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Potential Gains from Reducing Trade Barriers in Manufacturing, Services and Agriculture

Thomas W. Hertel

In November/December of 1999, leaders from around the world converged on Seattle with the goal of launching a new round of trade negotiations under the auspices of the World Trade Organization (WTO). This has been dubbed "WTO2000" in recognition of the new millennium. In light of the tremendous growth in world trade over the last fifty years—much of it fueled by multilateral trade liberalization under the General Agreement on Tariffs and Trade (GATT), the WTO's predecessor, many had high aspirations for this "Millennium Round." However, the Seattle meetings failed in the face of vigorous demonstrations by labor and environmental groups. In addition, there has been a marked lack of enthusiasm for this new round in the United States. The purpose of this paper is to provide a quantitative assessment of the potential gains available from trade liberalization under this new WTO round, thereby assessing whether greater enthusiasm is warranted.

The Millennium Round aims to follow on the footsteps of the Uruguay Round (UR), which was concluded in 1994 after prolonged negotiations. The implementation period for the UR in the case of developing countries, as well as sensitive sectors, is not due to be completed until 2004. So, why the rush into a new round? The UR agreement left in its wake a built-in agenda for revisiting the more difficult areas of previous negotiations. In particular, agriculture and services were two areas where a framework for liberalization was developed during the UR, but concrete progress toward free and open trade was limited. Not surprisingly, these are two sectors for which researchers have also had a difficult time quantifying the potential for gains from more liberal trade.

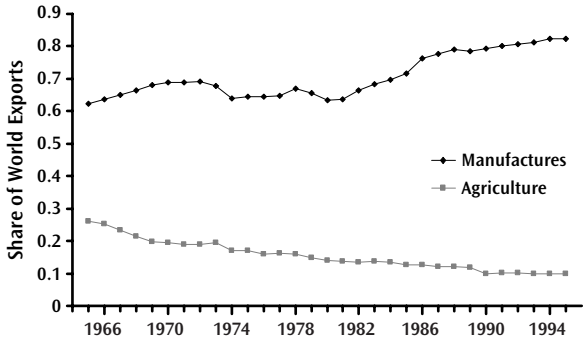
The UR created the General Agreement on Trade in Services (GATS), which established rules and disciplines on policies related to market access in services. However, as Hoekman (1995) noted, the commitments made under this agreement "are best described as bound standstill agreements," with real liberalization being deferred to future rounds of negotiations. The benefits of services trade, in particular, have proven elusive for quantitative economists. Hoekman (1995) made a valiant attempt to quantify services protection across sectors by relating coverage ratios to tariff equivalents, however, comprehensive measures such as those provided in manufactures and agriculture have yet to be obtained. This has frustrated attempts to quantify the impact of potential liberalization of trade in this sector. The present paper draws on a new set of estimates of protection in the business, finance, and construction sectors to begin to remedy this gap (Francois, 1999a).

Historically, agriculture has been largely undisciplined by the GATT (Josling, Tangermann and Warley, 1996). One of the great achievements of the UR was bringing agricultural policies under greater multilateral discipline. The UR Agreement on Agriculture led to the conversion of non-tariff agricultural import barriers into bound tariffs, and those bound tariffs, together with subsidies to farm production and exports, have been scheduled for phased reductions. This represents a major reversal of the trend since the 1950s of substantial growth in agricultural protection and insulation in the industrial economies (Johnson, 1973; Tyers and Anderson, 1992). Thus, the UR marks a watershed in the historical evolution of multilateral negotiations over agriculture. While the actual cuts in protection under the UR are likely to be quite small, Martin and Winters (1995) argue that the stage is now set for steady reductions in tariffs under WTO2000 and subsequent rounds of negotiations.

It is interesting that manufactures trade—previously the bread and butter of the GATT negotiations—is absent from the built-in agenda. Historically, progress in manufactures liberalization has derived its main impetus from the high-income, "industrialized" economies, with developing economies focusing more attention on trade in primary products. However, industrial tariffs in Organization for Economic Coop-

Figure 1

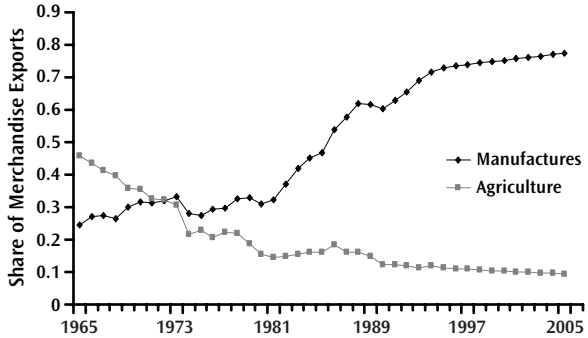
Shares of Manufactures and Agriculture in World Exports



SOURCE: GTAP version 4 database, McDougall et al., 1998.

Figure 2

Shares of Merchandise Exports from Developing Countries



SOURCE: GTAP version 4 database, McDougall et al., 1998. (Adjusted from Hertel and Martin, 1999.)

eration and Development (OECD) countries are now negligible for many sectors, and it is hardly surprising that the interests of high-income country negotiators have shifted to the rapidly growing area of services trade and investment. Yet, as Hertel and Martin (1999) point out, the relative importance of manufactures trade for developing countries has been increasing sharply since the 1980s, and this is projected to continue over the next decade. Furthermore, many developing-country manufactures tariffs are still very high. Consequently, the scope for gains may be quite substantial.

The objective of this paper is to evaluate the potential contributions of services, agricultural, and manufacturing liberalization to global trade and welfare. The next section of this paper examines patterns of trade and protection, as well as other structural features of the global economy that are likely to influence the welfare impacts of liberalizing trade. It then turns to projections of the global economy to the year 2005, when the UR implementation will be complete. The goal will be to assess the potential impact of further reductions in trade barriers from this post-UR base. The fourth section discusses the simulations performed and the key findings. The final section of this paper contains the summary and conclusions.

HISTORICAL PATTERNS OF TRADE AND PROTECTION

This section offers a brief review of some of the broad features of global production, consumption, trade, and protection in world trade. It draws heavily on Hertel and Martin (1999) and uses their aggregation of global trade into several broad sectors: agriculture, manufacturing, mining and services,[1] and two regional groupings: developed and developing countries.[2]

Agriculture and Manufacturing Compared

It is instructive to begin with a comparison of the evolution of agricultural and industrial trade over the past three decades. In the case of the manufacturing sector, protection in the OECD countries has fallen steadily since World War II. In particular, average tariffs on industrial goods imported into OECD countries have fallen from about 40 percent in 1947 to 1.5 percent in the late 1990s. In contrast, agricultural protection (measured as the nominal rate of assistance) has risen from about 30 percent in the late 1960s to 60 percent in 1998 (Roberts, et al., 1999). These opposing movements in protection have contributed to a shift in the composition of global exports, in favor of manufactured goods. Figure 1 shows that the share of agriculture

[1] The definition of manufactures used follows as closely as possible the definition utilized in the WTO. Thus, agriculture includes the raw and processed agricultural products defined by the WTO agreement on agriculture (WTO, 1995, p.56). The minerals and energy group is defined here to include fisheries, forestry and mining.

[2] For the purposes of this paper we identify developing countries with those most likely to adopt developing country status in the next round of WTO negotiations. With the notable exception of Korea, this definition is quite close to the list of non-OECD countries. The remaining countries are termed "high-income," or developed, for lack of a better term.

Table 1

Trade Balances: 1995 (FOB exports–CIF imports)
Millions of U.S. Dollars

	Agriculture	Minerals	Manufacturing	Services	Total
Developing	2306	133633	–221289	71237	–14112
High-Income	–33434	–159297	49822	157021	14112
Total	–31129	–25664	–171466	228258	0

Note: Sectoral trade balances don't sum to zero due to international transport service margins.
SOURCE: GTAP Version 4 database, McDougall et al., 1998.

in global merchandise trade fell from 28 percent in 1965 to about 10 percent in 1995. Virtually all of this decline was absorbed by manufactures' increased share of merchandise trade, which is now above 80 percent (mining and extraction products trade is omitted from this figure.) This shift towards the exports of manufactures is even stronger in the developing countries (Figure 2).

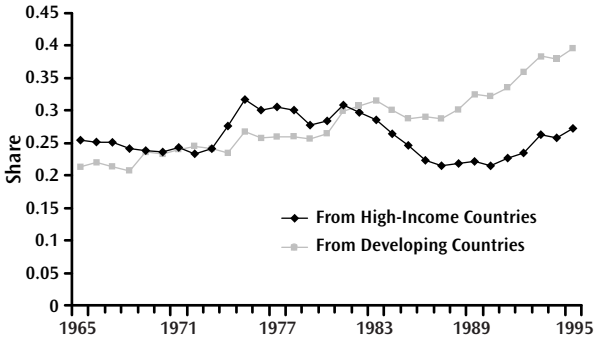
Nevertheless, developing countries as a group remain net importers of manufactured goods. Table 1 reports the trade balances for developing and high-income countries across primary, secondary, and tertiary sectors. From this we can see that, despite the strong increase in the share of manufactured goods in total merchandise exports from developing countries, the aggregated trade balance for these countries, *vis à vis* the high-income countries, continues to show a deficit in manufacturing. This is offset by a trade surplus in primary products—predominately minerals, but also food and other agricultural products. Both groupings of countries are net exporters of services—on a free-on-board (FOB) basis—due to the importance of services in international trade and transport margins (cost, insurance, and freight (CIF) less FOB values).

Trends in South-South Trade

Developing country markets have been becoming increasingly important destinations for merchandise trade over time. As Figure 3 shows, the share of developing country merchandise exports going to other developing countries—the so-called "South-South" trade—has increased steadily from about 20 percent in 1965 to nearly 40 percent in 1995. One might suspect that some of this increase is due to the simple fact that developing countries on average have been growing more rapidly than the high-income economies of Europe, North America and Japan.

Figure 3

Share of Merchandise Exports Destined for Developing Countries



SOURCE: GTAP version 4 database, McDougall et al., 1998.

Towards this end, Figure 3 also displays the share of high-income countries' total exports destined for the developing countries. Abstracting from the commodity price boom of the 1970s, there has been no net increase in high-income countries' share between 1965 and 1995. Clearly other factors must be at work. One important stimulus to the growth in intradeveloping country trade has undoubtedly been the reductions in developing country rates of protection during the last two decades (Srinivasan, Whalley and Wooton, 1993).

Current Protection Levels

Table 2 provides estimates of the most favored nation (MFN) applied rates of protection, which apply to three major categories of merchandise trade identi-

Table 2

Trade Barriers on Merchandise Trade and Services, by Commodity, Source and Destination, 1995

Exporting region	Importing Region		
	High-Income	Developing	World
Manufacturing	Percent	Percent	Percent
High-Income	0.8	10.9	3.8
Developing	3.4	12.8	7.1
World	1.5	11.5	4.7
Agriculture			
High-Income	15.9	21.5	17.5
Developing	15.1	18.3	16.4
World	15.6	20.1	17.1
Minerals/Energy			
High-Income	0.1	1.3	0.4
Developing	0.4	5.2	2.4
World	0.2	3.0	1.1
Construction Services			
High-Income	18.0	25.0	22.0
Developing	18.0	20.0	20.0
World	18.0	23.0	
Business & Financial Services			
High-Income	9.0	9.0	9.0
Developing	11.0	8.0	10.0
World	10.0	9.0	

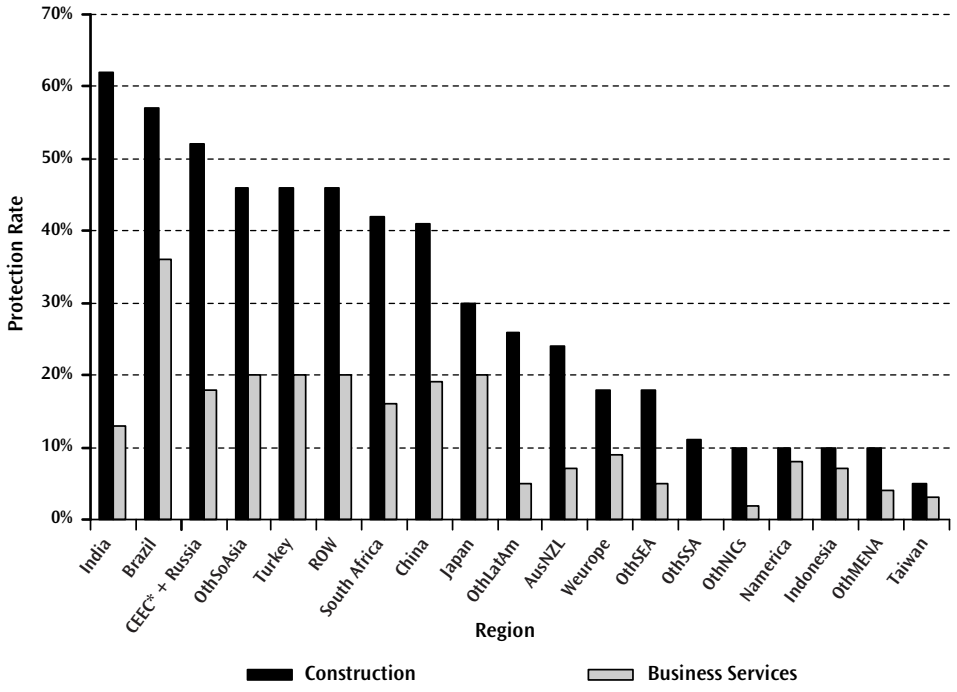
SOURCE: GTAP version 4 database, McDougall et al., 1998 and Francois, 1999a (adjusted from Hertel and Martin, 1999).

fied in the Global Trade Analysis Project (GTAP) model and two major categories of services trade. These tariff estimates for merchandise trade are taken from the GTAP Version 4 data base, which draws on the United Nations Conference on Trade and Development-Trade Analysis and Information System (UNCTAD-TRAINS) data collection effort for tariffs, and estimates of agricultural protection originally calculated by Ingco (1996). These patterns of protection against merchandise imports are broadly consistent with those presented by Laird (1999).

From the first of the five sections of Table 2, it is clear that, at 3.4 percent, the trade-weighted, aggregate MFN-applied tariffs facing developing country exporters of manufactured goods to high-income countries are almost four times higher than the same tariffs facing high-income country exporters to the same markets. This is entirely due to the composition of trade, with higher tariffs being levied on products imported from developing countries. Developing country importers do not discriminate against other developing countries to the same extent, with the average tariff of 12.8 percent against developing countries only around one-sixth above the 10.9 percent applied to exports from high-income countries. However, the average tariff rates on developing-country imports from other developing countries are still more than three and one-half times as high as

Figure 4

Estimated Rates of Protection for Construction and Business Services



*Central and Eastern European Countries

SOURCE: Francois, 1999a.

the high-income country tariffs applied to manufactured goods from developing countries.

Estimates of the trade-weighted, average tariff rates applying to food and agricultural products are presented in the second section of Table 2.[3] From these data, it appears that average agricultural tariffs in the high-income countries are around ten times as high as those applied in manufacturing. In contrast to manufactures, there is very little difference between the rates applied against imports from developing and high-income countries. In agriculture, natural resource endowments rather than labor endowments tend to determine comparative advantage, with high-income economies, such as Australia and New Zealand, remaining competitive in export markets. In developing countries, average agricultural tariffs are also higher than those on imports of manufactured goods, but the proportional difference is much smaller, with the average agricultural tariff less than twice that prevailing in manufacturing.

The estimates of tariffs on mineral and energy products presented in the third section of Table 2 suggest that trade barriers on these goods are generally relatively low. The only case where these tariffs exceed five percent is on imports by developing countries from other developing countries.

Protection for business and financial services and construction services, listed in the fourth and fifth sections of Table 2, are drawn from Francois (1999a), who estimates a gravity model of services trade using bilateral services trade data from the United States.[4] He adopts Singapore and Hong Kong

[3] Given the continued difficulties in obtaining reliable *ad valorem* tariff rates for agriculture, in many cases these tariffs have been estimated using price comparison data (McDougall et al., 1998, ch. 13). The estimates for non-OECD countries are based on extrapolations from the pre-Uruguay Round period of the late 1980s. Therefore they are very much out of date.

[4] The dependent variable in this model is U.S. exports, and the explanatory variables are the log of per capita income and GDP. A dummy variable is used for exports from the United States to Western Hemisphere nations.

as free-trade benchmarks and evaluates predicted imports from the United States relative to imports by these two economies. Discrepancies are attributed to protectionist policies; tariff equivalents of these policies are obtained by assuming a constant elasticity of demand function. Francois' estimates show considerable variation across countries, with tariff equivalents in construction ranging from 5 percent in Taiwan to 62 percent in India (Figure 4). In business and financial services, estimated rates of protection range from very low in a number of countries to 36 percent in Brazil. However, the summary figures in the bottom two sections of Table 2 show that there is no systematic difference between developing and high-income countries in these services-sector protection measures.

Unfortunately, comparable measures of protection are not available for the remaining services sectors. Of particular concern is the transport services sector. Based on the work of Hoekman (1995), it appears that protection levels in the transport services sector might be much higher than in construction and business services, particularly in the developing countries. Therefore, we are forced to acknowledge that our coverage of services protection is only a partial one at best.

The database underpinning this study is the version 4.0 GTAP database (McDougall, et al., 1998). This has been aggregated from the 45 region-50 sector level at which it is maintained to facilitate our analysis. It represents a snapshot of the world economy in 1995, which is the first year of implementation for the UR agreement. For our analysis of the potential gains from manufacturing liberalization in the next WTO round, we need to look ahead to 2005, when the UR agreement is due to be fully implemented. Of course, there will be many other changes to the world economy between 1995 and 2005, and we, therefore, employ a formal projections approach to establish a 2005 starting point for our WTO2000 analysis.

PROJECTIONS TO 2005

Overall Rates of Economic Growth

A modified version of the widely used GTAP model of global trade (Hertel, 1997) is used in this study.[5] This is a relatively standard, multiregion, applied general equilibrium model that features explicit modeling of international transport margins, a global "bank" designed to mediate between world savings and investment, and a relatively sophisticated consumer demand system designed to capture differential price and income responsiveness across countries. The latter is particularly important in the case of our projections. Throughout the paper we employ the simplistic, but robust, assumption of perfect competition and constant returns to scale in production activities.[6] Validation efforts with this model (Gehlhar, 1997; Coyle et al., 1998) show that it is able to track, to a reasonable degree, some of the major changes in trade patterns over the past two decades.[7]

To follow earlier projections with the GTAP model (Gehlhar et al., 1994; Anderson et al.,1997; Arndt et al., 1997), exogenous forecasts are required for population, skilled and unskilled labor, investment, and capital stock. These have been assembled by Hertel et al. (1999) (Appendix Table A5). When combined with assumptions about likely productivity growth rates, this permits us to predict the level and composition of gross domestic product (GDP) in 2005, as well as trade flows, input usage, and a wide range of other variables. The skilled labor projections depend on forecasts of the growth in the stock of tertiary educated labor in each developing country (Ahuja and Filmer, 1995). Projected rates of growth of skilled labor in developed countries obtained from the World Bank provide an indication of changes in the stock of those qualified for employment as professional and technical workers in the high-income economies. Growth rates of physical capital were obtained from 1995 and the projected 2005 stock of physical capital. Projections of the stock of physical capital were calculated using the Harberger-style, perpetual inventory method; that is, by adding investment net of depreciation to update the capital stock in each year. Data for initial physical capital stock for 1995, as well as annual forecasts of gross domestic investment, were obtained from the World Bank.

Projections of total factor productivity (TFP) growth vary by sector and region. Regions are grouped into four categories according to their assumed rate of annual productivity growth in manufacturing. These range from low productivity growth (0.33 percent/year), to medium (1 percent/year), and high (2 percent/

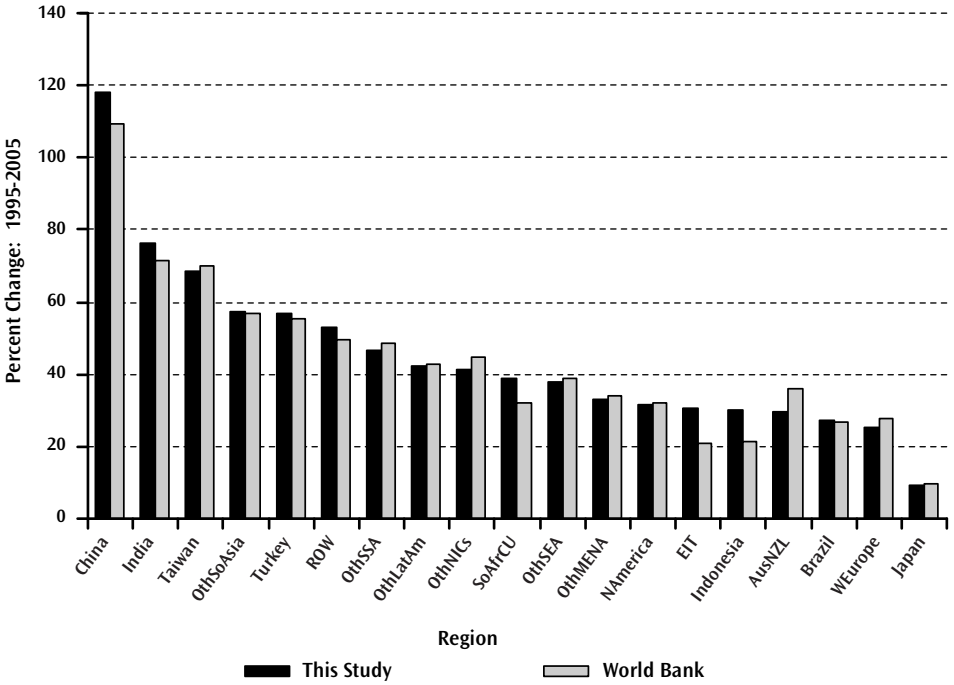
[5] The model is implemented using General Equilibrium Modeling Package (GEMPACK), (Harrison and Pearson, 1996).

[6] Alternative versions of the GTAP model feature imperfect competition (Francois, 1998), but these are demanding of additional information and unstable for projections purposes.

[7] Gehlhar's work showed that projections over a period of one decade were improved by increasing the size of the trade elasticities. Accordingly, for this work, we have doubled the size of the standard GTAP trade elasticities.

Figure 5

Cumulative GDP Growth: 1995-2005



SOURCE: Author's simulation results.

year), with a final category—very high (3 percent/year) reserved for China and Taiwan. The latter two economies seem to be growing at rates that can only be explained by taking into account factors such as the demographic transition (Bloom and Williamson 1998), rapid intersectoral movements of labor, and productivity-enhancing reforms. Sectoral variation in productivity growth builds on the econometric work of Bernard and Jones (1996). They find that the annual rate of productivity growth over the 1970-87 period in OECD agriculture was about 40 percent faster than that of manufacturing.[8] Similarly, services TFP growth was about half that in manufacturing, while they did not find significant productivity growth in mining over this period. By combining these factors of proportion with the above-mentioned manufacturing TFP growth rates, we are able to obtain region/sector-specific productivity forecasts for the 1995-2005 period.

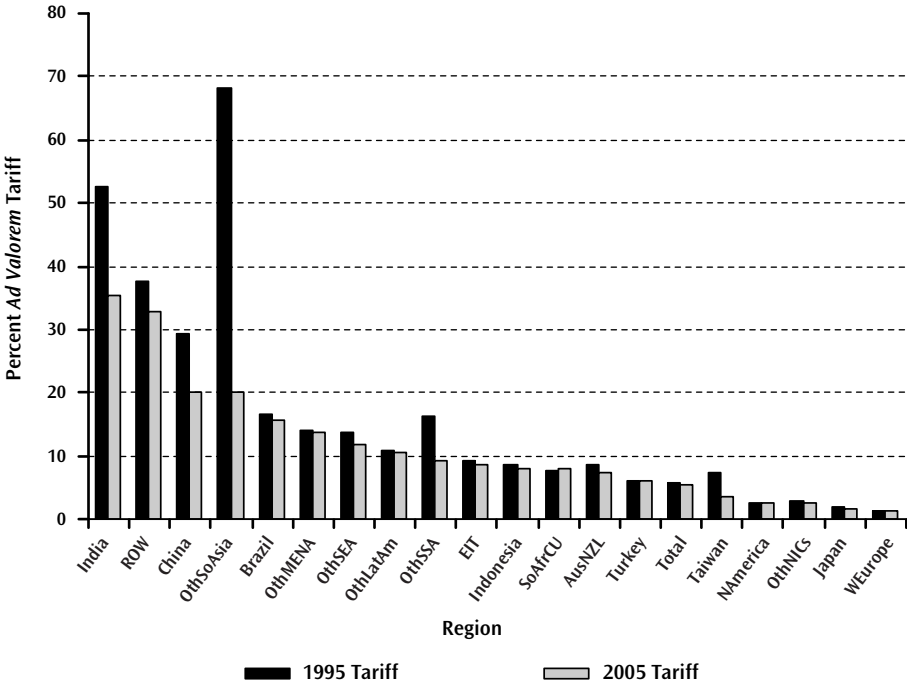
A difficult aspect of constructing such projections has to do with the rate at which natural resources are depleted—or perhaps augmented through new discoveries. Rather than attempt to estimate changes in the natural resource endowments over this period, we have simply opted to target a particular rate of change in the prices of natural resource-based commodities over the projections period. Grilli and Yang (1988) report an average rate of price decline for metals in the 20th century of about 0.8 percent/year, while grains prices have fallen about 0.3 percent/year, on average. We allow the model to select a rate of natural resource augmentation in agriculture and mining that achieves a continuation of these downward trends in commodity prices throughout the 1995-2005 period.

To gauge the reasonableness of these projections, Figure 5 compares projected GDP growth rates over this period to those from the World Bank's International Economic Analysis and Prospects Division. By and large they are quite close. This is hardly surprising, since the two studies share many basic assumptions. Significant departures arise in the cases of the South Africa Customs Union, the Economies in Transition (EIT), and Indonesia. In each case,

[8] Martin and Mitra (1996) find evidence of an even larger differential of agricultural over manufacturing productivity in developing countries.

Figure 6

Average MFN Tariff on Manufactures, by Importer: 1995 and 2005



SOURCE: GTAP version 4 database, McDougall et al., 1998 and simulation results.

projected growth rates are substantially higher than the World Bank's. The only way the World Bank forecasts for these three regions could be achieved in this framework is to have negative productivity growth rates, or substantial increases in unemployment rates. Having opted not to do either of these, the resulting forecasts are higher. The forecast for China's GDP growth is slightly higher than that of the World Bank, however, the difference is negligible when viewed in terms of annual growth rates.

Changes in Trade Policy

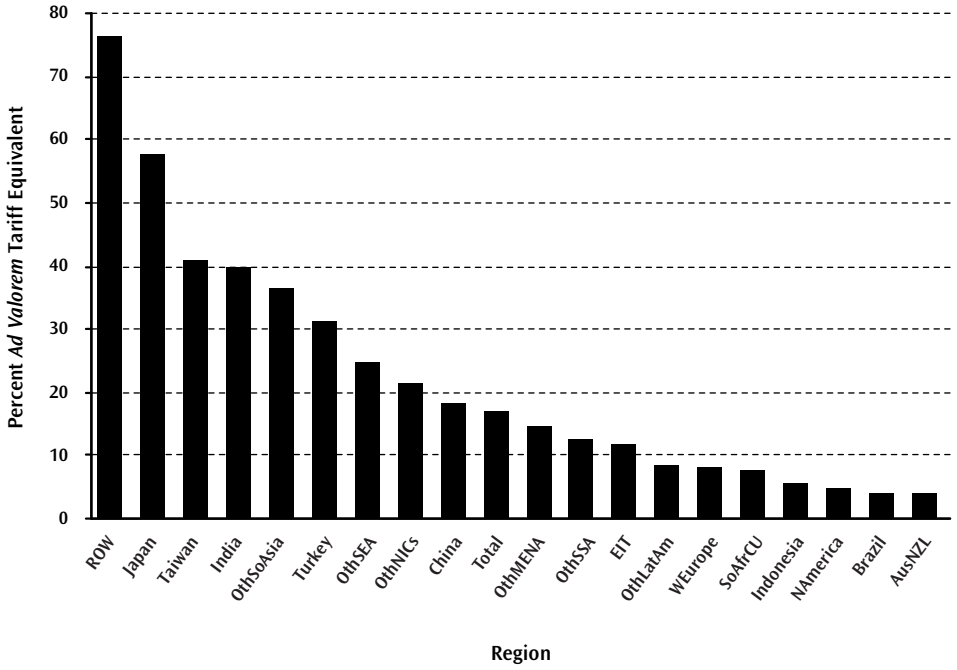
From the point of view of this paper, the most important trade policy developments over the 1995-2005 period are likely to be the completion of manufacturing tariff cuts under the UR, implementation of the Agreement on Textiles and Clothing (ATC) and the accession of China and Taiwan to the WTO.[9] These have been incorporated by drawing on the work of Francois and Strutt (1999) to specify the remaining UR cuts to be made from our 1995 base period. The estimate of China's reforms in manufacturing were made by beginning with its 1997 applied tariffs, and reducing them in those cases where her most recent multilateral tariff offer would require reductions. The reduction in protection in Taiwan and China was brought about by reducing industrial tariffs by a common factor designed to reach the widely-reported target of 4 percent in manufacturing.

Figure 6 reports the average MFN tariff on manufacturing, by importer in 1995 and 2005, where the latter is based on the lesser of individual countries' UR binding and their 1995 applied tariffs. For many regions, the 1995 and 2005 tariffs are very similar, indicating significant manufacturing tariff reductions are not anticipated over the course of the projections period. However, deep cuts are expected for South

[9] In addition to the baseline shocks discussed here, it should be noted that several significant adjustments were made to the levels of protection in the initial database prior to conducting the baseline projections. These are detailed in the appendix.

Figure 7

Average Food and Agricultural Tariff Equivalent in 2005, by Importing Region



SOURCE: Author's simulation results.

Asia, as can be seen from the bars for India and Other South Asia (OthSoAsia). Similarly, China's offer to the WTO appears to involve substantial cuts in manufacturing protection from the tariffs in place as of 1995.

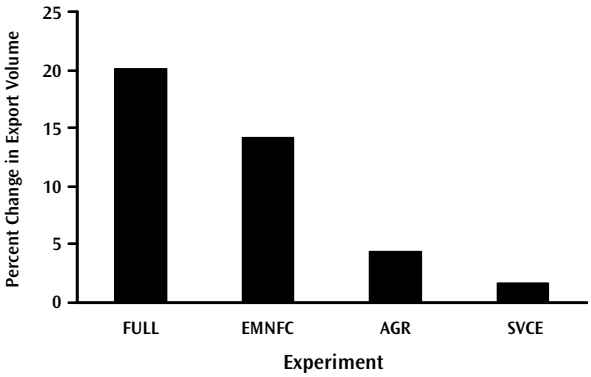
The Agreement on Textiles and Clothing implements accelerated growth of quotas established under the previous Multi-fiber Agreement (MFA), culminating in their abolition at the end of the UR implementation period. However, China and Taiwan, as non-members of the WTO, remain constrained by the old MFA quotas until a date to be determined in their accession negotiations. Thus, their accessions will bring important changes in the textiles and apparel trade. Since their accessions are likely to involve the complete elimination of quotas by China and Taiwan, (China's quotas by 2005 or soon after), it is likely that these reforms will largely be complete before any cuts under a Millennium Round are finalized. For this reason, their abolition is included in the baseline analysis as well.

Agriculture and services are more problematic. In the case of services, we believe that there is little in the UR commitments that can be effectively quantified, so we have not implemented policy changes there. On the other hand, quite a bit of quantification has been undertaken for agriculture. It must be pointed out that our base year, 1995, represents a period of very high world prices—and therefore, low measured protection. In contrast, UR commitments were based on a period in the late 1980s when prices were very low and measured protection was at a historic high. In light of these facts, and in light of the extensive "dirty tariffication" in agriculture (Hathaway and Ingco, 1995; Ingco, 1996), we believe that the assumption of no change from 1995 protection in agriculture is sensible, and we have implemented it in our baseline projections to 2005.[10] Figure 7 reports the

[10]Since China and Taiwan's offers are not linked to the UR base year, it would make sense to include their agricultural cuts in our baseline. However, we do not have solid estimates of their current protection rates and, at least in China's case, some of the bindings are clearly well above current protection levels. Therefore, we do not change their agricultural protection rates in the baseline simulation either.

Figure 8

Change in World Trade Volume Due to Trade Liberalization



SOURCE: Author's simulation results.

estimated average MFN tariff on food products by importer in 2005. The rest of the world (ROW), Japan, Taiwan and South Asia all show very high rates of protection. Western Europe shows relatively low protection rates since this figure includes intra-EU trade, which is very significant and not subject to tariffs. The agricultural exporting regions of Australia/New Zealand, Brazil, and North America show the lowest tariff equivalents when averaged across all food products.

ANALYSIS OF TRADE LIBERALIZATION IN 2005

Modeling Protection

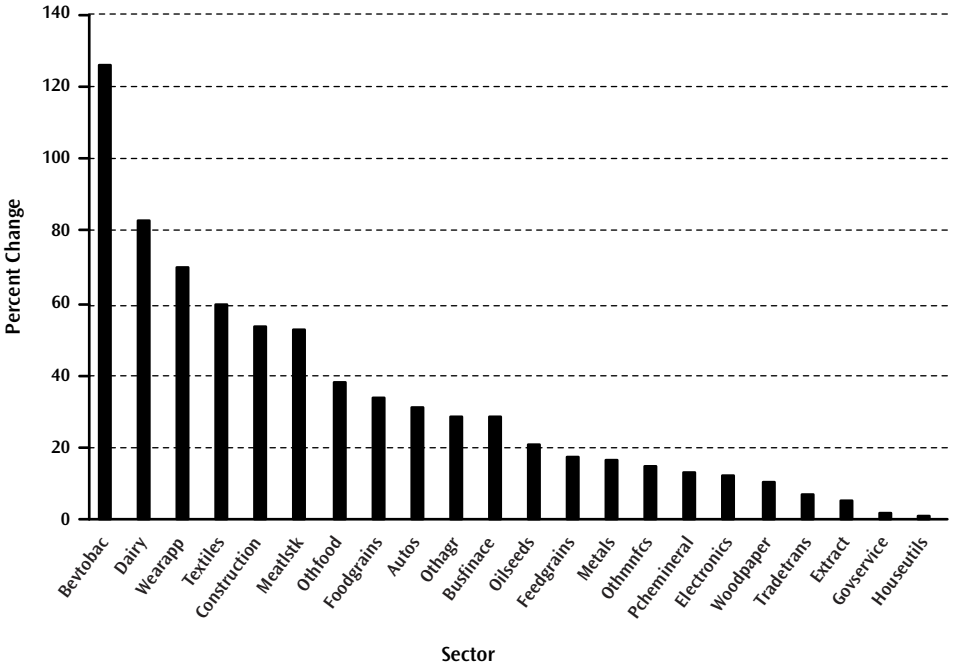
This section analyzes the impact of post-UR Round liberalization of the trade barriers identified above on global trade, economy-wide activity, and welfare. Specifically, across-the-board abolition of estimated 2005 agriculture protection (AGR), business and finance, and construction services protection (SVCE), as well as extractive industries and manufacturing tariffs (EMNFC) are each considered, in turn. A combined liberalization scenario (FULL) is also considered. Since we are completely abolishing protection, we are able to skirt a number of very difficult modeling issues. The first of these has to do with the distinction between applied and bound tariffs. As pointed out by Francois (1999b) and Josling and Rae (1999), applied tariffs are well below bound rates for manufactures' imports into developing countries, and for sensitive agricultural products worldwide. Since WTO negotiations focus on bound rates, a negotiated cut in tariffs will not reduce applied protection by the same amount. Indeed, Francois (1999b) finds that for most developing countries, a 25 percent reduction in bound industrial tariff rates would yield no reduction in applied rates.

A second issue sidestepped by assuming full liberalization is a question of how specific instruments are modeled. This is particularly difficult for agriculture, where the introduction of tariff rate quotas and a wide range of ingenious programs for administering "decoupled" producer subsidies have combined to frustrate those seeking greater transparency in farm policies. The complete liberalization approach to modeling reductions in agricultural support is also compatible with the way in which the GTAP database has incorporated protection for farm and food products. GTAP relies on price comparisons to assess the degree of border protection (market price support), and on producer subsidies to construct producer prices. Since these measures of protection are not instrument-specific, it makes sense to think of liberalization in the same summary fashion. In fact, since the version 4 database incorporates the domestic-world price wedges on both the import and export side, any reduction in support must logically reduce both the import tariff and export subsidy equivalents at the same rate. This is the route taken here.

Appropriate modeling of services protection poses even more challenging problems. Here, since there is no physical product being traded, the idea of modeling protection with revenue-raising tariff equivalents, following the work of Brown et al. (1995), seems inappropriate. This study instead follows Hertel et al. (1999) in assuming that barriers to services trade consume real resources on the part of firms attempting to access the protected market. This limits the actual volume of services that can be delivered at a given cost. Conversely, liberalization of restrictions on services trade can be viewed as augmenting the amount of services delivered from a given level of export effort, thereby reducing the effective price of services in the domestic market. We model this phenomenon using the "iceberg" approach to trading costs. The rate at which the "melting" is diminished is set according to the tariff-equivalent estimates of Francois (1999a) as discussed above. For example, in the case of India's imports of construction services, Francois has estimated that domestic prices of imports must be 62 percent above world market levels if one is to explain the rel-

Figure 9

Global Export Volume, by Sector: Percent Change Owing to Full Liberalization



SOURCE: Author's simulation results.

atively low share of imports in this market. Therefore, in the services trade liberalization experiment, an import-augmenting technical change is introduced that reduces the *effective* price of construction imports to Indian firms by 62 percent, *ceteris paribus*. It should also be re-emphasized that we do not have comparable protection estimates for the other service sectors. In addition, since direct trade is less important than foreign establishment trade for sectors like construction services, we are capturing only a small portion of the full "story" on services sector reform.

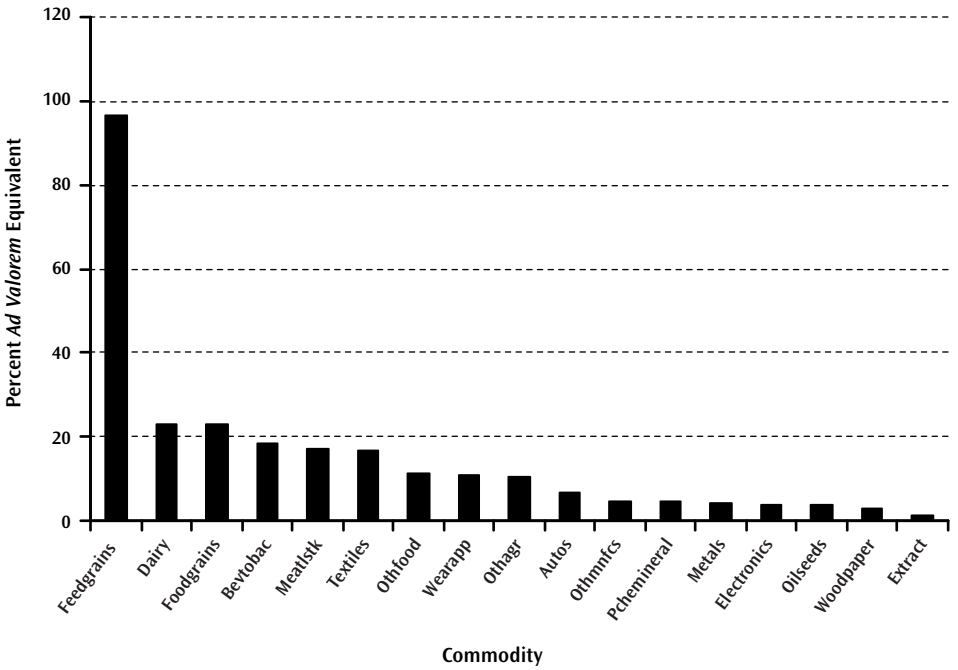
Results

Figure 8 reports the impact of the four liberalization experiments on world trade volumes. Combined liberalization across all sectors boosts world trade by about 20 percent. Three quarters of this increase is due to manufacturing tariff cuts, while most of the remainder is due to agricultural liberalization. The impact on world trade volume of liberalization of business services and construction trade is estimated to be quite modest. Of course, as noted previously, the approach used here will understate the total increase in services activity, when foreign establishment trade is also taken into account. Nevertheless, the percentage increase in direct trade for the construction and business services sectors is still quite significant, as shown in Figure 9. The largest increases in trade volume are for beverages and tobacco, dairy products, wearing apparel, and textiles. These are all commodities for which the average rate of protection worldwide is quite high, as shown in Figure 10. However, the trade increases for some of the agricultural products are lower than might have been predicted purely on the basis of average import protection. This is due to the elimination of subsidies on the production and exportation of farm products. The EU, in particular, reduces its food exports sharply as a result of trade liberalization.

When viewed on a regional basis, export volumes rise in all regions, as shown in Figure 11. The overall ordering of the regions in Figure 11 is quite similar to

Figure 10

Average Rate of Protection Worldwide for Merchandise Commodities



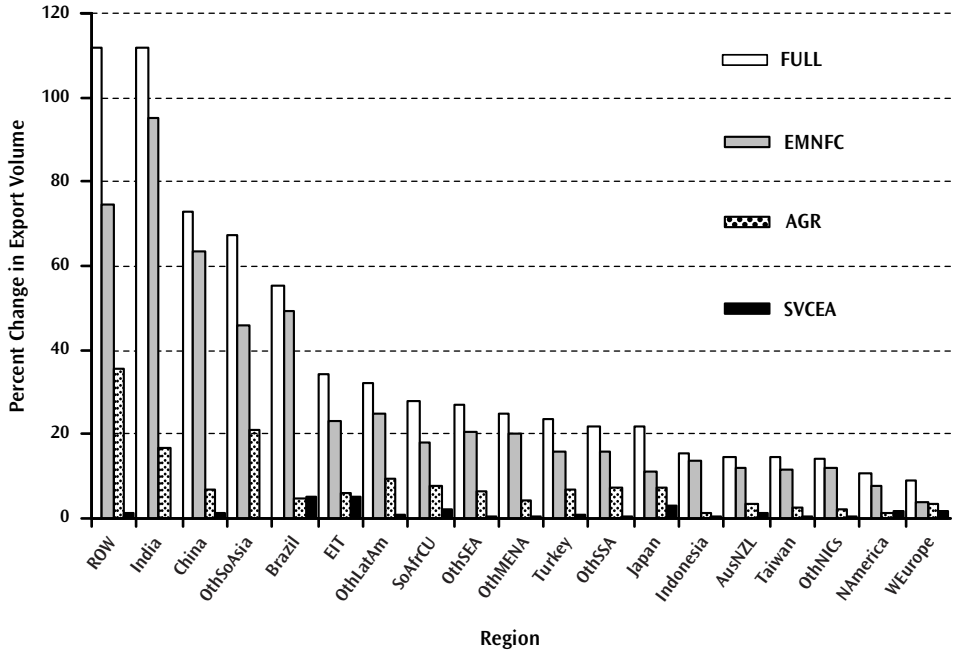
SOURCE: GTAP version 4 database, McDougal et al., 1998.

the ordering of countries in Figure 6, which summarizes protection in manufactures, ordered by the size of the manufacturing tariffs. Since a fixed trade balance is imposed in these simulations, liberalization in regions with the greatest protection level encourages the greatest increase in imports, thereby indirectly requiring higher export volumes. Not surprisingly, the largest volume increases are stimulated by tariff cuts in manufacturing. ROW, India, China, OthSoAsia, and Brazil top the list in terms of projected manufacturing tariff levels in 2005—and hence are required to make the largest cuts. These regions also experience the largest increase in export volumes following the liberalization. At the other end of the spectrum, Taiwan, OthNICs (Singapore, Hong Kong and Korea), North America, and Western Europe, show the smallest 2005 manufacturing tariffs in Figure 6. Therefore, it is not surprising that these economies also have the smallest export volume increases in the wake of the trade liberalization experiment. In some cases—most notably ROW, South Asia, Sub-Saharan Africa, and Latin America—the export volume changes owing to agricultural liberalization are also a significant share of the total. Services liberalization has a significant impact in some of the heavily protected economies including Brazil and the Economies in Transition (EIT: Eastern Europe and the former Soviet Union).

Figure 12 reports the worldwide welfare impacts of the trade liberalization experiments. It shows a global welfare gain of nearly $350 billion in 2005 as a consequence of full liberalization. About half of this is due to agricultural reforms, while the remainder is due to manufacturing and services liberalization. In light of the larger trade volume effect associated with the EMNFC liberalization experiment in Figure 8, it is perhaps surprising that elimination of support for agriculture actually generates larger welfare gains than does the manufacturing liberalization experiment. However, agricultural markets are fundamentally more heavily distorted (compare Figures 6 and 7).

Figure 11

Change in Regional Export Volume



SOURCE: Author's simulation results.

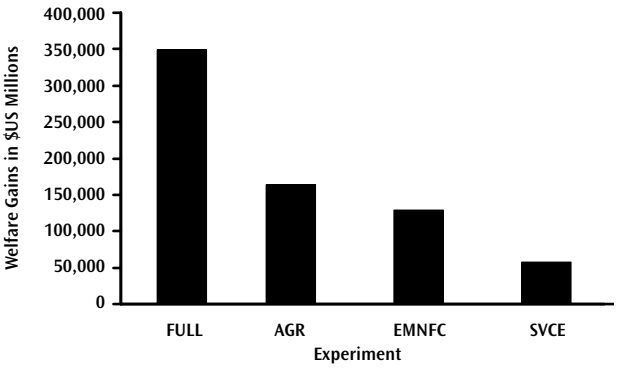
Since the welfare cost of such interventions rises roughly with the square of the height of the barrier, we expect much larger costs per dollar of support in agriculture. Furthermore, unlike manufacturing tariff protection, some of the agricultural policies act to promote exports so that their elimination actually leads to a contraction of trade in farm products.

The regional welfare impacts of multilateral liberalization are fundamentally determined by two factors: the change in the efficiency with which any given economy utilizes its resources, and changes in a country's terms of trade (TOT). Figure 13 sheds some light on the distribution of welfare gains between the developing countries and the high-income economies. With regard to the overall FULL scenario, the developing countries contribute nearly half the worldwide efficiency gains, and realize a somewhat smaller share of the real income gains. The difference is due to an adverse shift in the developing countries' TOT.

The remaining bars in Figure 13 help to sort out what is driving the distribution of welfare gains in the FULL liberalization experiment. The difference between

Figure 12

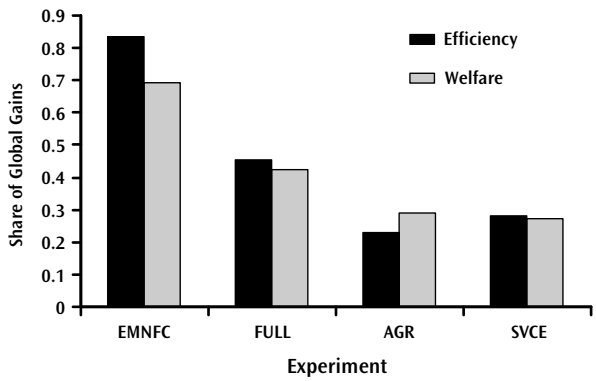
Global Welfare Gains from Alternative Experiments



SOURCE: Author's simulation results.

Figure 13

Share of Gains Accruing to Developing Countries



SOURCE: Author's simulation results.

the share of global efficiency gains generated in the developing countries under manufacturing (EMNFC) liberalization (83 percent) on the one hand, and agricultural (AGR) and services (SVCE) liberalization (23 percent and 28 percent, respectively) on the other is quite striking. This is largely a function of the fact that high-income countries have nearly eliminated manufacturing tariffs, while some developing countries are still expected to have quite high industrial tariffs, even after completion of the UR. Thus, most of the efficiency gains that remain in this area in 2005 will accrue to the developing countries. Of course, the flip side of this situation is that these same developing countries are likely to expand trade sharply in the wake of manufacturing liberalization. This depresses their export prices and raises their import prices. The resulting terms of trade deterioration are sufficient to shift 14 percent (= 83 percent efficiency share - 69 percent welfare share) of the global welfare gain from developing to high-income countries. On the agricultural side, there is a modest TOT improvement for the developing countries as a result of liberalization of food trade, while services engenders little aggregate terms of trade transfer.

This aggregate picture of efficiency and welfare gains can be further broken down to the region level, as shown in Figure 14. Since developing countries represent only 22 percent of global GDP, but reap a share of global welfare gains which is nearly double that percentage, it is not surprising that they feature prominently in the individual country/region gains. The largest efficiency gains as a share of regional income arise in OthSoAsia, ROW, China, Other South East Asia (OthSEA), India, Brazil and the OthNICs. In fact, in South Asia (outside of India), these annual gains approach 6 percent of GDP—a truly large number in this type of analysis. All of the top five efficiency gainers also experience TOT deterioration, as indicated by the smaller real income gains (first bar in Figure 14 lower than the second one). The NICs (Taiwan and OthNICs), Australia/New Zealand, non-Brazilian Latin America (OthLatAm), and Other Sub-Saharan Africa all show very strong TOT improvements as a result of global trade liberalization in 2005.

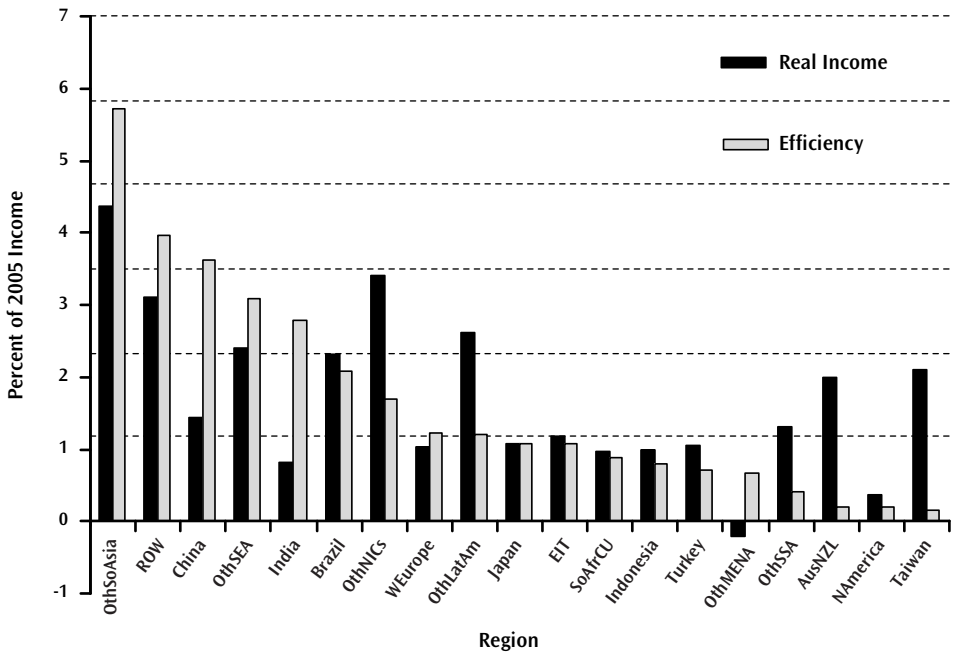
Sensitivity to Key Assumption

It should be noted that these welfare findings are quite sensitive to the size of the trade elasticities used. In this study, we have doubled the usual, medium term (3-5 years) GTAP elasticities to account for the longer-term nature of our analysis (10+ years). Larger elasticities may be expected to increase the size of the global welfare gains, and in separate simulations, the trade elasticities used in this study have been cut in half. This reduces the global efficiency gains by about one-half as well. This rule of proportionality works very well in predicting the effect of across-the-board changes in trade elasticities on predicted global welfare gains. However, by accentuating the regional terms of trade effects for regions engaging in the deepest tariff cuts, the lower elasticities shift the distribution of welfare gains across regions in favor of the regions making the smallest cuts in protection. This can have a significantly different impact on the outcome for particular regions.

To address the sensitivity of individual regions' gain to the assumed trade elasticities, a formal, systematic sensitivity analysis has been performed. The Gaussian Quadrature approach taken builds on the work of DeVuyst and Preckel (1997), following the theory outlined in Arndt (1996) and implemented based on Arndt and Pearson (1996). It involves specifying an explicit distribution for the unknown parameters—in this case the elasticities of substitution in international trade. This distribution is assumed to be symmetric and triangular, with the mean equal to the elasticity values used in this study, and the minimum values equal to $\frac{1}{2}$ these values (via symmetry, the maximum values equal $1\frac{1}{2}$ x the mean values). Furthermore, the elasticities are assumed to vary together, so that if

Figure 14

Efficiency and Real Income Gains Due to Global Liberalization in 2005



SOURCE: Author's simulation results.

a true elasticity is 30 percent below the mean, then this is the case for all elasticities.

Having specified a distribution for the unknown parameters, a weighted sample is drawn from this distribution, and the model is solved for each of these parameter combinations. The resulting mean welfare change as well as the associated standard deviations are reported in Figure 15. Note that most of the regional welfare gains are more than two standard deviations away from zero, indicating that their welfare improvement is rather robust for this kind of parameter variation. However, India's gain and the Middle East and North Africa's loss appear to be uncertain, in light of the assumed distribution of trade elasticities.

SUMMARY AND CONCLUSIONS

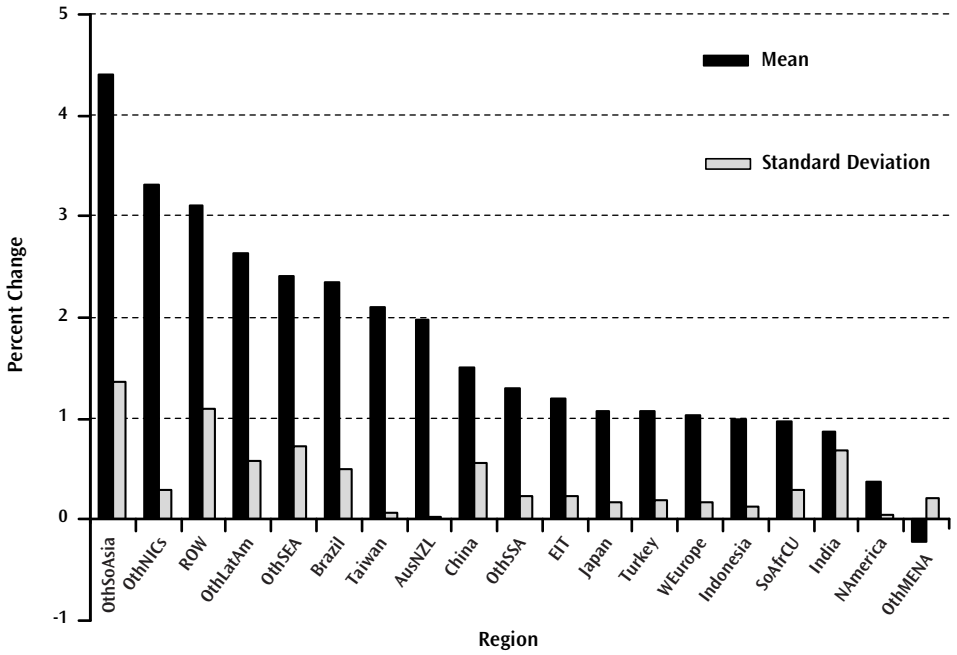
The objective of this paper has been to evaluate the potential contributions of services, agricultural, and manufacturing liberalization in the context of a prospective Millennium Round of WTO negotiations. The approach takes into account the dramatic changes in the pattern of trade since the lead-up to the UR. Furthermore, this paper has employed projections of the global economy to the year 2005, when the UR is to be fully implemented.

Examination of historical data reveals a number of significant trends over the past three decades. Rising protection for OECD agriculture has been accompanied by the erosion in agriculture's share of world trade, while manufacturing's share has been rising, fueled in part by falling tariffs. This shift has been especially pronounced for the developing countries, which are trading increasingly with one another. Projections to 2005 indicate that these trends are likely to continue as the UR Agreement is fully implemented.

The analysis in this paper focused on the impact of complete (FULL) liberalization of measured protection for agriculture, manufactures, and direct trade in business, financial, and construction services. Results

Figure 15

Real Income Impacts of Trade Liberalization in 2005



SOURCE: Author's simulation results.

suggest that manufacturing's liberalization accounts for three-quarters of the subsequent 20 percent increase in global trade. However, in terms of potential welfare gains, agricultural liberalization ranks higher, accounting for $164 billion of the estimated $349 billion in annual gains from complete (FULL) liberalization in 2005. This is followed by manufacturing which contributes $130 billion to the total welfare gain, with the remainder due to liberalization in the business, finance, and construction services sector. Like Hertel and Martin (1999), who focus on partial liberalization of manufactures' trade, we find that the majority of the gains from manufacturing tariff cuts accrue to developing countries. This stands in contrast with agriculture and services liberalization where the majority of the absolute gains accrue predominately to high-income countries. Overall, about 42 percent of the gains from a complete liberalization package in 2005 are estimated to accrue to developing countries. Since developing countries' share of global GDP is projected to be about 22 percent in 2005, this represents about twice their share of global income. Therefore, in percentage terms, developing countries tend to gain relatively more than high-income countries from this package of multilateral trade reforms.

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Appendix Tables

Table A1

List of 19 Regions Used in This Analysis

High-Income Countries	
NAmerica	North America
WEurope	Western Europe
AusNZL	Australia-New Zealand
Japan	Japan

Developing Countries	
China	China
Taiwan	Taiwan
OthNICs	Other Newly Industrial Countries
Indonesia	Indonesia
OthSEA	Other Southeast Asia
India	India
OthSoAsia	Other South Asia
Brazil	Brazil
OthLatAm	Other Latin America
Turkey	Turkey
OthMENA	Other Middle East and North Africa
EIT	Economies in Transition
SoAfrCU	South Africa Customs Union
OthSSA	Other Sub-Saharan Africa
ROW	All Other Regions

Table A2

Mapping from GTAP's (Version 4) 45 Regions into the 19 Regional Groupings Used in This Analysis

Abbreviation	Region	Regional Grouping
aus	Australia	AusNZL
nzl	New Zealand	AusNZL
jpn	Japan	Japan
kor	Korea	OthNICs
idn	Indonesia	Indonesia
mys	Malaysia	OthSEA
phl	Philippines	OthSEA
sgp	Singapore	OthNICs
tha	Thailand	OthSEA
vnm	Vietnam	OthSEA
chn	China	China
hkg	Hong Kong	OthNICs
twn	Taiwan	Taiwan
ind	India	India
lka	Sri Lanka	OthSoAsia
ras	Rest of South Asia	OthSoAsia
can	Canada	NAmerica
usa	United States of America	NAmerica
mex	Mexico	NAmerica
cam	Central America and Caribbean	OthLatAm
ven	Venezuela	OthLatAm
col	Colombia	OthLatAm
rap	Rest of the Andean Pact	OthLatAm
arg	Argentina	OthLatAm
bra	Brazil	Brazil
chl	Chile	OthLatAm
ury	Uruguay	OthLatAm
rsm	Rest of South America	OthLatAm
gbr	United Kingdom	WEurope
deu	Germany	WEurope
dnk	Denmark	WEurope
swe	Sweden	WEurope
fin	Finland	WEurope
reu	Rest of European Union	WEurope
eft	European Free Trade Association	WEurope
cea	Central European Associates	EIT
fsu	Former Soviet Union	EIT
tur	Turkey	Turkey
rme	Rest of Middle East	OthMENA
mar	Morocco	OthMENA
rnf	Rest of North Africa	OthMENA
saf	South African Customs Union	SoAfrCU
rsa	Rest of Southern Africa	OthSSA
rss	Rest of Sub-Saharan Africa	OthSSA
row	Rest of World	ROW

Table A3

Description of the 22 Sectors Used in This Analysis

Agriculture	
Foodgrains	Rice, Wheat, Coarse Grains
Feedgrains	Coarse Grains
Oilseeds	Oilseeds
Meatlstk	Ruminants And Non-Ruminants
Dairy	Dairy
Othagr	Other Farm Products
Othfood	Other Processed Foods
Bevtobac	Beverages And Tobacco
Minerals and energy	
Extract	Mining, Fish, Forestry
Manufactures	
Textiles	Textiles
Wearapp	Wearing Apparel
Woodpaper	Wood And Paper Products
Pchemineral	Petroleum, Coal, Chemical, Rubber, Plastic, Mineral Products
Metals	Metals And Metal Products
Autos	Motor Vehicles And Parts
Electronics	Electronic Equipment
Othmnfcs	Other Trans Equipment, Machines
Services	
Houseutils	Housing and Utilities
Tradetrans	Trade and Transport Services
Construction	Construction Services
Busfinance	Business and Financial Service
Govservice	Government Services

Table A4

Mapping from GTAP's (Version 4) 50 Detailed Sectors into the 22 Aggregate Sectors Used in This Analysis.

Abbreviation	Detailed Sector	Aggregate Sector
pdr	Paddy Rice	Foodgrains
wht	Wheat	Foodgrains
gro	Cereal Grains Nec	Feedgrains
v_f	Vegetables, Fruit, Nuts	Othagr
osd	Oil Seeds	Oilseeds
c_b	Sugar Cane, Sugar Beet	Othagr
pfb	Plant-based Fibers	Othagr
ocr	Crops	Othagr
ctl	Bovine Cattle, Sheep and Goats	Meatlstk
oap	Animal Products	Meatlstk
rmk	Raw Milk	Dairy
wol	Wool Silk-Worm Cocoons	Meatlstk
for	Forestry	Extract
fsh	Fishing	Extract
col	Coal	Extract
oil	Oil	Extract
gas	Gas	Extract
omn	Minerals	Extract
cmt	Bovine Cattle, Sheep and Goat	Meatlstk
omt	Meat Products	Meatlstk
vol	Vegetable Oils And Fats	Othfood
mil	Dairy Products	Dairy
pcr	Processed Rice	Foodgrains
sgr	Sugar	Othfood
ofd	Food Products	Othfood
b_t	Beverages and Tobacco Products	Bevtobac
tex	Textiles	Textiles
wap	Wearing Apparel	Wearapp
lea	Leather Products	Othmnfcs
lum	Wood Products	Woodpaper
ppp	Paper Products, Publishing	Woodpaper
p_c	Petroleum, Coal Products	Pchemineral
crp	Chemical, Rubber, Plastic Products	Pchemineral
nmm	Mineral Products	Pchemineral
i_s	Ferrous Metals	Metals
nfm	Metals	Metals
fmp	Metal Products	Metals
mvh	Motor Vehicles and Parts	Autos
otn	Transport Equipment	Othmnfcs
ele	Electronic Equipment	Electronics
ome	Machinery and Equipment	Othmnfcs
omf	Manufactures	Othmnfcs
ely	Electricity	Houseutils
gdt	Gas Manufacture, Distribution	Houseutils
wtr	Water	Houseutils
cns	Construction	Construction
t_t	Trade, Transport	Tradetrans
osp	Financial, Business, Recreation	Busfinance
osg	Public Administration & Defense, Education	Govservice
dwe	Dwellings	Houseutils

Table A5

Cumulative Percentage Growth Rates over the Period 1995-2005

(Annual growth in parentheses)

Regions	Population	Unskilled Labor	Skilled Labor	Capital	Total Factor Productivity*
North America (NAmerica)	11 (1.05)	14 (1.29)	39 (3.33)	39 (3.33)	low
Western Europe (WEurope)	1 (0.10)	0 (0.03)	29 (2.60)	9 (0.83)	high
Australia/New Zealand (AusNZL)	10 (0.97)	11 (1.09)	66 (5.20)	20 (1.84)	low
Japan	2 (0.20)	-3 (-0.29)	32 (2.83)	4 (0.37)	low
China	9 (0.83)	12 (1.17)	43 (3.66)	139 (9.08)	very high
Taiwan	8 (0.73)	13 (1.21)	51 (4.18)	56 (4.52)	very high
Other NICs (OthNICs)	9 (0.84)	8 (0.73)	66 (5.18)	23 (2.09)	high
Indonesia	14 (1.31)	21 (1.96)	126 (8.47)	20 (1.82)	low
Other Southeast Asia (OthSEA)	19 (1.73)	26 (2.36)	84 (6.29)	33 (2.87)	low
India	17 (1.59)	23 (2.11)	73 (5.65)	116 (8.01)	medium
Other South Asia (OthSoAsia)	23 (2.10)	33 (2.92)	77 (5.87)	40 (3.39)	medium
Brazil	13 (1.26)	22 (2.04)	70 (5.46)	-7 (-0.69)	high
Other Latin America (OthLatAm)	18 (1.63)	23 (2.11)	89 (6.55)	27 (2.41)	medium
Turkey	15 (1.44)	22 (2.02)	104 (7.41)	35 (3.06)	high
Other Middle East & North Africa (OthMENA)	27 (2.43)	37 (3.17)	109 (7.64)	11 (1.07)	low
Economies in Transition (EIT)	3 (0.27)	6 (0.60)	69 (5.37)	36 (3.09)	low
South Africa Customs Union (SoAfrCU)	23 (2.06)	29 (2.59)	162 (10.11)	-1 (-0.10)	low

Table A5 *continued*

Regions	Population	Unskilled Labor	Skilled Labor	Capital	Total Factor Productivity*
Other Sub-Saharan Africa (OthSSA)	33 (2.87)	37 (3.19)	88 (6.50)	25 (2.23)	medium
Rest of World (ROW)	18 (1.65)	21 (1.90)	83 (6.22)	50 (4.15)	medium

* The low, medium, high, and very high growth assumptions for total factor productivity (TFP) in manufacturing correspond to annual growth rates of 0.3 percent, 1 percent, 2 percent, and 3 percent, respectively. TFP growth in other sectors is based on a proportion of this rate. These proportions are: 1.4 (agriculture), 0.5 (services), and 0.0 (mining).

SOURCE: Hertel et al., 1999.