Estimating effects of price-distorting policies using alternative distortions databases

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Abstract

To analyse the effects of prospective policy changes, sectoral and economy-wide modelers need to begin with baseline estimates of policy induced price distortions. Global trade modelers mostly use the GTAP protection database, which currently relies heavily on 2004 import tariffs plus (for OECD countries) an estimate of agricultural production and export subsidies in that year. This chapter addresses three questions relating to the very extensive use of that database: Are there other price-distorting policy instruments worthy of inclusion in the base year? What is the appropriate counterfactual set of price distortions in the year of concern (such as when a proposed reform is expected to be fully implemented, as distinct from the base year of 2004)? And how are the price distortions (e.g. tariff rates) on individual products aggregated to the GTAP product groups? We first show there are some additional agricultural policy instruments that need to be included for some developing countries. Secondly, we draw on political economy theory, a set of political econometric equations and knowledge of current WTO-bound tariffs to show that some developing countries could well raise their agricultural protection rates over coming decades in the absense of a successful conclusion to the WTO's Doha round. Hence the appropriate counterfactual policy regime in projections modeling may not be the status quo, but rather higher agricultural protection rates for at least some countries. The alternative counterfactual considered generates much higher estimates of the prospective costs of not embracing trade policy reform. Thirdly, we draw on recent aggregation theory to show that the national and global welfare costs of current policies are seriously underestimated using conventional tariff aggregation methods.

Keywords: trade policy counterfactuals, tariff aggregation, economy-wide projections, agricultural protection growth

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1. Introduction

Ex ante or ex post economic analyses of the consequences of multilateral, plurilateral and bilateral negotiations between countries on international trade (or international environmental) policy issues rely increasingly on multisectoral, multiregional computable general equilibrium (CGE) models of the global economy. Outputs from such models can indicate the likely production, consumption, price, trade, welfare, income distributional, poverty and environmental effects of past or prospective policy actions relative to a baseline or counterfactual simulation. Milestone multilateral trade examples are *ex post* analyses of the GATT's Uruguay Round agreements (see, e.g., the collection in Martin and Winters 1996) and *ex ante* analyses of possible agreements to emerge from the World Trade Organization's Doha Development Agenda (see, e.g., Francois, van Meijl and van Tongeren 2005; Anderson, Martin and van der Mensbrugghe 2006a).

The focus of attention on such modeling results varies enormously across users. Multilateral and regional institutions and non-government organizations are interested in the global welfare and trade results and how they are shared between high-income and developing countries and among the various regions of the world. They are also interested in how much of any particular effect (such as on global economic welfare) is attributable to the policies of particular groups of countries, sectors, or policy instruments. By contrast, national governments are more interested in how their own economy and its trade will be affected and how much of those effects are due to own-country policies (over which they can act) versus policies of the rest of the world (over which they have little if any influence other than as participants in international negotiations). Estimates of the effects of own-country policies could be obtained using a national model, but a global model is required to estimate the effects on their terms of trade of other countries' policies. Other users of model outputs include private vested interest groups expecting to be helped or harmed economically by particular policy changes under consideration, and community groups interested in indicators such as environmental consequences or the effects on income inequality and poverty.

While it is sometimes possible to use econometrics to analyse *ex post* the effects of past policy changes on some variables of interest, there is no better way to analyse *ex ante* alternative trade, product tax/subsidy and other sectoral policies than model simulation. Even if only one sector is directly involved, there will be indirect effects on other sectors so economywide modeling is needed. For that reason CGE analysis has become a mainstream contributor to policy dialogue,[1] and CGE models and their databases and parameter sets are now very closely scrutinized by those with a stake in their findings.[2]

An obvious starting point of such scrutiny is the representation in the model of the actual policies in place and of the alternatives under consideration. The creation of the Global Trade Analysis Project at Purdue University involved not only development of a global CGE model (the GTAP Model – see Hertel 1997, 2012) but also a database that has been updated periodically. The version of that database used in this chapter (Version 7) relates to 2004, and previous versions still available at www.gtap.org are for 2001 and 1997. The GTAP database

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[1] Australia was perhaps the first country to successfully mainstream economy-wide analysis into national policy debate (Powell and Snape 1993), beginning with the ORANI Model (Dixon et al. 1977, 1982).

[2] An example is the scrutiny given to the World Bank's Linkage Model results on the global cost of trade-related policies, which prompted a paper by the Model's creator explaining why those numbers changed over time (van der Mensbrugghe 2006).

is a consistent representation of the world economy in the base year, and underlying it are national input-output tables, bilateral trade and macroeconomic data, and import protection and agricultural subsidy estimates for 113 countries/regions and 57 sectors/product groups. This is now by far the most widely used trade and protection database in the world.

The GTAP protection data are predominently based on aggregated tariffs on imports plus agricultural production and export subsidies in a past year (2004 in the case of Version 7), which raises at least three concerns. First, are there other price-distorting policy instruments besides import tariffs and OECD farm subsidies worthy of inclusion in the base year? Second, what is the appropriate counterfactual set of price distortions in the year of concern (such as when a proposed reform is expected to be fully implemented) as distinct from the base year? And third, how are the price distortions (e.g. tariff rates) on individual products aggregated to the GTAP product groups?[3]

This chapter addresses each of these concerns, and uses the World Bank's Linkage Model (van der Mensbrugghe 2005) as well as the GTAP Model (Hertel 1997) to assess their significance. It does so by first estimating the effects of goods trade-related policies as of 2004 using the standard Version 7 GTAP protection database (Narayanan and Walmsley 2008). These are then compared with the effects using alternative protection databases. A series of effects will be examined including national welfare, international product prices,

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[3] A fourth concern is that tariffs do not capture distortions in the service sector, but this chapter confines itself just to policies aimed at distorting the prices of goods. On the potential importance of services trade and investment policies, see for example Francois and Hoekman (2010), Christen, Francois and Hoekman (2012) and Tarr (2012). They are ignored here because much controversy still surrounds their measurement and how they should be modeled. This is reflected in the results emerging from attempts to include services distortions in trade reform modeling, which have led to widely differing results. Compare, for example, Brown, Deardorff and Stern (2003), Francois, van Meijl and van Tongeren (2005), and Hertel and Keeney (2006).

national factor prices and sectoral contributions to GDP, and the sectoral and regional policy contributions to global welfare and trade. Since agricultural distortions have been estimated to contribute in recent years to around two-thirds of the global welfare cost of policy distortions to goods markets and to have severely limited trade in farm products, special attention is given to the effects on that sector. Such indicators include the developing countries' share of global agricultural production and trade, and the shares of production of various agricultural goods exported and of consumption imported by different regions and globally.

2. The concern with missing price-distorting measures

Historically, tariff measures have been the predominant form of negotiable distortions affecting manufacturing trade, but in agriculture many other instruments are employed to distort producer and consumer incentives. This has been dealt with in the GTAP protection database by making use of the OECD Secretariat's estimates of price distortions (OECD 2010). More specifically, domestic price of a farm good in high-income countries may be distorted not only by trade restrictions or trade subsidies but also by producer price subsidies and other forms of domestic support. These have been carefully incorporated in the GTAP protection database (Narayanan and Walmsley 2008, Ch. 10),

Until recently there were no such comparable estimates for agricultural price distortions in developing countries, however, so the only significant interventions included in the GTAP database for the farm sector of those countries are applied import tariffs. That is unfortunate, because it thereby ignores not only the developing countries' farm producer price or export subsidies but also, and potentially more importantly, any production or export taxes or tax equivalents and any food import subsidies in place in those countries. Fortunately, a recent World Bank research project has generated a time series of ad valorem nominal rates of assistance to farmers and consumer tax equivalents to consumers (NRAs and CTEs) over the past half century for 41 developing countries that together account for just over half of global agricultural production and consumption (Anderson and Valenzuela 2008). The coverage involves an average of 11 key farm products per country, and those products account for around 70 percent of the value at undistorted prices of each country's overall agricultural output. For the developing countries in that sample, border measures are the major intervention. Their price-distorting impact is estimated by comparing the domestic wholesale price of a good with that of a like product at the country's border (adjusted appropriately for differences in quality, processing, etc. and for domestic transport costs if the domestic price was not measured at the border). The border price used was normally the c.i.f. import unit value or the f.o.b. export unit value, depending on whether the product is an import-competing good or an exportable. In the few cases where authors identified a producer or consumer price subsidy or tax (not including generic VAT/GST), its ad valorem equivalent was estimated and added to the NRA or CTE, respectively, for that product (Anderson et al. 2008). Using those estimates, Valenzuela and Anderson (2008) provide for modelers an alternative set of estimates of agricultural price distortions in developing countries to those provided for 2004 in the GTAP 7.0 Database. The preferential bilateral tariff structures included in the standard GTAP Version 7.0 Database are maintained by multiplying each bilateral tariff by the ratio of the aggregate import tariff equivalent measure from the World Bank project to the original GTAP aggregate national tariff for each product.

This approach allows us to evaluate the possible bias in not including developing countries' non-tariff farm policy measures. We do so by re-estimating the price, trade and welfare effects of 2004 trade-related policies and comparing them with those generated by the Linkage Model using the standard GTAP Version 7.0 protection database for 2004.

This new agricultural distortions database for developing countries also allows a reassessment of an issue that became quite controversial in the early stages of the WTO's Doha negotiations. It has to do with the question of whether global trade distortions still harm developing country farm industries – many more of whom receive protection from imports now than in the past (Anderson 2010a). Anderson, Martin and van der Mensbrugghe (2006b) and Anderson and Valenzuela (2007) each focus on this issue using the 2001 GTAP protection database (the first using the Linkage Model, the second using the GTAP Model). Here we re-look at the issue using the Linkage model and 2004 distortions, comparing the results generated using the new World Bank agricultural distortion estimates and those using the standard GTAP Version 7 estimates.

2.1 Price distortions in global goods markets

Border measures traditionally have been the main means by which governments distort prices in their domestic markets for tradable merchandise, with the relative prices of the various goods being affected by trade taxes or subsidies. Even for agriculture, product-specific domestic output or farm input subsidies have played a more limited role, as have food consumer subsidies, in part because of their much greater overt cost to the treasury.

To estimate the impacts of 2004 policies with an alternative database, the Altertax procedure (Malcolm 1998) is used to amend the distortions in Version 7 of the GTAP global protection database.[4] The amendments are mainly for farm price distortions in developing

[4] Altertax is a procedure that allows for modifying price distorting policies in the original GTAP database with an alternative set of policies. It is designed to minimize deviations of the base year data from original estimates

countries but, following Anderson and Valenzuela (2007b), cotton distortions in the United States also are altered, to better reflect policies there. To simplify the discussion below, the European transition economies' group (in which Turkey is included for convenience) is treated as one of the world's developing country regions, the others being Africa, Asia, and Latin America.[5]

Version 7 of the GTAP database includes estimates of bilateral agricultural tariffs and export subsidies and of domestic farm price supports as of 2004 for more than 100 countries and country groups spanning the world. The protection data come from a joint CEPII (Paris)/ITC (Geneva) project known as MAcMaps. MAcMaps is a detailed database on bilateral import protection at the HS6 tariff line level that integrates trade preferences, specific and compound tariffs and a partial evaluation of non-tariff barriers such as tariff rate quotas (TRQs).[6] A virtue of having bilateral tariffs is that they capture not only reciprocal but also non-reciprocal preferential trade agreements, the latter providing low-income exporters duty-free access to protected high-income country markets. This allows us to take into account the fact that future reform may cause a decline in the international terms of trade for those developing countries that are enjoying preferential access to agricultural and other markets of high-income countries.

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and to maintain the accounting consistency of the global database. In the application here, Altertax allows the insertion of the DAI database in the standard GTAP 7 database with minimal disruptions to the original data. In particular, all original policy distortions that are not modified by the DAI database are unaffected.

[5] There are no new price distortion estimates for countries in the Middle East, so in what follows little attention is given to this small and relatively affluent part of the global agricultural economy.

[6] More information on the MAcMaps database is available in Bouët et al. (2008) and at http://www.cepii.fr/anglaisgraph/bdd/macmap.htm. For details of its incorporation into the GTAP Version 7 dataset, see Narayanan and Walmsley (2008).

The sectoral averages of the standard GTAP database distortions, and the values from the Distortions to Agricultural Incentives project (hereafter the DAI database), are shown by instrument in Table 1. In both databases the weighted average applied import tax for non-farm goods in 2004 was just over 6 percent for developing countries and 1.7 percent for high-income countries, while for agriculture and lightly processed food it was much higher: around 24 percent for high-income countries and around half that for developing countries. Export subsidies for farm products for a few high-income regions, and export taxes in a few developing countries, were still in place in 2004, but they are generally small in their impact compared with import tariffs, as are production subsidies or taxes. At the most aggregated level the averages for 2004 in the GTAP Version 7 and the DAI databases are similar, except for the inclusion of developing countries' agricultural production and export taxes in the latter but not the former database. The trade taxes differ also because domestic-to-border price comparisons pick up the impact of any non-tariff border restrictions, thereby making their tariff equivalent higher than just the applied tariff rate. There are, however, two reasons why the DAI database rates might be lower than the GTAP ones. One is that if the domestically produced and imported products are not close substitutes in consumption, then the impact on the domestic price of an import tariff will be less than if they are perfect substitutes – and this is captured iby the domestic-to-border price comparison methodology used to generate the DAI database. The other is that the DAI's price comparison method also captures export restrictions or import or export subsidies, and the effects of producer or consumer subsidies or taxes.

[insert Table 1 about here]

For all the above reasons, the DAI database can be considered more comprehensive than the GTAP protection database for capturing distortions to agricultural incentives in developing countries. In some cases this means the DAI rates are higher than the GTAP rates in Table 1, but in the important cases of China and India they are considerably lower.[7] This could lead one to expect the estimated welfare cost to developing countries of their own policies to be less using the DAI rates than the GTAP rates.

2.2 The Linkage Model of the global economy

The model used for this section is the World Bank's global computable general equilibrium (CGE) model, known as Linkage (van der Mensbrugghe 2005). For more than a decade it has formed the basis for the World Bank's standard long-term projections of the world economy and for much of its trade (and more recently migration) policy analysis (e.g., World Bank 2002, 2004, 2005, 2006, 2007). The standard version of Linkage is typically implemented as a recursive dynamic model with a base year (currently 2004) and solved forward towards a terminal year. Each solution year is solved as a comparative static model with fixed factors of production. The annual equilibria are linked via dynamic equations that update population and labor stocks (using demographic projections), capital stock (through cumulative savings decisions adjusted for depreciation) and assumptions regarding productivity growth (and other efficiency type factors such as energy use and transportation margins).

The comparative static version of Linkage is in many ways similar in spirit to comparative static models such as the GTAP model (described in Hertel 1997). Producers minimize costs subject to constant returns to scale production technology, consumers maximize utility, and all markets – including for labor – are cleared with flexible prices. Production is modeled using a nested structure of constant-elasticity-of-substitution (CES) functions that aims to capture the substitution and complements across all inputs into

[7] The China and India estimates are based on careful country case studies by nationals very familiar with the most reliable price data. See Huang et al. (2009) and Pursell, Gulati and Gupta (2009).

production.[8] There are three types of production structures. Crop sectors reflect the substitution possibilities between extensive and intensive farming;[9] livestock sectors reflect the substitution possibilities between pasture and intensive feeding; and all other sectors reflect standard capital/labor substitution. There are two types of labor, skilled and unskilled, and the total employment of each is assumed fixed (so no change in their unemployment levels) but both are assumed to be intersectorally mobile. There is a single representative household per modeled region, allocating income to consumption using the extended linear expenditure system. Trade is modeled using a nested Armington (1969) structure in which aggregate import demand is the outcome of allocating domestic absorption between domestic goods and aggregate imports, and then aggregate import demand is allocated across source countries to determine the bilateral trade flows.[10]

Government fiscal balances are fixed in US dollar terms, with the fiscal objective being met by changing the level of lump sum taxes on households. This implies that losses of tariff revenues are replaced by higher direct taxes on households.[11] The current account

[8] Nested CES production structures are a relatively common specification for production in CGE models, although top-level flexible functional forms have also been implemented (see, e.g. Jorgenson, Jin and Slesnick 2012).

[9] Where land is relatively cheap, production increases will lead to land expansion (extensification), where land is scarce and expensive, production increases rely on more intense use of inputs such as capital and agricultural chemicals.

[10] The size of the Armington elasticities matters (see Valenzuela, Anderson and Hertel (2008) and Zhang and Osborne (2009)). The Linkage model assumes larger values than some other models because it is seeking to estimate long-run consequences of liberalization. An example of the difference this can make to the results is detailed in Anderson and Martin (2006, table 12A.2).

[11] There are other possible fiscal closure rules, some of which are likely to more closely match what policy makers would actually implement. The advantage of assuming a fixed deficit, fixed government expenditures

balance also is fixed. Given that other external financial flows are fixed, this implies that ex ante changes to the trade balance are reflected in ex post changes to the real exchange rate. For example, if import tariffs are reduced, the propensity to import increases and additional imports are financed by increasing export revenues. The latter typically is achieved by a depreciation of the real exchange rate. Finally, investment is driven by savings. With fixed public and foreign saving, investment comes from changes in the savings behavior of households and from changes in the unit cost of investment. [12] The model only solves for relative prices, with the numéraire, or price anchor, being the export price index of manufactured exports from high-income countries. This price is fixed at unity in the base year.

The results in this (and the next) section are based on the comparative static version of Linkage, so they do not include the (often much larger) dynamic gains that result from an acceleration in investment due to the reduction in tariffs on industrial goods lowering the cost of investment. Also missing, therefore, are any costs of adjustment to reform. And because this version of the Linkage Model assumes perfect competition and constant returns to scale, it captures none of the benefits of freeing markets that could come from accelerated

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and lump sum taxes are two-fold. The first assumption deflects from a discussion on the sustainability of the fiscal deficit. The latter two assumptions simplify welfare analysis, albeit still in a second-best world given all of the existing distortions in the model.

[12] Linkage has not been designed to determine investment behaviour. The fixed trade balance assumption, similar to the fixed fiscal deficit assumption, has the benefit of avoiding a discussion on the sustainability of a changing trade balance. It is also consistent with the Feldstein-Horioka finding of a strong correlation between domestic savings and investment (Feldstein-Horioka 1980). The GTAP model allows for some international capital flows responding to changes in rates of return across countries. The G-Cubed model has a more consistent representation of investment behaviour (including consistent stock/flow equations) and is better able to look at the cross-border investment related aspects of trade reform (see McKibbin and Wilcoxen 2012).

productivity growth, scale economies, and the creation of new markets. There is also a dampening effect on estimates of welfare gains because of product and regional aggregation, which hides many of the differences across products in rates of distortions. The results therefore should be treated as providing very much lower-bound estimates of the net economic welfare benefits from policy reform.[13]

The version of the Linkage model used in this section is based on an aggregation involving 23 sectors and 49 individual countries plus 11 country groups spanning the world (see van der Mensbrugghe, Valenzuela and Anderson 2010). There is an emphasis on agriculture and food, which comprise 16 of those 23 sectors. Note that, consistent with the WTO, we include Korea and Taiwan in the 'developing country' category.[14]

2.3 Effects of global removal of price-distorting policies

To see what could result from removing policies as of 2004, we examine in this sub-section the results from full global liberalization of both agricultural policies and non-agricultural goods trade policies. We do so first using the DAI database, and then using the standard GTAP database.[15] We examine several indicators, including global and national economic

[13] As well, the model does not include any divergences between private and social marginal costs and benefits that might arise from externalities, market failures, and other behind-the-border policies not represented in our amended GTAP protection database. These omissions could affect the welfare estimates in either direction.

[14] The more-affluent economies of Hong Kong and Singapore are in our high-income category but, since they have close to free trade policies and almost no farm production anyway, their influence on the results is not noticeable.

[15] The DAI results were first reported in Valenzuela, van der Mensbrugghe and Anderson (2009), and were elaborated on in Anderson, Valenzuela and van der Mensbrugghe (2010), but they have not before been published alongside comparable results based on the GTAP protection database.

welfare, quantities produced and traded, and product prices; and we also look at how global trade distortions affect developing country agriculture.

2.3.1 Global and national economic welfare

Beginning with the DAI baseline of the world economy in 2004, all agricultural domestic and trade subsidies and taxes plus import tariffs on other merchandise, as summarized in the left-hand half of Table 1,[16] are removed globally. Our Linkage model simulation suggests that would lead to a global gain of $168 billion per year (left-hand half of Table 2). As a share of national income, developing countries would gain nearly twice as much as high-income countries by completing that reform process (an average increase of 0.9 percent compared with 0.5 percent for high-income countries, using as weights each country's economic size). Thus in this broad sense of a world of just two large country groups, completing the global reform process would reduce international inequality to use the Milanovic (2005) term.[17] The results vary widely across developing countries, however, ranging from slight losses in the case of some South Asian and Sub-Saharan African countries that would suffer exceptionally large adverse terms of trade changes, to an 8 percent increase in the case of Ecuador (whose

[16] The only other policy change is the removal of export taxes on non-farm products in Argentina This is done because they were introduced at the same time (end-2001) and for the same reason (for the government to gain popular support from the urban poor) as were the country's export taxes on farm products.

[17] This would continue a process that began in the 1980s, when many countries began to reform their trade and exchange rate regimes. Using the same Linkage model and database as the present study, Valenzuela, van der Mensbrugghe and Anderson (2009) found that the global reforms between 1980-84 and 2004 also boosted economic welfare in developing countries proportionately more than in high-income economies (by 1.0 percent, compared with 0.7 percent for high-income countries).

main export item, bananas is currently heavily discriminated against in the EU market where former colonies and least developed countries enjoy preferential duty-free access).

[insert Table 2 about here]

If one were to treat each of the 60 regions in Table 2 as able to be represented by a single household (that is, ignoring intra-region inequality), income inequality between countries as measured by the Gini Coefficient would be reduced at least slightly, from 0.8513 to 0.8506.[18]

The second column of numbers and those in parentheses in Table 2 show the amount of that welfare gain due to changes in the international terms of trade for each country. For developing countries as a group the terms of trade effect is slightly negative, and conversely for high-income countries. [19]

The right-hand half of Table 2 reports the same results but using the standard GTAP price distortion database. Several differences with the above numbers are worth noting, bearing in mind that the GTAP price distortion estimates are less comprehensive than the ones in the DAI database. First, it overstates the global gain, at $210 billion compares with

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[18] This is a measure of inter-country inequality, again in the Milanovic (2005) sense of treating each country as a single observation and not taking into account its economic size. It is calculated using the 60 regions and Deaton's Gini coefficient calculation:

$$G = \frac{N+1}{N-1} - \frac{2}{N(N-1)u}(\Sigma_{i=1}^{n} P_i X_i)$$

where N is the number of regions, *u* is the sample average GDP per capita, P_i is the GDP per capita sample rank (with the highest being 1 and the lowest a rank of N) and X_i is the GDP per capita of country i.

[19] The terms of trade component is measured as the difference in the value of the trade balance at base year prices versus ex post trade prices. It is an average of the measure using base year volumes and post-simulation trade volumes.

the DAI estimate of $168 billion per year. Most of that difference is accounted for by developing country gains (overstated by 41 percent). However, the gain to high-income countries is also overstated (by 15 percent). Among the developing countries it is in Asia, especially China, India, Korea and Vietnam, where the differences are greatest: an overestimation by 71 percent. The main reason is that the applied tariffs used in the GTAP database for those countries evidently overstate the actual protection provided by those tariffs, as revealed by the domestic-to-border comparisons used to estimate DAI distortions. Notice also that the opposite is true for Argentina: because export taxes are included in the DAI database, the estimated gain from reform is greater for Argentina and thereby all of Latin America (by 16 percent) – even though the removal of those taxes turns the terms of trade against it to the point of more than offsetting the terms-of-trade benefit it receives from the removal of farm protection in the rest of the world.

2.3.2 Regional and sectoral distribution of welfare effects

One way to decompose the estimated real income gains that would result from full removal of price distortions globally, so as to better understand the sources of gain for each region, is to assess the impacts of developing country liberalization versus high-income country liberalization in different economic sectors. These results are provided in Table 3. The DAI-based results suggest global liberalization of agriculture and food markets would contribute 70 percent of the total global gains from merchandise reform. This is between the 63 per cent found for 2015 by Anderson, Martin and van der Mensbrugghe (2006b) using the earlier Version 6 of the GTAP database anchored on 2001 estimates, and the 76 percent found using

Version 7 of the GTAP database (final column of Table 3).[20] This robust result of roughly between two-thirds and three-quarters is remarkably high given the low shares of agriculture and food in global GDP and global merchandise trade of less than one-eighth. For developing countries, the importance of agricultural policies is even slightly greater. The slightly lower result from using the DAI database is again because the applied tariffs used in the GTAP database overstate the actual protection provided by tariffs in some developing countries, and notwithstanding the presence of export taxes in the DAI database.

[insert Table 3 about here]

More than two-thirds of those global gains that could come from removing agricultural policies are accounted for by the farm policies of high-income countries (see columns 3 and 6 of Table 3, 49 of 70 percent using the DAI database and 45 of 76 percent using GTAP Version 7 protection data). Those policies also account for half of the overall gains to developing countries from global agricultural and trade policy reforms (column 1 of Table 3). This again is less than the GTAP database result, which at 62 percent is an overestimate of one-quarter.

2.3.3 Quantities produced and traded

The full global liberalization results suggest there would be little change in the developing countries' aggregate shares of global output and exports of non-farm products other than for textiles and apparel. Their shares in agricultural and processed food markets, however, change noticeably: the export share rises from 54 to 64 percent and the output share rises

[20] It is also close to the 66 percent found for 2001 by Hertel and Keeney (2006, Table 2.9) using the GTAP-AGR Model and the Version 6 GTAP database, and the 62-64 percent found for 2030 by Anderson and Strutt (2011) using a projection from 2004 of the GTAP Model and the DAI database.

from 46 to 50 percent. The rises occur in nearly all agricultural and food industries. As a result, the share of global production of farm products that is exported rises dramatically for many industries and, for the sector as a whole (excluding intra-EU trade), it increases from 8 to 13 percent using the DAI database (Table 4). That 'thickening' of international food markets – which is only slightly less than suggested using the GTAP database – would have a substantial dampening effect on the instability of prices and quantities traded in those markets. This is because it increases the scope for (e.g., weather-induced) shortages in one region to be offset by above-average yields in other regions (Tyers and Anderson 1992).

[insert Table 4 about here]

The impact of full trade reform on agricultural and food output and trade is shown for each country/region in Table 5, where it is clear that global farm trade is enhanced by around two-fifths (6 percentage points higher using the GTAP database) whereas the global value of output is virtually unchanged (dropping just 3 percent). The anti-trade biases in the policies of both groups of countries reinforce each other in reducing the volume of global trade, whereas the output expansion due to the pro-agricultural policies of high-income countries are not quite fully offset by the output reduction of the anti-agricultural policies of developing countries. The doubling of exports of those goods from developing countries would be worth a huge $170 billion per year. Latin America accounts for nearly half of that increase using the DAI database (compared with an estimated one-third using the GTAP database),[21] but all developing regions' exports expand. This means their share of production exported would be much higher. It would increase for almost all developing countries, rising in aggregate for the group from 9.5 to 17 percent (Table 6).

[insert Tables 5 and 6 about here]

[21] Note that Argentina's estimated farm output and exports increase far more using the DAI database than using the GTAP one, indicating just how much its current export taxes discourage the farm sector of that country.

Also of interest is what happens to agricultural imports: developing countries as a group would see them growing less than half as much as farm exports, and less using the DAI database than the GTAP one (Table 5), although the extent of that difference varies a lot across the various developing country regions.

Together those changes mean their food and agricultural self sufficiency ratios would change. The change in aggregate is only slight though: for high-income countries that ratio would fall five percentage points, while for developing countries it would rise five percentage points (or two points for primary farm products and seven points for processed food – see Table 7). When broken down by developing country region, food and agricultural self-sufficiency in East Asia and Africa would rise two to three points, in South Asia it would be unchanged, and in Latin America it would jump from 112 to 126 percent (not shown in Table 7). Those effects are very similar regardless of whether the DAI or GTAP database is used, except for plant-based fibers because the DAI database includes some distortions to the US cotton market that were not included in the GTAP database.

[insert Table 7 about here]

Even though self-sufficiency does not alter much in aggregate, such reform would raise substantially the global share of various agricultural and food production exported. This is especially so for highly protected sugar and milk. In developing countries it is also the case for grains, oilseeds and meat: the share of their grain production that is exported would double, and for meat it would more than double. For sugar it would rise nearly four-fold, reflecting the fact that sugar, together with rice, is the most protected farm product globally (followed by milk and beef – see Croser, Lloyd and Anderson 2010).

2.3.4 Effects on product prices

The average real international prices of agricultural and lightly processed food products would be no more than 1 percent different in the absence of all merchandise trade distortions (Table 8: the model's numéraire is the export price index of high-income countries' manufactured exports). This again reflects the fact that the pro-agricultural policies of high-income countries are almost fully offset by the output reducing effect of the anti-agricultural policies of developing countries The effects vary considerably across products though, as well as differing as between the two databases. Current policies are especially dampening the international prices of beef, milk, rice and cotton – again because they are the most distorted product markets globally (Croser, Lloyd and Anderson 2010).

[insert Table 8 about here]

2.3.5 Effects on sectoral value added

Of crucial interest in terms of these policies' impact on inequality and poverty is how they affect value added in agriculture versus other sectors. In the case of countries where agriculture is mostly family farming with no hired help, no mortgage and no off-farm income, the former is the same as farm household income, while in other cases it can be thought of as net farm income before wages and interest are deducted. The DAI results reported in the first two columns of Table 9 show the effects of full global reform of just agricultural and food policies, while the second pair reports the effects when all merchandise trade policies are removed. They reveal not only that most of the effect on agriculture comes from agricultural policies, but also that when non-farm policies also are removed the impact on both farm and non-farm value added is not a lot different. This again underscores the point made earlier that the most distortive policies are in agriculture.

[insert Table 9 about here]

More specifically, the results show that for high-income countries, value added in agriculture would fall by about one-seventh if agricultural distortions were removed globally. For developing countries as a group, value added in agriculture is estimated to rise by 5.6 percent according to the DAI database (or 3.5 percent using the GTAP database), compared with under 2 percent for non-agriculture, following full global reform of all merchandise trade. Latin America is where net farm income expands most, averaging more than 30 percent and, according to the DAI database, exceeding 100 percent for Argentina and Ecuador and 40-50 percent for Brazil and Colombia. In East Asia it also expands, and more than non-agricultural value added, according to the DAI database. This is not the case with the GTAP database though, the difference being because that database overstates the import protection in China and India (see Table 1). Not surprisingly given the high levels of subsidies and import protection for Indian farmers shown in Table 1, net farm incomes are estimated to fall in South Asia according to both databases (by up to 9 percent) – but textiles and clothing would expand there and, in India where the skilled/unskilled wage differential rises, so too would skill-intensive goods and services production.

2.3.6 Effects on poverty using the elasticities approach

The above results for net farm income suggest both inequality and poverty could be alleviated globally by agricultural and trade policy liberalization. It is possible to go a step further in assessing reform impacts on poverty with a global model, even with only one single representative household per country. That involves using the elasticities approach. It involves taking the impact on real household income, applying an estimated income to poverty elasticity, and then assessing the impacts on the poverty headcount index for each country. The simple approach would assume distributional neutrality: the poor receive the same proportional increase in real income as the average household in the economy, and all are subject to the same higher rate of direct income taxation to replace the customs revenue forgone because of trade liberalization. A slightly more complex but more reasonable approach is to link key model variables to the possible change in the average per capita consumption of the poor, that is, to capture from the model's results some of the distributional aspects of the changes in real income, rather than simply the average gain. This is done here by calculating the change in the (pre-tax) average wage of unskilled workers deflated by the food and clothing CPI—presumably the most relevant consumer prices for the poor, including those many poorest of farm and other rural households that earn most of their income from wages and are net buyers of food. These workers are assumed to be exempt from the direct income tax imposed to replace the lost customs revenue following trade reform—a realistic assumption for many developing countries.[22]

Table 10 summarizes the key poverty results using this approach. According to the DAI database, under the full merchandise trade reform scenario, extreme poverty (the number of people surviving on less than US$1 a day) in developing countries would drop by 26 million relative to the baseline level of just under one billion, a reduction of 2.7 percent. In Sub-Saharan Africa the number of extreme poor would fall by 3.7 percent. In India (though not in the rest of South Asia), by contrast, the number of extreme poor is estimated to rise, by 4.0 percent. Under the broader definition of poverty—those living on no more than US$2 per day—the number of poor in developing countries would fall by 87 million under the full reform scenario compared to an aggregate baseline level of nearly 2.5 billion. This represents a somewhat larger proportionate reduction in the number of poor in developing countries, of

[22] Even if the fiscal closure affects a domestic sales or value added tax instead of direct taxes on households, in many countries food is exempt from taxation, or the tax on food is difficult to collect in practice because of the informal nature of many food markets.

3.4 percent, or 3.7 percent if China is excluded. The proportionate decline in Sub-Saharan Africa is 2.7 percent, while for India there is still an increase, of 1.7 percent. These changes in the number of poor as a results of trade liberalization are slightly lower than those obtained using the GTAP database (compare parts (b) and (c) of Table 10).

[insert Table 10 about here]

3. The concern with the counterfactual

The fact that 2004 is the latest year for which a global production, trade and protection database is available is of some concern because the world economy is continually growing and structurally adjusting, and because policies continue to change over time. One way of dealing with this is to first project the global ecconomy forward to create a new baseline against which to compare alternative scenarios. Key issues associated with such projections are the subject of the companion chapter in this *Handbook* by van der Mensbrugghe (2012). An important additional issue is: what counterfactual policy regime is to be assumed for that projected baseline year? Typically analysts assume the status quo, that is, that policies as in the 2004 baseline will remain in place. Yet there is very clear evidence of systematic differences across countries with different per capita income levels and comparative advantages, as well as over time as countries grow, and especially so in the case of agriculture (Anderson 2010b).

In recent years there has been renewed interest in projecting global commodity markets and the overall economy two or more decades ahead. Demand for such long-term projections has been driven by such things as the recent rises in food and energy prices, rapid growth in large emerging economies, and worries about greenhouse gas emissions and policy responses to them. Such projections are also sought by trade policy analysts as a baseline for estimating the effects of proposed or alternative trade policy reforms that tend to be phased in over anything up to two decades. One such proposal is the Doha Development Agenda of the World Trade Organization (WTO). There are also numerous regional and other plurilateral economic integration proposals under discussion, including a Trans-Pacific Partnership.

The most-common assumption in developing baseline projections is that trade-related policies do not change over the projection period. That may be reasonable for manufacturing protectionism, now that most major countries have liberalized most of their markets for industrial products. Agricultural policies, however, continue to be highly distorting – and they have been evolving in fairly systematic ways. How different might farm policies be in, say, 2030 from those in 2004 (the base year of the latest GTAP protection database) in the absense of a Doha agreement to undertake multilateral policy reform and any other plurilateral trade agreements?

This section addresses that question by drawing on the World Bank's distortions to agricultural incentives (DAI) database described in Section 2 above, political economy theory, a set of political econometric equations for the most important agricultural products, and knowledge of current WTO-bound tariffs. With those equations plus projections of pertinent variables from recent economywide modeling, agricultural price distortion rates are generated for the world in 2030. This provides an alternative to the common 'business-as-usual' projections approach of assuming the status quo will prevail on the policy front, allowing us to explore the extent to which results differ depending on the chosen counterfactual against which future trade-liberalizing scenarios are compared.

We begin with a brief summary of the post-World War II history of distortions to agricultural (relative to industrial) incentives globally. We then draw on political economy theory and institutional history to propose a set of political econometric equations for the most important agricultural products, aimed at providing a means of projecting future agricultural distortions for any country in the absense of further trade reform,[23] before presenting the econometric results. Section 3.4 shows how different the welfare effects of trade-distorting policies are when these alternative price distortions are inserted into a global economywide model instead of just assuming the 2004 DAI distortion rates remain unchanged. The key finding is that the contribution of farm policies to the estimated welfare cost of trade-distorting policies by 2030 is considerably higher – especially for developing countries – than if one assumes no change in farm policies over the next two decades.

3.1 Brief history of distortions to agricultural incentives

Some agricultural and other trade policy developments over the past half century or so have happened quite suddenly, been unpredicted, and been transformational, but most have been more gradual. For decades, agricultural protection and subsidies in high-income (and some middle-income) countries have been depressing international prices of farm products. The Haberler (1958) report to GATT Contracting Parties forewarned that such distortions might worsen, and indeed they did between the 1950s and the early 1980s (Anderson, Hayami and Others 1986). Meanwhile, the governments of many developing countries directly taxed their farmers, overvalued their currency, and pursued import-substituting industrialization by restricting imports of manufactures. Together, those measures strongly discouraged agricultural production in developing countries (Krueger, Schiff and Valdés 1988, 1991).

[23] This draws on Anderson and Nelgen (2011). Bouët and Laborde (2010) also seek to assess the implications for the world economy of protection growth that might result if the WTO's Doha round fails to agree to liberalize trade multilaterally. However, their assumed alternative protection rates are more ad hoc than those used here.

Since the 1980s those disincentives have been easing, however, as revealed in the new database of agricultural distortions over the past half-century compiled recently by the World Bank (Anderson and Valenzuela 2008). That database indicates the extent to which government-imposed distortions created a gap between domestic producer prices and what they would be under free markets, known as the Nominal Rate of Assistance (NRA).[24] Since the 1980s, some high-income country governments have also provided so-called 'decoupled' assistance to farmers. Because that support in principle does not distort resource allocation like direct price supports, its NRA has been computed separately and is not included for comparison with the NRAs for other sectors or for developing countries.

Each farm industry is classified either as import-competing, or a producer of exportables, or as producing a nontradable (with its status sometimes changing over the years), so as to generate for each year the weighted average NRAs for the two different groups of covered tradable farm products. Also generated is a production-weighted average NRA for nonagricultural tradables, for comparison with that for agricultural tradables via the calculation of a Relative Rate of Assistance (RRA), defined in percentage terms as:

$$(1) \qquad RRA = 100\left[\frac{100 + NRAag^t}{100 + NRAnonag^t} - 1\right]$$

where $NRAag^t$ and $NRAnonag^t$ are the percentage NRAs for the tradable parts of the agricultural (including noncovered) and nonagricultural sectors, respectively. Since the NRA cannot be less than -100 percent if producers are to earn anything, neither can the RRA (since the weighted average $NRAnonag^t$ is non-negative in all the country case studies). And if both of those sectors are equally assisted, the RRA is zero.

[24] Also calculated is a Consumer Tax Equivalent (CTE), which is equal to the NRA if and only if no domestic producer or consumer measures also are in place.

Historically, national nominal rates of assistance to agriculture (NRAs) have tended to be higher, the higher a country's income per capita and the weaker a country's agricultural comparative advantage. There has also been a (somewhat weaker) tendency since the 1960s for manufacturing protection to be lower, the higher a country's income per capita and the stronger a country's manufacturing comparative advantage. Together these tendencies would expect one to observe the relative rate of assistance to farmers (RRA) to be positively correlated with per capita income and negatively correlated with an index of comparative advantage in farm products. This is indeed what the DAI database reveals (Figure 1). Figure 2 shows the RRA has been rising over time for developing countries as a group, and also for high-income countries prior to the 1990s. The developing countries' RRA rose from around -50 percent in the latter 1960s to almost zero in 2000-04, while the RRA for high-income countries rose from 14 percent in the latter 1950s to a peak of just above 50 percent in the late 1980s. A movement in the RRA towards (away from) zero might indicate an improvement (worsening) in economic welfare, suggesting that the welfare cost of developing country policies may have been falling but may begin increasing if they follow the high-income countries' earlier example in raising their now-positive average RRA further. That is certainly what Korea and Taiwan did in following Japan, and China, India and other developing countries appear to be on a similar trajectory (Anderson 2009b).

[Insert Figures 1 and 2 about here]

A disaggregation of the NRA estimate for the agricultural sector into the NRAs for the export and import-competing sub-sectors, as in Figure 3, reveals that developing country exporters of farm products faced a tax of around 50 percent on average in the first decades of post-colonial government; but that average rate of taxation has gradually fallen to almost zero since the mid-1980s. Meanwhile, however, the NRA for import-competing farmers in developing countries has been positive and steadily rising throughout this period (apart from a spike in the mid-1980s when international prices fell to a near-record low as a consequence of a farm export subsidy war between the two sides of the North Atlantic). The trend for exporters could have reduced the welfare cost of agricultural distortions in developing countries, but the fact that import-competing farmers were increasingly assisted reduces that possibility. As for high-income countries, Figure 3(b) shows that their exporters received rising support until the end of the North Atlantic farm export subsidy war, but that import-competing farmers enjoyed higher and faster-rising support over that period than exporters.

[Insert Figure 3 about here]

3.2 What determines the evolution of NRAs over time?

Political economy theory to explain the pattern of agricultural distortions across countries and over time made some progress in the 1980s, but then it stalled. Only now are theorists beginning again to focus on improving our conceptualization of the issue, suggest hypotheses, compile appropriate data, and use political econometrics to test those hypotheses (see, e.g., Anderson 2010a; Rausser, Swinnen and Zusman 2011; Anderson, Rausser and Swinnen 2011). But even the earlier analysis can take us some way towards understanding the evolution of agricultural price-distorting policies. Anderson (1995), for example, suggests the following factors distinguish the domestic polities of developing and high-income countries.

First, in a poor agrarian economy (PAE), urban wage-earners and hence their employers care a great deal about the price of food, and are relatively well organized. Farmers by contrast, are numerous but poorly organized, and many are so small as to be able to sell only a little or none of their output in the market. In a rich industrial economy (RIE), by contrast, farm products (especially net of post-farmgate costs) represent a small fraction of urban household expenditure and hence of real wages. As well, urban households are far more numerous and so suffer from a free-rider problem of collective action in RIEs, just as farmers do in PAEs.

Secondly, a typical PAE has the majority of its workforce employed in agricultural pursuits and relatively few in manufacturing, whereas in RIEs there could be up to ten times as many engaged in industrial jobs as on farms. Altering the domestic price of farm relative to industrial products thus has a far bigger impact on the price of mobile labor in a PAE than in a RIE. Industrial capitalists therefore are more likely to be able to lobby successfully for (and governments face less opposition to) taxes on agricultural exports and on imports of manufactured goods in PAEs, whereas agricultural interests are more likely to be able to lobby successfully for (and governments face less opposition to) agricultural subsidies and import tariffs in RIEs.

Thirdly, high costs of collecting taxes other than at the border in PAEs make them much more likely than RIEs to employ trade taxes and thus be prone to an anti-trade bias in their sectoral policies, and high costs of dispersing funds make PAEs less fiscally capable of subsidizing any sector. By definition the PAE has a comparative advantage in agricultural goods, hence this anti-trade bias adds to the anti-agricultural bias in PAE policies.

Together these forces lead one to expect to observe countries gradually switching from a negative to a positive RRA as their per capita income grows, and more so if their agricultural comparative declines in the process of that development. That is consistent with the evidence presented in Figure 1 above. It is also consistent with a formal econometric test using those two variables for the full sample of countries in the Anderson and Valenzuela (2008) panel dataset, as well as separately for each of the three developing country regions and for high-income countries (Anderson 2010a, Table 2.12).

The domestic polity also can come under pressure from outside from time to time. Three sets of external forces during the past quarter-century are worth mentioning. One is the Uruguay Round Agreement on Agriculture, negotiations for which began in 1986 and implementation of which concluded in 2004. That led to agreements to convert non-tariff barriers to tariffs, to set caps (bindings) on those tariffs, and to phase down and cap domestic and export subsidies. [25] The caps were somewhat above applied rates in high-income countries, but they were very much above applied tariffs in the case of middle- and especially low-income countries. Hence those bindings currently provide little discipline on the agricultural policies of most developing countries.[26]

A second and complementary force in Europe was the likelihood and then reality of an eastern enlargement of the European Union, which required the budget for subsidies under the Common Agricultural Policy gradually to be spread over a dozen more countries. One consequence was a move away from price-support instruments to more-decoupled measures including single farm payments. The reforms came in various stages, under McSharry in 1992 and under Fischler in the early 2000s (Swinnen 2008), which explains much of the gradual fall in EU and hence high-income agricultural NRAs after the late 1980s (Figure 3(b)). For intra-EU political and budgetary reasons they are unlikely to trend back upwards in the foreseeable future.

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[25] A further consequence of the Uruguay Round was that it contributed to the unilateral decisions in Australia and New Zealand to phase out most of their agricultural assistance, although the main political drivers there were domestic and they led to even larger cuts to what had been high rates of manufacturing protection. Hence the (negative) RRA in those countries rose to zero, just as happened in developing countries (Anderson, Lloyd and MacLaren 2007).

[26] They are still valuable in limiting the scope for countries to raise tariffs when international food prices spike downwards though (Francois and Martin 2004) – as they have tended to do in the past, thereby accentuating the fall in the international price (Anderson and Nelgen 2011).

The third external force came from international financial institutions whose loans and other assistance to developing countries became somewhat conditional on better economic governance including more openness of their economies. That helped to bring down their NRAs for non-farm tradable sectors (Figure 2(a)) and to phase out their taxes on farm exports (Figure 3(a)). However, with so little discipline on farm import tariffs coming from the Uruguay Round Agreement on Agriculture, those tariffs have continued to drift upwards for developing countries over the past two decades.[27] It also means it has been difficult for the WTO membership to demand tight constraints on out-of-quota farm tariffs of countries seeking to accede to the WTO. This is the case even for China, where strong pressure resulted in low tariffs only on in-quota volumes of imports.

The above suggests high-income countries (including Eastern Europe's transition economies that are now part of the European Union) are unlikely in the foreseeable future to raise their assistance to farmers via price-distorting measures, developing countries are unlikely to return to farm export taxation (apart from temporarily at times of price spikes), and all countries are unlikely to return to high levels of protection for the manufacturing sector. But if the WTO's Doha Development Agenda fails to conclude with an agreement to greatly reduce developing countries' bindings on agricultural import tariffs, political economy theory and past experience suggest their agricultural protection growth may well continue. More specifically, such protection increases could be expected to be related to

[27] There are virtually no effective WTO disciplines on export taxes though. Some developing countries have chosen to use that freedom to impose export taxes (and lower import taxes) temporarily when international food price spike upwards, so as to not transmit all of such price spikes to their domestic food market. As already mentioned, the gap between their applied and bound import tariff also gives them latitude to raise applied rates when international prices fall, so as to protect their farmers from that slump. Evidence of extensive use of these freedoms is provided by Anderson and Nelgen (2011).

growth in per capita income and in agricultural comparative disadvantage, and to be higher for import-competing than exported farm products. According to the econometric evidence reported in Anderson (2010a, Table 2.12), an equation worth considering for projecting each country's tradable food products is the following:

$$NRA_i = f(YPC, LPC, TSI_i) \quad (2)$$

where *YPC* is the log of real per capita national income, *LPC* is the log of arable land per capita (an indicator of agricultural comparative advantage), and TSI_i is a trade specialization index for product *i* (exports minus imports as a fraction of exports plus imports of *i*) which, by definition, ranges between minus and plus one.

3.3 Projecting developing country NRAs from 2004 to 2030

Modelers wishing to estimate the likely effects of a future structural or policy shock need first to project a baseline of the global economy to a target future date such as 2030 in the absence of that shock. This can then serve as the counterfactual against which to compare the economy in that year in the presence of the shock of interest (e.g., the implementation of a multilateral trade agreement such as that being sought under the WTO's Doha Development Agenda).

Typically modelers assume for their baseline that trade-related policies remain unchanged over the projection period. The purpose of this section is to explore how the results for 2030 under that assumption differ from those based on an alternative counterfactual. The alternative considered here draws on estimates of Equation (2) for ten key traded farm products as of 2004. Projections of NRAs for each of those products in 2030 for each of the main developing countries (the 39 in the World Bank DAI database) are then generated using model-based projections of the exogenous variables on the right-hand siide of Equation (2).

The sample for the regression equation is all 75 countries in the World Bank distortion database in 2004. The estimated regression equations are reported for each product in Table 11. The results are not highly significant, but apart from maize at least one of the 3 explanatory variables is statistically significant in each equation. (The insignificant result for maize is not surprising in view of the very small range of its NRAs in the panel data set.) For the other nine products, the R^2 values are between 0.21 and 0.55. All product equations have a positive coefficient for *YPC* and a negative coefficient for *LPC*, as predicted by theory. All except the soybean equation have a negative coefficient for *TSI*, again consistent with the above theory.

[insert Table 11 about here]

To use these equations to project NRAs, it is necessary to have projected values for the three exogenous variables. These are taken from a recent exercise that employs the GTAP economy-wide model (and database, except for altering the developing country agricultural distortions to match the DAI estimates) to project the world economy to 2030 (Anderson and Strutt 2011). That projection assumes the 2004 trade-related policies of each country do not change over that 26-year period but that national real GDP, population, unskilled and skilled labor, capital, agricultural land and other natural resources (oil, gas, coal and other minerals) grow at exogenously set rates. Those exogenous growth rates are based on ADB, OECD, USDA and World Bank projections, plus historical trends in mineral and energy raw material reserves. Given those exogenous growth rates, the model is able to derive implied rates of growth in total factor productivity and GDP per capita. For any one country the rate of total factor productivity growth is assumed to be the same in each of its non-primary sectors, and to be somewhat higher in its primary sectors. Higher productivity growth rates for primary activities were characteristic of the latter half of the 20th century (Martin and Mitra 2001), and are necessary in this projection if real international prices of primary products (relative to the aggregate change for all products) are to rise only modestly to 2030.[28] Once those higher TFP growth rates for primary sectors are determined, the uniform rates for non-primary sectors are re-calculated to ensure the targeted GDP levels are obtained.

In addition to taking the real GDP, land and population values for 2030 from the Anderson and Strutt (2011) study, we also use its estimated trade structure for 2030 to estimate a value for *TSI* for each product and country. That provides all the exogenous variables needed to estimate a potential endogenous value for the NRA for each product and country. That estimated value is then subjected to the following series of tests. First, if a farm product was exported in 2004 and is projected still to be a net export product in 2030 (*TSI*>0), then its 2030 NRA is assumed to be the lesser of its 2004 NRA or zero. That is, all export taxes are assumed to be phased out by 2030, and no new export subsidies are introduced. And second, if it is projected to be an import-competing product in 2030 (*TSI*<0), then its 2030 NRA is assumed to be the lesser of the equation's projected NRA or its WTO-bound tariff rate. That is, all developing country governments are assumed to respect their commitment to WTO to not exceed their tariff bindings but otherwise they are assumed to

[28] That calibration is consistent with the World Bank's projections over the coming decades (see van der Mensbrugghe and Roson 2010, and van der Mensbrugghe 2012). An alternative in which agricultural prices fall is considered unlikely over the next two decades, given the slowdown in agricultural R&D investment since 1990 and its consequent delayed slowing of farm productivity growth (Alston, Babcock and Pardey 2010). It is even less likely for farm products if fossil fuel prices and biofuel mandates in the US, EU and elsewhere are maintained over the next decade. Another alternative is that real international primary product prices will rise over coming decades, in which case assistance to farmers might be less everywhere than suggested below. Neither of these alternatives are considered here, but they could be worthy of subsequent analysis.

respond to domestic political forces in determining the degree of protection provided to import-competing farm industries.

Using this methodology and set of selection criteria, projected values for each of the ten products and for each of the 39 developing countries in the World Bank sample are calculated. Their averages across countries for each region and across products for each country are reported in Tables 12 and 13, respectively.

[insert Tables 12 and 13 about here]

What do those estimates reveal? For developing countries as a whole, the average NRA for these products is projected to rise from 7 percent in 2004 to 35 percent by 2030. It happens that 35 percent is the 2004 average for high-income countries (including Europe's transition economies). Since we assume the NRAs for the latter countries do not change over the projection period, it means the NRA for these ten products for the world as a whole is projected to rise, from 20 percent in 2004 to 35 percent by 2030, other things equal. As shown in Table 13(b), the biggest increase is in developing Asia, where the average NRA rises from 11 to 42 percent over the projection period, followed by Africa (a rise from -9 to 16 percent) and Latin America (a rise from -1 to 17 percent). The biggest projected NRA rises are in rice and sugar, which is not surprising since they are the most distorted products in high-income countries (see bottom of Table 12).

For farm products other than these ten major ones, and for highly processed food and other merchandise, developing country import protection rates in 2030 are assumed to be the same as in 2004, and any agricultural export taxes in 2004 are assumed to be eliminated by 2030.

3.4 Projecting the cost of trade-distorting policies as of 2030

What would those projected NRAs imply about the cost of agricultural and other price- and trade-distorting policies in the world economy in 2030, compared with assuming no changes in trade policies since 2004? That question can be answered by comparing results from two global trade liberalization simulations with a global economy-wide model that has been projected to 2030. The first experiment assumes those 2004 distortions remain unchanged over the projection period, while the second assumes those 2004 distortions changed in ways described in the previous section for developing countries but that tariffs in high-income countries stay the same as in 2004. Such an exercise has been undertaken recently by Anderson and Strutt (2011). Their 2030 import tariffs for the first simulation are shown in the first three columns of Table 14, while their average tariffs for all of agriculture and processed food for the second simulation are shown in the final column of Table 14.

[insert Table 14 about here]

Anderson and Strutt (2011) use the standard GTAP Model of the world economy (Hertel 1997) and its Version 7.1 database for 2004. They aggregate the model to 33 countries/country groups and 26 sector/product groups, and then project the global economy to 2030 by first assuming no policy changes and then assuming the above-described agricultural protection growth in developing countries. Welfare results from those two simulations are summarized in Tables 15 and 16.

[insert Tables 15 and 16 about here]

Table 15 shows the distribution of the gains that would come from full global liberalization of all merchandise trade as of 2030. A comparison of parts (a) and (b) of that table suggest, unsurprisingly, that the global welfare cost of trade policies would be somewhat higher with that agricultural protection growth. In particular, the welfare cost of developing countries' agricultural policies would be more than one-quarter higher, increasing the cost of their policies overall by one-ninth – and raising agriculture's contribution to the global cost of all goods trade distortions by two percentage points.

Table 16 disaggregates those results to reveal their effects on major economies. The differences in the two sets of effects are a combination of higher protection rates and thus also consumer prices for some farm products in some developing countries, substitution towards the production and away from the consumption of those more-protected products in those countries, and, as a consequence of those adjustments, terms of trade changes for all countries. For most but not all of the countries/country groups shown in Table 16, their welfare would be lower (their gain from liberalization greater) in the scenario in which agricultural protection was greater. The exceptions are food-importing Japan, China and Rest of South Asia, all of whom would have benefitted from the lower international prices associated with higher agricultural protection and thus would suffer a greater terms of trade deterioration with reform.

The above analysis suggests the common assumption in developing baseline projections for the world economy, namely that trade-related policies do not change over a projection period as long as a quarter-century, may lead to underestimation of the gains from the phased implementation of prospective trade agreements. Had Japan and Korea been required to bind their agricultural tariffs at the rates in place when they signed onto the GATT in 1955 and 1967 respectively, estimates of the economic benefits of their membership of that club would have differed greatly had it been assumed their farm tariffs would remain unchanged over the following quarter-century rather than rise – as indeed they did, and spectacularly so (Anderson 2009b).

4. The concern with tariff aggregation

Protection rates—and many other economic distortions -- vary enormously across commodities in almost every country. These variations in rates of tariff protection raise the cost of any given 'average' level of protection, since the cost of protection increases with the square of the protection rate. Some degree of aggregation is essential because the available information on the structure of production and consumption is at a higher level of aggregation than information on tariffs and trade. Additional aggregation typically is undertaken to ease computational and reporting constraints for the modeler.

The usual approach to aggregation is to get weighted averages of tariffs, using as weights the value of external trade. This atheoretical approach is problematic because, as a protection rate rises, the weight associated with that measure declines – to the point that a tariff that completely blocks trade has the same measured impact as a zero tariff. The Overall Trade Restrictiveness Index approach used by Kee, Nicita and Olarreaga (2009, equation 16) deals with these problems by adding estimates of own-price elasticities as well as import weights, and by taking the square of the tariff to reflect the fact that the costs of a tariff rise with its square. If one makes the assumption that the off-diagonal elements of the matrix of trade elasticities are zero, this results in the following estimating equation:

$$(3) \qquad \text{OTRI} = \left[\frac{\sum m_i s_i T_i^2}{\sum m_i s_i}\right]^{\frac{1}{2}}$$

where m_i is the compensated elasticity of import demand for good i, s_i is the share of the good at world prices and T_i is the tariff on the good.

This approach is unfortunately not suited to the problem of aggregation within a trade model. A fundamental difference between this approach and one suited to aggregation in a general equilibrium model is that different parts of the model require different approaches to aggregation. When aggregating tariffs for use within an expenditure function, and hence the volume of imports which is derived by differentiating this function with respect to prices, tariffs should, intuitively, enter the aggregation function linearly, as noted by Lloyd, Croser and Anderson (2010). By contrast, when aggregating tariffs to assess the impacts of tariff changes on tariff revenues or welfare, the tariff change is likely to enter nonlinearly as in the OTRI defined above. Another concern with the conventional OTRI approach is the assumption that the off-diagonal elasticities of import demand are zero. Since the import demand elasticities underlying this function are compensated, the sum of these cross elasticities is, by homogeneity of degree one in prices, equal and opposite to the own-price elasticity. The fact that the elasticity terms being omitted are equal to and opposite in sign to the terms used in the OTRI raises concerns about the omission of these terms, particularly in countries where the share of trade in GDP is large.

Anderson and Neary (1994) propose a uniform tariff that yields the same welfare as the original differentiated tariff structure. In subsequent work they develop uniform tariff measures that are equivalent in their effects on the value of imports (Anderson and Neary 1996). The unifying feature of these aggregators is that they return the uniform tariff rate that yields the same value of a specific objective function as the actual, non-uniform tariff structure.

Building on the Anderson-Neary approach, Bach and Martin (2001) proposed an approach to aggregation in the context of structural economic models that mitigates many of the problems resulting from use of atheoretical aggregators—and show that the implications of aggregation could be large for specific countries. Martin, van der Mensbrugghe and Manole (2003) apply this methodology to additional countries and confirm that the impact on the results could be substantial. Manole and Martin (2005) develop the approach further, showing that it should be applied in specific ways, and establish relationships between different tariff indexes. A new aggregation method proposed by Anderson (2009) deals with both the aggregation bias and weighting problems, and maintains global payment balances, allowing it to be applied in global models. Laborde, Martin and van der Mensbrugghe (2011) apply that aggregation approach to ex ante assessment of global economic reforms, demonstrating that it is feasible and examining some of the key issues involved in applying it in a global general equilibrium model.

The effects of aggregation may also depend upon the nature of the reform considered. If the reform involves widely disparate cuts in protection rates, then it seems likely that the approach used for aggregation will be doubly important. To illustrate this point, we draw on the analysis of Laborde, Martin and van der Mensbrugghe (2012) who examine the impacts of the complex and exception-ridden Doha Development Agenda proposals from December 2008 (WTO 2008a, b).

In order to understand the logic of the aggregation approach, it is useful to begin with a simple case where there is only one distortion, say an import tariff. The essential difference between the new estimates and traditional trade-weighted averages is that the optimal aggregators take into account the fact that the quantity of a good imported subject to a tariff depends on the level of the tariff, with higher tariff rates resulting in a lower import volume. Including these changes in quantity weights has two important consequences. The first is that a tariff reduction of a given size on a particular product has a larger impact on the cost of imports and on partners' export opportunities in later stages of liberalization, that is, after the tariff has been reduced substantially and its weight in the expenditure cost index has increased. The second is that the impacts of a tariff cut on tariff revenues may be quite different than would be suggested when using a fixed weight – a difference that is largest in the early stages of liberalization, when tariffs are at their highest levels and increases in import volumes have their largest impact on tariff revenues.

Figure 4 helps to understand both of these effects. In this diagram, we consider a single tariff considered in the absence of any other distortions. This tariff is initially t_0, and the initial quantity of imports, x_0. If we consider a reform that progressively reduces this tariff, the quantity of the good imported rises as we move along the line labelled *x*. When the tariff reaches zero, the weight on this good in the import-cost index becomes x_1 under the optimal expenditure aggregator. When we consider large cuts in tariffs, the difference between a weight of x_0 and x_1 may have important impacts on the estimated effects of a tariff change on the cost of living or on partners' market access. If we use the traditional fixed-weight approach, the weight may stay at a very low level, suggesting that even a large tariff change has little impact on the cost of living. This effect is clearly important for reforms that involve large tariff reductions on products whose tariffs are initially very high and hence have very low quantities of imports.

[Insert Figure 4 about here]

The marginal impact of a tariff decline on tariff revenues may be quite different from that on the cost of imported goods. While x_0 gives the marginal impact of a change in the tariff on the cost of imported goods, the impact on tariff revenues depends also on the change in the quantity of the good and on the initial tariff rate on that good. In the diagram, this is shown by $x_0 + t_0 dx/dt$. As the tariff declines further, the marginal effect of a reduction in the tariff on tariff revenues is shown by the dashed line. When the tariff is high, a tariff cut may – as drawn – increase tariff revenues because we start from a point beyond the peak revenues for this tariff.[29] As the tariff reduction proceeds, the incremental increases in tariff revenues decline, and turn into revenue declines where the dashed line crosses the horizontal axis.

[29] This case is likely to be common given the protectionist motivation of much protection, the relatively high estimated values of the elasticity of substitution between products at fine levels, and the high and widely-dispersed patterns of tariff rates frequently observed.

After the dashed line crosses the horizontal line corresponding to the initial level of imports, x_0, the tariff revenue aggregator shows a larger reduction in tariff revenues than the fixed-weight index, despite allowing for the increases in import volumes associated with tariff declines. The marginal decline in tariff revenues remains below the decline in required expenditure until the tariff reaches zero, and the impact of a tariff reduction on tariff revenues is the same as its impact on the cost of the good.

The Anderson-Neary approach to tariff aggregation begins with a representation of the economy provided by the following two equations:

the income-expenditure condition,

(4) $$e(\mathbf{p}, u) - r(\mathbf{p}, \mathbf{v}) - (\mathbf{e_p} - \mathbf{r_p})(\mathbf{p} - \mathbf{p}^w) - f = 0$$

and the vector of behavioral equations,

(5) $$\mathbf{e_p}(\mathbf{p}, u) - \mathbf{r_p}(\mathbf{p}, \mathbf{v}) = \mathbf{m}$$

In the income-expenditure condition, e is the expenditure required to achieve consumer utility level u at domestic price vector **p**; r is the revenue function (also named the restricted profit function or GDP function) at domestic prices **p** attainable with the given resource vector **v**; $\mathbf{e_p} - \mathbf{r_p}$ is the vector of net imports/exports at world prices $\mathbf{p}^w$ and domestic prices **p**, so that $(\mathbf{e_p} - \mathbf{r_p})(\mathbf{p} - \mathbf{p}^w)$ represents net revenue from tariffs and export taxes/subsidies; and f is the net financial inflow from abroad needed to finance the gap between income and expenditure required to achieve utility level u. If f is exogenously-determined, then u is endogenous and vice versa. In the behavioral equations, **m** is a vector of net imports, including non-traded goods (for which $\mathbf{m} \equiv \mathbf{0}$) and supplied and demanded factors.

The balance-of-trade function (Anderson and Neary 1996) can be derived from equation (4) by reclassifying both the level of utility and f as exogenous, and introducing a new endogenous variable, B, to measure the hypothetical financial inflow required to maintain a specified level of utility, say u^0, in the face of an exogenous shock such as a change in the tariff vector, ($\mathbf{p}$ - $\mathbf{p^w}$), or a change in world prices, $\mathbf{p^w}$:

$$(6) \qquad B(\mathbf{p}, u^0) = e(\mathbf{p}, u^0) - r(\mathbf{p}, \mathbf{v}) - (\mathbf{e_p} - \mathbf{r_p})(\mathbf{p} - \mathbf{p^w}) - f$$

The balance-of-trade function gives us the transfer required to maintain the same level of utility given a change in prices, and is therefore a convenient measure of the compensation required to maintain national welfare at any specified level. Its use can be seen as a generalization of the use of the expenditure function to provide a money measure of the impact on consumers of price changes.

The Anderson-Neary Trade Restrictiveness Index (TRI) is the uniform tariff rate, τ^B, which satisfies:

$$(7) \qquad B(\mathbf{p}^w(1+\tau^B), u^0) = B(\mathbf{p}, u^0)$$

where the two price vectors being compared are the original vector of domestic prices associated with the non-uniform tariffs, **p**, and the vector of prices resulting from multiplying the vector of world prices, $\mathbf{p}^w$, by the scalar $(1+\tau^B)$.

While much better than a weighted average as an indicator of the welfare costs of existing trade distortions, this TRI measure is not suitable as an aggregator for use in a modeling context. For modelling, we need two quite different aggregators—one for the parts of the model that involve only the expenditure function, and the quantities that are derived by differentiating this function with respect to price, and another for the parts of the model involving tariff revenues.

Bach and Martin (2001) solved this problem by using one tariff aggregator, τ^e, for the expenditure function, as a uniform tariff that returns the same level of expenditure as the domestic prices resulting from the original, heterogeneous tariff vector:

$$(8) \qquad e(\mathbf{p}^w(1+\tau^e), u^0) = e(\boldsymbol{p}, u^0)$$

The tariff revenue aggregator for use in replicating the tariff revenues associated with the original, heterogeneous, tariff revenue function is similarly determined as the scalar, τ^r, that satisfies:

$$tr(\mathbf{p}^w(1+\tau^r), u^0) = r_j(\boldsymbol{p}, u^0) \quad (9)$$

where τ^r is the uniform tariff revenue aggregator and *tr* is the tariff revenue function.

A similar aggregator function can be used for the revenue function $r(\mathbf{p}, \mathbf{v})$. This is generally not necessary in applied work because the data available on the structure of production are typically much more aggregated than those available for traded goods, and export-market distortions are far less widely-used than import barriers.

By construction, the correct value of *B* can be obtained by using the tariff aggregates, τ^e and τ^r . This allows the model to be written in terms of aggregate variables that are consistent with the underlying model, rather than with the unmanageable disaggregated tariffs or with *ad hoc* aggregates such as weighted-average tariffs.

Laborde, Martin and van der Mensbrugghe (2012) use a three-tier strategy to implement this approach in the World Bank's LINKAGE computable general equilibrium model of the global economy (van der Mensbrugghe 2005), projected to 2025. They first calculate the tariff aggregators for expenditure and tariff revenues using the MacMapHS6 v2.1 database (Boumellassa, Laborde and Mitaritonna 2009) that provides detailed information on bilateral tariffs and trade flows at the HS6 level. The model is modified to make a distinction between aggregate quantities computed at domestic and foreign prices needed for this type of global analysis (Anderson 2009). For the expenditure aggregators, the popular Constant Elasticity of Substitution (CES) functional form is used to specify the ease of substitution between imported goods within the aggregates. By replacing the disparate tariffs in each group with the uniform tariff on all imported goods in the group that requires the same expenditure as actually observed, a uniform tariff equivalent for expenditures on imports is obtained. For the tariff-revenue aggregators, a trade-weighted average is used, with the quantities of each good adjusting in a manner consistent with the same CES functional form, to obtain the uniform tariff that generates the same tariff revenues.

In implementing this approach in applied modelling, two other levels of aggregation need to be taken into account. The first of these arises from the practical problem that some regions in the global model are aggregates covering more than one economy. The second is the fact that the six-digit products are likely to include varieties supplied by different countries. These challenges are dealt with by using three different levels of nesting in the model. At the highest level of aggregation, where there were multiple importing countries in an importing region, CES preferences are assumed across importing countries with an elasticity of substitution σ_0. At the second level of aggregation, CES preferences over the HS6 products within the composite goods appearing in the model are assumed. At this stage, the HS6 products are aggregates over varieties imported from all supplying regions, with elasticity of substitution σ_1. At the third level, the Armington approach is used, assuming CES preferences across the six-digit varieties from different exporters. At this stage, an elasticity of substitution of σ_2 is used between the products provided by different suppliers.

The relationship between the three levels of product substitution is shown in Figure 5. For this analysis, values of three different elasticities of substitution σ_0, σ_1 and σ_2 are needed. The value of σ_0 is set at 1 in order to hold constant each importer's share in the value of imports, primarily for want of better information; σ_1 is the elasticity of substitution between imported six-digit products from all sources within a composite good (such as between apples and oranges within a composite of vegetables and fruits); and σ_2 is determined by the elasticity of substitution between varieties of six-digit products supplied by different countries/regions. No estimate of exactly σ_1 and σ_2 are available. However, Hummels and Klenow (2008) consider elasticities of substitution between varieties that are differentiated by

HS six-digit product and by country of origin, concluding that these elasticities generally lie between five and ten. To the extent that these elasticities reflect the margins of substitution associated with both σ_1 and σ_2, we might expect them to be greater than our σ_1 elasticities of substitution but less than our desired estimates for σ_2. The analysis is therefore undertaken using core values of 1, 2 and 5 for those three key elasticities.

[Insert Figure 5 about here]

A sample of results from the analysis is presented in Table 17 for two different global reform scenarios in which reforms are phased in over the projection period to 2025. The first two columns in this table present results for the benchmark case of full liberalization of all merchandise trade. The first of these columns presents the results obtained using the standard weighted-average approach to aggregating tariffs; the second presents the results for the same experiment when the aggregation problem is allowed for and quantities are allowed to change in line with an elasticity of substitution of 2. The second group of results refers to the highly disparate set of tariff cuts that would result from implementing the formulas and exceptions inherent in the Doha modalities as proposed in WTO (2008a, b). Within this group of three columns, the key factor of interest is the differences between the weighted-average aggregation approach where the elasticity of substitution is implicitly set to zero (the standard weighted-average approach to aggregating tariffs), and the cases with elasticities of substitution of 2 and 5.

[insert Table 17 about here]

For most countries, moving from the standard trade-weighted averages to optimally-weighted averages results in larger estimated welfare gains as of 2025 because of the improvements in the measurement of the cost of imports, and of tariff revenues. This increase is particularly striking in cases such as China and the United States, where significant liberalization is proposed and where market access gains reflect the substantial increases in weights as protection in export markets is reduced. There are, however, some interesting exceptions to this general pattern. Chile is one such example, where there are few additional measured gains using the optimal approach, for two reasons. One is because most of Chile's applied tariffs are uniform, so liberalizing own tariffs has a relatively uniform effect across products. The other is that Chile has preferential arrangements with many partners, and the aggregation approach reveals a greater sensitivity to preference erosion as the larger weights on imports from trading partners with less preferential access are taken into account. In aggregate, though, the estimated welfare gain to the world as a whole from either total or partial global trade liberalization is far higher when the optimal tariff aggregation procedure is used, and more so the larger is the elasticity of substitution.

5. Conclusions

The above results illustrate how much trade reform modeling results can depend on the distortion database used in the analysis. Clearly it is important to choose a database best suited for the purpose at hand. If one is interested in trade effects of partial reform of tariff protection that might emerge from a preferential trade agreement, for example, then precision about bilateral tariff rates will be paramount. Other distortions may affect the welfare calculus, but the trade effects will be mostly dependent on just the bilateral tariffs to be altered. However, if the main interest is the effect of sectoral policies on domestic output, income distribution and national economic welfare, it is crucial to include all important distortions to producer incentives, including for other sectors which compete for mobile factors of production with the sector in question. That is the point of section 2 of this chapter: since agricultural policies are a major remaining source of trade distortions in the world, and farming is a major employer in developing countries, those policies need to be as fully represented as possible in the model's distortions database.

The DAI database suggests price distortions in developing countries were smaller than indicated by the applied import tariffs that appear in the GTAP database, one possible reason being that imported farm products are not perfect substitutes for domestically produced 'like' products and so the price-raising effect in the domestic market is less than the full extent of their tariff. According to the Linkage model results, the GTAP database for 2004 leads to an overestimate by more than 40 percent in the welfare effect on developing countries of global trade distortions.The overestimation would have been even larger had it not been for the fact that some developing countries still have export taxes in place, which are included in the DAI baseline data prior to simulating full liberalization. Hence the gains to Latin America are *under*estimated by 16 percent while those to developing Asia are overestimated by 71 percent. Those comparative results also reveal an overestimate for high-income countries (of about one-seventh), by exaggerating the beneficial terms of trade effect to them of developing countries' agricultural distortions. The contribution that agricultural policies make to the welfare effects of all merchandise trade distortions is also exaggerated by the GTAP database compared with the DAI one, by about one-tenth globally and one-quarter for developing countries.

Second, choosing the appropriate counterfactual set of price distortions in the year of concern (such as when a proposed reform is expected to be fully implemented), rather than simply assuming no change in policies over the projection period, can make a large difference to the estimated welfare effects of a reform program. The case illustrated in Section 3 involves agricultural protection growth in rapidly emerging economies should the WTO's Doha Round fail to add disciplines to national agricultual policies of developing countries. The gains that would come from full global liberalization of trade as of 2030 are somewhat higher with than without that agricultural protection growth. In the case of developing countries the estimated cost of their agricultural policies would be higher by one-quarter in 2030 if their farm protection grew as predicted in Section 3.

Finally, different methods of aggregating up to the GTAP product groups the price distortions (e.g. tariff rates) on individual products can make a large difference to the estimated welfare effects of liberalizing a set of trade-distorting tariffs, especially when initial tariffs are highly variable and/or the rates of tariff reduction are non-uniform. The differences in results reflect differences not just in the welfare impacts resulting from own-reform, but also from differences in the extent of market access liberalization by the country or its trading partners.

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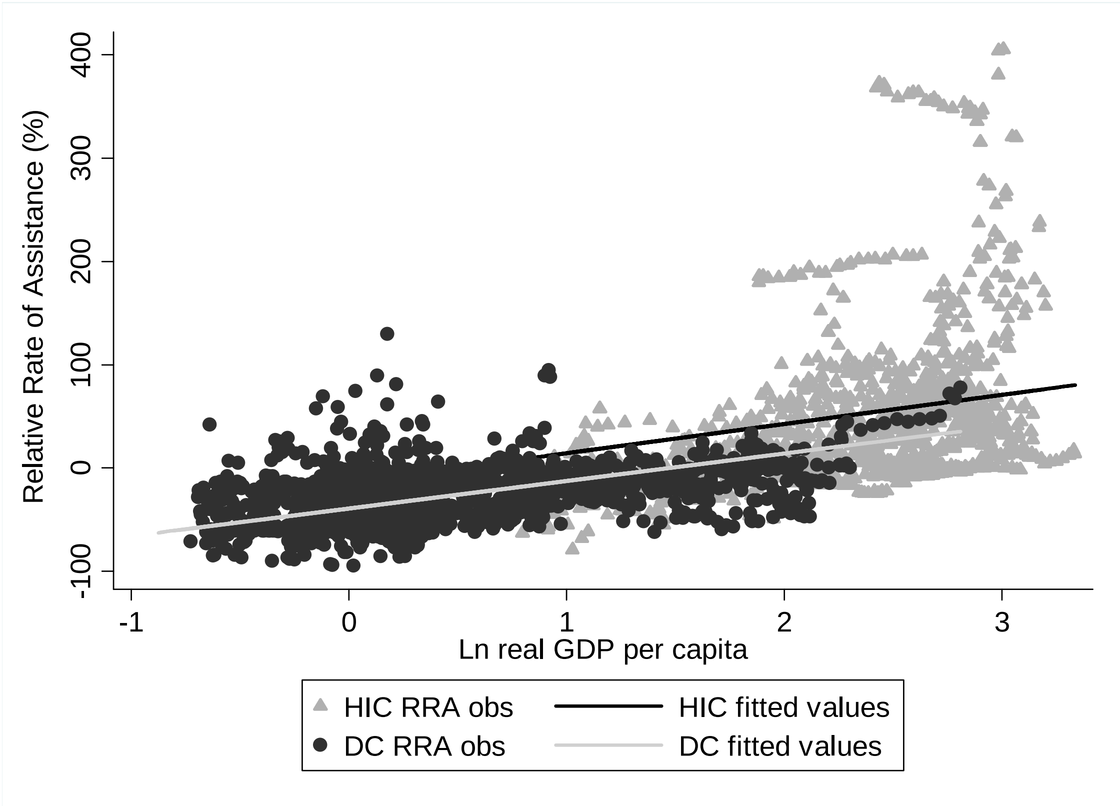
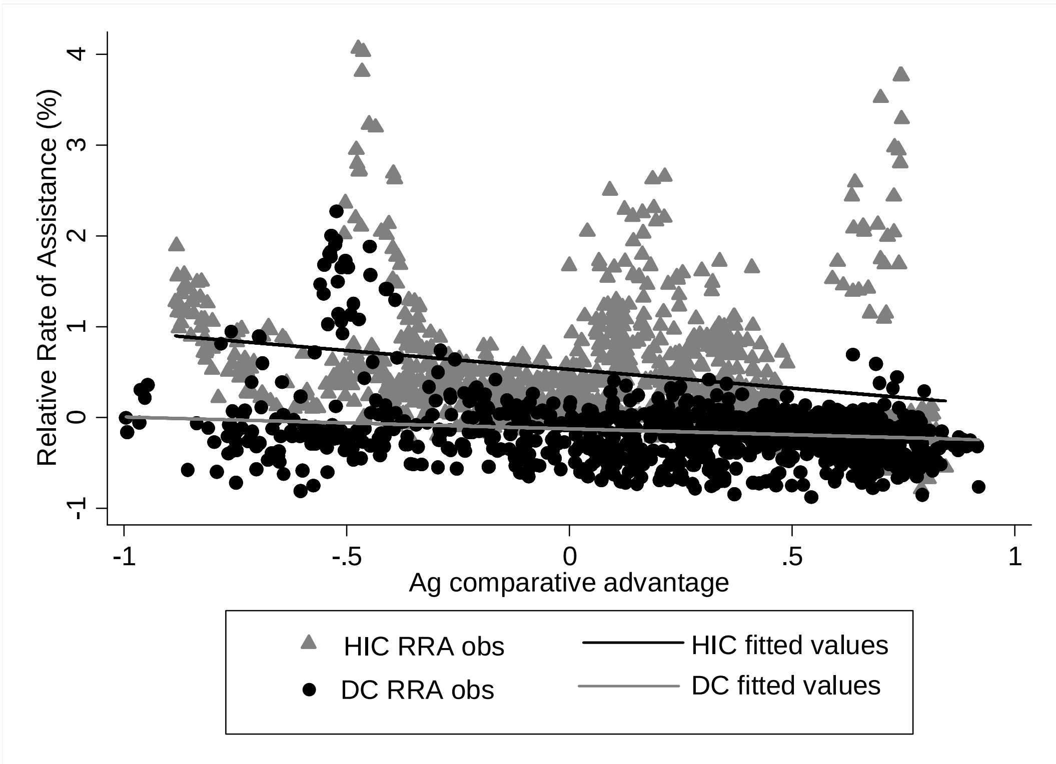
Figure 1: RRA mapped on income and agricultural comparative advantage,[a] 1955 to 2007
(a) RRA (%) mapped on log of real GDP per capita



(b)

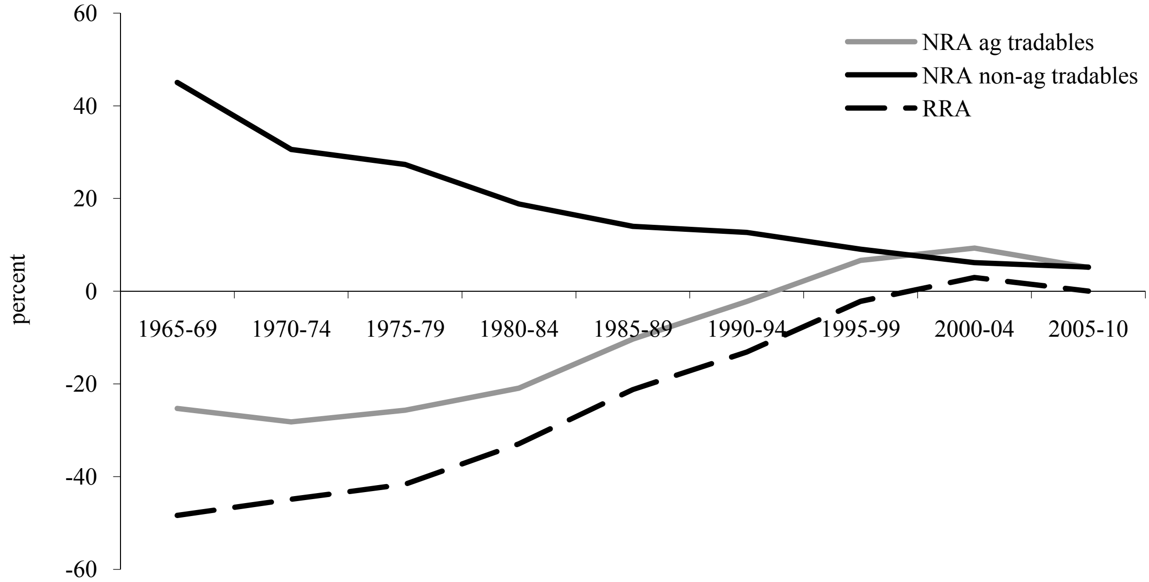
(b) RRA (%) mapped on agricultural comparative advantage[a]



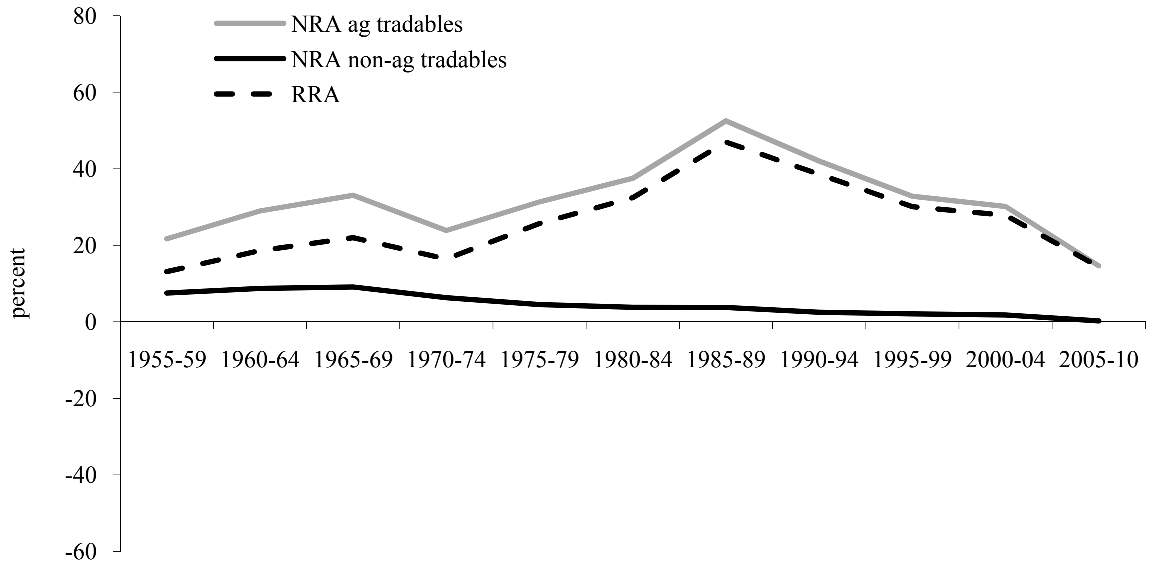
[a] Defined as agricultural net exports divided by the sum of agricultural exports and imports.
Source: Anderson (2010a, Figures 2.2 and 2.3)

Figure 2: Nominal rates of assistance to agricultural and non-agricultural tradable sectors and relative rate of assistance,[a] developing and high-income countries, 1955 to 2010
(percent, farm production-weighted averages across countries)

(a) Developing countries



(b) High-income countries

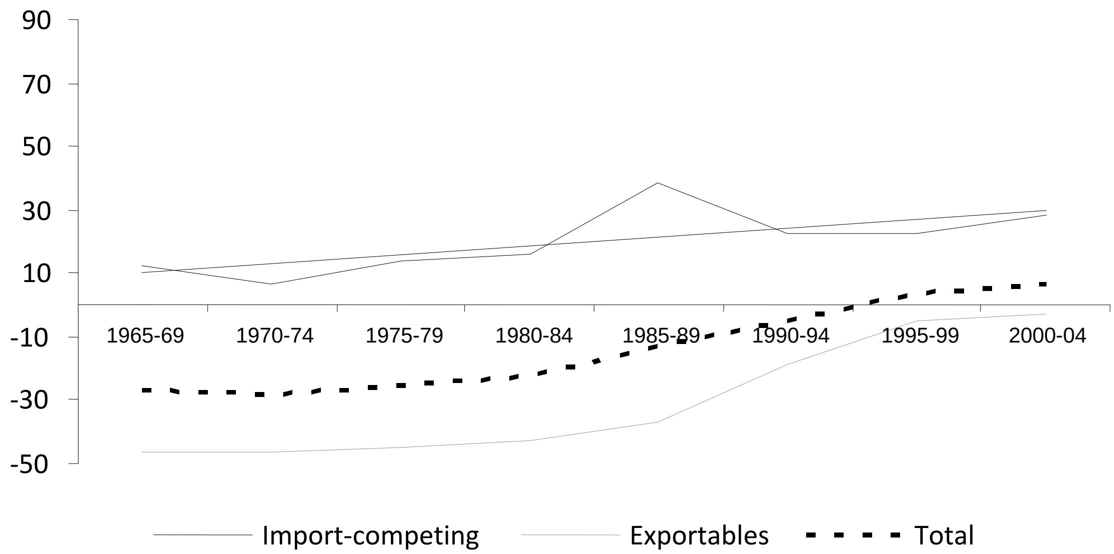


[a] The RRA is defined as $100*[(100+NRAag^t)/(100+NRAnonag^t)-1]$, where $NRAag^t$ and $NRAnonag^t$ are the percentage NRAs for the tradables parts of the agricultural and non-agricultural sectors, respectively.

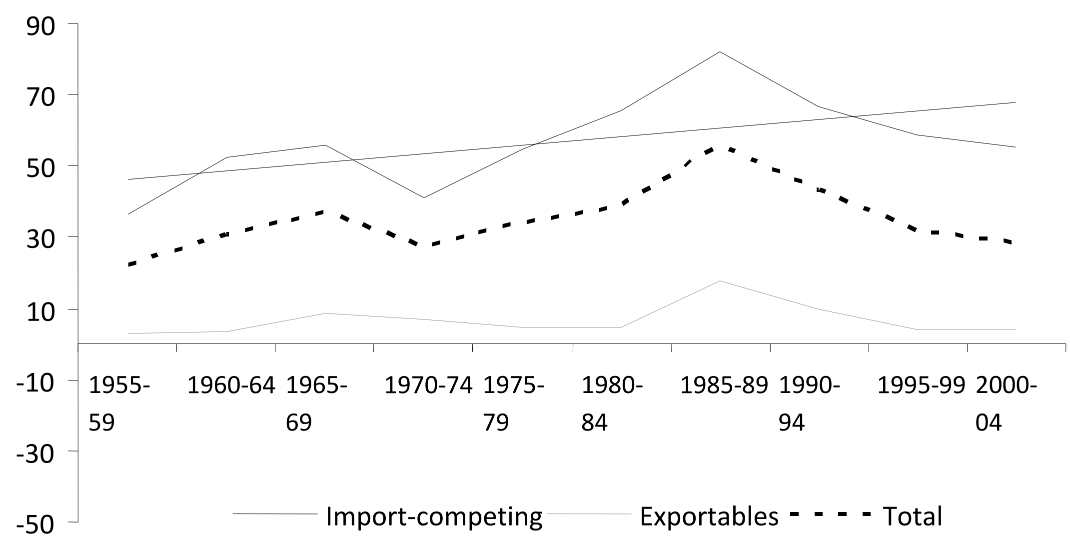
Source: Updated from Anderson (2009a, Ch. 1), based on estimates in Anderson and Nelgen (2012b).

Figure 3: Nominal rates of assistance to exportable, import-competing and all covered agricultural products,[a] high-income, transition and developing countries, 1955 to 2004 (percent, 5-year weighted averages)

(a) Developing countries

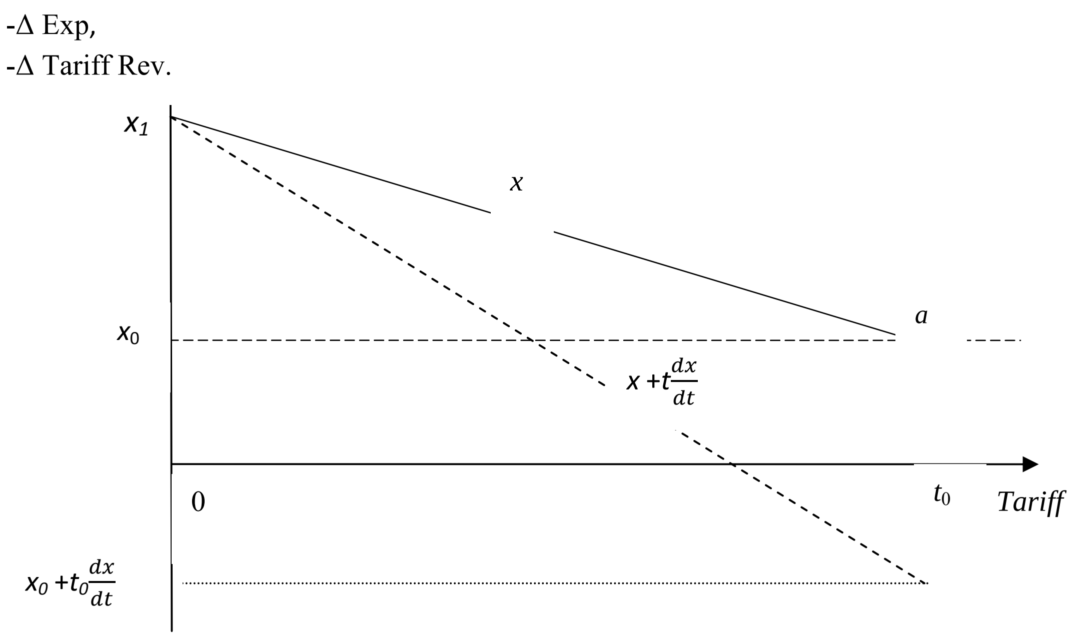


(b) High-income countries plus Europe's transition economies



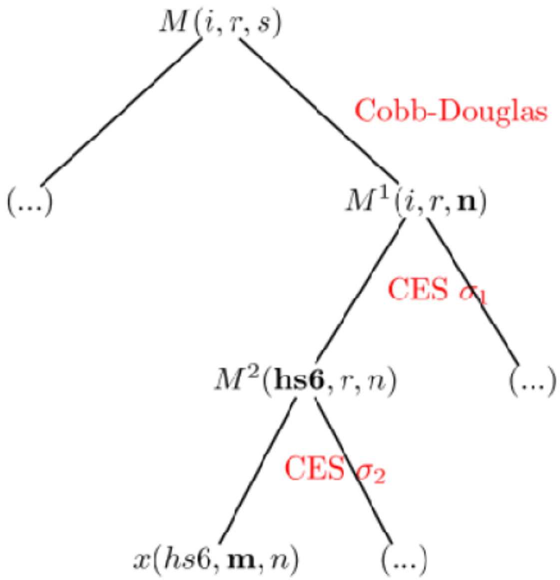
[a]Covered products only. The total also includes nontradables. The straight line in the upper segment of each graph is from an ordinary-least-squares regression based on annual NRA estimates for agriculture's import-competing sub-sector.
Source: Anderson (2009a, Ch. 1), based on estimates in Anderson and Valenzuela (2008).

Figure 4: Marginal impacts of tariff reductions on expenditure and tariff revenues



Source: Authors' depiction

Figure 5: Three levels of substitution



Source: Authors' depiction

Table 1: Structure of producer price distortions in global goods markets,[a] 2004

(percent)

	DAI Database				GTAP Version 7.0 Database			
	Primary Agriculture	Agriculture and Lightly Processed Food		Other goods	Primary Agriculture	Agriculture and Lightly Processed Food		Other goods
	Production subsidy[b]	Export subsidy[b]	Import tax	Import tax	Production subsidy[b]	Export Subsidy[b]	Import tax	Import tax
Africa	**-0.7**	**-0.5**	**17.7**	**11.8**	**-0.8**	**0.0**	**14.9**	**11.8**
Egypt	0.3	0.0	5.2	9.9	0.0	0.0	4.8	9.9
Madagascar	0.5	-21.8	3.5	3.9	0.0	0.0	3.8	3.9
Mozambique	0.7	-0.3	19.4	9.5	-0.1	0.0	10.1	9.5
Nigeria	0.0	0.0	44.6	21.5	0.1	0.0	29.2	21.5
Senegal	-0.3	-1.3	8.7	9.1	0.0	0.0	9.4	9.1
South Africa	0.0	0.0	11.9	6.4	0.0	0.0	7.3	6.4
Uganda	0.5	-7.1	8.5	4.9	0.0	0.0	6.9	4.9
Tanzania	0.4	0.0	19.1	9.3	-0.3	0.0	14.5	9.3
Zambia	-0.4	0.0	8.3	7.7	-0.8	0.0	7.2	7.7
Zimbabwe	-3.6	0.0	11.9	13.8	-3.4	0.0	14.2	13.8
Rest of Africa	-0.4	0.0	13.7	11.8	-0.4	0.0	12.8	11.8
East and South Asia	**2.1**	**-0.3**	**20.4**	**5.9**	**0.7**	**0.0**	**32.6**	**6.5**
China	0.0	0.5	8.0	6.3	0.0	0.0	21.4	6.3
Korea	-0.1	0.0	93.8	4.5	0.0	0.0	129.7	4.5
Taiwan	-0.4	0.0	23.3	3.3	-0.4	0.0	17.1	3.3
Indonesia	0.0	-1.6	5.1	4.4	0.0	0.0	4.6	4.4
Malaysia	0.2	-0.1	8.1	5.2	0.0	0.0	7.2	5.2
Philippines	-4.6	0.0	6.8	3.0	-4.6	0.0	10.8	3.0
Thailand	-0.2	0.0	25.2	8.6	-0.1	0.0	18.6	8.6
Vietnam	-3.5	-4.4	14.7	12.5	-3.5	0.0	10.5	12.5
Bangladesh	-1.1	0.0	19.2	18.9	-1.1	0.0	13.7	18.9
India	10.4	1.7	8.1	13.1	4.0	0.0	60.8	13.1
Pakistan	0.0	-2.1	13.7	16.3	0.0	0.0	19.9	16.3
Sri Lanka	0.9	-4.8	18.8	5.2	0.5	0.0	19.1	5.2
Rest of East & South Asia	-0.9	0.0	3.8	1.7	-0.5	0.0	8.1	11.2
Latin America	**-0.3**	**-5.4**	**6.7**	**6.1**	**-0.8**	**0.0**	**6.7**	**6.1**
Argentina	0.0	-19.4	0.0	6.0	-4.7	0.0	2.2	6.0
Brazil	0.0	0.0	3.8	8.5	0.0	0.0	2.9	8.5
Chile	0.1	0.0	3.4	2.0	-1.6	0.0	1.4	2.0
Colombia	-0.1	0.0	12.0	9.8	0.0	0.0	12.4	9.8
Ecuador	0.0	0.0	12.1	9.2	0.0	0.0	8.9	9.2
Mexico	0.8	0.0	3.5	3.2	1.0	0.0	4.3	3.2
Nicaragua	0.3	-8.6	11.9	3.7	0.0	0.0	8.9	3.7
Rest of Latin America	-1.6	0.2	10.0	9.4	-1.7	0.2	9.7	9.4
EEurope & Central Asia	**0.7**	**-0.8**	**15.3**	**3.1**	**0.8**	**1.1**	**10.3**	**3.1**
Baltic States	0.0	3.0	3.9	0.5	0.3	3.6	4.6	0.5
Bulgaria	0.6	0.0	18.9	6.9	0.6	0.0	21.5	6.9
Czech Republic	0.4	3.5	3.2	0.3	0.6	3.7	3.3	0.3

(continued)

Table 1 (continued): Structure of producer price distortions in global goods markets,[a] 2004

(percent)

	DAI Database				GTAP V7 Database			
	Primary Agriculture	Agriculture and Lightly Processed Food		Other goods	Primary Agriculture	Agriculture and Lightly Processed Food		Other goods
	Production subsidy[b]	Export subsidy[b]	Import tax	Import tax	Production subsidy[b]	Export Subsidy[b]	Import tax	Import tax
Hungary	2.8	2.2	5.1	0.4	2.9	2.2	5.3	0.4
Poland	0.3	3.2	5.1	0.4	0.3	3.4	5.1	0.4
Romania	1.3	0.0	21.7	6.3	1.3	0.0	23.8	6.3
Slovakia	-0.2	0.8	5.5	0.3	0.0	0.8	5.7	0.3
Slovenia	-1.3	5.4	5.6	0.3	0.0	5.5	5.2	0.3
Russia	1.7	-1.9	24.0	9.9	1.7	0.0	10.7	9.9
Kazakhstan	-0.7	0.0	4.0	4.0	-0.8	0.0	2.6	4.0
Turkey	0.8	0.0	18.0	1.4	0.8	0.0	14.7	1.4
Rest of EEur & CAsia	-1.0	-6.0	13.0	4.2	-0.5	0.0	12.0	3.9
High-income countries	**2.2**	**2.2**	**23.5**	**1.7**	**1.8**	**2.3**	**24.4**	**1.7**
Australia	0.0	0.0	0.8	4.1	0.0	0.0	1.0	4.1
Canada	2.0	0.3	8.8	0.9	1.6	0.4	11.6	0.9
EU15	1.0	8.9	17.2	1.5	0.9	9.1	17.8	1.5
Japan	1.7	0.0	39.6	1.3	1.7	0.0	41.8	1.3
New Zealand	0.0	0.0	0.5	3.1	0.0	0.0	1.1	3.1
Rest of Western Europe	2.6	3.6	54.0	1.0	3.7	4.7	56.6	0.8
USA	4.9	0.1	4.0	1.6	3.9	0.1	2.2	1.6
Developing countries	**0.4**	**-2.5**	**11.0**	**6.1**	**-0.4**	**0.2**	**13.6**	**6.4**
Africa	-0.7	-0.5	17.7	11.8	-0.8	0.0	14.9	11.8
East Asia	-0.3	-0.5	8.4	5.6	-0.3	0.0	16.2	6.4
South Asia	7.4	0.5	12.2	13.6	2.9	0.0	34.2	13.6
Latin America	-0.3	-5.4	6.7	6.1	-0.8	0.0	6.7	6.1
Middle East	-11.4	0.0	8.6	6.7	-11.3	0.0	9.8	6.7
EEurope and CAsia	0.7	-0.8	15.3	3.1	0.8	1.1	10.3	3.1
WORLD TOTAL	**1.1**	**-0.5**	**17.2**	**3.4**	**0.5**	**1.1**	**19.0**	**3.4**

[a] The DAI database uses value of production at undistorted prices as weights to aggregate price distortions across products and countries. The GTAP database in the case of import taxes uses import values as the basis for weights (see Bouët et al. 2008).

[b] The subsidy is net of any taxes, so a negative sign indicates a net tax on production or exports. No agricultural export taxes are included in the GTAP database.

Source: DAI data from Valenzuela and Anderson (2008), based on calculations compiled by Anderson and Valenzuela (2008); GTAP data from Narayanan and Walmsley (2008).

Table 2: Impact on real income of full liberalization of global merchandise trade, by country/region, 2004
(relative to the 2004 benchmark data, in 2004 US dollars and percent)

	DAI Database			GTAP V7 Database		
	Total real income gain p.a. ($billion)	Change due just to change in terms of trade ($billion)	Total real income gain as % of benchmark[a]	Total real income gain p.a. ($billion)	Change in income due just to change in terms of trade ($b)	Total real income gain as % of benchmark[a]
North & Sub-Sah Africa	***0.9***	***-6.0***	***0.2***	***1.5***	***-5.0***	***0.3***
Egypt	-0.2	-0.6	-0.3	-0.2	-0.6	-0.3
Madagascar	0.0	0.0	-0.9	0.0	0.0	-1.3
Mozambique	0.1	-0.1	2.4	0.1	0.0	1.5
Nigeria	0.3	-0.6	0.7	0.2	-0.5	0.4
Senegal	0.0	-0.1	-2.3	-0.1	-0.1	-2.9
South Africa	0.2	-0.7	0.1	0.6	-0.4	0.4
Uganda	0.0	0.0	-0.6	0.0	0.0	-0.3
Tanzania	0.0	0.0	-0.5	0.0	0.0	-0.4
Zambia	0.0	0.0	0.1	0.0	0.0	0.1
Zimbabwe	0.1	0.0	3.4	0.1	0.0	3.3
Rest of Africa	0.5	-3.8	0.2	1.0	-3.3	0.4
East and South Asia	***29.7***	***-4.9***	***0.9***	***55.1***	***-11.5***	***1.6***
China	3.3	0.5	0.2	7.7	-0.4	0.6
Korea	14.0	0.2	2.8	27.9	-4.8	5.5
Taiwan	1.0	0.0	0.4	1.4	-0.1	0.6
Indonesia	0.5	0.0	0.2	1.1	0.4	0.5
Malaysia	4.2	-1.0	4.7	5.4	-0.6	6.0
Philippines	0.0	-0.5	0.1	0.0	-0.8	0.0
Thailand	3.3	-0.1	1.4	2.9	-0.5	1.2
Vietnam	1.9	-0.9	5.3	3.6	0.2	10.2
Bangladesh	-0.2	-0.8	-0.4	-0.3	-0.7	-0.7
India	-0.8	-2.9	-0.2	3.2	-4.7	0.6
Pakistan	-0.1	-0.6	-0.2	-0.3	-0.7	-0.3
Sri Lanka	0.8	0.5	5.1	1.0	0.6	6.1
Rest of East & Sth. Asia	1.9	0.8	1.4	1.5	0.5	2.6
Latin America	***15.8***	***2.5***	***1.0***	***13.6***	***4.1***	***0.8***
Argentina	3.2	-0.7	2.6	1.3	0.4	1.1
Brazil	6.8	5.6	1.6	7.0	6.5	1.6
Chile	0.3	0.2	0.4	0.1	-0.1	0.1
Colombia	2.2	0.7	3.1	2.2	0.9	3.1
Ecuador	2.0	1.1	8.2	2.0	1.1	8.6
Mexico	-0.7	-3.4	-0.1	-0.4	-3.3	-0.1
Nicaragua	0.0	0.0	1.3	0.0	0.0	-0.1
Rest of Latin America	2.0	-1.0	0.5	1.5	-1.4	0.4

(continued)

Table 2 (continued): Impact on real income of full liberalization of global merchandise trade, by country/region, 2004

EEurope & Central Asia	***14.2***	***-3.6***	***1.2***	***12.8***	***-2.0***	***1.0***
Baltic States	0.5	0.1	1.8	0.6	0.0	1.9
Bulgaria	0.2	-0.2	1.4	0.2	-0.1	1.9
Czech Republic	1.0	-0.1	1.4	1.1	-0.1	1.6
Hungary	0.4	-0.1	0.6	0.6	-0.1	0.8
Poland	2.0	0.1	1.2	2.1	0.1	1.3
Romania	-0.1	-0.7	-0.3	0.0	-0.6	-0.1
Slovakia	0.7	0.1	2.3	0.7	0.1	2.4
Slovenia	0.3	0.1	1.5	0.4	0.1	1.6
Russia	5.4	-3.1	1.2	1.5	-2.1	0.3
Kazakhstan	0.4	0.2	1.1	0.4	0.2	1.2
Turkey	1.3	-0.5	0.6	1.7	-0.4	0.8
Rest of EE & Cent. Asia	2.2	0.5	2.1	3.5	0.9	2.9
High-income countries	***102.8***	***11.3***	***0.5***	***118.3***	***13.8***	***0.5***
Australia	2.4	1.9	0.5	3.0	2.2	0.6
Canada	0.6	-1.2	0.1	1.8	-0.7	0.3
EU 15	56.8	-3.8	0.7	62.6	-5.4	0.8
Japan	23.1	10.4	0.7	29.8	12.6	0.9
New Zealand	2.2	1.8	3.2	1.7	1.4	2.5
Rest of Western Europe	13.1	-0.1	2.7	14.6	0.7	3.1
United States	2.8	0.9	0.0	2.8	1.3	0.0
Hong Kong & Singapore	1.7	1.4	1.4	2.1	1.7	1.0
Developing countries	***64.9***	***-12.2***	***0.9***	***91.6***	***-14.3***	***1.2***
North Africa	0.9	-2.8	0.5	1.5	-2.6	0.8
Sub-Saharan Africa	0.0	-3.2	0.0	0.0	-2.4	0.0
East Asia	30.1	-1.0	1.1	51.6	-6.0	1.9
South Asia	-0.4	-3.9	-0.1	3.5	-5.6	0.5
Latin America	15.8	2.5	1.0	13.6	4.1	0.8
Middle East	4.2	-0.2	0.8	8.6	0.2	1.6
EEurope & Central Asia	14.2	-3.6	1.2	12.8	-2.0	1.0
World total	***167.7***	***-1.0***	***0.6***	***209.9***	***-0.5***	***0.7***

[a] Numbers in parentheses refer to that due to terms of trade effects.

Source: Authors' World Bank Linkage model simulations

Table 3: Regional and sectoral sources of welfare gains from full liberalization of global merchandise trade,[a] 2004

(relative to the 2004 benchmark data in 2004, percent[b])

	Using DAI Database			**Using GTAP V7 Database**		
	Developing	*High-income*	*World*	*Developing*	*High-income*	*World*
Developing countries liberalize:						
Agriculture and food	49	4	21	62	7	31
Manufacturing and services	8	36	25	6	32	20
Total	57	40	46	68	39	51
High-income countries liberalize:						
Agriculture and food	23	65	49	18	66	45
Manufacturing and services	20	-5	5	14	-5	4
Total	43	60	54	32	61	49
All countries liberalize:						
Agriculture and food	72	69	70	80	73	76
Manufacturing and services	28	31	30	20	27	24
Total	39	61	100	44	56	100

[a] Small interaction effects are distributed proportionately and numbers are rounded to sum to 100 percent

[b] Percentage in last row refers to the total regional gain relative to the world total.

Source: Authors' World Bank Linkage model simulations

Table 4: Impact of full global liberalization on shares of global output exported, and developing country shares of global output and exports,[a] by product, 2004

(percent)

	Share of global output exported[a]			**Developing countries' share of global output**			**Developing countries' share of global exports[a]**		
	Bench-mark	Global lib - DAI	Global lib - GTAP	Bench-mark	Global lib - DAI	Global lib - GTAP	Bench-mark	Global lib - DAI	Global lib - GTAP
Paddy rice	1	2	2	81	82	83	56	42	65
Wheat	16	22	27	67	71	67	25	39	36
Other grains	11	15	16	55	57	56	35	56	49
Oil seeds	21	28	25	69	74	74	54	68	68
Plant-based fibers	25	25	32	74	83	74	50	79	56
Vegetables and fruits	9	15	16	72	77	77	69	80	81
Other crops	14	17	18	49	49	50	75	62	69
Cattle sheep etc	2	2	2	43	48	50	56	59	64
Other livestock	4	4	5	65	67	68	43	46	55
Wool	13	14	18	82	81	77	16	18	15
Beef and sheep meat	7	21	22	27	41	43	31	68	71
Other meat products	7	12	13	32	34	35	42	45	42
Vegetable oils and fats	20	30	31	52	58	58	80	84	85
Dairy products	5	11	11	29	33	35	28	41	48
Processed rice	5	7	7	76	79	78	85	87	87
Refined sugar	8	42	39	52	85	83	78	90	89
Other food, bev.& tob.	9	12	12	35	36	37	50	59	61
Other prim. products	31	33	32	64	63	63	76	76	76
Textile and clothing	28	35	35	53	57	57	74	77	77
Other manufacturing	24	26	26	32	31	30	43	43	41
Services	3	3	3	20	20	20	31	30	28
Agriculture and food	8	13	14	46	50	50	54	64	64
Agriculture	8	11	12	62	65	65	55	64	64
Processed foods	8	14	15	37	40	41	52	63	64

[a] excluding intra-EU trade.

Source: Authors' World Bank Linkage model simulations

Table 5: Impacts of full global trade liberalization on agricultural and food output and trade, by country/region, 2004

(relative to 2004 benchmark data, in percent)

	Using DAI Database			**Using GTAP V7 Database**		
	Output	Exports	Imports	Output	Exports	Imports
High-income countries	***-13***	***-4***	***38***	***-14***	***-3***	***38***
Australia	20	41	11	22	52	16
Canada	-2	24	33	2	56	51
EU 15	-21	-29	32	-24	-37	34
Japan	-23	88	69	-24	156	64
New Zealand	47	74	27	39	61	24
Rest of Western Europe	-19	312	133	-25	406	124
United States	-3	1	32	0	12	25
Hong Kong and Singapore	2	6	2	10	32	5
Developing countries	***7***	***100***	***40***	***7***	***112***	***55***
North Africa	17	377	63	19	411	61
Sub-Saharan Africa	2	42	32	3	46	25
East Asia	4	77	37	5	128	70
South Asia	0	108	33	-3	132	128
Latin America	27	106	30	26	93	23
(of which Argentina	*38*	*96*	*82*	*24*	*38*	*1)*
Middle East	22	223	12	20	247	26
EEurope & Central Asia	-3	80	78	0	97	61
World total	***-3***	***39***	***39***	***-3***	***45***	***45***

Source: Authors' World Bank Linkage model simulations

Table 6: Impact of global liberalization on share of agricultural and food production exported by country/region, 2004

(percent)

	2004 bench-mark data	Full global liberalization	
		Using DAI database	Using GTAP database
Developing countries	***9.5***	***16.9***	***17.5***
North Africa	6.3	20.6	21.7
Sub-Saharan Africa	13.8	19.3	19.2
East Asia	8.4	15.1	16.7
South Asia	3.7	7.5	8.5
Latin America	18.1	28.2	27.5
Middle East	7.4	17.2	18.7
EEurope & Central Asia	6.8	11.1	11.4
High-income countries	***13.0***	***14.1***	***14.1***
World total	***11.4***	***15.4***	***15.8***

Source: Authors' World Bank Linkage model simulations.

Table 7: Impact of global liberalization on agricultural and food self-sufficiency,[a] 2004

(percent)

	High-income countries			**Developing countries**		
	Bench-mark	Global lib		Bench-mark	Global lib	
		Using DAI database	Using GTAP database		Using DAI database	Using GTAP database
Paddy rice	101	105	101	100	99	100
Wheat	141	140	154	88	89	85
Other grains	108	102	106	94	98	96
Oil seeds	104	92	93	97	103	103
Plant-based fibers	161	112	177	88	97	87
Vegetables and fruits	90	78	76	105	109	110
Other crops	90	91	89	113	110	114
Cattle sheep etc	100	100	99	100	100	101
Other livestock	101	101	100	100	100	100
Wool	161	180	207	92	91	86
Beef and sheep meat	101	85	83	97	134	138
Other meat products	100	99	98	100	103	104
Vegetable oils & fats	95	85	85	103	114	115
Dairy products	103	100	98	94	101	104
Processed rice	99	95	95	100	101	102
Refined sugar	98	41	48	102	133	128
Other food bev.&tob.	99	97	97	103	105	106
Other prim. products	76	76	76	122	122	122
Textile&wearing app.	81	76	76	123	128	128
Other manufacturing	101	102	102	98	96	96
Services	101	101	101	101	101	100
All agriculture& food	100	95	95	101	105	105
Primary agriculture	99	96	96	100	102	102
Processed foods	100	95	95	101	108	109

[a] Self sufficiency is defined as domestic production as a percentage of domestic consumption measured in value terms at fob prices.

Source: Authors' World Bank Linkage model simulations

Table 8: Impact of full global liberalization on real international product prices,[a] 2004

(percent relative to 2004 baseline)

	DAI database		**GTAP database**	
	Agric-ultural policies	*All goods sectors' policies*	*Agric-ultural policies*	*All goods sectors' policies*
Paddy rice	6.9	6.6	4.9	4.1
Wheat	1.8	1.4	3.3	2.1
Other grains	2.6	2.7	4.7	3.6
Oil seeds	-2.2	-2.4	3.8	2.6
Sugar cane and beet	-1.1	-2.0	-1.1	-2.5
Plant-based fibers	4.7	2.9	2.3	0.5
Vegetables and fruits	2.4	1.8	2.3	1.8
Other crops	1.7	1.0	2.1	1.4
Cattle sheep etc	-0.2	-1.1	-1.1	-2.1
Other livestock	-1.2	-2.1	-1.8	-2.8
Raw milk	0.7	-0.2	0.0	-2.4
Wool	3.5	3.3	4.5	4.2
Beef and sheep meat	5.6	4.6	5.7	4.6
Other meat products	1.3	0.6	0.4	-0.4
Vegetable oils and fats	-1.4	-1.9	-10.0	-10.3
Dairy products	4.6	3.8	3.9	2.8
Processed rice	2.8	2.9	2.6	2.5
Refined sugar	2.5	1.3	2.9	1.5
Other food, beverages and tob.	-1.7	-1.3	-2.7	-3.0
Textile and wearing apparel	0.3	-1.2	-0.2	-1.7
Other manufacturing	0.2	-0.2	0.2	-0.2
All agriculture and food	**0.8**	**0.3**	**-0.2**	**-1.0**

[a] Model numéraire is the export price index of high-income countries' manufactured exports

Source: Authors' World Bank Linkage model simulations

Table 9: Effects of full global liberalization of agricultural and all merchandise trade on sectoral value added, by country and region, 2004

(relative to benchmark data, percent)

	DAI database				**GTAP database**			
	Agricultural policies		*All sectors' policies*		*Agricultural policies*		*All sectors' policies*	
	Agric	Non-agric	Agric	Non-agric	Agric	Non-agric	Agric	Non-agric
High-income countries	**-13.8**	**0.2**	**-14.7**	**0.1**	**-13.2**	**0.2**	**-14.5**	**0.2**
Australia	10.9	1.5	13.7	2.1	19.1	1.5	21.4	2.0
Canada	3.4	0.3	5.3	-0.5	16.1	0.4	17.8	-0.4
EU 15	-23.0	0.2	-25.4	-0.4	-25.4	0.1	-28.2	-0.4
Japan	-16.7	0.1	-16.8	2.3	-18.3	0.2	-18.6	2.4
New Zealand	57.7	5.0	57.2	5.4	46.7	4.0	45.9	4.1
Rest of Western Europe	-25.8	1.0	-25.8	-1.3	-17.8	1.1	-19.9	1.6
United States	-5.7	0.2	-5.3	-0.2	-2.1	0.2	-2.2	-0.1
Hong Kong & Singapore	3.7	0.4	2.2	2.1	1.6	0.4	0.3	1.1
Developing countries	**5.4**	**1.0**	**5.6**	**1.9**	**3.1**	**1.1**	**3.5**	**1.7**
North Africa	-0.4	1.8	-1.1	0.8	3.1	1.8	1.5	0.9
Sub-Saharan Africa	0.3	0.3	-0.8	-0.5	2.0	0.3	0.8	-0.3
East Asia	2.6	0.6	4.7	3.5	-0.3	1.0	1.7	4.1
South Asia	-5.1	1.1	-6.7	-0.3	-7.9	0.6	-9.0	-0.7
Latin America	36.3	2.8	37.0	2.3	30.0	2.5	31.8	1.4
(of which Argentina	*116.8*	*7.4*	*103.5*	*13.8*	31.3	3.1	35.8	1.8
EEurope & Central Asia	-4.4	0.3	-5.2	0.3	-3.2	0.4	-4.1	-0.8
World total	**-1.0**	**0.4**	**-1.2**	**0.5**	**-2.3**	**0.4**	**-2.5**	**0.5**

Source: Authors' World Bank Linkage model simulations.

Table 10: Poverty effects of full global liberalization of merchandise trade reform, by region, 2004

(a) the benchmark

	Benchmark				Poverty elasticities	
	$1/day		$2/day		$1/day	$2/day
	Headcount (%)	*Number of poor* million	*Headcount* (%)	*Number of poor* million		
China	10	128	35	452	-1.9	-1.3
Other East Asia	9	41	50	232	-3.7	-2.1
India	34	371	80	868	-1.1	-0.5
Other South Asia	29	76	94	248	-2.5	-0.7
EEurope & Central Asia	1	4	10	46	-1.7	-1.7
Middle East & N. Africa	1	4	20	59	-2.5	-2.3
Sub-Saharan Africa	41	298	72	522	-0.7	-0.5
Latin America	9	47	22	121	-1.7	-1.1
All Developing countries	**18**	**969**	**48**	**2548**		

(continued)

Table 10 (continued): Poverty effects of full global liberalization of merchandise trade reform, by region, 2004

(b) DAI database

		$1/day		$2/day		Change in no. of poor	
	Income change, real (%)	Headcount (%)	Number of poor million	Headcount (%)	Number of poor million	$1/day million	$2/day million
China	*2.1*	9	123	34	440	-5	-12
Other East Asia	*8.1*	6	29	42	192	-12	-40
India	*-3.8*	36	386	82	883	15	15
Other South Asia	*4.0*	26	68	92	241	-8	-7
EEurope & Central Asia	*4.5*	1	4	9	43	-0	-4
Middle East & N. Africa	*14.3*	1	3	13	40	-2	-19
Sub-Saharan Africa	*5.3*	39	287	70	508	-11	-14
Latin America	*4.1*	8	44	21	115	-3	-6
All developing countries	***5.9***	**18**	**944**	**46**	**2462**	**-26**	**-87**

(continued)

Table 10 (continued): Poverty effects of full global liberalization of merchandise trade reform, by region, 2004

(c) GTAP database

		$1/day		$2/day		Change in no. of poor	
	Income change, real[a] (%)	Headcount (%)	Number of poor million	Headcount (%)	Number of poor million	$1/day million	$2/day million
China	*3.5*	9	120	33	432	-8	-21
Other East Asia	*9.5*	6	26	40	185	-14	-46
India	*2.8*	33	359	79	857	-11	-11
Other South Asia	*4.1*	26	68	91	241	-8	-7
EEurope & Central Asia	*2.5*	1	4	9	44	0	-2
Middle East & N. Africa	*16.6*	1	3	12	37	-2	-22
Sub Saharan Africa	*5.0*	40	288	70	509	-11	-13
Latin America	*3.5*	8	44	21	116	-3	-5
All developing countries	***5.9***	**17**	**912**	**45**	**2420**	**-58**	**-128**

[a] Nominal unskilled wage deflated by the food and clothing CPI

Source: Authors' World Bank Linkage model simulations.

Table 11: Relationship between NRA and income, arable land endowment and a product's trade status, developing countries, 2004

(endogenous variable: NRA)

Exogenous variables:	Beef	Cotton	Maize	Milk	Pigmeat	Poultry	Rice	Soybean	Sugar	Wheat
YPC	0.378***	0.150**	0.0222	0.198***	0.0895	0.197**	0.396***	0.330*	0.268***	0.0555*
	(0.0662)	(0.0655)	(0.0306)	(0.0594)	(0.0579)	(0.0928)	(0.0891)	(0.173)	(0.0542)	(0.0306)
LPC	-0.200**	-0.0477	-0.0735	-0.265***	-0.135*	-0.265*	-0.725***	-0.849**	-0.122	-0.122*
	(0.0977)	(0.120)	(0.0717)	(0.0817)	(0.0776)	(0.145)	(0.173)	(0.311)	(0.112)	(0.0691)
TSI_i	-0.169	-0.00249	-0.00486	-0.0383	-0.0795	-0.354*	-0.369**	0.115	-0.176	-0.114
	(0.120)	(0.107)	(0.0747)	(0.101)	(0.0973)	(0.187)	(0.159)	(0.328)	(0.126)	(0.0733)
Constant	-2.978***	-1.227**	-0.141	-1.483***	-0.693	-1.439*	-3.701***	-3.517**	-1.295***	-0.481*
	(0.592)	(0.552)	(0.261)	(0.530)	(0.522)	(0.833)	(0.766)	(1.561)	(0.482)	(0.271)
Observations	44	22	56	41	35	42	37	26	57	53
R-squared	0.554	0.241	0.031	0.410	0.214	0.268	0.527	0.309	0.336	0.265
Adj. R-squared	0.521	0.114	-0.0248	0.362	0.138	0.210	0.484	0.215	0.298	0.220

Standard errors are shown in parentheses
Significance levels are *** p<0.01, ** p<0.05, * p<0.10

Source: Anderson and Nelgen (2011), based on NRA estimates and other variable data compiled from the World Bank (World Development Indicators) and the United Nations (COMTRADE data) by Anderson and Valenzuela (2008).

Table 12: NRA averages by region and product, estimated 2004 (DAI database) and projected 2030

(percent, using 2004 value of production at undistorted prices as weights)

Asia	**2004**	**2030**	**Latin America**		
Beef	72	38	Beef	-8	24
Cotton	1	7	Cotton	1	0
Maize	7	23	Maize	-9	14
Milk	21	14	Milk	32	51
Pigmeat	2	18	Pigmeat	-8	25
Poultry	4	17	Poultry	11	15
Rice	14	85	Rice	31	55
Soybean	9	33	Soybean	-8	0
Sugar	49	92	Sugar	22	21
Wheat	13	30	Wheat	-7	13
			High-income countries		
Africa			Beef	36	36
Beef	-23	17	Cotton	26	26
Cotton	-35	0	Maize	17	17
Maize	-13	12	Milk	62	62
Milk	-2	13	Pigmeat	15	15
Poultry	20	5	Poultry	23	23
Rice	-5	34	Rice	328	328
Soybean	-49	0	Soybean	3	3
Sugar	51	51	Sugar	162	162
Wheat	2	14	Wheat	3	3

Source: Anderson and Nelgen (2011)

Table 13: NRA ten-product averages by country, estimated 2004 (DAI database) and projected 2030

(percent, using 2004 value of production at undistorted prices as weights)

(a) by country

	2004	2030		2004	2030
Bangladesh	-4	172	Madagascar	11	30
China	2	30	Mali	43	1
India	22	27	Mozambique	65	55
Indonesia	15	113	Nigeria	-16	32
Korea	258	166	Senegal	4	27
Malaysia	65	71	South Africa	4	26
Pakistan	-1	22	Sudan	-15	9
Philippines	10	91	Tanzania	-1	22
Sri Lanka	-9	0	Togo	6	1
Thailand	1	27	Uganda	6	34
Vietnam	26	48	Zambia	-41	16
Benin	0	0	Zimbabwe	-75	15
Burkina Faso	0	0	Argentina	-23	0
Cameroon	0	12	Brazil	5	4
Chad	0	0	Chile	0	72
Cote d'Ivoire	9	19	Colombia	25	67
Egypt	-11	9	Dominican Rep.	24	11
Ethiopia	-2	15	Mexico	0	43
Ghana	46	20	Nicaragua	-6	8
Kenya	7	15			

(b) by region

	2004	2030
Asia	11	42
Africa	-9	16
Latin America	-1	17
All developing	**7**	**35**
All high-income	**35**	**35**
World	**20**	**35**

Source: Anderson and Nelgen (2011)

Table 14: Average import-weighted tariff protection rates, by sector, 2030

(percent)

	2030 rates assuming no policy changes (same as 2004, DAI database)[a]			***2030 agric & food rates, assuming higher developing country agric protection[a]***
	Agric & processed food	**Other Primary**	**Manuf-actures**	
Western Europe	5.0	0.1	1.1	5.0
Eastern Europe & Russia	12.9	0.6	5.5	12.8
United States & Canada	5.9	0.2	1.8	6.1
Australia & New Zealand	2.2	0.0	4.1	2.2
Japan	24.2	0.0	1.1	24.7
China	10.9	0.8	6.5	20.4
ASEAN	13.1	0.7	4.6	19.6
Pacific Islands	22.4	0.6	7.9	32.4
Rest of East Asia	26.6	4.3	3.4	36.8
India	11.8	10.5	13.5	30.0
Rest of South Asia	13.1	5.3	14.8	18.9
Central Asia	10.3	0.1	5.5	23.4
Latin America	7.5	1.6	7.0	20.0
Middle East & Africa	13.1	2.6	9.4	26.6
High-income countries	**7.3**	**0.2**	**1.7**	**7.3**
Developing countries[b]	**12.3**	**3.3**	**6.7**	**23.0**
Total	**10.3**	**2.1**	**3.7**	**16.2**

[a] See text for description of the two alternative simulations.

[b] Developing countries are defined here as all but the first five in the above list (and so include Central Asia). Turkey is included in 'Eastern Europe'; the new EU27 members of Central and SE Europe are included in 'Western Europe', since they had all joined the EU by 2007.

Source: Anderson and Strutt (2011).

Table 15: Effects of full global liberalization of agricultural and other merchandise trade on global economic welfare, by sectoral policies and regions, without and with developing country agricultural protection growth,[a] 2030

(a) Assuming 2030 distortion rates unchanged from 2004

	Regional gain (2004$USbillion)			Regional gain (%)		
	Developing countries	High-income countries	All countries	Developing countries	High-income countries	All countries
Developing countries liberalize						
Agric and food	68	15	84	34	11	25
Other products	87	29	116	43	22	34
All products	155	45	200	76	33	59
High-income countries liberalize						
Agric and food	20	105	125	10	78	37
Other products	29	-15	15	14	-11	4
All products	49	91	140	24	67	41
All countries liberalize						
Agric and food	88	121	209	43	89	62
Other products	116	15	131	57	11	39
All products	**204**	**136**	**340**	**100**	**100**	**100**

(b) Assuming agricultural protection growth in developing countries from 2004 to 2030

	Developing countries	High-income countries	All countries	Developing countries	High-income countries	All countries
Developing countries liberalize						
Agric and food	87	26	114	38	18	30
Other products	90	30	120	39	20	32
All products	177	56	233	78	38	62
High-income countries liberalize						
Agric and food	20	107	126	9	72	34
Other products	32	-15	17	14	-10	4
All products	51	92	143	23	62	38
All countries liberalize						
Agric and food	107	133	240	47	90	64
Other products	121	15	136	53	10	36
All products	**228**	**148**	**376**	**100**	**100**	**100**

[a] See text for description of the two alternative simulations.

Source: Anderson and Strutt (2011).

Table 16: Effects of full global liberalization of agricultural and other merchandise trade on global economic welfare, by country/region, without and with developing country agricultural protection growth, 2030

(2004 US$ billion per year)

	Assuming 2030 distortion rates unchanged from 2004[a]	**Assuming agric protection growth in developing countries from 2004 to 2030**[a]
Western Europe	60.2	65.2
Eastern Europe & Russia	17.0	20.4
United States & Canada	5.0	18.7
Australia & New Zealand	6.8	8.4
Japan	32.1	30.8
China	30.2	25.2
ASEAN	37.6	38.5
Pacific Islands	1.0	1.2
Rest of East Asia	38.8	37.2
India	28.4	35.1
Rest of South Asia	6.3	0.3
Central Asia	3.3	4.4
Latin America	25.6	34.3
Middle East & Africa	47.8	56.6
High-income countries	**121.1**	**143.6**
Developing countries[b]	**218.8**	**232.8**
Total	**339.9**	**376.4**

[a] See text for description of the two alternative simulations.

[b] Developing countries are defined as all but the first five in the above list (and so include Central Asia). Turkey is included in ‘Eastern Europe’; the new EU27 members of Central and SE Europe are included in ‘Western Europe’.

Source: Anderson and Strutt (2011).

Table 17: Impacts on real incomes of full global merchandise trade liberalization and Doha partial liberalization, 2025

(2004 US$ billion per year)

	Total global lib'n		Partial Doha liberalization		
	Wtd Ave	σ =2	Wtd Ave	σ =2	σ=5
Australia and New Zealand	16.1	16.8	1.9	2.4	3.6
EFTA	20.0	31.6	3.0	4.2	6.2
EU 27	135.3	180.4	29.6	39.3	52.9
United States	47.9	53.8	6.4	9.9	14.1
Canada	7.3	8.6	0.2	0.8	1.7
Japan	52.0	64.9	18.4	21.8	26.1
Korea and Taiwan	77.1	98.7	9.3	9.8	10.5
Hong Kong and Singapore	28.7	29.2	2.5	2.5	2.5
Chile	2.2	2.1	0.2	0.2	0.2
Bangladesh	-0.5	0.2	-0.4	-0.2	-0.3
Brazil	21.7	30.8	4.2	4.7	6.0
China	-21.4	-8.6	5.7	8.9	13.9
Egypt	1.2	10.0	0.2	0.4	0.6
India	18.9	24.3	2.5	2b.4	2.4
Nigeria	3.0	6.8	-0.1	-0.1	-0.1
Pakistan	4.1	4.6	0.1	0.1	0.1
Indonesia	2.8	3.9	1.0	1.0	1.0
Thailand	6.6	8.7	1.8	2.6	4.2
Mexico	5.7	10.1	3.7	4.7	5.8
South African Customs Union	3.8	14.1	0.7	1.3	2.2
Turkey	8.2	11.3	0.4	0.5	0.6
Rest of Asia	6.8	24.5	-1.6	-1.2	-0.3
Morocco and Tunisia	3.5	6.1	0.9	1.6	2.7
Rest of Sub-Saharan Africa	6.4	9.4	-0.6	-0.6	-0.6
Rest of Latin America & Carib.	11.8	18.5	2.2	2.5	2.8
Rest of the world	26.4	64.3	1.4	1.9	2.5
High income countries	**384.4**	**484**	**71.3**	**90.7**	**117.6**
Developing countries	**111.4**	**241.2**	**22.2**	**30.7**	**43.7**
Latin America & Caribbean	41.5	61.6	10.4	12.1	14.8
Sub-Saharan Africa	13.2	30.4	0.1	0.6	1.5
World total	**495.8**	**725.2**	**93.5**	**121.4**	**161.3**

Source: Laborde, Martin and van der Mensbrugghe (2012)