Assessing the World Market Impacts of Multilateral Trade Reforms

by

Thomas W. Hertel and Maros Ivanic*

Chapter 3 in Putting Development Back into the Doha Agenda: Poverty Impacts of a WTO Agreement, Thomas W. Hertel and L. Alan Winters (eds.) forthcoming from the World Bank, Washington, D.C.

*Hertel is Professor at Purdue University and Ivanic is a consultant with the Development Economics Research Group, The World Bank. This research was conducted while Hertel was on leave with the World Bank. Financial support from the Bank-Netherlands Partnership Program is gratefully acknowledged.
Assessing the World Market Impacts of Multilateral Trade Reforms

Introduction

In order to deduce the national poverty impacts of the Doha scenarios outlined in the previous chapter, we need a modeling framework. One approach would be to employ a global model with sufficiently disaggregated households at the national level in order to say something about potential poverty impacts. This is the approach pursued by Ivanic in Chapter 15, where he explores the poverty impacts of global trade reform in fifteen focus countries. It is a useful way to offer an integrated analysis of the poverty impacts of multilateral trade reforms, but it is also a very demanding exercise that ultimately must abstract from many of the country-specific features that may play an important role in determining the poverty impacts of trade liberalization. Therefore, for most of the studies reported in this volume, we employ a two-step approach. In the first step we use a global model to estimate, for each of our target countries in turn, the price changes and estimated changes in export volumes as well as import price changes arising from the liberalization of trade in other countries. In the second stage, the authors who deal with specific countries use these as inputs into their national models, which are tailored to address particularly important features of their focus economy. This chapter describes the first step in the process, namely the approach to estimating country specific price and export volume changes and the methodology for passing these on to the country level.
1. Modeling World Price and Volume Changes

1.1 Choice of Model

There is always a trade-off between the use of detailed, partial equilibrium models of trade reform and less-detailed, but more comprehensive, general equilibrium approaches. A good example of the partial equilibrium approach is offered by papers collected in Aksoy and Beghin (2004). They provide a detailed exploration into the impacts of trade reform in nine different agricultural commodity markets. However, the goal of the present book is to assess the poverty impacts of comprehensive trade reforms that affect not just a few agricultural commodity markets, but also food processing, textiles and apparel, and other manufacturing trade. Also, since we are assessing the impacts of such reforms on poverty, we must consider not only the impact on traded commodities, but also the resultant changes in the prices of services and primary factors of production. Finally, to the extent that trade reform has adverse impacts on fiscal revenue, we must also consider the impacts of replacing lost tariff revenue with other tax instruments. For all of these reasons, a general equilibrium approach is required. Nevertheless, we will draw on the commodity-specific studies for insights into the market impacts of farm-specific support policies, and we will also seek to validate our general equilibrium approach against observed behavior in specific commodity markets.

Nearly all the global general equilibrium models today draw on the global production, use and trade data base collected and maintained by the Global Trade Analysis Project (GTAP)\(^1\). This data base provides a snapshot of the world economy for a single year (version 6 represents 2001), with complete bilateral trade flows and inter-

\(^1\) For the details on the data base see Dimaranan and McDougall (2002).
industry sales for a 57 sector disaggregation of each region (of which there are 87 in version 6). The models built on the GTAP data base often differ in their choice of parameters and model closure. Some are comparative static and some are dynamic. The simplest of these models, and therefore one of the most widely used, is the standard GTAP model (Hertel and Tsigas, 1997). It has the virtue of being well-documented, transparent and highly flexible when it comes to the aggregation of sectors and countries. However, this very flexibility can be a limitation when it comes to the analysis of specific commodity markets. As shown in the Chapter 2, a disproportionate share of the trade distortions arises in agriculture. Furthermore, as shown documented in Ivanic’s subsequent chapter (15), a disproportionate share of the poor is employed in farming—particularly in the lowest income economies, and the poor spend a disproportionate share of their income on food. Therefore, it is important to “get the story right” when it comes to farm and food impacts of trade reform. For this reason, we employ a special purpose version of the GTAP model, nick-named GTAP-AGR, which has been designed to draw on the latest econometric research on the underlying parameters governing supply and demand in the food and agricultural markets (Keeney and Hertel, 2005).

1.2 Model Description

As documented in Hertel (1997) and on the GTAP web site\(^2\), the standard GTAP model includes: demand for goods for final consumption, intermediate use and government consumption, demands for factor inputs, supplies of factors and goods, and international trade in goods and services. The model employs the simplistic but robust assumptions of perfect competition and constant returns to scale in production activities.

\(^2\) http://www.gtap.agecon.purdue.edu/products/models/
Bilateral international trade flows are handled using the Armington assumption by which products are exogenously differentiated by origin. This means that there is not a single “world price” for a given product—say rice. Rather the price varies with the origin of the product. For example, rice exported from Thailand is differentiated from rice produced and exported from the USA. This is a useful approach for several reasons. First of all, even at the level of rice, or processed sugar, commodities are heterogeneous. For example, processed sugar trade includes high fructose corn syrup as well as processed cane and processed beet sugar. The category of rice includes many different varieties, some of which substitute only imperfectly for one another. A second, closely related reason for adopting this product differentiation assumption is that it permits us to explain, within the model, why an individual country is both an exporter and an importer of a given product. For example the United States is an exporter of high quality beef, while it imports low quality beef for use in fast food.

Of course, an important, and well-known consequence of the Armington assumption is the presence of relatively high optimal tariffs, even for small countries. This is because every country faces a downward-sloping export demand schedule, with the small country elasticity being approximated by the elasticity of substitution amongst imports in the destination regions. Consequently, the optimal import tariff is roughly equal to the inverse of this Armington elasticity. In the model discussed below, the simple average of these elasticities is about 7 so that the optimal tariff for the countries analyzed in this book is in the neighborhood of 16 percent. Since many developing countries already have average tariffs in this range, further tariff cuts on a unilateral basis will likely generate aggregate welfare losses. While this does not mean that poverty will
necessarily increase, it certainly biases the model against showing favorable developments in the wake of own-liberalization. This will be an important point to bear in mind when we consider the impacts of developing country tariff cuts on poverty.

Using this standard modeling framework as a starting point, GTAP-AGR incorporates some alternative representations to bring focus on the intricacies of agricultural production and markets. Several structural features have been highlighted in the agricultural economics literature for their importance in the analysis of agricultural policy changes: inter-sector factor mobility and factor substitution in production, crop-livestock sector interactions, consumer food demand, and trade elasticities. The manner in which these features are introduced into the model is detailed in Keeney and Hertel (2004) and is discussed briefly below.

Recent work by the OECD (2001) on the cost and world market impacts of agricultural support highlights the role of factor market issues in an empirical partial equilibrium model. This work focuses on the segmentation that occurs in land, labor, and capital markets between the agricultural and non-agricultural economy, and provides the region specific factor supply elasticities used in the GTAP-AGR model. Keeney and Hertel (2005) also follow the OECD’s factor substitution regime for primary agriculture, focusing on substitution possibilities among farm-owned and purchased inputs, as well as between the two. They calibrate the constant elasticity of substitution cost functions for farm-level sectors to the region-specific Allen elasticities of substitution provided by the OECD.

The interaction between livestock and crop sectors received considerable attention in the literature following European CAP reform in 1992 and has continued to be an area
of concern (Peeters and Surry, 1997). The primary concern has to do with the ability of the livestock industry to change the mix of feedstuffs demanded in response to changing relative prices induced by farm support policies. The GTAP-AGR model follows the approach of Hertel and Rae (2000) in modeling the substitution possibilities for feedstuffs in livestock production as an additional part of the firm’s cost minimization problem, governed by a constant elasticity of substitution amongst ingredients. They calibrate this region-generic parameter to an average substitution elasticity calculated from Surry’s (1992) three-stage model describing the behavior of European livestock producers, composite feed mixers, and grain producers.

The importance of consumer demand for foodstuffs is prominent in the agricultural economics literature. The unique role of food in the consumer budget has been emphasized in much of this work especially as it relates to the distribution of incomes (Cranfield et al., 2002; Seale, Regmi, and Bernstein, 2003). Inelastic demand in many markets, coupled with volatile supplies, translates into volatile prices for staple products, which can have a significant impact on households near or below the poverty line. The GTAP-AGR model employs a recent set of estimates from a cross-country study of demand, keying on own-price and income elasticities of demand for food (Seale et al., 2003). In the GTAP-AGR model, Keeney and Hertel (2004) calibrate the parameters of the GTAP demand system to the elasticities for the eight food aggregates and an additional non-food aggregate.

International trade elasticities that describe the substitution possibilities between goods differentiated by origin have received considerable attention for the important role they play in simulation models determining the terms of trade impacts of liberalization.
Hertel et al. (2003) provide recent estimates of this substitution relationship at the same level of disaggregation as the sectors in the GTAP model. Those authors also show how the estimated gains from trade liberalization hinge critically on the value of these parameters. We make use of their region-generic estimates of the elasticity of substitution amongst imported goods from different sources as specified in the model’s Armington demand structure.3

1.3 Model Validation

While each of these individual model modifications is supported by the current literature, when used together in the context of a general equilibrium model, there remains the unanswered question of how well the model as a whole performs, relative to the historical record. Valenzuela et al. (2005) address this question in a validation exercise aimed at investigating how well the model performs in reproducing historical price volatility in world markets for agricultural products. Their approach makes use of the fact that most of the annual volatility in crop commodity markets is induced by shocks to supply—the majority of which are induced by exogenous natural phenomena (e.g., droughts, heat-waves, floods, etc.)

The authors’ validation experiment focuses specifically on wheat and begins by estimating a time series forecasting model to predict output trends, attributable to either technical advancements or year-to-year market signals, in wheat producing regions. The remaining year-to-year changes are attributable to nature-induced supply-side shocks.

3 Unfortunately, due to a lack of data on domestic purchases and prices, those authors are unable to estimate the elasticity of substitution between domestic goods and imports. As with the standard GTAP model, these parameters are still obtained using the “rule of two” (i.e. the import-import elasticities are assumed to be twice as large as the import-domestic elasticities). Liu, Arndt and Hertel (2004) formally test this hypothesis in a model-based analysis of changing trade shares in East Asia over the 1980’s and early 1990’s. They fail to reject this hypothesis.
These random shocks are used to build a distribution of annual supply shocks with which to perturb the model. The ensuing distribution of price predictions may then be compared to that observed historically in order to validate the model. Their specific validation criterion is the predicted vs. observed standard deviation in wheat prices for each country, where the model prediction is obtained by solving the model repeatedly, each time sampling from the historical distribution of supply-side shocks for each region of the world.

The most recent results from the work of these authors are summarized in Figure 3.1. Here, individual countries represented in the model are given by single points. Regions including multiple countries are represented by brackets, since the model predicts only one price per region, but the FAO data show a range of prices—differing for each country in the region. From this figure, we see that the model-predicted standard deviation of prices is virtually the same as that observed historically for wheat in the cases of the EU, MENA, South Asia, China and Australia. For Japan and Brazil, the model over-predicts price volatility. This is hardly surprising, since both of these countries have had domestic policies in place aimed at stabilizing prices, and these policies have not been captured in the model simulations. In the remaining individual countries shown in this figure—Canada, USA, Mexico and Argentina—the model predicts too little volatility in wheat prices. With the exception of Mexico, which is heavily influenced by the US market, these countries are major wheat exporters. As such, their domestic prices are influenced by other countries’ trade policies—which often serve to destabilize markets by dumping excess production on world markets (export subsidies) in times of surplus, and restricting sales in times of shortage. Since the model abstracts
from year to year changes in trade policies over this period, it appears to understate the variability of prices in the major export markets.

Finally, two regions stand out as having a very large range of price variation. These are: Rest of Latin America and Central and Eastern Europe. The authors attribute some of this price variation to policy volatility (particularly in Eastern Europe), as well as macro-economic instability and the difficulty of properly deflating year-to-year price changes to obtain estimates of real price variation over this period. Overall, it appears that the GTAP-AGR model shows reasonably valid behavior for many regions. Improving its performance will likely require more attention to how individual commodity policies operate at the margin. This goes well beyond the scope of this book, which focuses instead on the impacts of eliminating, or sharply reducing farm and food support policies. While the authors have thus far only conducted this validation analysis for a single commodity, we take this evidence as a positive indication that GTAP-AGR is indeed a valid framework for analyzing impacts of global agricultural liberalization on world markets. Therefore, we now turn to an analysis of the price impacts of multilateral agricultural trade reform.

2. Results

In this section, we consider the global and national impacts of the Full-Lib scenario, as well as the central Doha scenario outlined in Chapter 2. To briefly recap, recall that the first of these scenarios offers a simple, free-trade benchmark by assessing the impact of removing all merchandise trade barriers as well as domestic support in the OECD countries. The Doha scenario represents an aggressive interpretation of the July
2004 Framework Agreement for the Doha Development Agenda, including tiered formulae for reductions in tariffs and domestic support and full elimination of agricultural export subsidies. This scenario also embodies special and differential treatment for developing countries whereby cuts in bound commitments are only two thirds of those in developed countries, while the least developed countries make no cuts whatsoever.

2.1 Tariff Landscapes in the Focus Countries

The implications of these two scenarios for average tariffs in the focus countries are reported in Table 3.1. Here, average import tariffs on products coming into the country in question\(^4\) are reported in the first column of each block under the heading “original”. So, in Bangladesh, the average tariff on primary agriculture imports is 6%, whereas it is 20% on other primary products and processed foodstuffs. Table 3.1 also reports information on the average rate of protection facing a given country’s exports. In the case of Bangladesh, this is 8% for agriculture, 2% for other primary products and 1% for foodstuffs. By comparing tariff entries within a column, we can see which sectors are more heavily protected, and therefore likely to contract under unilateral abolition of trade barriers. By comparing the two “original” columns in a given row, we can see whether imports are relatively protected, when compared to exports, and hence whether a given industry is likely to expand or contract global free trade in a given product. Of course, the actual Full-Lib scenario will be a combination of these two forces.

The next column in this table (labeled Doha) reports the average tariffs following the Doha reforms. Note that in the case of most of the focus countries, the post-Doha

---

\(^4\) Note that two of the focus countries: Cameroon and Zambia are omitted from this Table. Cameroon is omitted since this country is not broken out in the GTAP data base. Therefore, price impacts of liberalization in the rest of the world will be inferred from the impacts on the “rest of SSA” region. In the case of Zambia, the country study focuses solely on cotton and therefore draws on partial equilibrium studies of trade reform.
tariffs are the same as the original tariffs. In the cases of Bangladesh and Mozambique, both of which are Least Developed Countries (LDCs), this is due to the fact that the Doha Agenda does not require them to make tariff cuts. In the case of many of the other developing countries in this table, there is also no difference. The reason that the Doha-negotiated cut in the tariff bindings has no impact is that the bound tariffs are far in excess of their applied rates (recall the discussion of binding overhang in Chapter 2). So cutting the bindings still leaves them above the applied rates in many cases. Indeed, the Doha scenario only has a measurable impact in the cases of Brazil, China, Russia and Mexico, where the binding overhang (i.e. the amount by which the bound rate exceeds the applied tariff rate) is less pronounced.

The change in tariffs levied on a given country’s exports can also be observed in Table 3.1. This is smallest for the LDCs, which already receive preferential access into many markets—as well as for Mexico, which already has nearly free trade with its largest trading partners. For China, the post-Doha tariffs are quite a bit lower—nearly 50% in the case of primary agriculture exports.

### 2.2 Full Liberalization

Tables 3.2–3.6 report the results from the Full-Lib experiment. These tables summarize changes in import and export prices, import and export volumes and commodity trade balances, respectively. While the model itself contains 29 regions, due to space constraints, and in keeping with the poverty emphasis of this book, we only

---

5 Since Russia is still in the process of joining the WTO, some assumptions about accession were made to obtain this binding.

6 Price changes for disaggregated products are Divisia indices. The composite price and quantity indexes reported in these tables represent aggregates of individual bilateral prices or trade flows that have been aggregated using base period trade weights—*fob* in the case of exports and *cif* in the case of imports. Intra-EU trade is excluded from the world price and volume changes.
report these changes for the world as a whole and for the ten focus countries for which general equilibrium, national case studies are provided in this book.

Begin with the impact of global trade liberalization on import prices as reported in Table 3.2. Price changes in this table are grouped into six broad categories: primary agriculture, other primary products, manufactured food products, textiles and apparel, other manufactures and services. The first thing to note is the relatively larger price changes for primary agriculture. As shown in Chapter 2, this is where the bulk of the commodity market interventions occur, when OECD countries remove domestic support for farm commodities, supply is reduced and world prices tend to rise. When coupled with a reduction in protection for imported products that simultaneously boosts demand, prices rise significantly. The world average price for primary agricultural products rises by 6.1 percent, relative to the numeraire price, which is an index of world primary factor prices. However, there is considerable variation within this broad category of goods, with world average prices rising more than 20 percent for plant-based fibers (primarily cotton) and paddy rice. These are followed by oilseeds and cereals. Wheat and wool also show above average price rises. Processed food products show the next highest world average price increase, and this category is led by diary and beef products, as well as processed rice. Most other world average price changes are quite modest.

This variation in commodity-specific price changes also gives rise to regional variation in import price indexes—particularly in food and agriculture. For example, Bangladesh is a heavy importer of cotton and oilseeds, the prices of which rise substantially following global trade reform. Accordingly, her national import price index for primary agriculture rises by 9.5 percent. The largest country-specific average
agriculture import price rise is 17 percent in the case of Mexico. As a result of geographic proximity, as well as the success of the North American Free Trade Agreement, the Mexican economy is heavily integrated with that of the United States. And the US has very large subsidies for cotton, rice, oilseeds and grains. Since Mexico sources the vast majority of her imports of these products from the US, she feels the full force of this subsidy removal. Indeed, Mexican import prices for paddy rice and plant based fibers rise by about two thirds. These import price rises for Mexico are far larger than those for Bangladesh, which sources only a modest share of imports of cotton and oilseeds from the US—or even the EU for that matter.

In summary, the commodity-specific import price indexes depend importantly on the source of a given country’s imports. This, in turn may be traced back to our “Armington” assumption of product differentiation. Of course, the degree to which prices for a particular commodity are permitted to diverge will depend on the elasticity of substitution amongst imports within that particular commodity group. As noted above, these elasticities are taken from the recent econometric study by Hertel et al (2003). Their estimates of this key parameter range from 2.6 for “other animal products” to 34.4 for natural gas.

Table 3 reports the export price changes for the same, Full-Lib experiment. While the world price changes are nearly the same as for imports—the difference being due to the presence of international trade and transport margins—the regional price changes are quite different. The difference between the changes in the national export and import price indexes is a measure of the change in each country’s terms of trade, which is also reported at the top of Table 3. Bangladesh, Cameroon, Mexico, Mozambique,
Philippines and Russia all experience negative terms of trade shocks from full trade liberalization, with Bangladesh’s loss standing out in particular.

The strong deterioration in the Bangladeshi terms of trade is driven by three factors. The first is the fact that she is a net importer of food products, and the world price of these products has risen (recall Table 3.2). The second stems from the fact that Bangladesh already faces very low tariffs in her export markets – particularly the industrial countries where she has tariff free access as a Least Developed Country (recall Table 3.1). When the industrial countries liberalize, this preference is eroded and export prices fall. The third factor derives from Bangladesh’s own-liberalization in the Full-Lib scenario, which involves elimination of her relatively high tariffs imposed on imports into Bangladesh (Table 3.1). When these tariffs are eliminated, imports increase. Therefore, exports must also increase to restore external trade balance. The bulk of Bangladeshi exports are in textiles and apparel, and since a substantial increase in these exports is required, the boost in demand following liberalization elsewhere in the world is insufficient to accomplish this, so a large price reduction ensues (-6.4 percent on average for textiles and apparel).

Brazil, China, Indonesia and Vietnam all experience terms of trade gains, with the largest gains by far going to Brazil. Global liberalization generates a substantial increase in the demand for Brazilian agricultural exports (recall the large tariffs on Brazilian exports reported in Table 3.1). As a result, Brazilian agricultural export prices rise by an average of 13.7 percent—twice the rate of increase worldwide. In order to restore external trade balance, the prices of all primary factors in Brazil must rise, relative to the world average factor price index. This in turn boosts prices for non-agricultural products.
and services, and so we see the associated export prices rising across the board in Table 3.3. A similar story, although much more muted, occurs in China, which takes advantage of falling import tariffs in East Asia to increase its farm and food exports (recall the high protection against China’s agriculture exports in Table 3.1). In Indonesia, the improved terms of trade are driven by natural resource-based products and light manufactures. Recall also from Table 3.1 that Indonesian tariffs are low, relative to those imposed against its exports, so full liberalization tends to boost demand for its goods and hence raise the prices for its products.

The next two tables report trade volume changes for the Full-Lib experiment. Worldwide, trade volume (including services trade) rises by 7.2 percent in this scenario. The largest increases come in food products, followed by textiles and apparel, then primary agriculture and other manufactures. Other primary product markets have few trade policy distortions and so experience only a small increase. In the case of services trade, as noted in the previous chapter, we have no solid measures of trade barriers, and the Doha Agenda does not appear to promise much liberalization, so we ignore any liberalization analysis in these markets.

The country-specific import volume increases range from 3.7 percent in the case of Mozambique, to 31.7 percent in the case of Bangladesh. In the case of primary agriculture, Brazil and Vietnam experience import volume changes above the world average, and Vietnam also shows a very strong increase in imports of non-agricultural primary products. In the case of processed food imports, all countries show a strong increase in import volume, with the largest increases arising in non-ruminant meat products and beverages and tobacco. The rise in textiles and apparel imports is even
higher for a number of the focus countries. Here, Bangladesh stands out, with more than a doubling of imports as import tariffs fall and apparel exports expand. Other manufactures import volume changes are quite heterogeneous. In the case of Mozambique, there are declines in import volume for many of these sectors. The change in volume of services imports is small—in keeping with the absence of any liberalization these markets.

Table 3.5 reports the change in export volumes by country and commodity. Whereas national imports, which reflect a composite of exports from many different sources, showed relatively uniform changes, national export volumes are much more heterogeneous—often showing a mix of positive and negative signs. For example, in the case of Brazil, where processed food exports increase very strongly, primary agriculture exports decline, as do exports of most non-food manufactures. This is due to the finite primary factor endowments in the country. It is not possible to increase production (and hence exports) of all products simultaneously. As manufactured food production increases, more agricultural products are required as inputs, thereby reducing the amount available for export.

Textiles and apparel exports increase sharply for Vietnam, and also for Bangladesh and Cameroon. Of course, as we saw in the previous table, imports also increase in these countries. To see the impact on the countries’ net trade position, we must turn to Table 3.6, which reports the change in the value of exports less imports (net trade), by commodity, in hundreds of millions of USD. Here we see that the trade balance in textiles and apparel improves markedly for Bangladesh, China, Indonesia, Philippines and Vietnam. Since the macroeconomic closure in our analysis fixes the ratio of the aggregate trade balance to national income in all but one of the model regions, a strong
increase in net trade in one sector forces some other sectors to experience a deteriorating trade balance. In the economies with a strongly expanding net trade position in textiles and apparel, we see declines in the net trade balance for non-manufactures. In the case of Brazil, it is the $11 billion increase in net exports of food products that drives the net trade story, with compensating reductions in primary agriculture, other manufactures and services.

A very useful feature of Table 3.6 is that it highlights the cases where the extraordinarily large percentage changes in trade volumes are irrelevant due to the extremely small size of the initial flow. Brazilian natural gas imports provide a case in point. There is more than a one thousand percent increase in exports, but the change in net trade is negligible according to Table 3.6.

2.3 Doha Scenario

Tables 3.7–3.10 report the price and trade volume results from the core Doha scenario developed in Chapter 2 of this book. It represents an aggressive implementation of the framework agreed upon by WTO members on August 1, 2004. The first thing to note is that the impacts on prices and trade volumes are much smaller. Compared with the full trade liberalization, world average agricultural prices rise by only one third as much under Doha, while world trade volumes for primary agriculture are virtually unchanged. In the latter case, the trade diminishing effect of export subsidy elimination offsets the trade enhancing impact of tariff reductions. In the case of food products, the rise in world average prices is more than two thirds of the Full-Lib case, but the rise in import volume is much less—again due to the elimination of export subsides in the US and the EU.
Due to the non-linearity in the tariff reduction formulae, as well as the great differences in binding overhang across commodities and regions, the composition of the price differences is quite different between Full-Lib and Doha. Under the Doha scenario, Vietnam has a terms of trade (TOT) deterioration instead of an improvement: as a non-member of the WTO, she does not enjoy the benefits of tariff cuts in other countries. Instead of a dramatic decline in its TOT, Bangladesh now shows a much smaller change. Recall much of the sharp decline under Full-Lib was a result of Bangladesh’s own-liberalization and the subsequent increase in export volumes in the face of modest increases or even decreases in export demand. As a least developed country, Bangladesh does not reduce its tariffs at all under the Doha scenario (recall Table 3.1), so this source of TOT deterioration is not present. In contrast, Brazil still experiences a TOT improvement amounting to about half of the Full-Lib case.

3. Communicating Global Results to the National Models

As noted at the outset, the goal of these model simulations is to provide country authors with a picture of how their external environment is likely to change as a result of multilateral trade reform under the Doha Agenda. On the other hand, we consider the individual country authors to be the experts in assessing the likely responses of their respective national economies to these external developments and to their own trade policy reforms. Accordingly, we must find a way to blend the global and national analysis into a single, coherent story. This section summarizes the approach that we have settled on for the studies reported in this volume.7

---

7 This section relies on research conducted by Mark Horridge and Fan Zhai. We thank those country authors for their valuable insights and guidance on this topic. The appendix to this chapter offers a detailed description of the methodology which they developed.
The idea of first solving a global model and passing the world price and/or volume results on to a national model is rather intuitive, but when faced with implementation, several problems arise. The first problem that we must confront is that we do not want to implement the national policy reforms twice—once in the global model and once in the national model. The global analysis should instead capture only the impact of policy reforms in the rest of the world. Consider, for example, the case of Brazil. It is desirable for the national model to receive results from the two scenarios discussed above, omitting Brazilian reforms in the process. The world price changes passed on to the national model would then reflect the impact on world markets of policy reform in all countries except for Brazil. The national model then takes these world price changes as exogenous and implements the Brazilian portion of the reform package. In the special case where the national model is identical to the Brazilian portion of the global model, this approach should give the same results for Brazil as were obtained under the comprehensive reform simulations reported in the preceding tables. So this is how we resolve the first problem, namely we solve each scenario with the focus economy omitted, thereupon passing the resulting world market effects onto the national studies, to be implemented as exogenous shocks in their country case studies.

A second problem which arises in linking the two models is how specifically to pass the information on world markets to the national model. Since all of the national models take import price as given, and import supply facing the focus economies in the global model is very elastic, it is easy to handle this side of the story. The import price changes generated in the global model are appropriately aggregated and then passed on to

---

8 Of course, if this were the case, then there would be no reason to separate the two analyses. The reason for the two-step approach is that we believe the national models to be more complete and accurate in their representation of the focus economies.
the national model where they are applied as exogenous shocks. Exports, however, are more challenging.

The fundamental problem with exports is that the global model treats products as being differentiated by origin—the so-called Armington assumption discussed earlier in this chapter. Therefore, Brazil’s export prices are not exogenous, even for products where their world market share is relatively small. Accordingly, we must consider the impact of world market changes on both price and quantity and the models’ differences in the connections between these two variables. Specifically, we have different export supply schedules for commodities in the global and national models, due to the differences in the two models’ representations of the Brazilian economy. Often we find that the national models of developing countries have less elastic export supply schedules, reflecting domestic constraints on export capacity not captured in the global model. On the other hand, the export demand schedule is treated as having the same slope in the two models. Nearly all of the country authors have built downward sloping export demand schedules into their models, and have taken the elasticity of export demand from the global model.⁹

Figure 3.2 illustrates this point for a specific product, for example processed sugar. The initial equilibrium for exports of Brazilian sugar is at point A where the supply schedule (SG in the global model and SN in the national model) intersects the global demand schedule, D. When a Doha scenario is implemented in the rest of the world, the first thing that happens to Brazilian exports of sugar is that the reduction in protection in the industrialized countries results in an outward shift in export demand to D’-D’. But the export supply curve may also be affected, owing for example to the limited endowments

⁹ In the global model, the price elasticity of export demand facing a small country is well-approximated by the inter-country elasticity of substitution among imports. These have been econometrically estimated and are reported in Table 1 of Hertel, Hummels, Ivanic and Keeney (2004).
of land, labor and capital in Brazil and the simultaneous shifts to import prices and other export demands. Here, we assume that there is a reduction in demand in manufacturing, thereby releasing additional resources for use in agriculture, and causing export supply to shift to the right. The global model finds a new equilibrium at point B, with price $P_G$ and quantity $Q_G$. Referring back to the tables of results for Doha, we see that point B embodies a small increase in Brazil’s sugar price (3.3%) and a somewhat larger increase in quantity (6.8%).

In order to communicate these changes in global markets to the national model, we assume that the national model will adequately take care of the supply shift due to domestic, general equilibrium changes in response to rest of world liberalization. This makes sense, since both models typically draw on the same underlying Social Accounting Matrix, and both embody the same general equilibrium restrictions. Thus we need only identify the extent to which the demand curve shifts outward in Figure 3.2. As shown in the appendix, this demand shift can be readily established with three pieces of information: the change in price, the change in quantity, and the slope of the export demand schedule. We can then solve the demand function for the shift necessary to ensure that the new equilibrium still lie on the demand curve.

Of course this approach is limited by the fact that the two models have different characterizations of supply. For example in Figure 3.2, even assuming the same shifts in demand and supply, the national model generates a different equilibrium at point C, with higher price, $P_N$ and lower quantity, $Q_N$ than in the global model due to the less elastic nature of supply. In summary, the price and quantity changes generated by the national model in response to these exogenous shocks will not be exactly the same as the global
model. A detailed comparison of the price and quantity outcomes in the global and national models has been conducted for Brazil and for China and they yield correlations of nearly 0.9 for quantities and somewhat less for prices. So, while the two sets of results are different, they are indeed highly correlated.

In summary, we face an inbuilt inconsistency: the global and national models treat exports differently. We cannot resolve it perfectly, but our approach to communicating between the global and national models permits us to utilize the strengths of each of the two models while ensuring broad consistency in results. It could be further perfected by modifying the global model to better reflect the national models, but this is well beyond the scope of the present project, and maybe not even desirable, since, for most purposes a global model needs a degree of consistency in its treatment of individual countries and so cannot reflect all the country details precisely.\textsuperscript{10}

In closing, one word of caution to the reader is advisable. In the subsequent chapters, authors report price changes for full liberalization and for the core Doha scenario, obtained from this global exercise. It will seem natural to compare these price changes to those reported in this chapter. However, recall that the price changes provided to the individual country authors omit the impacts of that country’s own actions. Also, in some cases, the country authors have rescaled the price changes by normalizing them on the domestic consumer price index, for example. While this rescaling doesn’t affect the results in their models, which only depend on relative price changes, it does make direct comparisons of price changes between chapters more difficult.

\textsuperscript{10} A model is, by definition, a simplification of reality – that is the point of models.
References


Figure 3.1. Validating the GTAP-AGR model: Predicted vs. Observed Standard Deviations for Wheat

Source: Hertel, Keeney and Valenzuela 2004.
Figure 3.2. Transmission of Global Results to a National Model