madagascar, Malawi, Mozambique, Tanzania, Uganda, Zambia, and Zimbabwe.

Notes: NZ: New Zealand; EFTA: European Free Trade Association; LAC: Latin American Countries; ECA: Europe and Central Asia.

Table 3. Impacts on real income from full liberalization of global merchandise trade, by country/region, 2015 (relative to the baseline, in 2001 dollars and percent)

	Total Real Income Gain p.a. ($billion)	Change in Income Due Just to Change in Terms of Trade ($billion)	Gain Due to Improved Efficiency of Resource Use Net of Terms of Trade Effect ($billion)	Total Real Gain as Percentage of Baseline Income in 2015[a]
Australia and New Zealand	6.1	3.5	2.6	1.0 (0.4)
EU 25 plus EFTA	65.2	0.5	64.7	0.6 (0.6)
United States	16.2	10.7	6.5	0.1 (0.0)
Canada	3.8	−0.3	4.1	0.4 (0.4)
Japan	54.6	7.5	47.1	1.1 (1.0)
Korea and Taiwan	44.6	0.4	44.2	3.5 (3.5)
Hong Kong and Singapore	11.2	7.9	3.3	2.6 (0.8)
Argentina	4.9	1.2	3.7	1.2 (0.9)
Bangladesh	0.1	−1.1	1.2	0.2 (2.4)
Brazil	9.9	4.6	5.3	1.5 (0.8)
China	5.6	−8.3	13.9	0.2 (0.5)
India	3.4	−9.4	12.8	0.4 (1.5)
Indonesia	1.9	0.2	1.7	0.7 (0.7)
Thailand	7.7	0.7	7.0	3.8 (3.4)
Vietnam	3.0	−0.2	3.2	5.2 (5.5)
Russia	2.7	−2.7	5.4	0.6 (1.2)
Mexico	3.6	−3.6	7.2	0.4 (0.8)
South Africa	1.3	0.0	1.3	0.9 (0.9)
Turkey	3.3	0.2	3.1	1.3 (1.2)
Rest of South Asia	1.0	−0.8	1.8	0.5 (0.9)
Rest of East Asia	5.3	−0.9	6.2	1.9 (2.2)
Rest of LAC	10.3	0.0	10.3	1.2 (1.2)
Rest of ECA	1.0	−1.6	2.6	0.3 (0.8)
Middle East and North Africa	14.0	−6.4	20.4	1.2 (1.7)
Selected sub-Saharan African countries	1.0	0.5	0.5	1.5 (0.8)
Rest of sub-Saharan Africa	2.5	−2.3	4.8	1.1 (2.2)
Rest of the world	3.4	0.1	3.3	1.5 (1.5)
High-income countries	**201.6**	**30.3**	**171.3**	**0.6 (0.5)**
Developing countries	**85.7**	**−29.7**	**115.4**	**0.8 (1.1)**
Middle-income countries	69.5	−16.7	86.2	0.8 (1.0)
Low-income countries	16.2	−12.9	29.1	0.8 (1.4)
East Asia and Pacific	23.5	−8.5	32.0	0.7 (1.0)
South Asia	4.5	−11.2	15.7	0.4 (1.4)
Europe and Central Asia	7.0	−4.0	11.0	0.7 (1.1)
Sub-Saharan Africa	4.8	−1.8	6.6	1.1 (1.5)
Latin America and the Caribbean	28.7	2.2	26.5	1.0 (0.9)
World total	**287.3**	**0.6**	**286.7**	**0.7 (0.7)**

Source: Authors' World Bank LINKAGE model simulations.
[a]Numbers in parentheses refer to that due to efficiency gains net of terms of trade effects.
Notes: EFTA: European Free Trade Association; LAC: Latin American Countries; ECA: Europe and Central Asia.

"terms of trade" effect is negative, reducing somewhat the gains from improved efficiency of domestic resource use (especially in China and India). When the terms of trade effect is netted out, it generates the numbers in parentheses in the final column of table 3, which can be interpreted as an indication of the relative degree of initial intersectoral distortion in each economy. By that indicator, developing countries are more than twice as wasteful of their resources as high-income countries—and low-income countries, nearly three times.

There are several ways to decompose the real income gains from full global trade reform to better understand the sources of waste for each region. One way is to assess the impacts of developing country versus high-income country liberalization in different economic sectors; another is to decompose by policy instrument. The latter gives results very similar to those reported in Hertel and Keeney and Anderson, Martin, and Valenzuela using the GTAP–Agriculture (AGR) model. These studies estimate that market access barriers explain 93% of the welfare effects of agricultural policies, with domestic support and export subsidy removal contributing only five and two percentage points, respectively.[11]

Table 4 reports our results decomposed by sector. They suggest that global liberalization of agriculture and food markets contributes 63% of the total worldwide gains (similar to Hertel and Keeney's 66%). This is consistent with the high tariffs in agriculture and food versus other sectors (table 1), but is nonetheless

Table 4. Regional and sectoral source of gains from full liberalization of global merchandise trade, developing, and high-income countries, 2015 (relative to the baseline scenario)

	Gains by Region in $billion			Percent of Regional Gain		
	Developing	High Income	World	Developing	High Income	World
Developing countries liberalize						
Agriculture and food	28	19	47	33	9	17
Textiles and clothing	9	14	23	10	7	8
Other merchandise	6	52	58	7	26	20
All sectors	43	85	128	50	42	45
High-income countries liberalize						
Agriculture and food	26	109	135	30	54	47
Textiles and clothing	13	2	15	15	1	5
Other merchandise	4	5	9	5	3	3
All sectors	43	116	159	50	58	55
All countries liberalize						
Agriculture and food	54	128	182	63	63	63
Textiles and clothing	22	16	38	25	8	14
Other merchandise	10	57	67	12	29	23
All sectors	86	201	287	100	100	100

Source: Authors' World Bank LINKAGE model simulations.
[a]Small interaction effects are distributed proportionately and numbers are rounded to sum to 100 percent.

Table 5. Developing countries' shares of global output and exports of merchandise, by sector, 2015 (percent, in constant prices)

	Primary Agriculture	Processed Food, Beverages, and Tobacco	Textiles and Clothing	Other Manufacturing	All Merchandise
Output					
—Baseline	70	40	62	35	40
—Free trade	75	40	65	35	41
Exports[a]					
—Baseline	47	34	63	30	34
—Free trade	62	40	67	32	37

Source: Authors' World Bank LINKAGE model simulations.
[a]Including intra-EU trade.

remarkable given the low shares of agriculture in global GDP (4%) and merchandise trade (9%). The farm policies of high-income countries account for seven-tenths of those gains, and the majority of the overall gains from trade reform to high-income countries. Developing country gains from high-income country reform are only half as large from textiles as from agricultural policies.

The full liberalization results suggest little change in the high-income countries' shares of global output and exports of processed food, beverages, and tobacco. The developing countries' shares for primary agriculture, change noticeably: the export share rises from 47% to 62% (including intra-EU trade) and the output share rises from 70% to 75% (table 5). Instead of rising by 1.6% per year (table 9), agricultural output in high-income countries would decline 0.1% per year over the projection period to 2015.

Table 6 shows the impact of full trade reform on agricultural and food trade, output and consumption for each country/region. It is clear that trade is enhanced while the global value of output is virtually unchanged. As a consequence, the global share of agricultural and food production exported rises from 9.5% to 13.2% (or from 6.6% to 11.6% when intra-EU trade is excluded). The increase in exports of those goods from developing countries would be $192 billion per year. Latin America accounts for a large part of that increase, but all regions' exports expand and even low-income countries would sell an extra $36 billion worth of such goods per year (a 52% increase).

Middle-income countries would see food imports grow less rapidly than farm exports, while low-income countries' imports of those goods would increase only as much as their exports of food and agricultural products, leaving their food and agricultural self-sufficiency ratio unchanged. Even for high-income countries, that ratio would fall only two percentage points, although it is concentrated in primary agricultural products where the fall is seven points. The opposite is true in sub-Saharan Africa and Latin America, while the agricultural self-sufficiency levels of South Asia and China would fall only one percentage point despite their expansion in exports of labor-intensive manufactures (table 7).

Table 6. Impacts of full global trade liberalization on agricultural and food trade, output and consumption, by country/region, 2015 (relative to baseline)

	$billion			Percent Change Relative to Baseline			
	Exports	Imports	Output	Exports	Imports	Output	Consumption[a]
Australia and New Zealand	18.0	1.4	27.9	38.0	23.0	20.5	11.1
EU25 plus EFTA	21.7	103.5	−185.8	−10.8	39.3	−12.3	−3.6
United States	18.4	16.5	30.7	11.6	25.6	0.0	0.5
Canada	14.6	6.9	7.2	40.2	54.3	4.8	−0.4
Japan	2.8	34.7	−91.7	60.4	169.7	−18.4	−5.2
Korea and Taiwan	33.2	12.3	−0.4	600.2	189.8	20.2	14.6
Hong Kong and Singapore	7.0	1.5	7.4	115.2	7.6	35.4	4.8
Argentina	10.4	0.7	12.2	44.2	36.9	11.5	1.5
Bangladesh	0.8	0.4	−2.5	60.9	15.6	0.8	−0.3
Brazil	38.0	2.8	66.4	120.6	48.4	34.0	16.9
China	15.1	24.1	−9.9	145.6	27.3	−0.9	−0.1
India	5.1	13.4	−23.8	53.2	165.4	−3.7	−0.1
Indonesia	3.6	1.9	4.5	32.2	23.5	2.4	1.1
Thailand	5.6	5.2	5.3	29.2	57.2	4.7	7.5
Vietnam	1.2	3.3	−2.1	13.9	170.4	−13.3	1.7
Russia	0.7	4.4	−7.8	15.4	22.3	−5.4	−1.3
Mexico	11.9	6.7	6.2	66.0	52.9	2.2	0.2
South Africa	2.4	1.1	1.4	55.9	40.2	4.9	1.6
Turkey	4.3	4.3	−0.1	109.4	140.3	0.5	2.8
Rest of South Asia	2.9	3.7	−1.5	57.1	83.3	−1.8	0.1
Rest of East Asia	9.4	5.8	7.4	61.7	50.7	6.8	5.3
Rest of LAC	36.0	9.6	37.0	68.1	42.3	11.7	2.9
Rest of ECA	9.2	10.9	−22.2	106.0	90.5	−1.6	−0.8
Middle East and North Africa	13.2	17.5	−7.8	64.1	43.1	−1.2	0.8
Selected SSA countries	4.5	1.3	5.3	50.0	74.4	9.2	3.8
Rest of sub-Saharan Africa	9.5	8.1	−4.1	45.4	79.2	−0.6	−1.3
Rest of the world	8.2	5.8	2.9	168.3	123.3	4.4	3.2
High-income countries	**115.8**	**176.7**	**−204.7**	**15.7**	**65.5**	**−5.3**	**−1.0**
Developing countries	**191.9**	**131.0**	**66.8**	**67.4**	**51.5**	**2.2**	**1.2**
Middle-income countries	156.1	93.1	88.2	72.7	41.9	3.2	1.4
Low-income countries	35.8	37.9	−21.4	52.3	99.3	−1.0	0.4
East Asia and Pacific	34.8	40.4	5.2	54.4	35.5	0.1	0.8
South Asia	8.9	17.5	−27.8	55.1	122.9	−3.0	−0.1
Europe and Central Asia	14.2	19.6	−30.0	79.7	62.6	−1.9	−0.5
Sub Saharan Africa	16.4	10.5	2.6	47.7	71.6	2.1	0.1
Latin America and the Caribbean	96.3	19.8	121.8	75.7	46.1	13.8	4.8
World total (excl intra-EU trade)	**307.7**	**307.7**	**−137.8**	**36.3**	**59.8**	**−1.3**	**0.2**

Source: Authors' World Bank LINKAGE model simulations.
[a]The consumption changes are in volume terms, whereas the other columns refer to values.
Notes: EFTA: European Free Trade Association; LAC: Latin American Countries; ECA: Europe and Central Asia; SSA: sub-Saharan African.

How the volume of food consumption changes is important to assess food security issues. The final column of table 6 shows that the volume of consumption of agricultural and processed food products (which includes nonfood items such as feedstuffs as well as beverages and tobacco) increases in most developing

Table 7. Impact of global liberalization on self sufficiency in agricultural and other products, selected regions, 2015

	High-Income Countries		Developing Countries		Sub-Saharan Africa		Latin America and Caribbean		South Asia		China	
	Baseline	Global Liberalization	Baseline	Global Liberalization	Baseline	Global Liberalization	Baseline	Global Liberalization	Baseline	Global Liberalization	Baseline	Global Liberalization
Rice	101	78	100	103	92	82	99	99	102	103	100	108
Wheat	160	140	91	94	55	39	92	127	99	98	92	93
Coarse grains	119	134	93	88	101	102	107	109	99	99	89	42
Oilseeds	135	79	90	106	158	278	188	249	100	102	3	3
Sugar	97	66	102	115	110	120	126	173	100	100	56	35
Cotton	121	84	96	103	389	698	95	107	89	92	94	96
Fruit and vegetables	89	80	103	105	139	144	147	185	97	91	98	98
Other crops	86	87	112	111	168	176	142	134	105	106	19	17
Livestock	104	104	98	98	103	103	103	102	99	99	96	95
Fossil fuels	81	80	124	125	152	160	119	118	71	61	88	85
Other natural resources	94	94	104	104	126	127	129	129	97	97	93	93
Processed meats	101	93	99	111	97	139	105	134	108	117	91	88
Vegetable oils and fats	98	91	102	108	89	76	113	107	77	34	96	91
Dairy products	104	103	90	94	78	79	95	96	97	98	66	61
Other food, beverages, and tobacco	98	101	102	99	102	96	108	108	112	110	99	98
Textiles	97	98	102	101	81	68	89	83	132	137	102	101
Wearing apparel	68	61	162	176	89	73	95	84	527	792	228	260
Leather products	60	56	139	144	92	66	110	92	173	191	158	167
Chemicals, rubber, and plastics	105	106	92	91	75	71	82	77	95	94	94	91
Iron and steel	101	101	99	98	106	107	102	95	98	95	94	93
Motor vehicles and parts	103	104	91	87	66	76	105	105	97	89	92	82
Capital goods	103	103	95	95	48	47	86	83	82	82	105	106
Other manufacturing	96	97	107	106	121	116	100	95	101	98	112	113
Agriculture and food	100	98	100	102	109	113	112	122	100	98	95	94
Agriculture	101	94	100	102	119	125	122	136	100	99	94	93
Processed foods	99	99	101	101	100	100	106	113	103	95	97	96
Textiles and wearing apparel	79	76	118	121	84	69	95	85	151	166	128	132
Other manufacturing	99	100	101	100	98	98	96	92	92	89	102	102

Source: Authors' World Bank LINKAGE model simulations.
Note: Self-sufficiency is defined as domestic production as a percentage of domestic consumption measured in value terms at free on board (FOB) prices.

Table 8. Changes in bilateral trade flows from full global liberalization, 2015 (difference in bilateral trade flows at FOB prices in 2015 compared to the baseline, $billion)

	Importer		
Exporter:	World	High-Income Countries	Developing Countries
Agriculture and food			
World	314	186	128
High income	104	54	50
Developing	210	133	77
Textiles and clothing			
World	164	79	85
High income	47	8	40
Developing	117	71	46
Other manufacturing			
World	595	227	368
High income	312	112	200
Developing	284	114	168
All merchandise trade			
World	1,073	492	581
High income	463	174	290
Developing	610	318	291

Source: Authors' World Bank LINKAGE model simulations.
Note: Aggregations exclude intra-EU trade.

country regions but declines 0.1% in South Asia. Consumption falls 1.3% in the rest of sub-Saharan Africa where the negative effect of the increase in food prices more than offsets the positive effect of higher incomes. In principle, that could be overcome by boosting foreign aid for their agricultural R&D, as proposed in the "aid for trade" package being discussed as part of the Doha Development Agenda (Nielson).

Would freeing global merchandise trade lead to more trade gains for developing countries than for high-income countries, given the latter's high-protection rates in agriculture and textiles? This question is pertinent for trade negotiators, who often think more in terms of the boost to the value of trade than to changes in economic welfare. Table 8 suggests that any imbalance of that sort is not likely to be a major problem, even with complete goods trade liberalization. Certainly in those two protected sectors exports would increase more for developing than for high-income countries.

For other manufactures, however, trade growth would have the opposite bias. Also, much of the developing countries' trade growth is with other developing countries. Hence for merchandise trade as a whole, developing countries would sell an extra $318 billion to high-income countries under free trade whereas high-income countries would sell $290 billion more to developing countries. A small amount of services trade liberalization by developing countries would be sufficient to close that gap, if full reciprocity were sought.

How large are the consequences of reform for farm output and employment growth over the implementation period post-2004? Table 9 shows the annual growth to 2015 in the baseline (no policy changes post-2004) and if all distortions to merchandise trade were removed. If there were completely free trade, farm output would decline (instead of growing slightly) in the EU and Japan while growing slower in a few other highly protective countries. For most countries/regions shown in table 9, however, farming activities would expand in contrast to the rhetoric suggesting farm protection cuts would cause a major collapse of protected sectors.

The farm employment picture is somewhat different. Typically, economic growth leads to declines in not only the relative importance of agriculture (for reasons explained in Anderson, and Martin and Warr) but also in absolute numbers employed in farming once a country reaches middle-income status. Thus, it is not surprising that numerous middle- and high-income countries are projected to lose farm jobs over the next decade in the baseline scenario (table 9). For the most protected farm sectors, that rate of farm employment decline would more than double if the world were to move to completely free trade, requiring more members of farm households to seek part- or full-time jobs in nonfarm activities. For other economies, though, farm employment would grow a little faster, allowing developing countries to absorb more workers on their farms.

Such reform also raises the share of agricultural and food production exported globally from 7% in the baseline to 12% under free merchandise trade (excluding intra-EU trade—table 10). Even in the protected countries, this ratio rises a little because farm resources would move within the sector from import-competing to more-competitive farming activities.[12] This is important because, by "thickening" international markets, food price fluctuations would be dampened, which would reduce concerns about vulnerability to import dependence.

Table 11 illustrates the extent of this global public good aspect of agricultural trade. Rice and sugar are especially noteworthy: their global shares of production exported treble. Interestingly, developing countries' shares of global output and especially exports, would rise. Their share of global wheat exports would double, for example, and would increase from 54% to 65% for all agricultural products.

The relatively small percentage changes in net national economic welfare hide that redistributions of welfare among groups within each country reform can be much larger following trade (table 12). The results also strongly support the expectation from trade theory that returns to unskilled labor rise substantially in developing countries, and by more than wages of skilled workers, which in turn increase more than earnings from produced capital. That is, full reform would likely improve equity and reduce poverty in developing countries, given that the vast majority of their poor earn income as unskilled laborers (including as farmers). For high-income countries, again consistent with standard trade theory, skilled workers gain more than unskilled workers. European and Northeast Asian farmers renting agricultural land would benefit from a large fall in farm rental costs, more or less offsetting lower prices for their output. Earnings of landowners in those countries would decline.[13]

Those changes in factor rewards assume labor is mobile between sectors. In the most densely populated developing countries, full liberalization would

Table 9. Agricultural output and employment growth, baseline, and full liberalization, 2005–2015 (annual percent growth rate between 2005 and 2015)

	Output Growth		Employment Growth	
	Baseline	Full Global Liberalization	Baseline	Full Global Liberalization
Australia and New Zealand	3.5	5.2	0.4	1.9
EU-25 plus EFTA	1.0	−1.5	−1.8	−3.9
United States	2.2	1.3	−0.8	−2.1
Canada	3.5	5.2	0.2	1.9
Japan	0.5	−4.3	−2.7	−6.5
Korea and Taiwan	2.2	0.1	−1.3	−3.9
Hong Kong and Singapore	2.8	3.3	0.0	0.2
Argentina	2.9	5.1	0.9	3.3
Bangladesh	4.2	4.4	1.1	1.2
Brazil	3.3	6.1	1.1	4.0
China	4.3	4.3	0.8	0.7
India	4.3	4.1	1.0	0.6
Indonesia	3.0	2.9	−0.7	−0.7
Thailand	−0.1	1.3	−4.6	−3.7
Vietnam	5.8	6.1	3.9	3.5
Russia	1.5	1.0	−2.3	−2.7
Mexico	3.9	4.1	2.0	2.3
South Africa	2.5	3.3	0.0	0.8
Turkey	3.0	2.6	−0.5	−1.2
Rest of South Asia	4.8	4.8	2.0	1.9
Rest of East Asia	3.7	3.5	0.2	−0.1
Rest of LAC	4.4	6.6	1.9	3.8
Rest of ECA	3.3	3.3	0.0	−0.1
Middle East and North Africa	4.0	4.0	1.5	1.4
Selected sub-Saharan African countries	5.3	5.7	3.0	3.3
Rest of sub-Saharan Africa	4.6	4.8	2.2	2.5
Rest of the world	5.0	6.4	2.4	3.5
High-income countries	**1.6**	**−0.1**	**−1.5**	**−3.1**
Developing countries (WB)	**3.9**	**4.2**	**1.0**	**1.2**
Middle-income countries	3.7	4.1	0.4	0.3
Low-income countries	4.4	4.5	1.2	0.9
East Asia and Pacific	4.0	4.0	−0.5	−0.8
South Asia	4.4	4.2	1.5	1.4
Europe and Central Asia	3.0	2.9	2.3	2.6
Middle East and North Africa	4.0	4.0	1.7	3.4
Sub-Saharan Africa	4.5	4.9	0.2	0.0
Latin America and Caribbean	3.8	5.8	0.4	1.9
World total	**3.2**	**2.9**	**−1.8**	**−3.9**

Source: Authors' World Bank LINKAGE model simulations.
Notes: EFTA: European Free Trade Association; LAC: Latin American Countries; ECA: Europe and Central Asia.

Table 10. Share of agricultural and food production exported, 2001 and 2015 (percent)

	Baseline 2001	Baseline 2015	Full Global Liberalization 2015
Australia and New Zealand	33.3	37.2	42.7
EU-25 plus EFTA	16.7	17.3	17.6
EU-25 plus EFTA (excluding intra-EU25)	4.0	5.1	7.7
United States	6.3	7.9	9.2
Canada	24.5	29.5	40.0
Japan	0.9	1.2	2.3
Korea and Taiwan	4.4	4.8	26.5
Hong Kong and Singapore	26.0	30.0	47.8
Argentina	21.6	25.2	32.5
Bangladesh	1.7	3.6	5.7
Brazil	15.3	17.3	28.9
China	3.3	0.9	2.2
India	3.5	3.0	4.7
Indonesia	11.9	10.0	12.9
Thailand	30.2	28.2	34.6
Vietnam	23.9	26.9	35.3
Russia	6.1	5.5	6.7
Mexico	5.6	7.8	13.2
South Africa	16.0	12.7	18.8
Turkey	9.6	6.0	12.4
Rest of South Asia	6.0	6.2	9.9
Rest of East Asia	16.1	14.6	22.1
Rest of LAC	13.9	18.1	27.1
Rest of ECA	2.4	1.7	3.7
Middle East and North Africa	5.2	6.7	11.2
Selected sub-Saharan African countries	13.2	18.1	25.4
Rest of sub-Saharan Africa	11.2	15.8	23.3
Rest of the world	6.6	7.0	17.7
High-income countries	**5.8**	**7.5**	**11.6**
Developing countries	**7.5**	**6.9**	**11.6**
Middle-income countries	7.6	6.6	11.4
Low-income countries	7.3	7.9	12.4
East Asia and Pacific	7.2	4.1	6.5
South Asia	3.8	3.6	5.7
Europe and Central Asia	3.7	2.7	5.0
Sub-Saharan Africa	12.5	15.8	23.1
Latin America and Caribbean	12.7	15.9	24.8
World total	**9.5**	**9.5**	**13.2**
World total (excluding intra-EU25)	6.6	7.2	11.6

Source: Authors' World Bank LINKAGE model simulations.
Notes: EFTA: European Free Trade Association; LAC: Latin American Countries; ECA: Europe and Central Asia.

Table 11. Impact of full global liberalization on shares of global output exported and the developing country shares of global output and exports, by-product, 2015 (percent)

	Share of Global Output Exported[a]		Developing Countries' Share of Global Output		Developing Countries' Share of Global Exports[a]	
	Baseline	Full Liberalization	Baseline	Full Liberalization	Baseline	Full Liberalization
Rice	3	9	78	91	68	70
Wheat	13	18	79	82	21	42
Coarse grains	12	22	69	65	26	31
Oilseeds	31	37	70	82	49	83
Sugar	6	20	62	80	79	88
Cotton	18	18	82	86	55	82
Fruit and vegetables	7	12	83	85	70	74
Other crops	17	20	61	60	76	73
Livestock	3	4	69	70	27	29
Fossil fuels	29	30	55	55	69	70
Other primary	11	11	65	64	68	69
Processed meats	7	15	38	43	37	55
Vegetable oils and fats	10	20	52	56	79	80
Dairy products	6	11	26	28	21	28
Other food, beverages, and tobacco	7	11	43	41	52	43
Textiles	22	29	65	66	55	55
Wearing apparel	34	43	55	61	81	84
Leather	37	47	71	73	76	75
Chemicals, rubber, and plastics	19	22	35	34	30	34
Iron and steel	13	15	43	42	51	51
Motor vehicles and parts	23	28	21	19	19	22
Capital goods	38	40	31	31	32	34
Other manufacturing	14	16	37	36	50	49
All agriculture and food	**7**	**12**	**54**	**56**	**51**	**55**
Agriculture	8	12	73	77	54	65
Processed foods	7	12	40	41	49	48
Textiles and wearing apparel	28	35	63	65	69	69
Other manufacturing	24	26	36	36	38	39
All merchandise	**20**	**24**	**42**	**42**	**42**	**44**

Source: Authors' World Bank LINKAGE model simulations.
[a]Excluding intra-EU trade.

encourage more farm workers to take up work in labor-intensive manufacturing and service activities. As a result, value added in agriculture would fall not only in economies where it has been highly protected (Europe, Northeast Asia, and the United States), but also in South Asia. Trade policies in South Asia have a slightly proagricultural bias according to the GTAP database, and these nations enjoy expanding market access abroad for those nonagricultural products in which the region has a strong comparative advantage.[14]

Net farm income would rise in all other developing country regions and the developed country Cairns Group members of Canada, Australia, and New Zealand. That is true of China because it already reduced much of its agricultural protection as part of its reforms associated with WTO accession in 2001 and because it faces extremely high tariff barriers in its export markets for farm products (Jean,

Table 12. Impacts of full global merchandise trade liberalization on real factor prices, 2015 (relative to the baseline in 2015, percent)

	Unskilled Wages	Skilled Wages	Capital User Cost[a]	Land User Cost[b]	CPI
Australia and New Zealand	3.1	1.1	−0.3	17.4	1.2
EU-25 plus EFTA	0.0	1.3	0.7	−45.4	−1.3
United States	0.1	0.3	0.0	−11.0	−0.4
Canada	0.7	0.7	0.4	22.8	−0.9
Japan	1.3	2.2	1.1	−67.4	−0.1
Korea and Taiwan	6.5	7.1	3.8	−45.0	−0.7
Hong Kong and Singapore	3.2	1.6	0.3	4.4	1.1
Argentina	2.9	0.5	−0.7	21.3	0.3
Bangladesh	1.8	1.7	−0.2	1.8	−7.2
Brazil	2.7	1.4	1.6	32.4	2.2
China	2.2	2.2	2.8	−0.9	−0.4
India	2.8	4.6	1.8	−2.6	−6.0
Indonesia	3.3	1.5	0.9	1.0	0.5
Thailand	13.2	6.7	4.2	11.4	−0.6
Vietnam	25.3	17.6	11.0	6.8	−2.3
Russia	2.0	2.8	3.5	−2.2	−3.3
Mexico	2.0	1.6	0.5	2.8	−1.4
South Africa	2.8	2.5	1.8	5.7	−1.6
Turkey	1.3	3.4	1.1	−8.1	−0.3
Rest of South Asia	3.7	3.2	0.1	0.1	−2.7
Rest of East Asia	5.8	4.2	5.2	−0.9	−1.6
Rest of LAC	5.7	1.4	−0.4	17.8	−1.2
Rest of ECA	2.3	4.2	2.1	−0.3	−2.6
Middle East and North Africa	4.1	4.1	2.6	2.4	−3.1
Selected sub-Saharan African countries	6.0	1.6	0.0	4.6	0.4
Rest of sub-Saharan Africa	8.2	6.5	2.2	5.2	−5.0
Rest of the world	4.4	2.7	1.1	6.3	−1.4
High-income countries	**0.6**	**1.1**	**0.5**	**−20.0**	**−0.6**
Developing countries	**3.5**	**3.0**	**1.9**	**0.9**	**−1.7**
Middle-income countries	3.2	2.6	1.9	2.2	−1.1
Low-income countries	4.2	3.9	1.9	−1.0	−4.0
World total	**1.2**	**1.5**	**0.8**	**−0.8**	**−0.8**

Source: Authors' World Bank LINKAGE model simulations.
[a]Nominal factor prices deflated by the consumer price index (CPI).
[b]The user cost of capital and land represents the subsidy inclusive rental cost.
Notes: EFTA: European Free Trade Association; LAC: Latin American Countries; ECA: Europe and Central Asia.

Laborde, and Martin). Net farm income would rise in the sub-Saharan African region, even when southern Africa is separated out, despite the fact that there are numerous net food importing and preference-receiving exporting countries in that region (see details in Anderson, Martin, and van der Mensbrugghe, 2006).

Table 13 shows the contributions of high-income and developing countries' farm policy reforms to that outcome. It is clear that most of the effects come

Table 13. Effects of full liberalization of global agricultural and other merchandise trade on agricultural value added, by country/region, 2015 (relative to baseline, billion U.S. dollars and percent)

	$Billion			Percent		
	Developing Country Agriculture and Food Policies	High-Income Country Agriculture and Food Policies	All Goods Trade Policies	Developing Country Agriculture and Food Policies	High-Income Country Agriculture and Food Policies	All Goods Trade Policies
Australia and New Zealand	2.5	3.2	6.4	10.1	13.0	25.6
EU-25 plus EFTA	7.3	−42.0	−39.1	4.9	−28.3	−26.4
United States	5.1	−20.7	−18.2	4.2	−17.0	−15.0
Canada	2.0	1.4	3.4	13.3	9.6	23.3
Japan	0.2	−17.7	−17.7	0.4	−39.6	−39.5
Korea and Taiwan	0.5	−10.1	−9.5	1.7	−35.4	−33.3
Hong Kong and Singapore	0.1	0.1	0.1	3.6	5.0	7.5
Argentina	0.4	4.9	6.1	2.1	27.4	33.8
Bangladesh	−0.4	0.2	−0.5	−3.3	1.7	−4.4
Brazil	0.0	15.1	15.1	0.1	46.2	46.3
China	−16.3	13.3	0.3	−3.8	3.1	0.1
India	−17.3	2.9	−17.1	−8.2	1.4	−8.1
Indonesia	−0.1	1.0	0.8	−0.4	3.3	2.7
Thailand	1.1	3.1	3.8	7.2	20.4	25.0
Vietnam	0.9	0.3	0.8	14.5	5.7	13.6
Russia	−1.8	0.7	−1.4	−8.4	3.2	−6.5
Mexico	−3.8	7.9	0.9	−9.9	20.9	2.5
South Africa	0.1	0.4	0.5	1.3	7.8	9.6
Turkey	−2.9	0.9	−2.0	−10.3	3.0	−7.2

Continued

Table 13. Continued

	$Billion			Percent		
	Developing Country Agriculture and Food Policies	High-Income Country Agriculture and Food Policies	All Goods Trade Policies	Developing Country Agriculture and Food Policies	High-Income Country Agriculture and Food Policies	All Goods Trade Policies
Rest of South Asia	−1.7	1.2	−0.6	−3.7	2.7	−1.3
Rest of East Asia	−1.4	1.2	−0.2	−5.5	4.6	−0.7
Rest of LAC	1.9	19.7	22.9	2.5	26.0	30.2
Rest of ECA	−2.1	1.4	−1.1	−3.3	2.3	−1.8
Middle East and North Africa	−4.8	6.2	0.3	−4.4	5.6	0.3
Selected sub-Saharan African countries	0.4	1.1	1.5	2.7	6.5	9.1
Rest of sub-Saharan Africa	−0.7	3.0	2.3	−1.7	7.2	5.4
Rest of the world	0.7	2.5	3.1	3.4	13.2	16.4
High-income countries	**17.6**	**−85.8**	**−74.6**	**4.6**	**−22.3**	**−19.4**
Developing countries	**−47.9**	**87.1**	**35.6**	**−3.9**	**7.0**	**2.9**
Middle-income countries	−29.6	74.8	45.3	−3.4	8.7	5.3
Low-income countries	−18.2	12.3	−9.7	−4.8	3.2	−2.5
East Asia and Pacific	−15.8	18.9	5.5	−3.2	3.8	1.1
South Asia	−19.4	4.4	−18.1	−7.2	1.6	−6.8
Europe and Central Asia	−6.8	3.0	−4.5	−6.0	2.6	−4.0
Middle East and North Africa	−4.8	6.2	0.3	−4.4	5.6	0.3
Sub-Saharan Africa	−0.2	4.5	4.3	−0.3	7.1	6.7
Latin America and the Caribbean	−1.4	47.7	45.0	−0.9	29.0	27.4
World total	−30.3	1.3	−39.0	−1.9	0.1	−2.4

Source: Authors' World Bank LINKAGE model simulations.
Notes: EFTA: European Free Trade Association; LAC: Latin American Countries; ECA: Europe and Central Asia.

from one of those reforms, with only a minor contribution to the residual from nonagricultural sectors. Those value-added changes are due in considerable part to the changes in import and export prices for farm and other products (tables 14 and 15). On average, real prices in international markets would be 5.5% higher for primary agricultural products and 1.3% higher for processed foods. The largest increases occur for cotton (21%); oilseeds (15%); dairy products (12%); and grain (4% to 7%).

Cotton is particularly important to Brazil and some sub-Saharan African countries because it is receiving special attention in the WTO's Doha Development Agenda following the Cancun Trade Ministerial in 2003 and the Dispute Settlement case that went against the United States in 2004 (Sumner). That is not surprising given that the United States and the EU provide a high degree of cotton subsidies and that cotton is important in farm income and exports of several African countries.

Under full trade and subsidy liberalization of all goods, global cotton markets would change dramatically: the value of production would fall by one-third or more than $5 billion per year in high-income countries (mostly in the United States), and the value of their exports would decline by $3.6 billion. The world totals would hardly change though, as developing country output and exports of cotton would expand by about the same amounts. Sub-Saharan Africa would enjoy more of that gain than any other region (table 16). Indeed, cotton is so important in sub-Saharan Africa (minus South Africa) that it contributes one-quarter of that region's net gain in agricultural value added from full liberalization. The benefit comes from increased output and exports of cotton, rather than a rise in the price of Africa's cotton exports. The region's net income from cotton would be $1.1 billion—and cotton exports $1.9 billion—greater per year in the absence of goods trade barriers and subsidies.

The bottom line, therefore, is that according to the latest GTAP database and the LINKAGE model, developing country agricultural production, employment, and real net income would increase by 2015 if all current distortions to world trade in merchandise were phased out. The gains would be greater in most regions within the developing country group except South Asia and Eastern Europe where import tariffs are higher for agricultural than nonagricultural goods. This does not necessarily mean that if each individual developing country were to unilaterally liberalize, we would find farmers benefiting in all cases except in South Asia and Eastern Europe. However, if we were to run those many individual model simulations, we may well get that result also. As table 3 reveals, terms of trade effects of reforms by others are usually dominated by efficiency gains from own reforms except for the least-distorted economies.

Finally, which commodities contribute most to the global cost of agricultural protection depends on the nominal rate of protection, the relative size of each subsector and the different degrees of responsiveness of inputs to changes in relative output prices. According to the LINKAGE model, rice, sugar, and meat (especially beef) are the key contributors (table 17).[15] Rice and sugar are especially important to developing country farmers, so it is not surprising that their interest in agricultural trade reform is so intense.

Table 14: Impact of full liberalization of global merchandise trade on indexes of real export and import prices (change in export and import price in 2015 relative to baseline, percent)

	Export Prices			
Import Prices	**Agriculture and Food**	**All Merchandise**	**Agriculture and Food**	**All Merchandise**
Australia and New Zealand	4.5	2.2	2.0	0.1
EU-25 plus EFTA	1.0	−0.1	−0.1	−0.4
United States	10.1	0.5	1.5	−0.4
Canada	2.4	−0.3	3.4	−0.2
Japan	−5.0	0.9	1.6	0.0
Korea and Taiwan	−14.9	0.8	5.0	0.2
Hong Kong and Singapore	1.6	1.8	2.0	0.2
Argentina	2.8	2.9	3.3	0.3
Bangladesh	−6.5	−5.5	5.9	0.7
Brazil	6.0	3.0	2.6	−0.2
China	−0.2	−0.3	7.4	1.0
India	−3.5	−6.1	5.0	0.1
Indonesia	1.8	0.5	8.0	1.3
Thailand	2.5	−0.2	1.4	0.1
Vietnam	4.8	−0.8	3.7	0.3
Russia	−2.7	−1.9	4.8	0.2
Mexico	1.7	−1.5	8.3	0.3
South Africa	−0.6	−0.1	1.6	−0.3
Turkey	−0.5	−0.4	9.0	0.0
Rest of South Asia	0.2	−2.1	3.8	0.1
Rest of East Asia	0.3	−0.1	3.6	0.6
Rest of LAC	2.0	−0.3	3.5	0.1
Rest of ECA	−2.6	−2.5	1.8	−0.8
Middle East and North Africa	−1.0	−1.8	4.5	0.1
Selected sub Saharan Africa countries	2.6	1.4	1.5	−0.6
Rest of sub Saharan Africa	−1.4	−3.1	3.7	−0.1
Rest of the world	0.1	−0.5	−0.8	−0.3
High-income countries	3.2	0.3	0.9	−0.3
Developing countries	1.2	−0.8	5.0	0.4
Middle-income countries	1.7	−0.6	5.2	0.4
Low-income countries	−0.1	−2.2	4.1	0.3
East Asia and Pacific	1.6	−0.2	6.2	0.8
South Asia	−2.7	−5.1	4.8	0.1
Europe and Central Asia	−2.2	−1.8	4.2	−0.3
Sub Saharan Africa	−0.4	−1.5	3.0	−0.2
Latin America and the Caribbean	3.1	0.0	4.8	0.1
World total (excluding intra-European trade)	3.9	0.1	3.1	0.0

Source: Authors' World Bank LINKAGE model simulations.
Notes: EFTA: European Free Trade Association; LAC: Latin American Countries; ECA: Europe and Central Asia.

Table 15. Impact of full global liberalization and of Doha reform scenarios on real international product prices, 2015

	Percent Relative to Baseline
Rice	4.2
Wheat	5.0
Other grains	7.0
Oilseeds	15.1
Vegetable oils and fats	1.9
Sugar	2.5
Cotton	20.8
Fruit and vegetables	2.8
Other crops	2.6
Livestock	2.5
Processed meats	4.3
Dairy products	11.9
Other food, beverages, and tobacco	−0.7
All agriculture and food	**3.1**
All primary agriculture	5.5
All processed foods	1.3
Textile and wearing apparel	−1.4
All merchandise trade	**0.0**

Source: Authors' World Bank LINKAGE model simulations.

Lessons, Implications, and Areas for Further Research

The following key messages emerge from our analysis:

1. The potential gains from global trade reform are nontrivial, including for developing countries, despite its adverse terms of trade impact on many developing countries.
2. Agriculture would enjoy the greatest gains from trade liberalization.
3. Liberalization would cause farm output and farm employment to rise in developing countries relative to the baseline, except in South Asia.
4. The poorest people appear most likely to gain from the global trade liberalization, namely farmers and unskilled laborers in developing countries. Net farm income would be enhanced in all developing country regions other than South Asia, where job growth would be greater in nonfarm activities.

Agriculture must receive the largest cuts in bound tariffs and subsidies to realize potential significant gains. That is a daunting task, however, because of the political sensitivity of farm support programs, coupled with the complexities of the measures introduced in the Uruguay Round Agreement on Agriculture and the modalities set out in the Doha Framework Agreement of July 2004. The well-established principle of Special and Differential treatment allows developing countries to make smaller cuts than industrial countries. This makes it relatively difficult for developing countries to lock in the efficiency gains from their own

Table 16. Impact of full global liberalization on output, value added and exports of cotton, by region, 2015

	Share of Production Exported (Percent)[a]		Change in Cotton Output ($Billion)	Change in Value Added in Cotton Production ($Billion)	Change in Cotton Export Value ($Billion)[b]
	Baseline	Full Liberalization			
United States	38	4	−4.7	−2.8	−3.5
EU-25 plus EFTA	72	70	−1.4	−0.5	−1
Other high-income	66	69	1	0.4	0.9
Sub-Saharan Africa	78	88	2.2	1.1	1.9
Latin America	24	29	1.2	0.6	0.7
Other developing	6	9	1.8	0.4	1.6
World total	**18**	**18**	**0.1**	**−0.7**	**0.6**

Source: Authors' World Bank LINKAGE model simulations.
[a]Actually all plant-based fibers, but cotton is more than 95% of that sector. These results assume subsidies and import tariffs on all merchandise (not just on cotton) are removed.
[b]Including intra-EU trade.
Note: EFTA: European Free Trade Association.

reforms and the benefits from improved market access in other developing countries. However, with global gains of $290 billion per year at stake from removing trade barriers, even if no reforms were forthcoming in services, and even if the counterfactual is the status quo rather than protectionist backsliding, it is worth expending considerable effort to try to bring about such reform. The WTO's Doha Development Agenda is an obvious vehicle for moving down this path (Anderson and Martin 2005, 2006). Multilateral cuts in tariff bindings are especially helpful because they can lock in previous unilateral trade liberalizations; and they can

Table 17. Shares of the global cost of agricultural subsidies and tariffs attributable to specific products, 2015

	Percent
Rice	20
Sugar	18
Meat products	16
Coarse grains	9
Oilseed products	7
Dairy products	5
Wheat	2
Other (including beverages and tobacco)	23
Total	**100**

Source: Authors' World Bank LINKAGE model simulations.

be used as an opportunity to multilateralize previously agreed upon preferential trade agreements and thereby reduce the risk of trade diversion from those bilateral or regional arrangements.

The results concerning the extent of bias in trade policies against or in favor of agriculture are very much dependent on the levels of distortion in the GTAP database. Those for high-income countries are reasonably reliable, thanks in large part to the protection estimates provided by the OECD. Currently available estimates of (particularly agricultural) trade distortions and subsidies in developing countries are less reliable, because few estimates of export taxes or tax equivalents of quantitative restrictions and bans on exports are included in the GTAP database. Distortions to factor markets, particularly labor, may also have an important influence on the results for some countries if they were to be included in the model. It also remains for the trade economics profession to provide better estimates of distortions to services trade and foreign direct investment (none are in the current version of the GTAP database), so as to see what impact they have on agricultural and other goods production and trade; and to estimate the poverty consequences of such reforms (building on pioneering empirical work in Hertel and Winters).

Acknowledgments

This is a product of the World Bank's project on *Agricultural Trade Reform and the Doha Development Agenda*. The authors are grateful for helpful comments from project participants and for funding from the UK Department for International Development. The views expressed are the authors' alone and not necessarily those of the World Bank, its Executive Directors, or the countries they represent, nor the projects' funders.

Endnotes

[1]The Krueger, Schiff, and Valdes, and the Jensen, Robinson, and Tarp studies focused on effects of just own-country policies, the first using partial equilibrium and the second using national general equilibrium models. On the relationship between those two methodologies, see Bautista et al.

[2]Apparently only a few minor export taxes remain—see Piermartini and also Thiele.

[3]This is reflected in the results emerging from attempts to include services distortions in trade reform modeling, which have led to widely differing results. Compare, for example, Brown, Deardorff, and Stern; Francois, van Meijl, and van Tongeren; and Hertel and Keeney.

[4]More information on the MAcMaps database is available in Bouët et al. and at http://www.cepii.fr/anglaisgraph/bdd/macmap.htm. For details of its incorporation into the GTAP Version 6 dataset, see Dimaranan and McDougall.

[5]Manole and Martin show that this can result in a substantial downward bias in the estimated benefits of reform.

[6]The results would change with a different assumption on unemployment, but in a direction that depends explicitly on the assumption made about the workings of labor markets. A reforming economy could be modeled to determine overall employment at current consumer real wages (in which case, a decline in tariffs would almost certainly reduce unemployment by lowering producer real wages), or could be modeled to have rigidities in inter-industry adjustment in which case wages and employment in sectors subject to protection cuts would fall. Since neither assumption is pertinent to all economies, we have chosen to retain the standard long-run assumption of flexible labor markets since we are focusing on the adjustment over a ten-year horizon.

[7]The size of the Armington elasticities matters. The LINKAGE model assumes larger values than the standard GTAP model, because it is seeking to estimate long-run consequences in a decade's time of a liberalization phased in over several years. The difference this makes to the results is detailed in table 12A.2 in Anderson and Martin (2006).

[8]These turn out to be of very minor importance relative to import tariff protection in terms of their global trade and welfare effects (Anderson, Martin, and Valenzuela 2005). Adding the export subsidy equivalent of implicit assistance via food aid, export credits, and state trading enterprises was

considered, but from the (rather sketchy) available estimates it changed the results very little and so they are ignored in what follows.

[9]For the sake of simplicity they are fixed in U.S.$ terms at their base year level, minimizing potential sustainability problems; but this implies they decrease over time as a percentage of GDP for expanding economies.

[10]The important changes to EU and U.S. agricultural policies since 2001 are deliberately not included in this presimulation because those WTO members will expect to get "credit" for those changes when they bind them as part of their eventual commitments at the conclusion of the Doha Round, the base for which is likely to be early this decade. The results presented below therefore do represent the potential gains from a successful conclusion to the Doha Round, although they overstate the gains from removing remaining EU distortions—and understate the gains from removing remaining U.S. distortions—as of 2005.

[11]To help explain these numbers, Anderson, Martin, and Valenzuela first present a back-of-the-envelope calculation which reconciles the numbers in the PSE calculations by the OECD and those in the GTAP database. They then estimate those numbers using the very simplest partial equilibrium model and get similar shares to those from their full-blown general equilibrium model. Hoekman, Ng, and Olarreago also reach a similar conclusion from estimating the effects of halving each of the three types of agricultural distortions, in their case using another type of partial equilibrium analysis. Key elements of the recent domestic subsidies, which are relatively unimportant are: trade measures distort consumption as well as production; import restrictions dominate distortions in developing countries; and trade measures are more variable across products which further adds to their welfare cost.

[12]Recall from table 6 that imports of farm and food products rise in most regions, as countries would specialize more in what they do best within the sector. If the model had been more disaggregated, the extent of intra-industry trade growth would show up even more strongly, and the greater variety of exotic foods available in each country would be an additional source of welfare gain to that measured above. Feenstra, Markusen, and Zeile suggest that the welfare cost of protection can be underestimated by as much as a factor of ten when this consideration is not included. (From a study of U.S. import data from 1972 to 2001.)

[13]Their loss is relative to the no-reform baseline, which ignores the fact that such farm landowners have long enjoyed protection-inflated returns, in some cases for several decades.

[14]The move to free trade would boost South Asia's ratio of production to consumption in textiles and clothing from 1.51 to 1.66, for example (see table 7).

[15]Dairy's estimated contribution is much less despite the high rates of assistance to dairy farmers, presumably because the GTAP protection database relies just on tariffs and excludes the protective effect of nontariff import barriers such as sanitary and phytosanitary restrictions, which may be much higher for fluid milk than for most other farm products.

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