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Modeling the Impact of Trade Liberalization on Global Poverty

This chapter applies one of the leading computable general equilibrium (CGE) models of international trade and a prominent international database on trade and protection to estimate the impact of alternative trade liberalization scenarios on trade, welfare, and global poverty. The purpose is to extend and complement the estimates developed and surveyed in chapter 3, and to obtain a better understanding of the forces and interactions that determine the poverty impact of trade liberalization.

For these estimates, the analysis applies the CGE model developed by Harrison, Rutherford, and Tarr (1996, 1997a; hereafter, the HRT model). When combined with the Global Trade Analysis Project (GTAP) database developed by a network of researchers centered at Purdue University (Dimaranan and McDougall 2002), the HRT model is capable of estimating the change in trade flows, economic welfare, and product and factor prices that can be expected to result from changes in protection and subsidies. Varying aggregations by sector and country can be applied, depending on the focus in question and subject to computational feasibility.

The strategy of this chapter is to examine the effects of alternative scenarios for international trade liberalization, and particularly their impact on factor prices, as the basis for then calculating the corresponding impact on global poverty. For this purpose, the principal production factor of interest is unskilled labor, which accounts for the bulk of income of households at the poverty level. It is possible to combine the factor price estimates from simulations using the HRT model with the poverty elasticity estimates of chapter 1 to arrive at estimates of changes in global poverty that might be expected from alternative trade liberalization scenarios. The country and regional detail is chosen taking into account the most important country concentrations of poverty. The combined model of this chapter, centered on the HRT CGE model as tailored to the poverty-oriented regions and extended to derive poverty-impact estimates, may be called the Poverty Effects–HRT, or PEHRT, model.

The Harrison-Rutherford-Tarr CGE Model

The HRT model is in the family of "Walrasian" CGE models. More broadly, CGE models are descendants of early multisectoral planning or policy models and, like the earlier multisectoral models, are built around a core input-output structure required for interindustry consistency. The more Walrasian of these models are based on optimizing the behavior of representative agents (e.g., the representative firm, for production, and the representative household, for consumption) in a framework of welfare economics. They can be distinguished from "macrostructuralist" CGE models, which also involve the simultaneous determination of sectoral quantities and prices in response to exogenous or policy shocks, but which may depart from optimizing behavior in favor of ad hoc components designed to increase empirical relevance (Thissen 1998; Robinson 1989).

The underlying analytical structure of the HRT model closely follows that developed by de Melo and Tarr (1992).[1] Producers maximize profits, subject either to constant returns to scale or increasing returns to scale. The representative firm in each industry purchases factors of production (e.g., unskilled and skilled labor) and intermediate input goods from domestic or foreign suppliers, in combinations that minimize cost for any given level of production. Sectoral output equals the amount demanded domestically by consumers and intermediate users, plus the amount sold in exports. There is a "constant elasticity of transformation" (CET) between production allocated to the domestic market and that placed on the export market, and producers make this allocation in the light of domestic and export prices so as to maximize profits.[2]

1. De Melo and Tarr (1992) display a full set of model equations. The various published versions of the HRT model do not do so. Instead, for the core economic equations, the HRT model relies on a computer-code version incorporated into the General Algebraic Modeling System (GAMS) software system (Rutherford 1998).

2. The CET has the same functional form as the more widely known constant elasticity of substitution (CES) function. This form is $z = a[\delta_x x^{-\rho} + (1 - \delta_x)y^{-\rho}]^{\{-1/\rho\}}$, where z is production (or total output to be sold), x is one factor of production (or output allocated to one market, domestic) and y is the other factor (or output allocated to the other market, foreign). The parameter ρ is equal to $\rho = [1/\sigma - 1]$, where σ is the absolute value of the elasticity of substitution.

The "representative" consumer purchases domestic goods and imports so as to maximize utility. Demand is "nested" at successive stages. At the top level, demand is Cobb-Douglas among the various sectoral products, which means that the share of total spending on each sector will be constant with a higher (or lower) price offsetting a lower (higher) volume.[3] For each composite good, at the next level down there is a constant elasticity of substitution (CES) aggregation between the aggregate import and the domestic good, with a base-case elasticity of substitution of 4.[4] Within the aggregate import, the composition of the goods from the various country suppliers is obtained with an ("Armington") CES aggregate applying a base-case elasticity of substitution of 8. Thus, there is closer substitutability among imports from varying sources than between overall imports of the good and the domestic variety.[5]

Consumer income is determined by the model outcome for factor prices and hence payments to households for factors, plus transfers. Consumer income equals expenditures on commodities, with the composition but not the total affected by relative prices. The equality of expenditure on commodities available (supply) with consumer income (demand) is the feature of the model that enforces "Walras's law." The government collects trade taxes (tariffs and export taxes) and redistributes them to consumers in a manner that does not affect consumer behavior ("lump-sum" payments). The government operates under a balanced budget. The real exchange rate is assumed to adjust to maintain the base period current account balance unchanged.

The model is first "benchmarked" or calibrated so that the initial equilibrium solution replicates actual sectoral production, consumption, and factor use in the base year. Trade policy experiments can then be conducted by shocking the model, reducing specified import tariffs or export taxes. The model solution is driven by the required equality of the unit cost of production for each sector with the market-clearing price of consumption in each sector. To reach a new equilibrium after the shock, the nonlinear programming algorithm varies the sectoral assignment of factors and trade patterns so as to meet all the simultaneous equations once again. If these equations are met, welfare is maximized.[6] Thus, elimina-

3. Harrison, Rutherford, and Tarr (1997a, 1408). The Cobb-Douglas consumption is of this form: $C = a(X^{\beta}Y^{(1-\beta)})$, where β is the share of the consumer budget spent on good X.

4. That is, a rise of 1 percent in the ratio of the price of imports to domestic supply will cause a 4 percent decline in the ratio of the volume of the import to the domestic good.

5. There is similar CES nesting of domestic varieties on the production side, in the increasing-returns-to-scale version of the model, which specifies a number of firms rather than just a single representative firm, as in the constant-returns-to-scale (CRTS) version.

6. Welfare is measured by Hicks's Equivalent Variation (EV) and Compensating Variation (CV). The first uses initial prices and asks how much income would have to be given to consumers to make them as well-off as they would become after liberalization. The second uses

tion of a high tariff will tend to reduce the relative price of the good in question, increase its consumption and the volume of imports, and reduce domestic production as the lower price makes the good less profitable for the domestic representative firm. The model treats voluntary export quotas (most important, in the textile and apparel sector) as export taxes imposed by the supplying country. It treats export subsidies (important in agriculture) as negative export taxes, which make the good more attractive to foreign purchasers.

The change in composition of domestic production resulting from the array of changes in import tariffs and export taxes will change the relative demand for the various factors of production (land, capital, skilled labor, and unskilled labor), inducing a change in their relative prices. More generally, product prices will change in each sector, and factor prices will change for each factor, such that each of the product sector and factor markets will "clear" (no "excess demand" or "excess supply").

Production for a given sector is CES at the level of intermediates between domestic and imported intermediates. It is also CES among the various factors in the production of sectoral value added. Given the production functions, factor prices are obtained using Shephard's lemma, which states that the quantity of a factor demanded is the partial derivative of the cost function with respect to the price of the factor in question. Production is "Leontief" (fixed-coefficient) between the aggregate intermediate input and the aggregate value added, to arrive at final sectoral output. For each sectoral good, there is similarly a CES composite aggregating the domestic and imported product. The sectoral import, for its part, is a CES Armington composite of imports from all the various supplying countries and regions.

The HRT model used in the analysis below is the version that is publicly available.[7] The model is solved using the General Algebraic Modeling System, or GAMS (Meeraus 1983; Brooke et al. 2003).

There are three variants of the HRT model: constant returns to scale (CRTS), increasing returns to scale (IRTS), and the "Steady State." In their calculations of the impact of the Uruguay Round, the three authors find that in their methodologically preferred IRTS version, the results are "striking" in their similarity to the CRTS estimates (Harrison, Rutherford,

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the new prices and asks how much income would have to be taken away from consumers after liberalization to make them no better off than they were before. In an indifference curve diagram showing alternative combinations of two goods generating the same utility, both measures can be thought of as the distance between the before-shock (lower utility) and after-shock (higher utility) indifference curves. In the CRTS model, profits are zero, so the welfare gains are fully appropriated by consumers in the form of increased consumer surplus.

7. The model can be downloaded from http://dmsweb.badm.sc.edu/Glenn/ur_pub.htm. Rutherford has prepared software for use of the HRT model with the GTAP databases. This GTAPinGAMS software is available at http://nash.colorado.edu/tomruth/gtapingams/html/gtapgams.html.

and Tarr 1996, 236). Against benchmark 1992 levels of world GDP and trade, full implementation of the Uruguay Round liberalization is estimated to bring annual welfare gains of $96 billion (0.418 percent of global GDP) in the IRTS version, compared with welfare gains of $93 billion (0.405 percent) in the CRTS version.

Harrison, Rutherford, and Tarr emphasize that this difference is far smaller than usually believed. They suggest two reasons. First, on the basis of their review of the empirical literature on returns to scale, they use more modest implied gains from scale economies than are often assumed. They define the cost disadvantage ratio (CDR) as the ratio of average cost to marginal cost. For the 13 of their 22 product sectors in which they apply increasing returns, the maximum CDR shows the average cost at 13 percent above the marginal cost; the minimum, 3 percent; and the median, only 5 percent (Harrison, Rutherford, and Tarr 1996, 234).

Second, they judge that numerous CGE models that have quantified the effect of shifting from constant to increasing returns have changed other parameters (e.g., elasticities) at the same time, biasing the estimated impact of considering increasing returns. In part because the IRTS results appear to be close to the CRTS results, the estimates below rely on the CRTS version, despite the analytical elegance of the IRTS variant.[8]

The third version, the Steady State, does yield major differences in the estimated effects. In this version, instead of assuming that all factors remain at their initial economywide endowments, it is assumed that the stock of capital is allowed to increase to the point where the marginal return on investment after liberalization falls once again to its preliberalization level. Although this variant must be interpreted with care, as discussed below, it does provide insight into the important distinction between static and much larger dynamic welfare gains from trade liberalization.

The GTAP5 Trade and Protection Database

The empirical data set used for the calculations in this chapter is that compiled in the Global Trade Analysis Project (GTAP) system. Whereas the Harrison, Rutherford, and Tarr (1996, 1997a) results for the Uruguay Round applied the 1992 benchmark GTAP data (GTAP2), the estimates here apply the successor GTAP5 database, which has trade and protection data primarily for 1997 but in agriculture for 1998. The data include estimates of sectoral production, taxes, interindustry input flows, and factor payments.

The GTAP data for bilateral merchandise trade are primarily from the United Nations' COMTRADE database. The data are screened for consis-

8. An additional reason is that implementation of the IRTS model requires additional software expense.

tency between exports reported by a country and the corresponding imports reported by its relevant trading partner. The tariff data for manufactures are from the UN Conference on Trade and Development's Trade Analysis and Information System (TRAINS) database, and apply the World Bank's World Integrated Trade Solution (WITS) software to combine the trade and protection data for purposes of aggregation. The tariffs on food and agricultural goods are from the Agricultural Trade Policy Database of the Economic Research Service of the US Department of Agriculture. These data in turn are largely from the Agricultural Market Access Database (AMAD) compiled jointly by the Department of Agriculture and certain international counterparts and official agencies. Agricultural export subsidies are from country submissions to the World Trade Organization (WTO). Domestic support in agriculture is divided into output subsidies, intermediate input subsidies, land-based payments, and capital-based payments, which are drawn from the Organization for Economic Cooperation and Development's (OECD's) producer subsidy equivalent (PSE) statistics.

All protection data are most-favored nation (MFN) rates, so a given country's protection for a given aggregate product varies across partners only because of varying subcategory product composition. Protection rates are not adjusted for preferential access, such as that under the Generalized System of Preferences (GSP). Bilateral trade among partners in the principal free trade arrangements, or FTAs (European Union; North American Free Trade Agreement, or NAFTA; Australia–New Zealand, and South African Customs Union), is treated as having zero protection, however.[9] Other details are given in Dimaranan and McDougall (2002).

The absence of specific treatment of preferential market access under the GSP and other special regimes considered in chapter 2 (the Everything But Arms, or EBA, program of the European Union; and the African Growth and Opportunity Act, or AGOA, Caribbean Basin Initiative, or CBI, and Andean Trade Preference Act, or ATPA, programs of the United States) raises the question of whether and by how much the welfare gains and poverty reduction from global trade liberalization will be overestimated. The broad answer is that the overstatement is unlikely to be large in the aggregate but may be significant for individual countries enjoying special-regime preferences. Nonetheless, several considerations should tend to limit overstatement.

First, the special-regime countries represent only a small fraction of developing-country trade. As noted in chapter 2, the heavily indebted poor countries (HIPCs), the least developed countries (LDCs), and sub-Saharan Africa (SSA) account for only 6.4 percent of US imports from developing countries, 8.5 percent for the European Union, and 3.8 percent for Japan.

9. However, zero-duty partner trade is not captured for Mercosur and other more recent FTAs.

Second, as reviewed in chapter 2, the special regimes have tended to have numerous restrictions (especially in agriculture and textiles-apparel, and especially under the GSP as opposed to the narrower regimes) that have meant the market access provided is far from full free entry. Third, that portion of welfare gains arising from own-country liberalization (the traditional welfare triangles) rather than terms-of-trade gains associated with foreign market liberalization should be accurately captured by the protection database. Fourth, estimates of export terms-of-trade gains from foreign market liberalization will not be overstated for that portion of exports going to other developing countries and to industrial countries not providing special-regime access (including Japan except for the GSP).

The database provides information at the level of 57 product sectors and 66 countries or regions. Some aggregation is necessary because the full detailed set of countries and products is beyond the computational capacity for the CGE model. The analysis of this chapter aggregates the data into the same 22 product groups as used in Harrison, Rutherford, and Tarr (1996). This disaggregation gives considerable attention to agricultural and food products (8 of the 22 sectors) and textiles and apparel (2 sectors), so it is already appropriate for estimations of special interest to developing countries.

The choice of countries and regions for the PEHRT model application of this chapter is tailored even more toward developing countries and especially those with major concentrations of poverty. One variant (B25) is for 25 "big" countries that are important in international trade; the other variant (P26) emphasizes the 26 economies relatively more important in the totals for global poverty.

The economy disaggregation for the B25 version is close to that in the 24-region HRT model (Harrison, Rutherford, and Tarr 1996).[10] The B25 version provides somewhat more detail on regions important for poverty, however (Central America, India, South Africa, Turkey), while aggregating other economies without poverty at the $2 per day level (Australia is combined with New Zealand; and Singapore, Hong Kong, and Taiwan are treated as a single region).

The P26 version provides still greater detail for poverty-relevant countries (separating out Bangladesh, Mozambique, Pakistan, Tanzania, Uganda) while aggregating other economies into broader regions (South Korea is combined with Hong Kong, Singapore, and Taiwan; Malaysia with Other Asia; Argentina with Other Latin America; and Turkey with the Middle East and North Africa). Because the B25 version provides greater detail on countries that bulk large in international trade, it is used for the main simulations oriented toward reviewing alternative trade liberalization policies, whereas a combination of the B25 and P26 versions is

10. The computational constraints for a GAMS solution appear to begin to be relevant as the model reaches the size of about 25 sectors and 25 regions.

used for the estimates of poverty impacts. Appendix 4A shows the GTAP5 regions and product sectors, along with the aggregations applied in the analysis here.[11]

Finally, it should be noted that using the GTAP5 database to calculate the effect of the Doha Round of trade liberalization likely involves a modest overstatement of the prospective gains from unfinished business in trade liberalization. Doha Round cuts apply to protection levels that already incorporate complete implementation of the Uruguay Round cuts. Yet the 1997 data for manufactures and 1998 data for agriculture will generally reflect incomplete Uruguay Round reductions, although by this period the bulk of reductions should have occurred. The Uruguay Round cuts were to begin in 1995 and be completed in 1999 (WTO 2002, 1), so some exaggeration of the post–Uruguay Round protection level is likely involved in using 1997–98 data as the protection base. For agriculture, this is probably a lesser problem than in manufactures, because the Uruguay Round in effect largely converted existing agricultural protection from quotas to tariff-rate quotas rather than lowering its level.

One specific area in which truly post–Uruguay Round protection would be lower than in the 1997 GTAP5 data would be for textile and apparel quotas. These are supposed to be phased out entirely by 2005 under the Uruguay Round agreements. Nonetheless, the model estimates below do incorporate effects from the removal of these quotas insofar as they were still present in 1997. As noted below, however, the level of their protection in the GTAP5 database was already far below that in the earlier 1992 GTAP2 database (albeit likely more for reasons of different methodology than because of major elimination of quotas during the intervening period).

Trade Liberalization Simulation Results

The first step in evaluating the impact of global trade liberalization on world poverty is to calculate the change in economic welfare and factor prices that would result from liberalization. The size of the welfare gains for developing countries will depend on the particular scenario considered (e.g., global free trade, different depth of liberalization for industrial vs. developing countries, and different degrees of liberalization for different major sectors). The estimates will also depend on whether the calculations are only for static effects or also seek to incorporate dynamic effects using the Steady State model. For policy purposes, a key issue in the

11. The aggregation from GTAP5 data to the regions and sectors used here is done using the GTAPinGAMS software referred to above.

various calculations is the share of total potential gains for developing countries that arises from the liberalization of industrial-country markets as opposed to the liberalization of developing countries' own markets.

Static CRTS: Free Trade

Trade liberalization is simulated in the HRT model by reducing or eliminating the benchmark rates of tariffs, export subsidies (e.g., on agricultural goods), export taxes (in particular, those representing voluntary export restraints under the Multi-Fiber Arrangement, or MFA), and input subsidies (e.g., those in agriculture included in the PSE estimates). Table 4.1 reports the welfare impact estimates of completely eliminating protection, using the CRTS version of the model. For the B25 groupings, free trade increases global welfare by $227.8 billion annually against the 1997 trade and production base, or by 0.93 percent of world GDP. Separate detail is shown as a memorandum item for the five additional countries treated individually in the P26 variant of the model.[12]

For comparison to the earlier results for the Uruguay Round, the model was also applied using the "full" Uruguay Round cuts in protection used in Harrison, Rutherford, and Tarr (1996) but as implemented with the GTAP5 data and PEHRT regions. This calculation yielded global welfare gains of $85.5 billion annually, or 0.35 percent of world GDP. This is about the same nominal level as found for the actual Uruguay Round in the original HRT results ($92.86 billion; Harrison, Rutherford, and Tarr 1996, 221), but smaller as a proportion of world GDP (the original result was 0.405 percent). A lower expected level of further welfare gains from applying a second round of the same proportionate cuts in protection is thus nearly offset by the rise in the nominal base of trade and GDP values (with world GDP expanding from $22.9 trillion in the GTAP2 database for 1992 to $24.6 trillion in the GTAP5 database for 1997).

Table 4.1 shows the sectoral composition of the potential gains from free trade. There are three broad sectors: agriculture and food; textiles and wearing apparel; and other manufactures and nonagricultural goods, abbreviated in the table as "manufactures." The contribution of each sector to total gains is obtained by running the model with free trade for all sectors except the one in question, and then subtracting the result from the result for total free trade. There is thus a residual that implicitly arises from the interaction of joint liberalization of all sectors, which is also displayed in the table.

12. The P26 model gives a nearly identical aggregate estimate of $224.7 billion. The sectoral decomposition is carried out only for the B25 and thus is not included in the memorandum for additional P26 country detail.

Table 4.1 Welfare effects of free trade: CRTS model
(billions of dollars or percent of GDP)

Region or economy	Agriculture	Textiles and apparel	Other manufactures	Interaction effect	Total	Total percent of GDP
B25						
ANZ	8.42	0.07	0.04	0.64	9.17	2.41
CAN	3.98	1.31	–0.44	–0.46	4.39	0.90
USA	22.31	8.04	2.00	6.85	39.20	0.57
JPN	21.67	1.25	14.03	–5.25	31.70	0.85
KOR	5.92	1.19	4.48	–2.14	9.44	2.41
E_U	21.62	6.25	14.94	–3.85	38.96	0.61
IDN	0.20	–0.02	1.15	0.10	1.43	0.74
MYS	–0.71	0.05	0.86	–0.22	–0.02	–0.02
PHL	1.39	–0.21	–0.16	0.17	1.20	1.50
THA	0.64	–0.01	2.01	0.44	3.08	2.21
CHN	1.64	1.64	0.97	0.21	4.47	0.62
AG3	2.05	1.85	3.32	0.08	7.30	1.55
ARG	3.62	–0.03	1.15	0.52	5.27	1.65
BRA	5.83	0.23	3.95	0.20	10.20	1.54
MEX	–1.42	–0.46	–0.04	–0.14	–2.06	–0.60
OLA	2.64	0.13	1.26	0.09	4.12	1.23
SSA	1.32	0.07	1.22	0.04	2.66	1.41
MNA	9.56	1.14	10.77	–4.42	17.05	3.00
EIT	3.71	0.67	2.18	–0.37	6.20	0.82
XAS	3.44	0.03	1.63	0.34	5.45	1.33
EFTA	6.83	1.01	12.54	–2.52	17.86	5.73
IND	0.82	0.57	0.43	0.40	2.22	0.63
TUR	2.24	0.17	0.53	0.14	3.08	1.72
XCM	2.32	0.08	1.51	0.18	4.09	4.03
XSC	0.46	0.10	0.89	–0.09	1.37	1.28
DGC	45.68	7.20	38.09	–4.46	86.51	1.35
DEV	84.83	17.94	43.11	–4.59	141.29	0.78
WLD	130.51	25.14	81.20	–9.05	227.80	0.93
Memorandum: From P26 results						
BGD	n.a.	n.a.	n.a.	n.a.	0.39	0.90
XSA	n.a.	n.a.	n.a.	n.a.	0.98	1.51
MOZ	n.a.	n.a.	n.a.	n.a.	0.12	3.24
UGA	n.a.	n.a.	n.a.	n.a.	0.09	1.33
TZA	n.a.	n.a.	n.a.	n.a.	0.29	4.11

CRTS = constant returns to scale
n.a. = not available

Note: For definitions of the B25 and P26 economies, see the text above. For the meanings of the codes used for regions and economies, see table 4A.2 below.

Source: Author's calculations.

For services, the GTAP5 database includes tariff protection data for only one sector (electricity), and this tariff level is zero for most countries (Dimaranan and McDougall 2002, 4–6 to 4–11). This protection database thus clearly does not attempt to capture the large protection estimated in some other studies for the services sector (e.g., using departures from benchmark gross operating margins as proxies for services protection; see chapter 3). The trade liberalization estimates here should thus be interpreted as essentially referring to merchandise trade only.[13] Moreover, the protection database does not include estimates of the protective effect of antidumping measures, product standards, or other "process" protection instruments.

The estimates in table 4.1 tend to confirm several important stylized facts of trade liberalization. The first is that agriculture accounts for a major part of the remaining gains from opening trade. Of the total gains (prorating the "interaction effect"), agriculture accounts for 55 percent globally, 58 percent for industrial countries (DEV), and 50 percent for developing countries (DGC).[14] The high gains for industrial countries reflect removal of high protection, in the cases of the European Union, the European Free Trade Area (EFTA), and Japan, and benefits from major export opportunities opened up, in the cases of the United States, Australia–New Zealand, and Canada.[15]

Similarly, the results confirm that high protection in textiles and apparel means that they are second only to agriculture in providing potential gains from liberalization that are large relative to the trade base. Thus, moving to free trade in textiles and apparel would generate 31 percent as much in global welfare gains as would adopting free trade in all other manufactured and nonagricultural goods. This ratio is much higher than the respective shares in world trade (worldwide imports of textiles and apparel are only 7.3 percent of global imports of other manufactures and nonagricultural goods in the GTAP5 database).[16]

The results also confirm the view that developing countries have much to gain from global trade liberalization. Their combined gains from global free trade amount to about 1.4 percent of their GDP, about three-fourths

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13. Thus, the difference in world welfare gain from complete liberalization and liberalization excluding the services sector is only $0.090 billion.

14. DGC refers to all developing countries, the same group as referred to as LDC in Harrison, Rutherford, and Tarr (1996).

15. This is a distinct difference from the Harrison, Rutherford, and Tarr (1996) estimates for Uruguay Round cuts. In those results, the gains for agriculture are large for Japan and the European Union ($43.7 billion together), but relatively small for the United States, Canada, Australia, and New Zealand (a combined total of $2.9 billion). Although it is clear that free trade should generate much larger total gains in agriculture than the Uruguay Round (which was modeled in HRT as reducing agricultural tariffs by 36 percent in industrial countries and by 24 percent in developing countries), it is not clear why the composition of gains would have shifted so much toward the exporters in the free trade variant.

16. Total global imports (and exports) in the GTAP5 database for 1997 are $6.72 trillion. Agricultural and food products account for $321.2 billion; textiles and apparel, $385.5 billion; services, $758.8 billion; and other manufactures and nonagricultural goods, $5.25 trillion.

larger than the 0.78 percent of GDP gains for industrial countries.[17] The gains relative to GDP tend to be even higher for some of the countries identified separately in the poverty-oriented P26 grouping (with welfare gains reaching 3.2 percent of GDP in Mozambique and 4.1 percent in Tanzania). However, as recognized above, the absence of special treatment of non-MFN access already available to the LDCs and sub-Saharan African countries under various special regimes means that the estimates of welfare gains for some of these countries will tend to be exaggerated.

The positive results identified for developing countries differ in important ways from the earlier HRT finding using the same model that sub-Saharan Africa, the Middle East and North Africa, Eastern Europe, and Hong Kong would suffer welfare losses from liberalization in the Uruguay Round (Harrison, Rutherford, and Tarr 1996, 221).[18] They attributed these losses to adverse terms-of-trade effects for food importers in the face of reduced European Union and other subsidies for agricultural production, and to losses of quota rents for textile and apparel exporters as the MFA is dismantled. Neither of these broad diagnoses seems to be confirmed in the results here. Even though the earlier results were for Uruguay Round cuts only and could thus be expected to differ from estimates for free trade, the differing qualitative results suggest that extrapolating the earlier findings to full free trade could be misleading.

Thus, table 4.1 shows gains for all the developing-country regions that were identified as losing in the earlier HRT results. The findings here receive some additional support by virtue of their greater country detail, with separate estimates for several countries or regions not treated individually in the HRT Uruguay Round results (Bangladesh, BGD in the table; Central America, XCM; India, IND; Mozambique, MOZ; Pakistan, XSA; Tanzania, TZA; Turkey, TUR; and Uganda, UGA). The only developing countries to experience losses in the results here are Mexico (MEX, –0.6 percent of GDP welfare effect) and Malaysia (MYS, –0.02 percent). Mexico's loss is understandable as a reversal of the present strong preferential entry into the large US market under NAFTA, once free trade gives other suppliers equal status. Malaysia's loss is less transparent but in any case minimal.

17. The largest gains for industrial countries are for EFTA (comprising mainly Switzerland and Norway), where high protection of manufactures and especially agriculture means that free trade would raise welfare by 5.7 percent of GDP. Thus, the unweighted average import tariff in agricultural goods stands at 114 percent in Switzerland and 185 percent in other EFTA member countries (mainly Norway), compared with 51 percent for the European Union and 8.1 percent for the United States (Dimaranan and McDougall 2002, 4-10, and GTAP5 database).

18. Note that this study's implementation of the HRT model (using the software MRTMDL and MRTCAL) was first applied to their "full" Uruguay Round formula using their original regions and GTAP2 data, and successfully replicated the results reported in Harrison, Rutherford, and Tarr (1996). Comparisons of the results therefore should not be biased by nonreplication problems.

The loss in terms of trade for agricultural importers as diagnosed by the earlier HRT estimates does not seem to dominate welfare effects in the results here. The overall terms of trade do fall under the free trade scenario here for the three regions identified by HRT: by 0.4 percent for "other" sub-Saharan Africa (SSA),[19] 3.1 percent for the Middle East and North Africa (MNA), and 0.8 percent for Eastern Europe (EIT). Nonetheless, as noted, these three areas show net welfare gains from free trade. Table 4.1 shows, moreover, that the addition of agriculture to the sectors liberalized generates net welfare gains even for these three areas. The implication is that the welfare gains from increased efficiency of factor use are more important than the welfare losses from terms-of-trade movements. Once again in agriculture, only Malaysia and Mexico have negative welfare effects from agricultural liberalization in the estimates here.

Neither do the results here confirm the earlier HRT diagnosis of adverse effects for developing economies from textile and apparel liberalization. In the results here, as a group the developing economies gain $7.2 billion from this liberalization, concentrated in China ($1.64 billion), South Korea (KOR, $1.19 billion), Hong Kong–Singapore–Taiwan (AG3, $1.85 billion), and India ($0.57 billion). Although it is true that some developing countries lose (Indonesia, IDN; the Philippines, PHL; Thailand, THA; Argentina, ARG; and Mexico), their combined losses of $0.73 billion are far smaller than the gains of the developing countries that show positive welfare effects in the sector. These results are consistent with intuition, considering that the group of gainers is broadly the set of countries facing textile and apparel quota constraints, whereas the losers include Mexico, which already has open access to the US market, and other countries likely to be pressed by more competition as markets are opened to the East Asian suppliers.

Harrison, Rutherford, and Tarr (1996, 221) find instead that developing economies combined would experience a welfare loss of $2.3 billion in textiles and apparel from Uruguay Round liberalization, with the combined losses of South Korea, Hong Kong, Taiwan, and Singapore placed at $2.8 billion. Instead, in the results of table 4.1 here, these four economies experience combined gains of $3.0 billion in textiles and apparel. HRT emphasized that it was the loss of export tax revenue from the elimination of quotas that caused the sectoral losses for these East Asian suppliers.

An important difference between the GTAP5 database and the GTAP2 database used by HRT, however, is that the more recent database sharply reduces estimates of export tax equivalents of these quotas. For the supply from Asia and Latin America, the GTAP2 database used export tax equivalents of MFA quotas that averaged 14.7 percent and 20.3 percent

19. In this chapter, because "SSA," as specified here, refers to a code for a subset of only some sub-Saharan African countries, the abbreviation "SSA" is not used to refer to the region, as it is elsewhere in the book.

for textiles in the North American and EU markets, respectively, and 34 percent and 31.7 percent for apparel in the North American and EU markets, respectively (Yang, Martin, and Yanagishima 1997, 260). In contrast, in the GTAP5 database the corresponding export tax equivalents average only 2.7 percent for textiles and 5.7 percent for apparel (Dimaranan and McDougall 2002, 4-12 to 4-15).[20] The GTAP5 estimates rely in part on new surveys of quota-rent values in Hong Kong and China, and they expressly take into account the fraction of imports not covered by the quotas (François and Spinanger 2002).[21]

The downward revision of textile and apparel export tax equivalents is one important reason for the earlier estimated losses from liberalization to diminish or disappear. Another reason for the change is that the Uruguay Round tariff (as opposed to export tax) cuts simulated by HRT were quite modest for apparel imports into the United States (only a 9 percent cut in the tariff) and the European Union (a 13 percent cut). This is a sharp contrast to the free trade scenario of table 4.1 (a 100 percent cut). The overall effect is that the textile and apparel data and scenario in Harrison, Rutherford, and Tarr (1996) tended to overstate the negative effects for developing countries (by exaggerating the levels of export tax equivalents and hence export tax losses from liberalization) and understate the potential positive effects (by specifying small cuts in the tariffs in the key markets), or at least to overstate and understate in these areas relative to conditions in the late 1990s and relative to a free trade scenario.

Alternative Liberalization Scenarios

In order to approximate more realistic scenarios than complete free trade, and in addition to highlight some key issues such as whether developing countries should liberalize their imports, it is useful to consider alternative trade policy shocks using the PEHRT model. Once again, the B25 groupings are used as the most relevant basis for comparison, given their greater detail on several major trading nations than in the poverty-oriented P26 grouping.

20. In both cases, the averages here are unweighted. The GTAP5 data are for Asian and Latin American exports to all markets, but North America and the European Union (E_U) should dominate. Note that the export subsidies (rather than taxes) of Uruguay and "other South America" are excluded from the GTAP5 averages, as are the zero rates of Mexico in view of NAFTA.

21. The GTAP2 export tax equivalents had been based on East Asian market conditions in the mid-1980s and assuming 100 percent product coverage. To update, the GTAP2 authors cut the rates by 30 percent for three economies (South Korea, Hong Kong, and Taiwan) but left them unchanged for exporters on grounds that rising protection offset any overstatement from assumed 100 percent coverage. Rates were extrapolated to other regions based on assumed ratios to the rates for China (the most restricted East Asian economy) at, e.g., the full China rate for South Asia and one-half the China rate for Latin America (Gelhar et al. 1997, 94–95).

Table 4.2 Welfare effects of alternative trade liberalization scenarios (billions of dollars or percent of free trade potential)

Region or economy	2-tier liberalization		Asymmetric free trade		Differential liberalization		US Swiss formula with 50 percent agriculture cut	
	Dollars	Percent	Dollars	Percent	Dollars	Percent	Dollars	Percent
ANZ	2.72	29.7	7.20	78.5	2.56	27.9	1.27	13.8
CAN	1.93	43.9	2.43	55.4	2.78	63.2	1.00	22.8
USA	21.44	54.7	17.51	44.7	13.63	34.8	21.80	55.6
JPN	20.97	66.2	18.70	59.0	10.18	32.1	10.47	33.0
KOR	6.37	67.5	1.47	15.6	12.11	128.3	3.17	33.6
E_U	39.60	101.6	7.66	19.7	24.80	63.6	18.26	46.9
IDN	1.25	87.2	1.70	118.7	2.02	140.9	0.62	43.2
MYS	0.89	—	–0.15	—	2.15	—	0.49	—
PHL	0.19	16.1	1.53	127.7	0.51	42.6	0.11	9.2
THA	2.82	91.6	3.44	111.7	3.64	118.1	1.33	43.2
CHN	4.42	98.8	6.99	156.3	9.48	212.0	3.83	85.6
AG3	4.64	63.6	4.48	61.4	9.35	128.1	2.22	30.4
ARG	2.89	54.9	3.66	69.5	4.95	94.0	1.49	28.3
BRA	6.04	59.2	4.35	42.6	10.94	107.2	2.88	28.2
MEX	–0.59	28.6	–2.63	127.8	–0.15	7.3	–0.33	16.0
OLA	2.30	55.9	3.73	90.7	3.70	89.8	1.10	26.7
SSA	1.86	70.1	3.00	113.0	2.14	80.5	0.88	33.1
MNA	13.63	80.0	3.27	19.2	14.48	84.9	6.12	35.9
EIT	3.57	57.7	8.03	129.6	6.89	111.1	2.03	32.8
XAS	3.06	56.3	4.78	87.7	3.53	64.9	1.70	31.2
EFTA	17.44	97.6	15.52	86.9	16.19	90.6	7.55	42.3
IND	1.80	81.1	1.31	59.1	2.66	119.8	1.14	51.4
TUR	1.52	49.4	2.20	71.7	2.35	76.5	0.87	28.3
XCM	2.49	61.0	4.41	107.9	2.74	67.0	1.04	25.4
XSC	1.19	86.7	0.98	71.5	1.59	116.2	0.61	44.7
DGC	60.35	69.8	56.55	65.4	95.05	109.9	31.30	36.2
DEV	104.09	73.7	69.02	48.9	70.12	49.6	60.36	42.7
WLD	164.44	72.2	125.57	55.1	165.17	72.5	91.67	40.2

— = not meaningful because of near-zero free trade estimate

Note: For the meanings of the codes used for regions and economies, see table 4A.2 below.

Source: Author's calculations.

The first alternative scenario, two-tier liberalization, applies free trade to manufactures (and other goods, as well as the GTAP services sectors), but only a 50 percent cut in tariffs, export taxes and subsidies, and input subsidies for agriculture and for textiles and apparel. This scenario is designed to address the reality that these are the two broad areas of persistent hard-core protection. As shown in table 4.2, this scenario would achieve about two-thirds of the free trade potential for developing countries and almost three-fourths for the industrial countries. This gain ($164 billion globally) turns out to be somewhat more than would be calculated simply taking the full gains from manufactures and half of the gains from agriculture and textiles and apparel in table 4.1 ($159 billion). The PEHRT model thus exhibits mild nonlinearity of welfare effects in the direction that would be expected (greater proportionate welfare gains from cuts in higher tariffs), in contrast to the linear welfare effects in at least one recent CGE model (Brown, Deardorff, and Stern 2001).[22] The greatest shortfalls from the free trade potential in this scenario are in the main agricultural exporters (Australia–New Zealand achieve only 30 percent of potential, Canada 44 percent, and the United States and Argentina 55 percent).

There is an important departure from the general pattern of welfare effects in this scenario that is most evident in the case of the European Union. Its welfare gains are slightly *larger* with two-tier liberalization than in the case of free trade. Further examination with a run of the model applying a 60 percent cut in agricultural, textile, and apparel protection (rather than 50 percent) elicits a cluster of four other countries that also do better under two-tier than full liberalization. In the 60 percent case, the ratios of welfare gains to free trade welfare gains are as follows: China, 146 percent; European Union, 104 percent; and EFTA, India, and Indonesia, 102 percent. In sharp contrast, the corresponding ratio for all other countries is only 67 percent.

The explanation for the paradox for these five countries seems to be that their initial agricultural protection is so high that it is far above an optimum-tariff protection level; that as the protection is cut down to about 40 percent of its initial level, the increase in welfare to consumers increasingly exceeds any loss of terms of trade; but that as the protection is cut further, additional losses in terms of trade begin to dominate. This interpretation is consistent with the high level of protection identified for the European Union in chapter 3, at overall tariff-equivalent protection of 46 percent in agriculture. The significance of implicit optimum-tariff effects in the underlying HRT model is discussed below in connection with the differential liberalization scenario.

Some might interpret the findings for the two-tier scenario as evidence that it is not in the interest of the European Union to cut agricultural (and textile) protection by more than about 50 or 60 percent, because of optimum-tariff losses beyond that point. A more appropriate interpretation is that though there is little difference between such cuts and 100 percent cuts for the European Union, there is a large difference for other countries that would experience a considerable sacrifice of potential welfare gain in the two-tier as opposed to free trade outcome. The results nonetheless suggest the caveat that in trade negotiations, EU negotiators might be expected to seek increasing reciprocal opening in other products and dimensions as they are asked to make reductions in agricultural protection (in particular) that go well beyond the 50 to 60 percent range.

22. In static welfare estimates, the welfare cost of a tariff rises with the square of the tariff (see, e.g., Cline 1995).

The next alternative scenario is "asymmetric liberalization." In this case, industrial countries grant free trade in all sectors and eliminate agricultural input and export subsidies.[23] In contrast, developing countries do not change protection at all. Global welfare gains fall further, to only 55 percent of their free trade potential. Developing countries achieve only 65 percent of the welfare gains possible if they also liberalize their markets.

However, there is a somewhat surprising pattern in which a number of developing countries and regions actually increase their welfare gains above the levels under total free trade, including Indonesia, the Philippines, Thailand, China, SSA (but not South Africa, XSC), Eastern Europe, and Central America. These extra gains are more than outweighed by losses (relative to free trade) in other developing countries, especially South Korea, the East Asian Group of 3, Latin America, and the Middle East and North Africa.[24] The difference between the gainers and losers depends in part on their degree of dependence on developing-country markets in their exports. Thus, the seven developing countries showing gains relative to free trade have an average of 32.5 percent of their exports going to developing countries, whereas the eight showing relative losses have a corresponding average of 42.5 percent.[25] Similarly, the loss in welfare gains compared with free trade is greater for the European Union, for which 44.1 percent of (non-intra-EU) exports go to developing countries, than for the United States, for which 35.3 percent of exports go to developing countries, excluding its free trade partner Mexico.

The results of asymmetric liberalization contrast sharply with those in some other CGE studies in one crucial dimension: the share of potential gains achieved by developing countries even if they do not liberalize their own trade. This share is approximately the opposite of what is estimated in the World Bank Global Economic Prospects (WBGEP) model and the IMF–World Bank CGE runs. As shown in table 3.12 above, for static welfare effects the WBGEP model calculates that 59 percent of developing countries' potential gains stem from removal of their own protection, and only 41 percent from the elimination of protection by industrial countries.[26] In contrast, in table 4.2 it is found with the PEHRT model that only 35 percent of developing countries' potential free trade gains can be at-

23. Developing countries also eliminate export taxes on textiles and apparel, as industrial-country protection in these sectors including quotas is removed.

24. Note that the changes in the table for especially Malaysia but also Mexico are not meaningful, because both countries experience small welfare losses in the free trade base case, and a large "increase" in the welfare effect is thus an even larger loss (which can be manyfold because of the near-zero base).

25. This excludes the disparate rest of Asia grouping, XAS.

26. Total static welfare gains for developing countries are $184 billion annually at 1997 prices and 2015 economic scale. Of this amount, only $75 billion is attributable to liberalization by industrial countries.

tributed to their own liberalization, while 65 percent stems from liberalization by industrial countries.

This contrast carries important policy implications. Some commentators have criticized the developing-country Group of 21 (G-21) for having blocked the progress of the Doha Round negotiations at the Cancún ministerial meeting in September 2003 and have argued that this was self-defeating, citing (for example) the World Bank's estimates that 80 percent of developing-country potential gains in agriculture come from liberalizing their own agricultural protection rather than that of industrial countries (*The Economist*, October 6, 2003, 60). If the PEHRT results are correct, however, this argument tends to lose force, and the alternative argument gains strength: that the developing countries appropriately chose a confrontational strategy in an attempt to break open the industrial-country market for agricultural goods, in recognition that liberalizing export markets there was at least as important as achieving gains from liberalizing their own markets and their markets for each other.

The analysis below returns to this question. It is useful to note, however, that the "optimum-tariff" influence discussed below in explaining the results of other scenarios is also likely to play a part in the seeming mirror image of the PEHRT results from the World Bank results for the asymmetric liberalization scenario. The parameters applied tend to give the underlying HRT model somewhat stronger terms-of-trade and "optimum-tariff" effects than does the CGE model used by the World Bank. As discussed below, an even more important influence generating relatively higher importance for opening export markets in industrial countries than for opening own-import markets in developing countries is that the PEHRT model is comparative-static against today's world economy, whereas the World Bank model applies to a projected future world for 2015 in which industrial-country agricultural markets are relatively less important and developing-country markets for manufactures are relatively more important.

A third alternative scenario, "differential free trade," applies free trade in industrial countries except for limiting reductions in protection and subsidies to half their initial levels in agriculture and in textiles and apparel. For developing countries, protection is cut by only half in all goods, except that free trade is granted to imports from other developing countries. Global welfare gains in this variant are almost the same in the variant of two-tier liberalization, at about 72 percent of the total free trade potential. This time, however, nine developing countries and regions gain more than under full free trade, and because they tend to be larger economies than the eight that gain less than in free trade, overall the developing countries achieve about 10 percent larger welfare gains than in the full free trade scenario. In contrast, for the industrial countries, this scenario is as unfavorable as the asymmetric free trade case, with both generating slightly less than half the welfare gains possible under global free trade.

Finally, table 4.2 reports estimates for an approximation of the US proposal in the Doha Round of trade negotiations. That proposal calls for nonagricultural tariffs to be cut according to a particular "Swiss formula," namely: $t_1 = [t_0 \times 8]/[t_0 + 8]$.[27] For agriculture, the US proposal applies a more lenient formula (with the 8 replaced by 25), and moreover the formula does not apply to the tariff-quota rates (although the threshold volumes for these would be expanded at a target rate).[28] Because the extreme protection is in tariff-rate quotas, the overall effect of the agricultural proposal is moderate, so the scenario here simply models it as a cut of agricultural protection (including input and export subsidies) by half.

Global welfare gains in the US formula are the lowest of the scenarios considered, at only 40 percent of the free trade gains. This reflects the fact that the depth of liberalization is less in the US formula than in any of the other scenarios here, which all call for free trade in nonagricultural and non-textile-apparel goods on the part of at least the industrial countries. The gains are especially low for the developing countries under the US formula, at only 36 percent of the free trade potential.

The welfare-effect findings are provocative in that they indicate that developing countries might do better with less liberalization of their own markets than that offered by industrial countries. Although this might seem sensible to the layperson, it is somewhat counterintuitive to the economist. Usually even unilateral free trade will be better for a country than retaining protection, in the static welfare model, which emphasizes gains in consumer surplus from lower prices on imported goods. The main exception arises with the "optimum-tariff" argument, in which a country that unilaterally liberalizes its imports could experience a terms-of-trade loss, because by increasing its demand for the imported good, it would tend to drive up the price of the import; and by exporting more to pay for the increased imports, it would tend to drive down the price of its export. The optimum-tariff argument, however, is usually reserved for the case of a large country capable of influencing the world price.

Similarly, the relatively unfavorable results for developing countries in the US formula case appear largely to be the opposite side of the coin from the differential liberalization scenario. As a harmonization formula, the US formula cuts higher tariffs proportionately more than lower tariffs. Because they tend to have higher tariffs in manufactures than industrial countries, developing countries will be cutting their protection by a larger rather than smaller proportion than industrial countries in this scenario. So the optimum-tariff influences in the HRT model will act to their disfavor rather than to their favor, as in the differential liberalization scenario.

27. For example, a 10 percent tariff would be cut to 4.44 percent (= $[10 \times 8]/[10 + 8]$).

28. With this formula, a 10 percent tariff is cut to 7.1 percent, and a 50 percent tariff is cut to 16.7 percent.

Again, however, the question arises as to why optimum-tariff effects should apply to small countries.

The explanation of the paradox of optimum-tariff results for developing countries in the PEHRT model lies in its use of Armington imperfect substitution among goods. This assumption is required if there is to be two-way trade in a given good. But the imperfect-substitution assumption also in effect makes every country, no matter how small, capable of affecting the price of its export good. In this framework, it is possible for free riders to do better than full liberalizers, because they obtain the gains of lower prices on international supply without pushing down the prices of their own exports.

More specifically, Harrison, Rutherford, and Tarr (1997b) have shown that in trade models using the two-tiered Armington elasticity structure (e.g., the HRT model used here), with one tier for substitution between the domestic good and all imports of the good (σ_D) and a second tier for substitution among alternative country supplies of the import in question (σ_M), the optimal tariff is inversely related to the second-tier elasticity. The argument starts from the price elasticity of demand for the country's exports. For sectors in which the country has a small share in world supply, and with other countries having a uniform second-tier elasticity of demand among alternative suppliers equal to σ_M, this will also be the price elasticity of demand for the country's export (ε). The optimal export tax is $1/(\varepsilon - 1)$, which collapses to zero when foreign demand is infinitely elastic. The authors then appeal to the Lerner symmetry theorem (stating that an import tariff is equivalent to an export tax) to conclude that the optimal tariff equals $1/(\sigma_M - 1)$. Applying the uniform value of $\sigma_M = 8$ in the main runs of the HRT model here, the implied optimum tariff is $1/7 = 14$ percent. Because developing countries tend to have tariffs above this level, deep liberalization scenarios cut the tariffs below the optimal level, tending to erode the welfare gains from multilateral liberalization.

A test was conducted for the optimum-tariff causation of the better outcome for developing countries in the differential liberalization (DL) scenario by examining the terms-of-trade impact in comparison with free trade (FT). It was found that in all 19 developing-country areas in the B25 model, there was an increase in the terms of trade in the DL scenario relative to the free trade scenario, by a median 1.2 percentage point. Confirming this interpretation, for the industrial-country areas in the model, the changes in terms of trade were systematically less favorable under DL than under FT. Thus, US terms of trade rise 1.3 percent under FT but remain unchanged under DL; Australia–New Zealand's terms of trade rise 8.4 percent under FT but only 2.1 percent under DL; and Japan's terms of trade fall 0.6 percent under FT and fall 1 percent under DL.

A further test of the same issue (i.e., an optimum-tariff explanation for the puzzle of higher developing-country gains under DL than under FT) was carried out by magnifying the key second-tier substitution elasticity by 50 percent (raising σ_M from 8 to 12). With a higher elasticity, the optimum tariff should be lower. In this test, the ratio of developing-country welfare gains under DL to those under FT fell to 1.044, from a ratio of 1.10 in the base runs of tables 4.1 and 4.2. This shrinkage of the relative extra gains from differential liberalization as the import–import substitution elasticity increases further confirms the optimum-tariff interpretation of the more advantageous (for developing countries) results of the differential liberalization scenario.[29]

The results showing greater benefits for developing countries in the differential liberalization scenario should perhaps be taken with a grain of salt. Broadly, the experience of developing countries in the past several decades has tended to be one of unfortunate inefficiencies associated with domestic protection. The relationship of trade openness to growth performance is revisited in chapter 5. For the purposes of the present chapter, however, the specific alternative-scenario results warrant consideration from the standpoint of forcing one to think further about the usual free trade recommendation, but they probably do not warrant a strong inference that partial (free-rider) liberalization would be better than full liberalization for the developing countries. In any event, for the developing countries as a whole, differential liberalization gives gains that are just 10 percent higher than gains under free trade. Moreover, it is crucial to keep in mind that in the differential liberalization scenario developing countries do grant free trade access to imports from each other.

Developing-Country Versus Industrial-Country Liberalization Impact

As highlighted in the discussion above of the results of asymmetric liberalization, a key issue for global trade policy is whether the potential gains for developing countries stem primarily from the opening of their own import markets, primarily from the opening of industrial-country markets for their exports, or a relatively balanced combination of the two. Differing perceptions generate different views of what type of reform is "fair." Some of those who believe that the great bulk of potential developing-country gains can be achieved by their own unilateral liberalization will naturally be led to question why the developing countries should risk the collapse of the Doha Round by insisting on the deep liberalization of

29. In the high import–import elasticity runs, developing countries achieve welfare gains of $110.2 billion under free trade and $115 billion under differential liberalization. Industrial countries achieve gains of $159 billion under free trade but only $85 billion under differential liberalization. Thus, whereas the ratio of developing-country to industrial-country welfare gains goes from 0.61 under FT to 1.36 under DL in the base runs (tables 4.1 and 4.2), this ratio goes from 0.69 under FT to 1.12 under DL in the higher import–import elasticity runs. This narrowing of the relative free-rider benefits for developing countries goes in the expected direction from the curbing of terms-of-trade (or optimum-tariff) effects by the use of a higher elasticity.

industrial-country agricultural markets, a risk that arose in the collapse of the Cancún ministerial meeting of the WTO in September 2003 over this issue as well as the new "Singapore issues" (investment, competition, government procurement, and trade facilitation).

In a partial equilibrium model in which world supply is assumed to be perfectly elastic (horizontal world supply curve for imports) and the products are homogeneous, welfare gains from global trade liberalization arise solely on the import side. In a general equilibrium model in which the export good is differentiated, a reduction of foreign protection increases the demand for and price of the export good. In this case, simple consumer welfare gains from lower protection (consumer welfare triangles) must be compared with terms-of-trade effects that arise from an induced rise in exports needed to cover the additional import bill after liberalization. In this context, whether the foreign trading partner liberalizes will have an important effect in avoiding a terms-of-trade loss (or achieving a terms-of-trade gain).

The HRT model appears to have strong welfare gains on the export side, reflecting terms-of-trade gains from increased demand in newly opened export markets. The cleanest test of this proposition is the case of the HRT results for Singapore, which has zero protection in 37 of the 42 GTAP5 merchandise trade categories and average protection of less than 9 percent in the other 5 (which are agricultural sectors). With near-zero protection overall, Singapore should gain nothing from global trade liberalization in a partial equilibrium world with homogeneous goods, because it has no tariffs to reduce and hence no unexploited consumer welfare triangles to harvest. Yet in the HRT model results for the Uruguay Round effects, Singapore turns out to have one of the largest welfare gains of any country, at 2.1 percent of GDP (Harrison, Rutherford, and Tarr 1996, 221).

As noted above, the WBGEP model finds that about 60 percent of developing countries' potential welfare gains from global free trade arise from the liberalization of their own markets. In contrast, the results of the PEHRT model for asymmetric liberalization (table 4.2) suggest that 65 percent of developing countries' potential gains come instead from increased export opportunities associated with the liberalization of industrial-country markets. The sources of this divergence are analyzed below. First, however, it is important to recognize that the attribution question of whose liberalization confers the benefits on developing countries suggests that even the question itself is inherently ambiguous. The answer will depend on whether the scenario tested involves liberalization by developing countries only, liberalization by industrial countries only, or some combination.

The World Bank (2002a, 171) presents free trade attribution results that are noncontingent and strictly additive, in the following sense. With W_{ijk} as the welfare effect of free trade in sector i (e.g., agriculture) conferred by the liberalization of market j (e.g., industrial countries as a group) and received by group k (e.g., developing countries), global welfare is simply $W = \Sigma_{ijk} W_{ijk}$. To report such results requires the implicit assumption that the welfare impact of developing countries' own liberalization is independent of whether industrial countries liberalize, that the welfare gains from agricultural liberalization are independent of whether manufactures are liberalized, and so forth.

A further analysis suggests instead that decomposing the welfare gains by source generates a range of estimates contingent on how the question is posed. We seek to estimate what fraction of developing-country total gains can be attributed to their own liberalization. One way to pose this question is as is done in table 4.2: Compute asymmetric liberalization in which developing countries do not liberalize, and subtract the results from the estimates for total free trade in order to estimate the additional contribution attributable to developing countries' own liberalization. This formulation of the question attributes only 35 percent of total potential developing-country gains to the liberalization of their own markets (i.e., table 4.2 shows 65 percent of potential free trade gains occurring even with developing countries leaving their own protection intact).

Now suppose instead that the scenario is reversed and that only developing countries liberalize while industrial countries are the free riders. In this reverse asymmetry scenario, global static welfare gains are \$100.45 billion, of which \$41.11 billion is for developing countries and \$59.34 billion is for industrial countries. When this is the viewpoint, developing countries' own liberalization generates 48 percent of the total free trade potential. There are two main points. First, these estimates from the PEHRT model are in a range of 35 to 48 percent, well below the 60 percent point estimate in the WBGEP model as the share of potential total gains attributable to developing countries' own liberalization. Second, a single point estimate for such source-of-gain attribution does not seem to be well defined. One can estimate own-liberalization effects on each side with zero liberalization on the other and obtain two alternative estimates of the fraction of global free trade gains attributable to the group's own liberalization. The two different answers arise because in one case the developing countries are the ones that gain from the optimum-tariff (terms-of-trade) effects of being the free riders, whereas in the other case it is the industrial countries that obtain these gains. The source-attribution question would thus seem inherently to require a range answer rather than a point estimate answer.

Table 4.3 shows the range of source estimates corresponding to this diagnosis, using the PEHRT (B25) model. Row A shows welfare gains when only developing countries (DGC) liberalize (reverse asymmetry). Row B shows gains when only industrial countries (DEV) liberalize (the asymmetric liberalization scenario above). Row C shows the simple sum of the first two. Row D shows the results for joint global free trade, in which both

Table 4.3 Decomposition of static welfare gains between developing and industrial countries

	Beneficiary					
Liberalizing area	DGC (billions of dollars)	Percent of DGC total	DEV (billions of dollars)	Percent of DEV total	Total (billions of dollars)	Percent of global free trade
A. DGC only	41.11	47.5	59.34	42.0	100.45	44.1
B. DEV only	56.55	65.4	69.02	48.8	125.57	55.1
C. Simple sum	97.66	112.9	128.36	90.8	226.02	99.2
D. Global free trade	86.51	100.0	141.29	100.0	227.80	100.0
E. Interaction effect	–11.15	–12.9	12.93	9.2	1.78	0.8

DGC = developing countries
DEV = industrial countries

Source: Author's calculations.

sides liberalize. And row E shows the divergence of global free trade results from the simple sum of the two asymmetric scenarios.

As the table shows, row A attributes 47.5 percent of potential free trade gains for developing countries to their own liberalization. In contrast, row B arrives at 34.6 percent for the same source-attribution estimate. (That is, in row B, 65.4 percent of total potential developing-country gains are obtained when only the industrial countries liberalize, implying that only 34.6 percent of potential gains for developing countries arise from their own liberalization.) The simple sum of the two asymmetric scenarios *exceeds* the global free trade potential, for developing countries, because interaction effects tend to erode their gains. There is a mirror image pattern for gains in industrial countries, where global free trade generates a larger welfare outcome than the simple sum of the two unilateral (or asymmetric) cases. At the world level, the interaction term disappears, and global gains for total free trade are virtually the same as the sum of the two asymmetric cases.

In sum, the results here suggest that about half to two-thirds of developing countries' potential gains from multilateral free trade arise from increased opportunities in industrial-country markets rather than from the efficiency effects of liberalizing their own markets and the terms-of-trade effects of obtaining full access to each others' markets. Three further runs of the PEHRT (B25) model for agriculture alone do show a greater relative weight of developing countries' own-market impact on their gains, but once again to a lesser degree than in the World Bank estimates. Thus, free trade in agriculture alone generates global gains of $120.0 billion, developing-country gains of $40.3 billion, and industrial-country gains of $79.7 billion.[30] When only developing countries liberalize agri-

30. These "direct" agricultural estimates are close to the "indirect" agricultural estimates in table 4.1. The difference is that in table 4.1, the sector's contribution is obtained by subtracting from global free trade results the results with the sector in question excluded from liberalization.

culture, the respective gains are $31.5 billion, $22.8 billion, and $8.7 billion. When only industrial countries liberalize agriculture, the respective gains are $85.4 billion, $17.4 billion, and $68.0 billion. For this sector, both of the asymmetric estimates generate virtually the same result for the developing-country gains attributable to the liberalization of their own agricultural markets ($22.8 billion for the reverse-asymmetric case, and $40.3 – $17.4 = $22.9 billion for the asymmetric case). These own-liberalization gains amount to 57 percent of the total in agriculture for developing countries. Even though in agriculture the developing countries thus obtain more than half of their potential gains just by freeing their own markets, this share remains well below the 80 percent estimated for the agricultural sector by the World Bank (2003, 51).

A similar but even more extreme finding is obtained in a recent study by the OECD (2003c). Using the standard GTAP CGE model (Hertel 1997), the OECD authors obtain a benchmark estimate of $97 billion as annual global static welfare gains from removing all tariffs.[31] In this model, the developing countries obtain the greater part of global gains ($68 billion, or 70 percent). More dramatically, the sourcing of developing-country gains comes heavily from the removal of protection in industrial-country markets ($59 billion, or 79 percent of developing-country total gains).[32] Perhaps most dramatic, industrial countries obtain more than the entirety of their gains from increased export opportunities in developing-country markets ($31.6 billion), because their terms-of-trade losses mean that the liberalization of their own markets generates net negative effects (of $2.8 billion).

The differences between the OECD, WBGEP, and PEHRT model attributions for the source of developing-country gains appear to stem in considerable part from the different values used for the (Armington) elasticity of substitution between alternative sources of import supply. As discussed above, this elasticity turns out to drive the optimum tariff. In this study's PEHRT model, this elasticity is set at a uniform value of 8. In contrast, the simple average of the sectoral values for this elasticity in the OECD study is 5.6, almost identical to that in the standard GTAP model.[33] This means that that the implicit optimum tariff in the OECD model is 1/(5.6 – 1) = 21.7 percent, higher by about half than in the PEHRT model. This difference would appear easily large enough to explain why the OECD model has much stronger terms-of-trade effects than the PEHRT model, and correspondingly why the OECD results attribute the great bulk of developing-country gains from multilateral liberalization to the opening of industrial-country markets.

31. The study estimates that this gain is additional to an initial $18 billion from completion of tariff-cut implementation of Uruguay Round cuts beyond those already adopted as of 1998, the GTAP database year.

32. Like the World Bank, the OECD is silent on the question of source-attribution ambiguity.

33. Douglas Lippoldt, OECD, personal communication, November 28, 2003.

On the other side, the average for the import-import substitution elasticity in the WBGEP model is 8.8 (van der Mensbrugghe 2004). The implication is that whereas the OECD model has a much higher optimum tariff than the PEHRT model, the PEHRT model has only a modestly higher optimum tariff than the WBGEP model.[34] Although there is no close agreement among CGE modelers about the appropriate value for this elasticity, the fact that the PEHRT elasticity is intermediate between the OECD and WBGEP values provides some comfort that the estimates are not substantially biased in one direction or the other. Moreover, recent econometric estimates by a key author of the GTAP model used by the OECD suggest that the proper average value for the elasticity of substitution between alternative sources of imports is approximately 7, rather than the lower value of 5.3 in the basic GTAP parameter set (Hertel, Hummels, et al. 2003).

Nonetheless, for the PEHRT versus WBGEP results, the divergent values for the import–import substitution elasticity are insufficient to explain fully the difference in attribution of developing-country welfare gains between industrial- and developing-country liberalization. Instead, there are two other more dominant sources of this divergence.[35] First, the WBGEP model (LINKAGE) essentially deals with the world as it is projected to be in 2015, not 1997. A major difference by 2015 is that China and other major developing countries will represent a far larger share of world output than they do today. Moreover, because developing countries tend to have high protection in manufacturing, and because their economies will evolve toward larger shares of manufacturing, the result is that their share in protection-weighted global production will rise even more, above the share of developing countries in protection-weighted production today.

This ballooning of developing countries' measured share in the amount of global protection is accentuated further by a second model difference. The HRT model has "Cobb-Douglas" consumption, which holds each sector's share constant as income rises, reflecting an income elasticity of unity for each sector in consumption. The WBGEP model instead uses a consumption structure with an extremely low income elasticity for agricultural goods, for industrial countries.[36] The result is that agricultural demand falls sharply as a share of industrial-country consumption in the baseline projection to 2015. Yet agriculture is the high-protection sector for industrial countries. So the effect is to shrink the share of highly protected goods in the projected market of industrial countries.

34. The optimum tariff stands at 21.7 percent, 14.3 percent, and 12.8 percent for the three models respectively, based on values for σ_M of 5.6, 8.0, and 8.8, respectively.

35. I am indebted to Dominique van der Mensbrugghe (2004) for special runs of the WBGEP model to elucidate the differences and similarities of the two models.

36. WBGEP-LINKAGE uses an Extended Linear Expenditure System and places the income elasticity for agricultural goods at only about 0.04 for the industrial countries.

With the future-year basing of the WBGEP model involving the relative expansion of high-protection developing-country market shares and the relative contraction of high-protection industrial-country market shares, it is not difficult to understand why the World Bank projects that the liberalization of developing-country markets becomes the main potential source of welfare gains from trade liberalization. The question then becomes whether this approach or the comparative-static approach in PEHRT based on today's global economic profile is more relevant for policy purposes. Implicitly, the PEHRT model is more ambitious in reflecting the consequences of immediate liberalization, whereas the WBGEP model is much more gradualist in achieving free trade only by 2015. The World Bank approach may be closer to political reality, but it would seem further removed from the proper basis on which to make statements about whose protection—that of the developing countries or that of the industrial countries—is more important *today* in thwarting welfare gains that otherwise could be obtained by developing countries. The answer to that question, which is the question that is relevant for the current trade debate, would seem more accurately to be provided by the PEHRT results than by the WBGEP results. Even so, as emphasized by van der Mensbrugghe (2004), in most regards (of particular importance, including the magnitudes of the overall welfare effects and their division as between developing and industrial countries), when scaled to the same base year, the PEHRT and WBGEP results are quite similar.[37]

Relative Level of Protection

There is, of course, one case in which developing countries would be unambiguously responsible for failing to harvest the gains of free trade: if their protection were extremely high already and industrial-country protection were extremely low. In this case, even a model sensitive to export demand and terms of trade would not pick up much gain beyond the unilateral liberalization of developing-country imports. This is not the reality, however. In general, industrial countries tend to have higher protection than developing countries in agriculture, whereas the reverse is true for manufactures other than textiles and apparel.

Table 4.4 reports average tariff levels in industrial and developing countries for all merchandise trade divided into four groups: agriculture and food, textiles and apparel, all other manufactures, and energy (mainly oil) and nonagricultural raw materials. These tariff levels are from the GTAP5 database (Dimaranan and McDougall 2002, 4-6 to 4-11), and they include

37. Thus, the WBGEP model, which as a dynamic recursive model incorporates new investment over time, has an aggregate welfare effect of global trade liberalization that, after scaling back to 1997 economic level, is intermediate between the static and the steady state versions of the PEHRT model (i.e., the results in tables 4.1 and 4.5).

Table 4.4 Most-favored nation tariff protection, 1997–98 (percent)

Economy group	Agriculture, food	Textiles, apparel	Other manufactures	Energy, nonagricultural raw materials
Industrial countries[a]	35.6	11.6	3.1	0.1
Australia	3.7	22.1	4.4	0.0
Canada	30.4	18.0	4.1	0.1
European Union	32.6	10.6	4.3	0.0
Japan	76.4	10.2	1.2	0.0
New Zealand	5.6	15.4	5.7	0.0
Norway	153.5	15.3	3.8	0.2
Switzerland	118.9	1.9	0.2	1.0
United States	8.8	12.1	2.8	0.1
Developing economies[a]	30.3	18.2	11.5	0.7
Bangladesh	19.8	29.0	17.7	0.9
China	29.9	27.9	15.3	0.5
Hong Kong	0.0	0.0	0.0	0.0
India	31.5	31.6	24.6	1.1
Indonesia	19.6	19.2	11.5	0.6
Korea	50.7	7.9	6.9	0.4
Malaysia	17.8	16.9	10.2	0.4
Philippines	19.2	17.0	8.7	0.7
Singapore	4.2	0.0	0.0	0.0
Sri Lanka	36.7	30.8	18.1	5.7
Taiwan	17.2	8.9	6.5	0.4
Thailand	33.3	31.7	16.7	0.8
Vietnam	22.5	38.2	14.2	1.2
Argentina	12.5	18.6	14.0	0.2
Brazil	22.9	17.6	15.4	0.4
Chile	13.5	11.1	10.9	2.0
Colombia	14.7	18.0	11.9	0.8
Mexico	22.1	22.8	10.8	1.0
Peru	15.0	17.2	12.1	2.1
Venezuela	14.6	18.0	12.6	1.0
Hungary	33.3	10.8	7.9	0.2
Poland	59.0	18.9	12.3	0.5
Turkey	43.6	8.3	6.4	0.1
Morocco	57.3	31.5	14.6	0.2
Botswana	7.0	7.6	5.7	2.6
Malawi	20.9	36.3	21.4	0.1
Mozambique	17.6	31.0	13.1	0.6
South Africa	37.8	19.3	7.8	0.2
Tanzania	22.8	17.3	20.3	2.2
Uganda	20.2	19.2	14.6	2.3
Zambia	14.0	21.8	13.5	2.4
Zimbabwe	25.3	50.9	20.7	2.8

a. Weighting by average of shares in group GDP and trade turnover.

Source: GTAP5, using world output weights (Dimaranan and McDougall 2002).

the effect of tariff-rate quotas in agriculture. However, they exclude the effect of agricultural subsidies and MFA quotas in textiles and apparel. Within each broad product group, product subsectors are weighted by their respective shares in global production (Dimaranan and McDougall 2002, 3-1 to 3-5). For the aggregate estimates for industrial and developing countries, respectively, the individual country or region tariff averages in all product categories are weighted by an average of the country's share in world output and its share in trade turnover (exports plus imports) in the world total (Dimaranan and McDougall 2002, 2-4 to 2-5, and GTAP5 database).[38]

There are two principal patterns of protection in table 4.4. First, the sectoral ranking of protection is remarkably similar across both industrial and developing countries. Protection is highest in agriculture, relatively high in textiles and apparel, somewhat lower in all other manufactures, and close to zero for oil and other nonagricultural raw materials. Actual protection is even higher in the first two categories because of the exclusion of subsidies and MFA quotas. The second broad pattern is that protection tends to be higher in agriculture in industrial countries and higher in manufactures in developing countries.

These data confirm the estimates in chapter 3 in suggesting that there is sizable protection in especially agriculture but also textiles and apparel in industrial countries. Correspondingly, one should expect that a sizable fraction of welfare gains to developing countries from global liberalization should arise from the opening of industrial-country markets in these sectors, especially considering that they are precisely the sectors in which developing countries tend to have a comparative advantage. A parallel implication is that one should be cautious about model results that show a very limited role for industrial-country liberalization in potential gains for developing countries from global free trade.

Table 4.4 also shows, however, that protection remains relatively high in developing countries (though by no means as high as in the heyday of import-substituting industrialization in the 1970s). It is therefore reasonable to expect that industrial-country negotiators will insist on some degree of reciprocal liberalization by at least middle-income countries (including China and low-income India) in the process of the Doha Round negotiations.[39]

Dynamic Effects

In addition to the CRTS and IRTS static variants of the HRT model (of which only the CRTS is used in PEHRT), there is a Steady State (SS) vari-

38. This excludes intra-EU trade for the trade turnover weights.

39. Whether China's liberalization already undertaken as the price of WTO entry will suffice for this purpose is unclear.

ant designed to capture one important dimension of dynamic effects. In this version, instead of holding total factor endowments for each economy constant, the model stipulates that there is an expansion of the capital factor sufficient to bring the postliberalization rate of return on investment back down to the preliberalization rate. The idea is that over an undefined medium-term horizon, firms can be expected to respond to the new opportunities offered by trade liberalization by making new investments, thereby raising the capital stock. The welfare gains in this approach to measuring dynamic effects must be interpreted with care, because they are not a windfall gain but require additional resources. Nonetheless, they help establish a range that shows how large total effects, including dynamic responses, might be. Although Harrison, Rutherford, and Tarr (1996) do not do so, it is possible to interpret the SS results further in terms of net welfare gains by imputing an opportunity cost of capital to the extra capital resources estimated and by deducting this cost from the total SS welfare gains.

The return on investment in the HRT model depends on two influences. The first is the real factor price of capital (i.e., "rental price" or "real return"). The second is the "price of a new unit of investment." The SS version of the model expands the capital stock until the ratio of the rental price of capital to the price of a new unit of investment falls back to its preliberalization level. The source of this effect can be a rise in the rental price of capital, a decline in the unit price of investment, or both. For developing countries, removing protection against imported capital goods can be a major source of an increased attractiveness of investment, because it reduces the denominator of this ratio.[40] It is somewhat more counterintuitive that the rental price of capital (the numerator) can also rise, considering that the Stolper-Samuelson theorem in its extreme form would imply an absolute reduction in the rental price of capital for developing countries where capital is relatively scarce (Stolper and Samuelson 1941).

In the HRT model, however, the rental price of capital can rise from liberalization even for developing countries, although typically it will rise by less than the price of unskilled labor, yielding a change in the relative factor prices in the Stolper-Samuelson direction.[41] Important influences in the HRT model that are not present in the extreme version of the Stolper-Samuelson model include four production factors instead of just two: terms-of-trade effects as foreign markets are opened and imperfect substitutability between the domestic good and the imported variety. These and perhaps other influences make it possible for the absolute level

40. This is a common finding of CGE models of global trade liberalization. Thomas Hertel, personal communication, October 23, 2003.

41. Thomas Rutherford, personal communication, November 5, 2003.

of the rental price of capital to rise in the HRT model even for developing countries.[42]

Table 4.5 shows the results of applying the HRT SS model to the PEHRT regions using the GTAP5 trade and protection data. The gross welfare gains are far larger than the static CRTS gains, amounting to $613.8 billion globally, or 2.5 percent of 1997 world GDP. The gains are especially large for developing countries, reaching 5.5 percent of GDP on average and as high as an estimated 12.6 percent for Central America and 31.2 percent for Thailand. Although the latter case appears to be an aberration, the overall pattern is one of relatively large gains.[43]

It is evident in table 4.5, however, that these large gross welfare gains come at the expense of a considerable increase in capital stock. The percentage increases in capital stock are shown in the third column. Weighting by GDP, for developing countries capital stock would rise by 15.8 percent, and for industrial countries by 2.15 percent. In order to estimate net welfare gains after taking account of the opportunity cost of the additional capital, it is possible to apply capital-output ratios to the various economies and regions (taken from Cline 1997, 183). These ratios are typically in the range of 3. The fourth column in table 4.5 shows the rise in capital stock expressed as a percentage of GDP, obtained by multiplying the percent rise in capital stock by the economy's capital-output ratio.

The final two columns report net welfare gains after deducting the annual opportunity cost of the extra capital, which is imputed using a real interest rate of 7 percent.[44] The net welfare gains are still relatively high at $343 billion globally, compared with a $604 billion gross welfare gain. The net welfare gains in the SS version are 50 percent larger than the global welfare gains in the static version of the model ($228 billion, table 4.1). The increment is higher for developing countries, however. For these countries, the net welfare gains in the SS version reach $162 billion, or 2.5 percent of GDP. This is about 90 percent more than the $87 billion (1.35 percent of GDP) in the static version.

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42. Brown, Deardorff, and Stern (2001) report similarly that "we routinely find in our CGE modeling that both labor and capital gain from liberalization" (p. 9). They emphasize the "additional sources of gain from trade due to increasing returns to scale, competition, and product variety . . . [which] are shared across factors."

43. As before, the table includes the SS estimates for five additional country-detail cases from the P26 run of the SS model, which as before generates a result very close to that for the B25 groupings (global welfare gain of $608 billion annually, compared with $614 billion in the B25 version). For the case of Thailand, the outsized estimate likely reflects the fact that in the GTAP5 database the share of capital (including resources) in total factor payments is an inordinately large 80 percent.

44. The estimation of a net welfare effect deducting cost of capital is not part of the underlying HRT model.

Table 4.5 Steady state welfare gains from free trade (billions of dollars, percent of GDP, and percent change in capital stock)

Region or economy	Billions of dollars	Percent of GDP	Percent change in capital	dK as percent of GDP	Net change in welfare[a]	
					Billions of dollars	GDP
B25						
ANZ	21.90	5.76	11.32	37.58	11.89	3.13
CAN	6.53	1.34	1.80	4.88	4.86	1.00
USA	80.23	1.17	1.92	5.22	55.06	0.80
JPN	44.25	1.18	1.78	5.85	28.92	0.77
KOR	16.44	4.20	17.88	48.44	3.17	0.81
E_U	89.34	1.41	1.90	5.69	64.02	1.01
IDN	7.06	3.64	13.98	33.28	2.55	1.31
MYS	3.21	3.73	22.91	54.53	–0.07	–0.09
PHL	3.91	4.91	14.81	35.25	1.95	2.44
THA	43.39	31.16	67.03	159.53	27.84	19.99
CHN	6.46	0.90	14.14	33.51	–10.45	–1.45
AG3	16.06	3.42	9.69	26.27	7.42	1.58
ARG	15.66	4.89	11.53	34.93	7.83	2.44
BRA	40.13	6.04	12.85	38.94	22.02	3.32
MEX	3.47	1.02	3.41	10.04	1.07	0.31
OLA	27.32	8.16	17.92	54.31	14.60	4.36
SSA	13.90	7.36	19.80	51.48	7.09	3.75
MNA	50.60	8.91	18.40	47.83	31.58	5.56
EIT	24.55	3.26	10.82	36.24	5.44	0.72
XAS	26.90	6.58	18.20	43.31	14.51	3.55
EFTA	20.98	6.73	6.37	21.14	16.37	5.25
IND	23.86	6.74	21.99	51.46	11.10	3.14
TUR	9.76	5.45	9.72	25.28	6.59	3.68
XCM	12.72	12.55	37.42	113.37	4.67	4.61
XSC	5.22	4.88	13.10	34.06	2.67	2.49
DGC	350.62	5.48	15.75	42.18	161.59	2.52
DEV	263.22	1.45	2.15	6.46	181.13	1.00
WLD	613.84	2.50	5.70	15.77	342.71	1.40
Memorandum: From P26 results						
BGD	1.72	3.94	13.66	32.52	0.73	1.67
XSA	14.11	21.72	69.07	164.39	6.64	10.21
MOZ	0.38	9.84	25.99	67.84	0.20	5.09
UGA	0.32	4.90	13.37	34.89	0.16	2.45
TZA	0.91	12.89	33.10	86.40	0.48	6.84

dK = change in capital stock

a. At a capital cost of 7 percent.

Note: For definitions of the B25 and P26 economies, see the text above. For the meanings of the codes used for regions and economies, see table 4A.2 below.

Source: Author's calculations.

It could be argued that any excess of the SS welfare gains over the static gains should not be considered because capital markets already optimize the intertemporal choice between consumption and investment. Under this argument, any induced-investment effect from free trade bears an extra cost that fully offsets the additional welfare gains.[45] However, this argument would seem to miss the point that trade liberalization is a positive shock that alters the optimal intertemporal saving equilibrium by boosting the rate of return to investment. Even if the intertemporal equilibrium is optimal ex ante, it will no longer be so ex post as free trade opens up new opportunities.

Consider the analogy of a technological breakthrough, such as the invention of the steam locomotive. It would make no sense to discard welfare gains from such an invention on the grounds of the intertemporal equilibrium argument, that the extra investment required by definition has a cost that fully offsets the potential gains from applying the innovation. Neither should this argument be invoked to discard welfare effects from induced investment in the case of trade liberalization, as long as a reasonable opportunity cost has already been applied to the capital required. In the estimates here, the 7 percent real rate for capital opportunity cost is relatively high, so ample allowance has already been made for the capital costs of the induced investment.[46]

It should be noted, finally, that Rutherford currently considers that the calibration of the HRT model in Harrison, Rutherford, and Tarr (1996; the model used here) may have generated excessive SS welfare estimates.[47] In a balanced SS growth path, the gross rental value of capital would be the stock of capital multiplied by the SS interest rate plus the depreciation rate. The level of gross investment would be the stock of capital multiplied by the SS growth rate plus depreciation. With reasonable values for growth (e.g., 2 percent), real interest rate (5 percent), and depreciation (7 percent), the ratio of gross capital rental value to gross investment would be about 1.3. The benchmark calibration of this ratio instead placed it considerably higher (at about 1.8).

At the same time, the more fundamental question is whether the SS model overstates the dynamic effects of trade liberalization. Rutherford and Tarr (2002) develop a dynamic version of the HRT model that incorporates productivity gains, driven by an increased number of "varieties" of inputs in a Dixit and Stiglitz (1977) framework. In that model, welfare gains from trade liberalization are far higher than in the traditional static welfare estimates.[48] So whereas the Harrison, Rutherford, and Tarr (1996)

45. This view is held by Dani Rodrik; comment on a draft of this study; personal communication, October 20, 2003.

46. For example, during the 1990s the 10-year US Treasury bond had an average nominal interest rate of 6.4 percent. Average inflation was 2.8 percent, so the average real interest rate was 3.5 percent, only half the rate used here.

47. Personal communication, November 5, 2003.

48. Their central estimate in the dynamic productivity model is that a 10 percent tariff cut leads to a 10.6 percent increase in welfare, far higher than in the traditional static welfare triangles method.

SS model may in retrospect overstate potential dynamic gains from the standpoint of induced investment, the authors would now consider that it substantially understates total dynamic gains by not incorporating the productivity gains associated with increased varieties of inputs.

In short, in the context of the overall set of models developed by these authors, the estimates of net welfare effects in the SS version in table 4.5 are likely to understate rather than overstate the overall dynamic effects. For the purposes of the present study, in chapter 5 a specific attempt is made to estimate the dynamic productivity gains separately. Only half of the estimated SS net welfare and poverty effects are used in the consolidated estimates of that chapter, making some allowance for possible overstatement in the model calibration along the lines just reviewed, as well as for possible limits to the feasibility of mobilizing the additional capital for the potentially induced investment.

Factor Price Effects

The PEHRT model's estimates of changes in factor prices form the basis for the estimates of the impact of trade liberalization on global poverty. Table 4.6 reports the estimated percentage changes in real factor prices resulting from free trade in the CRTS static model.

Because the HRT model generates only relative price changes against a "numeraire," it is necessary to subtract the change in the numeraire price from all factor price changes calculated. In the model, the US representative agent consumer is the numeraire entity. The unit price of consumption in the United States falls by 0.7 percent in the free trade results, so 0.7 percent is added to the price changes reported in the HRT results to obtain the real factor price changes presented in table 4.6.

The factor price changes generally go in the expected direction.[49] The expected (Stolper-Samuelson) change in relative factor prices, with an increase of the relative price of the country's relatively abundant factor—inherent in the Heckscher-Ohlin model of international trade based on relative factor abundance—is evident in the estimates in that the change in the price of the country's most abundant factor tends to rise the most. This effect is dramatic in the case of land, where the changes are large. There are increases of well over 100 percent in the real price of land for Australia–New Zealand (ANZ) and Canada (CAN), a rise of more than 50 percent for South Africa (XSC), and increases on the order of 25 to 35 percent in the five Latin American countries or subregions and Tanzania. The

49. For the purposes of discussing relative factor price changes, the direct estimates in table 4.6 are cited for convenience. As discussed below, however, these are subsequently adjusted to ensure consistency with the overall welfare estimate, for the purposes of estimating the poverty impact.

Table 4.6 Impact of free trade on real factor prices and welfare: CRTS static model (percent change)

Region	Land	Unskilled labor	Skilled labor	Capital and resources	Weighted sum	Welfare	Lambda
B25							
ANZ	124.9	4.5	1.9	1.8	3.62	3.3	0.91
CAN	140.5	2.1	1.8	2.3	2.80	1.2	0.43
USA	4.8	1.0	1.0	1.0	1.02	0.7	0.69
JPN	–70.9	3.5	4.0	3.7	3.50	1.3	0.37
KOR	–31.2	9.4	9.6	9.6	8.54	4.0	0.47
E_U	–51.3	1.2	1.7	1.4	0.96	0.8	0.83
IDN	8.6	2.4	1.4	2.0	2.63	1.1	0.42
MYS	–0.6	8.6	8.3	8.5	8.07	1.0	0.12
PHL	12.4	5.2	3.4	3.2	4.46	2.0	0.45
THA	51.3	10.6	5.8	5.2	7.44	3.6	0.48
CHN	0.7	8.3	8.5	8.2	7.89	1.1	0.14
AG3	6.4	3.7	3.1	3.3	3.41	2.3	0.68
ARG	36.5	2.5	1.2	1.5	2.94	2.1	0.71
BRA	23.4	1.6	1.7	2.3	2.27	2.0	0.88
MEX	–2.3	1.0	1.1	1.1	0.97	–0.8	–0.83
OLA	32.5	4.3	2.6	2.6	3.89	1.6	0.41
SSA	18.9	6.0	4.0	3.9	5.12	1.7	0.33
MNA	–22.4	9.6	11.4	12.2	10.91	4.2	0.38
EIT	10.8	4.4	4.0	4.0	4.25	1.1	0.26
XAS	7.2	5.0	4.6	4.4	4.83	1.7	0.35
EFTA	–65.3	12.9	12.9	12.0	11.97	7.9	0.66
IND	3.4	2.8	2.5	2.5	2.71	0.9	0.33
TUR	14.3	4.3	3.3	3.5	3.85	2.4	0.62
XCM	26.5	9.7	8.1	9.2	9.91	5.2	0.52
XSC	56.0	4.3	4.1	5.0	4.81	1.7	0.35
Memorandum: P26							
BGD	4.7	6.4	5.5	5.4	5.8	1.1	0.19
XSA	7.2	9.7	10.0	9.0	9.1	1.9	0.21
MOZ	8.3	6.5	6.2	6.0	6.3	3.9	0.62
UGA	3.3	2.8	2.3	2.3	2.6	1.6	0.61
TZA	32.4	8.8	2.1	3.4	7.3	4.9	0.67

CRTS = constant returns to scale

Note: For definitions of the B25 and P26 economies, see the text above. For the meanings of the codes used for regions and economies, see table 4A.2 below.

Source: Author's calculations.

opposite side of this coin is a sharp decline in land prices in the countries and groups with relatively less land and relatively high protection of agriculture: Japan (–71 percent), the European Union (–51 percent), the EFTA (–65 percent), and South Korea (–31 percent).

The relative prices of skilled versus unskilled labor also tend to move in the expected direction, although far less sharply. For major industrial countries where skilled labor is abundant relative to unskilled labor, there tends to be a rise in the price of the former relative to that of the latter. Thus, for the European Union, the real price of skilled labor rises 1.7 percent, while that of unskilled labor rises 1.2 percent; for Japan, the corresponding comparison is 4.0 percent with 3.5 percent. The effect is not particularly strong, however, and for both the United States and the EFTA the rise in the price of skilled and unskilled labor is identical. For their part, Australia–New Zealand and Canada contravene the expected pattern, because the price of unskilled labor rises more than that of skilled labor. The explanation here may be the strong influence of the agricultural sector (in view of the extreme increases in land price), coupled with a relatively greater intensity of unskilled labor in agriculture than manufactures.

For the developing countries, the expected factor price effect is generally confirmed, although again often this effect is only mild. For South Korea, by now the economy is relatively skill-abundant, so the finding of a slightly greater increase in the price of skilled than unskilled labor is consistent with the theory. For the 18 other developing countries shown in the table, the expected increase in the price of unskilled labor relative to the price of skilled labor is confirmed. Usually the differences are moderate, however. In the two cases where the unskilled labor price rises sharply more than that of skilled labor, Tanzania and Thailand, the explanation likely again lies in the connection with agriculture (given the large land price outcomes in these two cases) rather than the relative skill intensity in the mix of manufacturing products. The same agricultural explanation likely explains why the unskilled-labor price rises less than that of skilled labor in the Middle East and North Africa, considering that this region has a sizable decline in land price.

An important surprise for the relative price of unskilled versus skilled labor is for China, where the former rises slightly less than the latter. The other exceptions to the developing-country rule (Brazil and Pakistan, XSA) show only very small differences between the increases for unskilled and skilled labor.[50]

Again confirming the Heckscher-Ohlin expectation, in 20 of the 25 developing countries or regions in table 4.6, the price of unskilled labor rises more than that of the capital.[51] The overall finding that the factor price for unskilled labor tends to rise relative to that of skilled labor and capital for the developing countries is extremely important for the globalization debate, because it confirms standard international trade theory and contradicts the fears of antiglobalists that trade liberalization will increase the inequality of income in developing countries.

The final column of table 4.6 shows the ratio of the estimated percentage increase in welfare to the weighted sum of the real factor price increases, weighting by ex ante factor shares in each country (see appendix

50. The results for Mexico are ambiguous, because in some sense it already has free trade because of NAFTA and the strong dominance of the US market in its trade.

51. Note that in the PEHRT model the GTAP5 "capital" factor is aggregated with its "resources" factor. In the underlying data, capital is by far the more important in the aggregate.

table 4A.4). In principle, these should be equal, apart from the question of whether ex ante or ex post weights are used. In practice, the ratio is systematically less than unity, having a median of 0.42 in these CRTS static effects of free trade. The discrepancy arises primarily from the HRT model's treatment of the fiscal constraint. When import tariffs and export taxes are removed, their original revenue must be replaced by other taxes to keep the fiscal balance unchanged. The model applies "lump-sum" factor taxes to offset the loss of trade tax revenue. The factor price increases reported are gross of taxes, so the net factor price increases are smaller than the reported increases. A test confirms that the revenue treatment is the main source of divergence between the weighted sum of factor price increases and the percent rise in welfare.[52]

To adjust for the trade revenue effect as well as any other sources of divergence between welfare and factor price change, the poverty estimates below shrink the factor price increase estimates if their weighted sum exceeds the welfare estimates. Thus, the analysis uses the *minimum* of two estimates. The first is the direct estimate, that is, the weighted sum of real factor price changes, weighting by factor shares *at the poverty household level*:

$$\hat{z} = \sum_f \hat{y}_f \varphi_f^p,$$

where $\hat{z}$ is the proportionate change in real income for poverty-level households, $\hat{y}$ is the proportionate change in the real factor price, φ is the factor share, f refers to the factor in question, and p refers to households at the poverty threshold. The second is the same measure but multiplied by the economywide aggregate ratio of the proportionate change in welfare divided by the weighted sum of proportionate increases in real factor prices (this time weighting by the economywide factor shares), or by

$$\lambda = \hat{w} / [\sum_f \hat{y}_f \varphi_f].$$[53]

The estimated proportionate increase in real income at the poverty level is thus $\hat{z}$ if $\lambda \geq 1$, and $\lambda\,\hat{z}$ if $\lambda < 1$.

Finally, it should be noted further that the percentage welfare increase in table 4.6 is systematically somewhat higher than the change in welfare

52. For the regions of the B25 model (excluding Malaysia), the simple average ratio of import and export tax revenue to the base magnitude of welfare is 3.83 percent. The simple average excess of the factor-share-weighted sum of factor price increases over percent increase in welfare is 2.57 percent, in the same order of magnitude. A regression across the 24 countries of the latter on the former yields $d = 0.19 + 0.62r$, where d is the excess of weighted factor price percent increases over percent increase in welfare and r is trade tax revenue as a percentage of base welfare, with an adjusted R^2 of 0.73 and a t-statistic of 7.9 on r.

53. Factor shares in the GTAP5 database for the PEHRT regions are shown in table 4A.4.

as a percentage of GDP shown in table 4.1, because the welfare base refers to private consumption plus investment (net of depreciation) rather than full GDP.[54]

Poverty Effects: Static

With the real factor price effects of trade liberalization in hand, the next step is to calculate the corresponding impact on global poverty. This involves two components: estimating the percent increase in the factor prices relevant to households at the poverty level; and multiplying this percent change by the "poverty elasticity" examined in chapter 1 to obtain the corresponding percentage reduction in countrywide poverty.

In the first instance, a good approximation of the relevant factor price change at the poverty level should be the rise in the real price of unskilled labor, because this will be the principal source of income at this level. Ideally, additional detail would be included to take account of any income stemming from poverty households' endowments of land, skilled labor, and capital as well. Obtaining data on factor shares at the poverty level is difficult, however. Household surveys typically do not carefully divide income into that attributable to each of the principal factors of production.

One set of empirical estimates is available for Brazil in Harrison, Rutherford, Tarr, and Gurgel (2002). This study finds the following sources of household income at the poverty level in the rural areas of Brazil: land, 0; unskilled labor, 80.2 percent; skilled labor, 8.3 percent; capital, 0.2 percent; and transfers, 11.3 percent. For urban households at the poverty level, the corresponding shares are 0.3 percent, 67.2 percent, 18.1 percent, 0.6 percent, and 13.9 percent.[55] The shares of the total number of poor people located in the rural (38.8 percent) and urban (61.2 percent) areas (table 3C.1 above) can then be applied to obtain the economywide factor shares for households in poverty in Brazil.

These data raise the question of how to treat transfers. The approach taken here is simply to apply the economywide proportionate gain in welfare to estimate the proportionate rise in transfers, on the grounds that

54. The simple average ratio of the welfare base to GDP for the B25 countries is 0.725. The exclusion of capital depreciation (the difference between GDP and net national product) in limiting the welfare base is straightforward. The exclusion of "government provision" from the welfare base is somewhat more ambiguous, however. Nonetheless, as the welfare percent increase is already being used to shrink the direct estimates of real factor price increases, and because use of welfare change as a percentage of GDP would contain a clear understatement bias as the denominator includes capital depreciation, the direct estimate of the welfare percent change is the more reasonable to use for estimating λ.

55. These are the shares for the second of the 10 household groupings arrayed by ascending income, in both the rural and urban areas (Harrison et al. 2002, 42).

nonpoor relatives and the government are at least as likely to use the gains from liberalization to increase their transfers to poor households as they are to use them for other purposes.

Unfortunately, comparable factor shares at the poverty-household level are not available for other countries.[56] On the basis of the Brazil estimates, the calculations below assume for all other countries that transfers account for 10 percent of poverty-household income. Otherwise, the principal calculation assumes that the remaining 90 percent of poverty-level income comes from unskilled labor, which is surely the dominant factor endowment of the poor. A sensitivity test is conducted in which it is assumed instead that transfers account for 10 percent, unskilled labor for 70 percent, and land for 20 percent. The reason for an alternate incorporating significant weight to land is that where smallholder agriculture is present, the land factor could be important in household income. As indicated in table 4.6, because of the importance of agricultural liberalization, the most dramatic factor price changes tend to be for land, so this sensitivity test should provide a good indication of the possible range of effects.

The poverty-impact calculations here do not take special account of any differential effect of trade liberalization on the consumption basket of the poor as opposed to at the aggregate national level. There might be grounds for concern that the prices of consumption items of greater importance to the poor might be less favorably affected than those on average (or even adversely affected, given the expectation of an increase in global agricultural prices; see chapter 3 and appendix 3C). The existing research suggests, however, that such effects on the consumption-composition side are minor relative to the effects on the factor payments side (Hertel et al. 2002).

Table 4.7 reports the results of the poverty-impact calculations for free trade using the CRTS model, static effects. The estimates are made for 25 developing countries or regions in the B25 and P26 model results discussed above. The table first repeats the World Bank estimate of the number of poor people at the $2 per day threshold (see chapter 1). The next column reports the poverty elasticity using the lognormal distribution as applied to the Gini coefficient and the ratio of average to poverty-level income in the country in question, applying equation B.9 from appendix 1B. To ensure against extreme values of the elasticity, a floor of 1.0 and a

56. The data compiled in Hertel, Preckel, Cranfield, and Ivanic (2002) for seven developing countries come close, but do not provide overall factor shares for households at the poverty level. Instead, their data are organized by household type (i.e., agricultural enterprises, nonagricultural enterprises, households dependent on wage and salary labor, households dependent on transfers, and "diversified" households). It is unclear what share of income in each household type is derived from each of the factors of production, as well as what fraction of the total poverty population is in each of the household types.

Table 4.7 Impact of free trade on global poverty: CRTS static model

Region and economy		Poor (millions)	Poverty elasticity	Percent change in real poverty-level income		Change in number of poor (millions)	
				Base case	Alternative	Base case	Alternative
Asia							
Bangladesh	BGD	99.3	2.4	1.2	1.1	–2.8	–2.7
China	CHN	673.2	2.9	1.2	0.9	–22.3	–18.2
India	IND	859.9	2.5	0.9	1.0	–19.7	–20.5
Indonesia	IDN	136.8	3.0	1.0	1.5	–4.2	–6.3
Korea	KOR	0.9	3.5[a]	0.2	–2.7	0.0	0.1
Malaysia	MYS	5.6	2.7	1.0	0.8	–0.2	–0.1
Pakistan	XSA	114.2	3.2	2.0	1.9	–7.4	–7.0
Philippines	PHL	29.2	2.2	2.3	3.0	–1.5	–1.9
Thailand	THA	17.0	3.5	4.9	8.8	–2.9	–5.2
Hong Kong, Taiwan, Singapore	AG3	0.0	2.0[b]	2.5	2.9	0.0	0.0
Other	OAS	84.8	2.0[b]	1.3	1.1	–2.3	–1.9
Subtotal		2,020.9				–63.2	–63.8
Latin America							
Argentina	ARG	5.4	2.9	1.8	6.6	–0.3	–1.0
Brazil	BRA	29.2	1.5	1.5	5.3	–0.7	–2.3
Central America and Caribbean	XCM	26.6	2.0[b]	5.1	6.8	–2.7	–3.6
Mexico	MEX	41.1	2.1	0.8	0.2	–0.7	–0.1
Other	OLA	45.9	2.0[b]	1.7	4.1	–1.6	–3.7
Subtotal		148.2				–5.9	–10.8
Central and Eastern Europe	EIT	92.2	2.0[b]	1.1	1.5	–2.1	–2.7
Middle East and North Africa	MNA						
Turkey	TUR	11.6	3.5[a]	2.6	3.9	–1.1	–1.6
Other	MNA	76.4	2.0[b]	3.7	1.3	–5.7	–1.9
Subtotal		88.0				–6.7	–3.5
Sub-Saharan Africa							
Mozambique	MOZ	13.6	0.9	4.0	4.2	–0.5	–0.5
South Africa	XSC	15.1	1.7	1.5	5.1	–0.4	–1.3
Tanzania	TZA	19.7	1.0[a]	5.8	9.0	–1.1	–1.8
Uganda	UGA	16.6	1.4	1.7	1.8	–0.4	–0.4
Other	SSA	328.4	2.0[b]	2.0	2.8	–12.8	–18.4
Subtotal		393.2				–15.2	–22.4
Total		2,742.5				–93.2	–103.2

CRTS = constant returns to scale

a. Constrained; see text.
b. Assumed; see text.

Source: Author's calculations.

ceiling of 3.5 are imposed, on the basis of international patterns as reviewed by the World Bank (2001, 54). In particular, a combination of low inequality with a high ratio of average income to poverty-level income can result in a high elasticity. As it turns out, these constraints affect only

Korea, where an extremely high elasticity of 9.0 is estimated; Turkey, where the direct estimate at 3.58 is almost the same as the ceiling allowed; and Tanzania, where the direct estimate is 0.47. As expected, the estimated poverty elasticities tend to be higher in Asia, where income inequality is lower, and lower in Latin America, where income is more unequal. The elasticity also tends to be low in Africa, where the ratio of mean income to the poverty level income tends to be low because such a large fraction of the population is poor. For regions where individual Gini coefficients and mean/poverty income estimates are not available, a standard poverty elasticity of 2 is applied (the general value used in World Bank 2001).

The next two columns of table 4.7 show the percent change in the weighted average real factor price (and transfers) for poverty-level households in the country in question, using the factor shares just discussed and the constrained factor price effects discussed above (i.e., direct estimates or these multiplied by λ, table 4.6). The base case applies the direct estimates for poverty-level factor shares for Brazil and the standard set of assumed shares (90 percent unskilled labor, 10 percent transfers) for all other countries; the alternative estimates apply 20 percent land, 70 percent unskilled labor, and 10 percent transfers.

The final two columns of table 4.7 apply the percent change in poverty obtained by multiplying the poverty elasticity by the percent change in real income for poverty-level households, to the number of poor in each country. The results show that free trade systematically reduces poverty in the developing countries. The largest absolute reductions are in India and China, reflecting their large poor populations. For Asia as a whole, the two alternative estimates place the reduction in poverty at about 64 million, or about 3 percent of the poor in the region. The reduction in Latin America is 6 to 11 million, or about 5 percent of the region's poor. In sub-Saharan Africa, in the base case the number of poor falls by about 15 million, or by 4 percent; but in the alternative case, postulating a 20 percent factor share of land, the reduction is by about 21 million, or 5.4 percent. In the Middle East and North Africa and in Eastern Europe, the poverty reduction estimates range from 4.0 to 7.6 percent of the current population in poverty.

The aggregate reduction of 93 to 102 million in the number of poor globally is smaller than the suggested estimate of 200 million in chapter 3 for the impact of complete agricultural liberalization, using the simple model of hypothesized price effects and rural-urban elasticities relating real income to agricultural prices. A number of influences could contribute to this divergence.

First, the back-of-the-envelope model developed in appendix 3C postulates a 10 percent rise in global agricultural prices as the consequence of free trade, based on a few aggregative product price increases reported in

CGE estimates elsewhere (IMF 2002d). In the central version of that simple model, this translates into a 9 percent rise in the real domestic agricultural price at the farm gate. The corresponding price increase in PEHRT could be smaller. Second, the rural-urban dichotomy in the earlier model is not present in the PEHRT model. Although the latter does treat each production sector as occupied by a "representative firm," it treats all households identically as the "representative consumer." Third, and related, the underlying HRT model treats factors as mobile across sectors within the country. Implicitly, the simple model of appendix 3C treats rural and urban households as fixed within their existing production sectors.[57]

For these reasons, it is not overly surprising that the PEHRT results differ from those of the simple rural-urban poverty model. Nor is it surprising that the difference is in the direction found, considering that the rural-urban detail in the PEHRT model is essentially missing and in view of the fact that the driving force in the earlier model is the much greater share of poor households located in the rural than the urban sectors.

As for the first possible source of the difference noted above, it turns out that in the PEHRT free trade scenario, the rise in the real domestic price to agricultural producers is 8.5 percent if weighted by the agricultural exports of seven major exporting countries (ANZ, CAN, USA, ARG, BRA, OLA, and XCM). This is almost identical to what is assumed in the model of chapter 3. However, for the countries more directly relevant for poverty effects, the rise is substantially less. Weighting by country shares in global poverty, the rise in the domestic agricultural production price turns out to be only 2.7 percent in the PEHRT free trade static results. This average is dragged down by heavily weighted India (an increase of 2.9 percent) and especially China (an increase of only 0.55 percent). It is important to keep in mind, however, that especially for the relatively homogeneous agricultural goods, the HRT Armington substitution assumptions may tend to permit a greater gap between the domestic agricultural price increase and the global export price increase than would in fact occur.

The principal implications of a comparison of the results in table 4.7 with those of appendix 3C, then, are that the simple model of chapter 3 may tend to overstate somewhat the poverty reduction from agricultural liberalization; but also that the poverty estimates from the static version of the PEHRT model may tend to understate rather than overstate the scope for global poverty reduction through trade liberalization.

57. It might be asked whether a fourth source of the divergence is that implicitly the earlier model imputes land income as well as unskilled-labor income to rural households, whereas the land factor has a zero share in poverty-level factor payments in the PEHRT model's base case. However, all that is required for the model of appendix 3C to be consistent with a zero land share for the poor is for the unskilled wage in the rural sector to rise at least proportionately with total farm income, not that land factor income accrues to the poor.

Poverty Effects: Steady State

The results for poverty impact can be calculated for the steady state (SS) effects of free trade as well, corresponding to the welfare effects shown in table 4.5. Table 4.8 reports the SS model estimates of real factor price changes.[58] Once again, it is necessary to check the factor price changes against the welfare changes, in this case using the net welfare estimates after deducting the imputed cost of induced capital investment. Once again, most countries (24 of 30) show the weighted sum of factor price changes as higher than the increase in net welfare as a percentage of the welfare base, so again in most cases the relevant factor price increase is multiplied by the term λ to obtain the adjusted factor price increase.

As would be expected, the real factor price increases are typically much larger in the SS results than in the static results. The exception is for capital, because by design this version of the model allows the quantity of capital to rise until the rate of the return on investment is brought back down to the preliberalization level. In about half of the countries, this involves an absolute reduction in the factor price for capital, whereas there was an increase in all capital factor prices in the static case (table 4.6). The implication is that for about half of the countries, the price of investment goods falls sufficiently that in order for the ratio of the rental price of capital to the unit cost of investment to be brought back down to its original level, capital must be increased by enough so that its rental price falls below the level before liberalization.

Table 4.9 reports the results of applying the real factor price changes of table 4.8 to obtain the poverty-level real income changes and resulting changes in the number of poor in each country or region. The sequence of steps in the calculation is the same as that set forth for the static poverty-impact effects discussed above.

The poverty-impact estimates are far larger for the SS case than for the static case. Thus, the average of the base and alternative estimates amounts to 491 million globally lifted out of poverty, or 18 percent of the global poor population. This impact is 5.0 times as great as that in the static case, whereas the corresponding aggregate net welfare gains for developing countries are only 1.9 times as high (tables 4.5 and 4.1). A key difference is that in the SS, India, "other" sub-Saharan Africa (SSA), and Pakistan experience much larger increases in poverty-level real incomes (on the order of 8, 10, and 25 percent respectively) than in the static case (only about 1, 2, and 2 percent respectively). The greater poverty reduction relative to aggregate welfare increase in the steady state case than in the static

58. As before, these are the direct PEHRT calculations minus the percent change in the price for the consumer representative agent in the numeraire country (United States), which in this case adds 1.5 percent to the B25 factor price changes and 1.4 percent to the P26 changes.

Table 4.8 Impact of free trade on real factor prices and welfare: Steady State CRTS model (percent change)

Region or economy	Land	Unskilled labor	Skilled labor	Capital and resources	Weighted sum	Net welfare	Lambda
B25							
ANZ	142.7	7.9	4.5	–0.1	4.52	4.28	0.95
CAN	156.6	3.3	2.9	2.4	3.61	1.33	0.37
USA	10.2	2.2	2.1	1.4	1.92	0.98	0.51
JPN	–69.4	4.8	5.4	4.2	4.51	1.19	0.26
KOR	–27.5	14.2	14.0	5.6	9.44	1.35	0.14
E_U	–48.9	2.7	3.0	1.9	1.98	1.31	0.66
IDN	15.9	6.9	4.7	–2.0	2.93	1.96	0.67
MYS	11.8	16.2	14.0	2.8	7.86	3.69	0.47
PHL	20.7	9.5	6.2	–0.4	4.90	3.24	0.66
THA	74.4	38.3	21.6	–1.8	6.60	32.54	4.93
CHN	5.0	12.7	12.0	3.2	8.45	–2.57	–0.30
AG3	12.6	7.0	5.9	1.6	4.38	2.34	0.53
ARG	45.7	6.5	4.4	–1.0	3.93	3.12	0.79
BRA	37.6	5.7	4.6	–0.1	3.17	4.32	1.36
MEX	2.1	3.2	2.9	1.0	1.70	0.42	0.25
OLA	46.7	10.6	6.4	–0.9	4.53	5.67	1.25
SSA	31.4	12.6	7.2	–2.4	5.49	4.53	0.83
MNA	–11.9	15.5	15.2	6.9	10.84	7.78	0.72
EIT	18.4	7.7	6.5	1.2	4.91	0.97	0.20
XAS	18.4	10.2	7.7	–0.6	5.38	4.53	0.84
EFTA	–62.6	14.9	14.9	10.4	12.68	7.24	0.57
IND	16.0	8.6	5.0	–4.2	3.03	4.50	1.48
TUR	24.6	9.2	7.1	2.0	4.87	5.13	1.05
XCM	48.2	19.9	13.1	–0.6	9.46	5.94	0.63
XSC	72.7	8.2	7.0	1.51	5.68	3.31	0.58
Memorandum: P26							
BGD	14.5	10.3	7.4	0.7	6.11	2.05	0.33
XSA	42.5	26.4	14.4	–11.3	9.43	12.86	1.36
MOZ	23.8	14.3	10.1	–2.9	6.64	6.38	0.96
UGA	9.1	6.8	4.2	–2.3	3.23	2.84	0.88
TZA	55.5	21.0	–9.6	4.1	13.61	8.13	0.60

CRTS = constant returns to scale

Note: For definitions of the B25 and P26 economies, see the text above. For the meanings of the codes used for regions and economies, see table 4A.2 below.

Source: Author's calculations.

case reflects the greater increase in the factor price for unskilled labor relative to the percent increase in net welfare. This in turn reflects the rise in the capital/labor ratio from induced investment in the steady state case.

China is the one case in which the SS net welfare effects turn negative (table 4.8), indicating that the increased gross welfare effects are smaller than the increased capital cost when imputed at the standard 7 percent real interest rate. It makes no sense, however, to attribute a corresponding estimate of negative poverty reduction (i.e., a poverty increase), because under these circumstances the additional investment would not take place

Table 4.9 Impact of free trade on global poverty: Steady State CRTS model

Region and economy		Percent change in real poverty-level income: Base	Percent change in real poverty-level income: Alternative	Change in number of poor (millions): Base	Change in number of poor (millions): Alternative
Asia					
Bangladesh	BGD	3.3	3.5	–7.6	–8.3
China	CHN	0.0	0.0	0.0	0.0
India	IND	8.2	9.7	–174.7	–206.2
Indonesia	IDN	4.4	5.6	–17.9	–22.8
Korea	KOR	1.9	0.8	–0.1	0.0
Malaysia	MYS	7.2	6.8	–1.1	–1.0
Pakistan	XSA	25.0	28.3	–91.8	–103.6
Philippines	PHL	6.0	7.4	–3.9	–4.9
Thailand	THA	37.7	44.9	–22.3	–26.5
Hong Kong, Taiwan, Singapore	AG3	3.6	4.2	0.0	0.0
Other	OAS	8.2	9.5	–13.8	–16.2
Subtotal				–333.1	–389.5
Latin America					
Argentina	ARG	4.9	11.1	–0.8	–1.7
Brazil	BRA	5.4	11.9	–2.3	–5.2
Central America and Caribbean	XCM	11.9	15.4	–6.3	–8.2
Mexico	MEX	0.8	0.7	–0.7	–0.6
Other	OLA	10.1	17.3	–9.3	–15.9
Subtotal				–19.4	–31.6
Central and Eastern Europe	EIT	1.5	1.9	–2.7	–3.5
Middle East and North Africa	MNA				
Turkey	TUR	8.8	11.9	–3.6	–4.8
Other	MNA	10.8	6.9	–16.5	–10.5
Subtotal				–20.1	–15.3
Sub-Saharan Africa					
Mozambique	MOZ	13.0	14.8	–1.6	–1.8
South Africa	XSC	4.6	12.1	–1.2	–3.0
Tanzania	TZA	12.2	16.3	–2.4	–3.2
Uganda	UGA	5.7	6.1	–1.3	–1.4
Other	SSA	9.9	13.0	–64.8	–85.3
Subtotal				–71.2	–94.7
Total				**–446.5**	**–534.7**

Source: Author's calculations.

and thus the negative welfare effect would not occur. For the SS estimates of poverty impact (table 4.9), the entries for China are thus set at zero. This is a conservative approach, because it could be argued that instead the poverty reduction could be at least as great as in the static case (22 million, table 4.7). The conservative use of zero is consistent with a probabilistic interpretation of the estimates, in which one should expect overstatement for some countries and understatement for others. Setting the SS poverty impact at zero for China helps lean against any possible overstatement of the results for other countries, in particular for India, where the estimates are large at about two-fifths of the global total.

The SS results do raise the question of feasibility. The extra capital required would amount to 42 percent of developing-country GDP (table 4.5), or $2.7 trillion (at 1997 GDP scale and prices). This amount is not as impossibly large as it might seem at first glance. Suppose the developing countries themselves achieved extra saving amounting to, say, 3 percent of GDP annually (raising the saving rate by about one-tenth in Asia and one-seventh in Latin America). Suppose net capital flows to developing countries rose to 4 percent of developing-country GDP annually, or $256 billion. This figure is actually smaller than the 1996 peak of $330 billion in net capital flows to emerging-market economies, although it is far above the 2000–02 average of $145 billion in the aftermath of the East Asian, Russian, and Argentine financial crises (IIF 2003). The result would be potentially an extra 7 percent of developing-country GDP in annual capital formation, so after 6 years the additional capital to support the SS scenario would be in hand. (There would be some leakage of foreign capital to extra consumption and capital depreciation, but an offset from a growing GDP base and hence larger absolute scale corresponding to the extra 7 percent of GDP capital formation.)

The main implication of these considerations is that there is a central role for mobilizing capital, both domestically and from abroad, as a necessary counterpart to trade liberalization to permit the potential gains of free trade to be fully realized. For poor countries, this probably means "trade and aid," not one or the other; and for middle-income countries, it highlights the importance of strengthening global capital markets after their severe difficulties from financial crises and occasional conspicuous defaults in recent years.

There is another relevant question about the SS results: Even if somehow the extra capital could be mobilized, would this be an efficient way to attack global poverty? The extra $2.7 trillion in capital to reduce poverty by an extra 353 million (the difference between the results in tables 4.7 and 4.9) works out to about $7,600 per person removed from poverty, or an annual cost of about $530, applying a real opportunity cost of capital of 7 percent. Once again the dimensionality is not as disproportionate as the large numbers might at first suggest, considering that the extra annual income even just for those near the poverty line would be about $50 (using an illustrative 7 percent increase on the basis of the median identified in table 4.9), and more fundamentally, that the gains of the 353 million lifted out of poverty would be only a small portion of the economic gains from liberalization with capital accumulation, because the bulk would accrue to the general economy and not just to that set of the poor near the poverty line.

It should be stressed that even the SS model does not necessarily capture the full dynamic effects of trade liberalization. As noted in chapter 3 and examined further in chapter 5, there is a strong tradition in the literature holding that the increased competitive pressure from trade liberalization will stimulate technological change and the pace of total factor productivity growth. Increased productivity growth would be additive to effects from a more rapid accumulation of capital. Chapter 5 takes productivity gains into account, and it obtains consolidated dynamic effects by adding the estimated productivity gains to a conservative estimate (i.e., half) of the incremental SS gains.

Preference Erosion

The estimates of this chapter are based on the removal or reduction of protection as reported in the GTAP5 database. Except for NAFTA (for Mexico) and trade within the South African Customs Union, for developing countries these data refer to MFN protection. They do not make explicit allowance for existing preferential entry under the GSP, the EU's Cotonou and EBA arrangements, and the US arrangements under CBI, APTA, and AGOA (see chapter 2). The question thus arises as to whether the estimates significantly overstate global poverty reduction from the move to free trade by failing to take account of the erosion of preferences as MFN protection declines.

The broad answer to this question is that aggregate global poverty reduction is unlikely to be overstated by much as a consequence of absence of specific attention to existing preferential entry. As noted in chapter 2, the three "at-risk" country groupings—LDCs, HIPCs, and sub-Saharan Africa—account together for only about 4 percent of imports from developing countries into Japan, 6 percent for the United States, and 8 percent for the European Union. Yet these are the groups of countries eligible for the more meaningful existing regimes of preferences. The broader GSP, which in principle applies to middle-income countries as well, in practice has had so many restrictions that it does not provide meaningful free entry.

Whereas the CGE model estimates of this chapter should therefore give a broadly accurate calculation of aggregate global poverty reduction from free trade, they may significantly overstate poverty reduction for some of the poorer regions and countries. It is possible to examine this question further using a tailored run of the PEHRT model for the P26 groupings, which provide the greatest detail on the poor countries eligible for these arrangements. The US AGOA regime and the European Union's EBA arrangement represent perhaps the most open special regimes for poor countries, although even these programs contain considerable restrictions (see chapter 2). A relatively strong test of the "preference erosion effect" can thus be obtained by leaving unchanged the measured protection by the United States

Table 4.10 Test for overstatement of gains from exclusion of preference erosion
(welfare effects, billions of dollars)

Region or economy	Free trade (P26)	Free trade except unchanged US and EU protection against P7
SSA	2.36	–0.02
MOZ	0.13	0.09
UGA	0.09	0.07
XSC	1.33	0.28
TZA	0.29	0.24
XCM	4.02	1.78
BGD	0.39	–0.20
Subtotal (P7)	8.61	2.24
DGC	82.78	77.43
DEV	141.92	142.25
WLD	224.69	219.68

Note: For definitions of the P7 and P26 economies and for the meanings of the codes used, see the text.

Source: Author's calculations.

and the European Union against the relevant P26 countries in a scenario that otherwise applies global free trade.[59] The test should overstate rather than understate preference erosion effects because existing entry for the relevant poor countries is not fully free, even in the US and EU markets.[60]

Table 4.10 reports the results of this test. US and EU protection is frozen against Mozambique (MOZ), Uganda (UGA), South Africa (XSC), Tanzania (TZA), "other" sub-Saharan Africa (SSA), Central America (XCM), and Bangladesh (BGD), while global free trade is implemented otherwise. The result is to reduce static welfare gains for these seven regions ("P7") from $8.6 billion (table 4.1) to $2.2 billion annually. However, the striking finding is that these countries nonetheless enjoy positive benefits, except for very small losses in other sub-Saharan Africa and Bangladesh. Moreover,

59. That is, if in reality the applicable tariff against country X is zero but the database says it is the MFN tariff of 10 percent, then the tariff erosion effect of eliminating US tariffs against all other countries can be approximated by applying the model with the US tariff against country X left unchanged at the base value of 10 percent while eliminating US tariffs against all other countries. The proportionate change in the price of supply from country X relative to that from other countries will be the same, and hence so will the calculated shift of supply away from X to the other countries, as if the database had accurately reported the base tariff against country X as zero and had then eliminated protection against all countries.

60. This fact should more than offset any understatement from limiting the protection freeze to the United States and the European Union, because the preference programs of most other industrial countries tend to be more restrictive and the import bases smaller. Thus, whereas the United States and the European Union together accounted for a total of $18 billion in imports from the LDCs in 2000, Japan and Canada together accounted for only $1.2 billion (table 1.4).

this strong test of preference erosion only reduces aggregate developing-country welfare gains from free trade by 6.5 percent.

A key message of table 4.10 is that the countries already enjoying the most complete preferential access to the US and EU markets can nonetheless expect to reap further gains, instead of suffer losses, from global free trade.[61] The reason is that their losses from the erosion of existing preferential entry are more than offset by their gains from removing their own protection and from increased market opportunities in other countries (including developing countries) not currently providing free entry. The policy implication is that negotiators for LDCs and other at-risk countries should not fear global free trade liberalization, because the new opportunities it gives their countries should outweigh the preference erosion that results. This conclusion would of course be even stronger if the Doha Round outcome included a "parallel track" of immediate deepening of free entry (and tax incentives for direct investment) for the at-risk countries, as proposed in this study (chapters 2 and 6).

The test for preference erosion effects can be extended to decompose the welfare gains for the P7 countries between own-liberalization and effects of liberalization of non-US and non-EU markets. This distinction is of relevance because some might judge that own-liberalization is not a benefit of multilateral negotiations, because countries can carry out the removal of their own protection without the help of WTO negotiations. (This concern is questionable, because both the authorities and business groups in even the poorer countries are likely to seek to maximize their export opportunities by linking the liberalization of their own markets to requests made in multilateral negotiations, probably in support of a bloc of countries making requests on the same set of products.)

When the P26 model is run, freezing not only US and EU protection against the P7 countries but also the protection of the P7 countries themselves, welfare gains for the P7 fall by very little: from $2.24 billion (table 4.10) to $2.06 billion.[62] The strong implication is that there are considerable gains from liberalization of non-US and non-EU markets facing the at-risk countries, so that gains from global free trade outweigh preference erosion even after setting aside the gains arising solely from the removal of these countries' own protection.

61. The single important exception appears to be that of Bangladesh, where the costs from preference erosion would amount to an estimated $200 million per year, or 0.4 percent of GDP. This suggests the appropriateness of a special development assistance initiative for Bangladesh to accompany a Doha Round agreement achieving deep multilateral liberalization.

62. For the residual sub-Saharan Africa grouping (SSA), welfare effects actually rise in this run, from –$0.02 billion to $0.29 billion. In contrast, the main instance of lower welfare gains when own-protection is frozen is the case of South Africa (XSC), where the gains fall from $0.28 billion (table 4.10) to –$0.01 billion. The implication is that relatively high trade between SSA and XSC leads to significant terms-of-trade differences between the case in which these countries liberalize their own protection and the case in which they do not.

Poverty Effects in Alternative Scenarios

Although the calculations for tables 4.7 and 4.9 could be repeated for each of the other trade liberalization scenarios considered above, the effects of these alternatives can more readily be approximated by comparing their corresponding relative welfare effects. For this purpose, each country's welfare effect needs to be weighted by its share in global poverty.

The poverty-weighted welfare effects show the following gains in welfare as a percentage of GDP for developing countries as related to poverty effects (B25 results). Static free trade (CRTS) shows 0.95 percent of GDP gains; SS free trade, 5.26 percent; two-tier liberalization, 0.71 percent; asymmetric liberalization, 0.90 percent; differential liberalization, 1.07 percent; and the US formula, 0.43 percent.[63] Thus, with the poverty-weighted impact of static free trade at an index of 100, the other scenarios generate poverty impacts with index values of 554 (steady state), 74.7 (two-tier), 94.7 (asymmetric), 112.6 (differential), and 45.3 (US formula).

The broad implication is that the more restrictive liberalization scenarios fall short of the poverty reduction potential of (static) free trade, especially the variant cutting agriculture and textile-apparel by only half. The sole exception is the differential liberalization case in which developing countries grant each other free trade but cut protection against industrial countries by only half, while industrial countries extend free trade to all. As discussed above, however, it is a moot point whether the differential scenario would be better for developing countries (and their poor populations) than outright free trade. The special characteristics of the CGE model say so, but there is a strong presumption in the bulk of the mainstream economic literature to the contrary, as terms-of-trade and optimum-tariff effects are more typically considered to be less affected by a "small" country's own liberalization than is implied in the CGE structure.[64]

Implications

This chapter has implemented one of the leading CGE models, coupled with the leading trade and protection database available for trade modeling, to estimate the factor price changes and hence changes in poverty that could be expected to result from international trade liberalization. The results show that trade has a large potential to reduce global poverty. In the static free trade version of the model, free trade would reduce the

63. These are percentage increases in welfare, not in welfare as a percentage of GDP, as discussed above.

64. Specifically, the use of a less than infinite "Armington" elasticity of substitution among trading partners' alternative sources of imports yields a price elasticity of export demand low enough for even small countries to influence their terms of trade.

number of the poor globally by an estimated 98 million, or by 3.6 percent. In the Steady State version of the model, which captures an important dimension of dynamic effects by allowing capital investment to respond to new trade opportunities, the medium-term reduction in poverty could amount to about 450 million, or by 16 percent.

The static estimate is likely a lower-bound estimate for free trade effects. A simple model for the response of rural and urban poverty to free trade in agriculture alone, developed in chapter 3 above, places the central estimate at a reduction of 200 million in poverty from removing protection and subsidies in agriculture. The dynamic SS estimate, conversely, is likely an overstatement for practical purposes, because it would imply large increases in capital that in turn would require boosts in investment by about 7 percent of GDP annually for 6 years. Even so, the SS estimate does not include effects on productivity growth and technical change, which could be a partial replacement for the large capital increases otherwise needed. Chapter 5 draws together the static and SS poverty estimates in combination with dynamic productivity-impact estimates developed in that chapter.

There are eight important additional features in the model estimates. First, agriculture is the most important sector to liberalize globally. It provides about half of total welfare gains from free trade.

Second, textiles and apparel constitute the next most important sector. They contribute about 11 percent of total welfare gains under free trade.

Third, developing countries gain the most from free trade, which generates welfare gains equal to 1.35 percent of GDP for developing countries and 0.78 percent for industrial countries, in the static model, and 2.5 percent of GDP for developing countries versus 1.0 percent for industrial countries in the dynamic SS version.

Fourth, concerns about adverse effects for numerous developing countries identified in earlier results should be allayed by the present results. The HRT model's authors estimated in 1996 that the Uruguay Round cuts in protection would cause welfare losses for sub-Saharan Africa, the Middle East, and Eastern Europe. They attributed the losses to higher agricultural prices facing food importers and to losses of quota rents in textiles and apparel. The new results here—applying the same model to more recent trade and protection data with greater disaggregation for developing countries—show instead that all these areas gain from global free trade. The difference from the earlier results stems in part from lower estimates of textile-apparel quota rents in the more recent data, and from the application of free trade rather than the limited reductions in protection for agriculture and textiles and apparel in the earlier estimates. The only developing country estimated to experience loss is Mexico, where global free trade means a loss of preferred status in the US market.

Fifth, the model results for alternative liberalization scenarios suggest that a differential formula in which industrial countries grant free trade while developing countries cut protection only in half could generate welfare gains for developing countries that are about the same or even modestly larger than those from full free trade, but only if the developing countries grant free trade access to each other as part of such a package. This result depends in part on the special features of the model, suggesting that it is at least as likely that full free trade would generate better results for developing countries and their poor populations.

Sixth, results from "asymmetric" liberalization tests suggest that between 52 and 65 percent of total potential welfare gains for developing countries stem from the liberalization of industrial-country markets rather than developing-country liberalization. This finding contradicts the view that developing-country losses from global protection are primarily of their own making. The driving force in this finding is that the HRT model provides significant terms-of-trade impact estimates, although not as large as those in the findings of the OECD (GTAP) model, which attributes an even higher fraction of developing-country gains to industrial-country liberalization than estimated here. In contrast, the more widely cited results of the WBGEP (LINKAGE) model attributing the bulk of developing-country gains to their own rather than industrial-country liberalization would seem potentially misleading. They refer to a world in 2015 when relatively highly protected developing-country manufactures are projected to be a much higher share of the world economy, and highly protected industrial-country agriculture is projected to be a much lower share of the world economy, than is true today.

Seventh, the SS results underscore how important it will be that global capital markets achieve renewed strength to provide capital flows to developing countries. A return to capital market flows to emerging markets on the order of $250 billion annually, as reached before the financial market crises of the late 1990s, would potentially provide somewhat more than half of the extra capital required to raise the capital stock and achieve the large potential dynamic welfare gains (about $350 billion annually for developing countries).

Eighth, special tests with the PEHRT model suggest that concerns about injury to poor countries from the erosion of trade preferences as a consequence of global free trade are largely misplaced. These countries generally have more to gain from the liberalization of markets in which they do not enjoy free entry, and from removing their own protection, than they stand to lose from preference erosion.

Overall, these results confirm that trade liberalization could contribute in a major way to the reduction of global poverty. Moreover, the estimates are understated rather than overstated from the standpoint that they exclude the effects of liberalizing services-sector trade. They nonetheless also serve as a reminder that even in the most optimistic formulation (the medium-term SS version), freeing up trade would provide only a partial solution to the problem of global poverty.

Appendix 4A
PEHRT Model Definitions

Table 4A.1 Mapping of GTAP5 to PEHRT regions

GTAP5			PEHRT B25	PEHRT P26
1	AUS	Australia	1	1
2	NZL	New Zealand	1	1
3	CHN	China	11	10
4	HKG	Hong Kong	12	8
5	JPN	Japan	4	4
6	KOR	Korea	5	8
7	TWN	Taiwan	12	8
8	IDN	Indonesia	7	6
9	MYS	Malaysia	8	17
10	PHL	Philippines	9	7
11	SGP	Singapore	12	8
12	THA	Thailand	10	9
13	VNM	Vietnam	20	17
14	BGD	Bangladesh	20	26
15	IND	India	22	19
16	LKA	Sri Lanka	20	17
17	XSA	Rest of South Asia	20	20
18	CAN	Canada	2	2
19	USA	United States	3	3
20	MEX	Mexico	15	12
21	XCM	Central America and Caribbean	24	25
22	COL	Colombia	16	13
23	PER	Peru	16	13
24	VEN	Venezuela	16	13
25	XAP	Rest of Andean Pact	16	13
26	ARG	Argentina	13	13
27	BRA	Brazil	14	11
28	CHL	Chile	16	13
29	URY	Uruguay	16	13
30	XSM	Rest of South America	16	13
31	AUT	Austria	6	5
32	BEL	Belgium	6	5
33	DNK	Denmark	6	5
34	FIN	Finland	6	5
35	FRA	France	6	5
36	DEU	Germany	6	5
37	GBR	United Kingdom	6	5
38	GRC	Greece	6	5
39	IRL	Ireland	6	5
40	ITA	Italy	6	5
41	LUX	Luxembourg	6	5
42	NLD	Netherlands	6	5
43	PRT	Portugal	6	5
44	ESP	Spain	6	5
45	SWE	Sweden	6	5
46	CHE	Switzerland	21	18
47	XEF	Rest of EFTA	21	18
48	HUN	Hungary	19	16
49	POL	Poland	19	16
50	XCE	Rest of Central European Association	19	16
51	XSU	Former Soviet Union	19	16
52	TUR	Turkey	23	15
53	XME	Rest of Middle East	18	15
54	MAR	Morocco	18	15
55	XNF	Rest of North Africa	18	15
56	BWA	Botswana	17	14
57	XSC	Rest of South African Customs Union	25	23
58	MWI	Malawi	17	14
59	MOZ	Mozambique	17	21
60	TZA	Tanzania	17	24
61	ZMB	Zambia	17	14
62	ZWE	Zimbabwe	17	14
63	XSF	Other South Africa	17	14
64	UGA	Uganda	17	22
65	XSS	Rest of sub-Saharan Africa	17	14
66	XRW	Rest of world	20	17

Note: See table 4A.2 for the PEHRT regions.

Table 4A.2 PEHRT regions

Big 25 (B25)			Poverty 26 (P26)		
1	ANZ	Australia and New Zealand	1	ANZ	Australia and New Zealand
2	CAN	Canada	2	CAN	Canada
3	USA	United States	3	USA	United States
4	JPN	Japan	4	JPN	Japan
5	KOR	Korea	5	E_U	European Union
6	E_U	European Union	6	IDN	Indonesia
7	IDN	Indonesia	7	PHL	Philippines
8	MYS	Malaysia	8	AG4	South Korea, Hong Kong, Singapore, and Taiwan
9	PHL	Philippines	9	THA	Thailand
10	THA	Thailand	10	CHN	China
11	CHN	China	11	BRA	Brazil
12	AG3	Hong Kong, Singapore, and Taiwan	12	MEX	Mexico
13	ARG	Argentina	13	OLA	Other Latin America
14	BRA	Brazil	14	SSA	Other sub-Saharan Africa
15	MEX	Mexico	15	MNA	Middle East, North Africa, and Turkey
16	OLA	Other Latin America	16	EIT	Eastern Europe
17	SSA	Other sub-Saharan Africa	17	OAS	Other Asia
18	MNA	Middle East and North Africa	18	EFTA	European Free Trade Association
19	EIT	Eastern Europe	19	IND	India
20	XAS	Rest of Asia	20	XSA	Pakistan and other South Asia
21	EFTA	European Free Trade Area	21	MOZ	Mozambique
22	IND	India	22	UGA	Uganda
23	TUR	Turkey	23	XSC	South African Customs Union
24	XCM	Central America and Caribbean	24	TZA	Tanzania
25	XSC	Southern African Customs Union	25	XCM	Central America and Caribbean
			26	BGD	Bangladesh

Table 4A.3 Mapping of GTAP5 to PEHRT product sectors

GTAP5 sectors			Allocated to PEHRT	PEHRT sectors		
1	pdr	Paddy rice	1	1	pdr	Paddy rice
2	wht	Wheat	2	2	wht	Wheat
3	gro	Cereal grains n.e.c.	3	3	gro	Grains excluding wheat, rice
4	v_f	Vegetables, fruits, nuts	4	4	ngc	Nongrain crops
5	osd	Oil seeds	4	5	for	Forestry, fishing, lumber, wood, paper, and wool
6	c_b	Sugar cane, sugar beet	4	6	pcr	Processed rice
7	pfb	Plant-based fibers	4	7	mlk	Milk products
8	ocr	Crops n.e.c.	4	8	tex	Textiles
9	ctl	Cattle, sheep, goats, horses	17	9	wap	Wearing apparel
10	oap	Animal products n.e.c.	7	10	crp	Chemicals, rubber, plastics
11	rmk	Raw milk	7	11	i_s	Primary iron and steel
12	wol	Wool, silk-worm cocoons	5	12	nfm	Nonferrous metals
13	for	Forestry	5	13	fmp	Fabricated metal
14	fsh	Fishing	5	14	trn	Transport industry
15	col	Coal	18	15	t_t	Trade and transport
16	oil	Oil	18	16	cgd	Investment goods
17	gas	Gas	18	17	mea	Meat products, livestock
18	omn	Minerals n.e.c.	19	18	enr	Energy and products
19	cmt	Bovine meat products	17	19	min	Minerals and products
20	omt	Meat products n.e.c.	17	20	foo	Food, beverages, and tobacco
21	vol	Vegetable oils and fats	20	21	mac	Machinery, equipment, and other manufacturing
22	mil	Dairy products	7	22	ser	Services and utilities
23	pcr	Processed rice	6			
24	sgr	Sugar	20			
25	ofd	Food products n.e.c.	20			
26	b_t	Beverages and tobacco products	20			
27	tex	Textiles	8			
28	wap	Wearing apparel	9			
29	lea	Leather products	9			
30	lum	Wood products	5			
31	ppp	Paper products, publishing	5			
32	p_c	Petroleum, coal products	18			
33	crp	Chemical, rubber, plastic products	10			
34	nmm	Mineral products n.e.c.	19			
35	i_s	Ferrous metals	11			
36	nfm	Metals n.e.c.	12			
37	fmp	Metal products	13			
38	mvh	Motor vehicles and parts	21			
39	otn	Transport equipment n.e.c.	21			
40	ele	Electronic equipment	21			
41	ome	Machinery and equipment n.e.c.	21			
42	omf	Manufactures n.e.c.	21			
43	ely	Electricity	22			
44	gdt	Gas manufacture, distribution	22			
45	wtr	Water	22			
46	cns	Construction	22			
47	trd	Trade	15			
48	otp	Transport n.e.c.	14			
49	wtp	Water transport	14			
50	atp	Air transport	14			
51	cmn	Communication	22			
52	ofi	Financial services n.e.c.	22			
53	isr	Insurance	22			
54	obs	Business services n.e.c.	22			
55	ros	Recreational, other services	22			
56	osg	Public administration, defense, education, health	22			
57	dwe	Dwellings	22			

n.e.c. = not elsewhere classified

Table 4A.4 Economywide factor shares (percent)

Region or economy	Land	Unskilled labor	Skilled labor	Capital and resources
B25				
ANZ	0.8	31.4	21.8	46.1
CAN	0.5	42.1	16.7	40.7
USA	0.6	36.1	25.6	37.7
JPN	0.3	37.2	22.8	39.8
KOR	2.4	38.4	16.0	43.2
E_U	0.8	32.9	21.9	44.4
IDN	8.0	34.3	6.6	51.1
MYS	4.8	27.0	8.9	59.2
PHL	6.5	32.2	11.3	50.0
THA	3.4	12.1	4.2	80.4
CHN	5.2	44.6	10.4	39.8
AG3	0.7	32.3	22.4	44.6
ARG	3.2	36.6	12.8	47.4
BRA	1.4	33.8	16.4	48.4
MEX	3.2	22.7	8.6	65.6
OLA	2.7	28.5	11.9	56.9
SSA	2.4	40.5	10.5	46.6
MNA	0.9	33.7	14.4	51.0
EIT	1.4	39.8	16.8	42.0
XAS	7.0	34.7	10.8	47.5
EFTA	0.8	37.1	26.3	35.9
IND	12.2	32.4	6.8	48.6
TUR	1.4	27.9	10.7	60.0
XCM	4.0	31.7	11.8	52.5
XSC	0.5	40.7	19.6	39.2
P26				
BGD	6.3	39.4	43.0	11.3
PAK	12.8	32.1	48.3	6.9
MOZ	4.5	42.4	45.0	8.1
UGA	6.2	48.4	38.9	6.5
TZA	5.6	43.5	45.5	5.4
OAS	5.6	29.1	56.1	9.2

Source: GTAP5 database.