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Abstract

For decades the world's agricultural markets have been highly distorted by national government policies, but very differently for different commodities such that a ranking of weighted average nominal rates of assistance across countries can be misleading as an indicator of the trade or welfare effects of policies affecting global markets. This article develops a new set of more-satisfactory indicators, drawing on the recent literature on trade restrictiveness indexes. It then estimates those two indicators for each of 28 key agricultural commodities from 1960 to 2004, based on a sample of 75 countries that together account for more than three-quarters of the world's production of those agricultural commodities.

Key words: Distorted commodity markets, agricultural price and trade policies, trade restrictiveness index

JEL codes: F13, F14, Q17, Q18

How Do Agricultural Policy Restrictions to Global Trade and Welfare Differ across Commodities?

To compare agricultural distortions across countries, it is common to calculate weighted averages of nominal rates of assistance (NRAs) or consumer tax equivalents (CTEs) of those policies for key products. Those national averages vary considerably, and tend to be high for high-income countries (OECD 2008) and lower or even negative for developing countries (Krueger, Schiff and Valdes 1988). NRAs also vary greatly across commodities. Unsubsidized exporters of a particular product are keen to know by how much global trade in that product has been reduced by other countries' policies, for that influences the amount of effort they are willing to expend in getting together with similar countries to seek more liberalization via trade negotiations. Governments and market participants have an interest also in understanding how distortions vary over time through each commodity cycle, particularly so they can anticipate what might happen when international prices spike up or down.

However, neither the NRA nor the CTE global average is a good indicator of the global trade or welfare effects of policy interventions affecting a particular commodity market, for at least two reasons. First, the fact that there is international trade means each product's production weight differs from its consumption weight for each country and so the global average NRA for any farm product will not be identical to its global average CTE. This will hold even if there were no behind-the-border tax or subsidy policies driving a wedge between the producer and consumer domestic prices. Hence neither can be a true indicator of the global trade effect of distortionary policies. Second, the welfare effect of a policy such as an import tariff is related to the square of that tariff rate, unlike the trade effect which is related just to the rate itself.

Certainly a global modeller in possession of a particular commodity market (or of a global economy wide computable general equilibrium (CGE) model) could insert NRA and CTE estimates and generate partial (or general) equilibrium estimates of the global trade and welfare effects of those distortionary policies in the year for which the model's data are calibrated. However, reliable global models do not exist for many commodities, global CGE models typically have to aggregate many of the smaller commodities into groups to keep the model tractable, and both types of model depend on scant econometric estimates of price elasticities. Moreover, such models are calibrated to a particular year and do not provide a long time series of estimates of the global trade and welfare effects of distortionary policies affecting particular commodity markets.

Pending the improvement of that modelling situation, the purpose of the present article is to develop an alternative pair of indicators whose estimation requires no more data than that needed to estimate global NRAs and CTEs but which provide a far more precise indication of the trade or welfare effects of global distortions to particular product markets. To do so we draw on the recently developed literature on the family of trade restrictiveness indexes. That literature focuses mostly on policy distortions to imports, but we focus also on policies that distort exports (since the latter are still prevalent in a number of agricultural markets) and policies that drive a wedge between domestic producer and consumer prices.

The first of the new indexes is the ad valorem trade tax rate which, if applied uniformly to a commodity in every country would generate the same reduction in trade as the actual cross-country structure of NRAs and CTEs for that commodity. The second of the new indexes refers to the partial equilibrium global welfare cost of that same structure of NRAs and CTEs: it is the ad valorem trade tax rate which, if applied uniformly to that commodity in every country would generate the same reduction in global economic welfare as the actual NRA/CTE structure across countries.

To distinguish the indexes from indexes developed previously, we label these indexes the global trade reduction index (GTRI) and the global welfare reduction index (GWRI). We show that, if one is willing to assume that the domestic cross-price elasticities are zero and that own-price elasticities of supply are equal across countries for a particular commodity, and likewise for the own-price elasticities of demand for that commodity – as indeed some global commodity modellers do, for lack of country-specific econometric estimates – then there is no need to know the size of those elasticities in order to estimate our GTRI and GWRI.

The next section of the article develops the theory of these indexes. We then exploit recently compiled NRA and CTE estimates in the World Bank’s global Agricultural Distortion database to generate estimates of these two new indicators for each of 28 key agricultural commodities over the past half century, based on NRA and

CTE estimates for a sample of 75 countries. The sensitivity of those estimates to our elasticity assumptions are then tested, before offering concluding observations in the final section.

Defining our trade and welfare reduction indexes

There is a growing theoretical literature that identifies ways to measure the welfare- and trade-reducing effects of international trade policy in scalar index numbers. This literature overcomes aggregation problems (across different forms of policy, and across products or countries) by using a theoretically sound aggregation procedure that answers precise questions regarding the trade and welfare reductions imposed by each country's agricultural price and trade policies. The literature has developed considerably over the past two decades, particularly with the theoretical advances by Anderson and Neary (summarized in and extended beyond their 2005 book) and the partial equilibrium simplifications by Feenstra (1995).

Notwithstanding these advances, few estimates of such indexes across countries or commodities have yet been published. A prominent exception is the work of Kee, Nicita and Olarreaga (2008, 2009) who, following the approach of Feenstra, estimate a series for developing and developed countries. However, they provide estimates across commodities for individual countries and only for a snapshot in time (the mid-2000s), and their estimates are based only on import barriers. An early country-specific study is an application to Mexican agriculture in the late 1980s (Anderson, Bannister and Neary

1995). Perhaps further applications have not been forthcoming because to date that has required the same price elasticity estimates that are needed for formal supply-demand models.

The indexes we estimate for individual commodities are well grounded in this same theory: they belong to the family of indexes first developed by Anderson and Neary (2005) under their catch-all name of trade restrictiveness indexes. As mentioned above, we label our indicators with terms that are more precise descriptors for the two indexes: a global trade reduction index and a global welfare reduction index.[1] They are computed from sub-indexes of the NRA and CTE for each commodity. While they are partial rather than general equilibrium measures,[2] they have the advantage of being more comprehensive in terms of instrument coverage (as needed when dealing with agricultural policies). They are developed for each commodity market, first for the import-competing countries and then for exporting countries.

The import-competing countries

We consider a particular good and assume it is imported into many small open economies that produce the good in a competitive market. However, the individual country markets for this importable good may be distorted by a tariff and/or other non-tariff border measures and/or behind-the-border measures such as domestic producer or consumer taxes or subsidies or quantitative price controls. The effect of those countries' policy-induced price distortions on global imports of the commodity is captured in our GTRI. This is defined as the uniform import tariff rate which, if applied to all countries in place of all actual price distortions, would result in the same reduction in the volume of imports as has resulted from the actual distortions.

Consider the market for one good, good *i*, which is affected in producing and/or consuming countries ($j = 1 \ldots n$) by a combination of policy measures that distort the consumer and producer prices of that good. For the producers of the good, the distorted domestic producer price in each country, p_{ij}^{P}, is related to the world price, p_i^*, by the relation, $p_{ij}^{P} = p_i^*(1 + s_{ij})$ where s_{ij} is the rate of distortion of the producer price in proportional terms. For the consumers of the good, the distorted domestic consumer price, p_{ij}^{C}, is related to the world price by the relation, $p_{ij}^{C} = p_i^*(1 + r_{ij})$ where r_{ij} is the rate of distortion of the consumer price in proportional terms. In general, $r_{ij} \neq s_{ij}$. Using these relations, the change in imports in the market for good *i* in country *j* is given by:

$$\Delta M_{ij} = p_i^* \Delta x_{ij} - p_i^* \Delta y_{ij}$$

$$= p_i^{*2} dx_{ij} / dp_{ij}^{C} r_{ij} - p_i^{*2} dy_{ij} / dp_{ij}^{P} s_{ij} \qquad (1)$$

where the quantities of good *i* demanded and supplied in country *j*, x_{ij} and y_{ij}, are assumed to be functions of own domestic price alone: $x_{ij} = x_{ij}(p_{ij}^{C})$ and $y_{ij} = y_{ij}(p_{ij}^{P})$, respectively. The neglect of cross-price effects, among other things, makes the analysis partial equilibrium.

Strictly speaking, this result holds only for small distortions. In reality rates of distortion are not small. If, however, the demand and supply functions are linear, the reduction in imports is given by equation 1 with dx_{ij} / dp_{ij}^{C} and dy_{ij} / dp_{ij}^{P} equal to constants. If the functions are not linear, this expression provides an approximation to the loss.

With *n* import-competing countries that together are small in the global market for good *i* and each subject to different levels of distortions, the aggregate reduction in imports for good *i*, in the absence of cross-price effects, is given by:

(2) $$\Delta M_i = \sum_{j=1}^{n} p_i^{*2} dx_{ij} / dp_{ij}^{C} r_{ij} - \sum_{j=1}^{n} p_i^{*2} dy_{ij} / dp_{ij}^{P} s_{ij}$$

However, when *n* countries together are no longer small in the global market for good *i*, this expression no longer holds, because the world price is now endogenous. In this case, in a partial-equilibrium setting, the aggregate reduction in imports in good *i* is given by equation 2 but with endogenously determined world prices (and therefore domestic prices and quantities) that would prevail when each import-competing country takes into account the distortion by each other import-competing country. In the remainder of this section, we denote with a $\tilde{}$ those prices and quantities that result once each import-competing country has taken into account the distortion in each other import-competing country. In our empirical work below (which incorporates exporting countries into the analysis) to compute the GTRI, we use real world observed prices and quantities — which are those that prevail when summing over *n* countries that together are not small in the global market for good *i* .

Setting the result of equation 2 equal to the reduction in imports from a uniform tariff, T_i, we have:

(3) $$\sum_{j=1}^{n} \tilde{p}_i^{*2} d\tilde{x}_{ij} / d\tilde{p}_{ij}^{c} r_{ij} - \sum_{j=1}^{n} \tilde{p}_i^{*2} d\tilde{y}_{ij} / d\tilde{p}_{ij}^{P} s_{ij} = \sum_{j=1}^{n} \tilde{p}_i^{*2} d\tilde{m}_{ij} / d\tilde{p}_{ij} T_i$$

where $\tilde{m}_{ij}$ is the quantity of good *i* imported in country *j*, which is a function of the import-competing price, $\tilde{p}_{ij}$.

Solving for T_i, we get

(4a) $$T_i = \{R_i a_i + S_i b_i\},$$

where

(4b) $$R_i = \left[\sum_{j=i}^{n} r_{ij} u_{ij}\right] \text{with}\, u_{ij} = \tilde{p}_i^{*2} d\tilde{x}_{ij} / d\tilde{p}_{ij}^{C} / \sum_j \tilde{p}_i^{*2} d\tilde{x}_{ij} / d\tilde{p}_{ij}^{C}$$

(4c) $$S_i = \left[\sum_{j=i}^{n} s_{ij} v_{ij}\right] \text{ with } v_{ij} = \tilde{p}_i^{*2} d\tilde{y}_{ij} / d\tilde{p}_{ij}^{P} / \sum_j \tilde{p}_i^{*2} d\tilde{y}_{ij} / d\tilde{p}_{ij}^{P}$$

and

(4d) $$a_i = \sum_j \tilde{p}_i^{*2} d\tilde{x}_{ij} / d\tilde{p}_{ij}^{C} / \sum_j \tilde{p}_i^{*2} d\tilde{m}_{ij} / d\tilde{p}_{ij}, \quad b_i = \sum_j \tilde{p}_i^{*2} d\tilde{y}_{ij} / d\tilde{p}_{ij}^{P} / \sum_j \tilde{p}_i^{*2} d\tilde{m}_{ij} / d\tilde{p}_{ij}$$

The GTRI can be regarded as a true index of average tariff rates across countries, since what is held constant is the value of imports in constant prices. R_i and S_i are indices of global average consumer and producer price distortions. They are arithmetic means across countries. Evidently, T_i can be written as a weighted average of the levels of distortion of consumer and producer prices. An important advantage of using this decomposition of the index into producer and consumer effects is that it treats correctly the effects of non-tariff measures and domestic distortions. We can deal with, and analyse, the production and consumption sides of the product market separately.

In equations 4b and 4c, the weights for each commodity are proportional to each country's marginal response of domestic production (or consumption) to changes in international free-trade prices. It might be convenient to write these weights as functions of, among other things, the domestic price elasticities (at the protected trade situation) of supply and demand (σ_{ij} and ρ_{ij}, respectively):

(5) $$u_{ij} = \rho_{ij}(\tilde{p}_i^* \tilde{x}_{ij}) / \sum_j^n \rho_{ij}(\tilde{p}_i^* \tilde{x}_{ij}) \quad \text{and} \quad v_{ij} = \sigma_{ij}(\tilde{p}_i^* \tilde{y}_{ij}) / \sum_j^n \sigma_{ij}(\tilde{p}_i^* \tilde{y}_{ij})$$

In the absence of estimates of domestic demand and supply elasticities, if we assume domestic price elasticities of supply are equal across countries for a particular commodity, and similarly for the domestic price elasticities of demand for a particular commodity, the elasticities in the numerator and denominator of equation 5 cancel. Thus we can find R_i (S_i) by aggregating the change in consumer (producer) prices across countries, using as weights the share of each country's domestic value of consumption (production) at undistorted prices. We discuss the plausibility and implications of this elasticity assumption below.

Estimating T_i in equation 4a also requires an assumption about the weights a and b (equation 4d). The weight a (b) is proportional to the ratio of the marginal response of domestic demand (supply) to a price change relative to the marginal response of imports to a price change. If we assume the marginal responses of supply and demand to a price change are the same in aggregate, then a=b=0.5.[3]

Now we turn to the measure of the effect of a commodity's distortions on global welfare, the GWRI. The derivation follows the same steps as in the derivation of the GTRI. The distortions in the market for good i in country j creates a welfare loss, L_{ij}. In partial equilibrium terms, this loss is given by the sum of the change in producer plus consumer surplus net of the tariff revenue. The loss of producer and consumer surplus is given by:

$$(6) \qquad L_{ij} = \frac{1}{2}\left\{ (p_i^* s_{ij})^2 \, dy_{ij} / dp_{ij}^P - (p_i^* r_{ij})^2 \, dx_{ij} / dp_{ij}^C \right\}$$

where the demand and the supply for good i in country j are again functions of own domestic price alone.

Strictly speaking, this result too holds only for small distortions. With non-trivial rates of distortion, the welfare losses are defined by the familiar triangular-shaped dead-weight loss areas under the demand and supply curves for the good in a small open economy. These areas can be obtained by integration. If the demand and supply functions are linear, the welfare loss is given by equation 6 where dx_{ij} / dp^C_{ij} and dy_{ij} / dp^P_{ij} are constants. If the functions are not linear, this expression provides an approximation to the loss.

In the special case where $r_{ij} = s_{ij} = t_{ij}$ (and thus $p^C_{ij} = p^P_{ij} = p_{ij}$), the expression reduces to:

(7) $$L_{ij} = -\frac{1}{2}\left\{ (p^*_i t_{ij})^2 dx_{ij} / dp_{ij} \right\}$$

Equation 7 yields the fundamental result that the loss from a tariff is proportional to the square of the tariff rate. This holds because the tariff rate determines both the price adjustment and the quantity response to this adjustment (Harberger 1959). If $r_{ij} \neq s_{ij}$, the expression in equation 6 yields the result that the consumer and the producer losses are each proportional to the square of the rate of distortion of the consumer or producer price, respectively.

With n countries (together small in the market for good *i*) applying different levels of distortions to good *i*, the welfare loss for the group of countries, in the absence of cross-price effects, is given by:

(8) $$L_i = \frac{1}{2}\left\{ \sum_{j=1}^{n} (p^*_i s_{ij})^2 dy_{ij} / dp^P_{ij} - \sum_{j=1}^{n} (p^*_i r_{ij})^2 dx_{ij} / dp^C_{ij} \right\}$$

When n countries together are no longer small in the global market for good i, we need to take account of the change in world prices induced by each country taking into account the distortions in each other country. Equilibrium prices and quantities for the global market in good i are marked with a $\tilde{}$ below.

The uniform import tariff rate, W_i, that generates a global deadweight loss identical with that of the actual distortions of different countries for good i is determined by the following equation:

$$(9) \qquad \sum_{j=1}^{n} (\tilde{p}_i^* s_{ij})^2 \, d\tilde{y}_{ij} / d\tilde{p}_{ij}^P - \sum_{j=1}^{n} (\tilde{p}_i^* r_{ij})^2 \, d\tilde{x}_{ij} / d\tilde{p}_{ij}^C = -\sum_{j=1}^{n} (\tilde{p}_i^* W_i)^2 \, d\tilde{m}_{ij} / d\tilde{p}_{ij}$$

Solving for W_i, we have:

(10a) $W_i = \{R_i'^2 a_i + S_i'^2 b_i\}^{1/2}$, where

(10b) $R_i' = \left[\sum_{j=i}^{n} r_{ij}^2 u_{ij} \right]^{1/2}$ and (10c) $S_i' = \left[\sum_{j=i}^{n} s_{ij}^2 v_{ij} \right]^{1/2}$

and u_{ij}, v_{ij}, a_i and b_i are as defined earlier.

R_i' and S_i' are measures of the average levels of consumer and producer price distortions, respectively. They are means of order two. The desired GWRI, W_i, is an appropriately weighted average of the levels of distortions of consumer and producer prices and so is also a mean of order two. As with the index T_i, we can deal thus with, and analyse, the production and consumption sides of the market separately.

As noted, the weights in the construction R_i' and S_i' and W_i (in equation 10) are the same as the weights for R_i and S_i and T_i (in equation 4) except that in the case of the GTRI we construct arithmetic means (which are the means of order one) whereas in the case of the GWRI we construct means of order two. This difference is due to the fact that the losses of import volume in each country are all proportional to the distortion rate whereas the losses of welfare are proportional to the squares of the distortions rates (compare equation 1 with equation 6).

Adding the exporting countries

The indexes can each be written also for countries exporting good *i*. In an exporting country, an export subsidy reduces welfare in the same way as an import tax in the import-competing sector, but it increases trade whereas the tariff reduces trade. As such, we keep separate track of import-competing and exporting countries for the purpose of estimating the GWRI and GTRI. This is done by extending the country set and dealing separately with import-competing countries (hereafter countries 1 to *n*) and exporting countries (hereafter countries *n+1* to *z*).

The GTRI for both importing and exporting countries can be written as an expansion of equation 4:

(11a) $$T_i = \{(R_{iM}\omega_{iPM} + R_{iX}\omega_{iPX})a_i + (S_{iM}\omega_{iCM} + S_{iX}\omega_{iCX})b_i\}$$

where a_i and b_i are as already defined, R_{iM} and S_{iM} are R_i and S_i from equations 4b and 4c, and

(11b) $$R_{iX} = \left[\sum_{j=i+n}^{z} - r_{ij} u_{ij} \right] \quad \text{and} \quad S_{iX} = \left[\sum_{j=i+n}^{z} - s_{ij} v_{ij} \right]$$

and the ω expressions are shares of the value of production and consumption for import-competing and exporting countries in goods market i at endogenously determined equilibrium prices and quantities:

(11c) $$\omega_{iPM} = \frac{\sum_{j=1}^{n} \tilde{y}_{ij} \tilde{p}_{ij}^{P}}{\sum_{j=1}^{z} \tilde{y}_{ij} \tilde{p}_{ij}^{P}}, \qquad \omega_{iPX} = (1 - \omega_{iPM}) = \frac{\sum_{j=n+1}^{z} \tilde{y}_{ij} \tilde{p}_{ij}^{P}}{\sum_{j=1}^{z} \tilde{y}_{ij} \tilde{p}_{ij}^{P}},$$

$$\omega_{iCM} = \frac{\sum_{j=1}^{n} \tilde{x}_{ij} \tilde{p}_{ij}^{C}}{\sum_{j=1}^{z} \tilde{x}_{ij} \tilde{p}_{ij}^{C}}, \text{ and } \qquad \omega_{iCX} = (1 - \omega_{iCM}) = \frac{\sum_{j=n+1}^{z} \tilde{x}_{ij} \tilde{p}_{ij}^{C}}{\sum_{j=1}^{z} \tilde{x}_{ij} \tilde{p}_{ij}^{C}}.$$

It can be seen that when including both importing and exporting countries, we continue to first aggregate for producers and consumers separately. Global producer and consumer distortions are aggregated in the last step with the assumption that the marginal responses of supply and demand to a price change are the same in aggregate (that is, $a_i = b_i = 0.5$). The aggregates in equation 11b are the weighted average levels of distortions to consumer and producer prices in the good i exporting countries, respectively, with weights u_{ij} and v_{ij} given in equation 4b and 4c. Importantly, distortions to exporting countries enter equation 11b as negative values. This is because whilst a lowering of r_{ij}

(the distortion of the consumer price of good *i* in country *j)* or s_{ij} (the distortion of the producer price of good *i* in country *j)* in the importing countries lowers the trade reduction index, a lowering of r_{ij} or s_{ij} in the exporting countries increases T_i .

The resulting GTRI measure, T_i, can be regarded as the good *i* trade tax rate which, if applied uniformly across all countries, would give the same reduction in trade as the combinations of individual country measures distorting consumer and producer prices in the importing and exporting countries.

The GWRI for import-competing and exporting countries can be written in the same form as 11a as an expansion on equation 10, where the R_i and S_i terms are the mean of order two equivalents:

$$(12) \qquad W_i = \{(R'^2_{iM}\omega_{iPM} + R'^2_{iX}\omega_{iPX})a_i + (S'^2_{iM}\omega_{iCM} + S'^2_{iX}\omega_{iCX})b_i\}^{1/2}$$

These extensions of the GTRI and the GWRI to exporting countries have precisely the same properties as the indexes for the import-competing countries. GTRIs and GWRIs can be aggregated across product groups using as weights an average of the global commodity consumption and production at undistorted prices. Indexes for the 5-year periods reported below are unweighted averages of the annual indexes.

Decomposing the GTRI and GWRI

It is possible to quantify the contribution of each country to the reduction in world trade or world welfare as measured by the GTRI or GWRI. The contribution, C_i , of each country to the reduction in world imports for good *i* comes from the decomposition of the element in square brackets in equations 4b and 4c on the consumption and production sides of the economy, respectively. There are similar decompositions for exporting countries, albeit with the positive assistance measures entering as negative contribution shares (see equation 11) for T_i because positive assistance increases rather than reduces world trade.

To bring together the import-competing and exportable sides of the market, we multiply the contributions by the overall share of imports or exports in the value of production (consumption) for each commodity:

$$(13) \qquad C_{Mi}^{P} = s_{ij} v_{ij} \omega_{iPM} \quad , \qquad C_{Xi}^{P} = -s_{ij} v_{ij} (1-\omega_{iPM})$$

$$C_{iM}^{C} = r_{ij} u_{ij} \omega_{iCM} \quad , \qquad C_{Xi}^{C} = -r_{ij} u_{ij} (1-\omega_{iCM})$$

For the GWRI, we use equation 10 to derive a similar decomposition from our data. The contributions are the same as equation 13 with the absolute value of the s_{ij} and r_{ij} terms entering as squared terms, because the GWRI is a mean of order two. To then find the overall contribution to the reduction in trade or welfare, we average the production and consumption contributions.

The World Bank's Agricultural Distortions database

A new database generated by the World Bank's Agricultural Distortions research project (Anderson and Valenzuela 2008), using a methodology summarized in Anderson et al. (2008), provides a timely opportunity to estimate GTRIs and GWRIs for individual commodity markets. The database contains consistent estimates of annual NRAs and CTEs at the commodity level, for a set of agricultural products (called covered products). These products account for around 70 percent of total agricultural production in 75 countries (called focus countries), which in turn account for 92 percent of global agricultural GDP. The data cover a time period between 1955 and 2007 for the majority of countries, but the country coverage is most complete for the years 1960 to 2004 so only those are used here. Global NRAs and CTEs for various commodities are estimated using as weights the values of production and consumption, respectively, at undistorted prices. Appendix Tables 1 and 2 report those estimates for 28 major products.

The range of measures included in the Agricultural Distortions database NRA and CTE estimates is wide. By calculating domestic-to-border price ratios the estimates include the price effects of all tariff and non-tariff trade measures, plus any domestic price support measures (positive or negative), plus an adjustment for the output-price equivalent of direct interventions in farm input markets. Where multiple exchange rates operate, an estimate of the import or export tax equivalents of that distortion are included as well.

An important feature of the World Bank dataset is that the reported prices and quantities are the endogenously determined equilibrium prices and quantities (represented by ˜ in the analysis above). This allows us to estimate GTRIs and GWRIs using observed data.

Estimates of trade and welfare reduction indexes

Table 1 reports our time series of estimated GTRIs for the 28 agricultural commodities, and for four aggregated groups of commodities (grains and tubers, oilseeds, tropical crops, and livestock products). Generally those GTRIs are somewhat above the NRAs and CTEs in Appendix Tables 1 and 2, and especially for tropical products where the trade-reducing effects of import taxes of some high-income countries are reinforced by the export taxes of some lower-income countries. By contrast, for some other products the global average GTRI is less than the NRA and CTE, reflecting the fact that export subsidies have been in place for some higher-income countries or import subsidies for some lower-income countries, which offset the trade-reducing effects of tariffs. In some cases (e.g., millet) there are even some five-year periods when the GTRI is negative, indicating that policies on net have encouraged international trade in those goods — which can be just as damaging to national and global economic welfare as policies that discourage trade.

The differences within the four groups of commodities in the extent to which their global trade has been taxed are considerable. Among the grains it is rice trade that has been taxed most since the 1970s, while among the oilseeds and tropical crops it is sesame and sugar trade, respectively, that are taxed most. Feedgrain and oilseed trade, especially the major items of maize and soybean, has been taxed least among those crops shown, and at very low rates compared with livestock products, especially milk. Note, however, that the extent of distortions to trade has diminished more for livestock products than for crops since the 1980s when agricultural price and trade reforms (as chronicled in Anderson 2009) began to be implemented in numerous countries.

In table 2 the 2000-04 GTRI estimates are disaggregated to show their production and consumption components, from which three points are worth noting. First, the production and consumption components tend to be similar in magnitude, indicating that the main policy interventions are at the national borders of countries rather than behind-the-border domestic measures. Second, for those few products for which the GTRI is negative, indicating that there is still some use of explicit or implicit trade-expanding measures, the disaggregation reveals possible reasons. In the case of cotton it is coming predominantly from pro-trade production measures (such as have operated in the United States), whereas in the case of millet and groundnuts it is coming mostly from pro-trade consumption measures (such as import subsidies in Africa at desperate times of food shortages just prior to the next harvest, when regional prices of food staples are at their highest and well above the preceding season's post-harvest price). And third, the final two columns of Table 2 confirm that countries that are importers of a product assist their producers far more than countries that export that good.

Tables 3 and 4 similarly report the GWRI estimates. These are all necessarily positive, given that they are means of order two measures. And they are substantially above the NRAs, with 5-year averages across the 28 commodities between 1960 and 2004 in the range of 50 to 80 percent compared with the 9 to 27 percent range for the NRA averages. This greater size is partly because the welfare cost is proportional to the square of the NRA, and partly because some NRAs are negative and so offset positive NRAs in the process of averaging them whereas the welfare cost of those negative and positive NRAs are additive. The most distorted among the 28 commodities in 2000-04 in terms of their global welfare cost are rice, sugar, milk, beef, poultry and cotton. Their and the other GWRIs for that period are shown in Figure 1, together with the (necessarily always lower) GTRIs.

When disaggregating those GWRIs as in Table 4, it is again clear that the sub-indicators differ little as between the production and consumption components, and that countries for which a product is an importable tend to be much greater contributors to the product's GWRI than those countries for which it is an export item. The final two columns also reveal that, among the exporting countries shown, cotton is (equal) second only to milk in terms of the size of its GWRI, thanks to the huge cotton export subsidies in the United States and the cotton export taxes of several developing countries.

Figures 2 and 3 present the country contributions to the global reduction in commodity market trade or welfare for the five most distorted farm products. The figures reveal that for some commodity markets such as rice, there are only a handful of countries whose policies are responsible for most of the global distortion, whereas for other commodities such as sugar and beef, a large number of countries' policies contribute more evenly to the reduction in global trade and welfare. Note that the country rankings are different for the two indicators though. In the global rice market, for example, India is the main contributor to the distortion to the level of trade whereas Taiwan, Japan, Vietnam and Korea are much more significant contributors to the reduction in global welfare in the rice market. This arises because the effect on GWRI of the large NRAs and CTEs of the latter four countries swamp those for India.

Sensitivity analysis

In this section we consider some important caveats, because the paper's two indexes have been calculated with the help of a number of simplifying assumptions. The most noteworthy are that each country's own-price elasticity of supply (and also of demand) for a particular product is the same as that for every other country, and that cross-price elasticities are zero. It is not uncommon for modelers of the global market for particular farm products to adopt these assumptions, for want of reliable or agreed econometric estimates of those elasticities for each country (an early global example being Valdés and Zietz 1980). Even so, these price elasticity assumptions could introduce potential biases into our GTRI and GWRI index estimates, and in either direction. So too could our assumption for simplifying the aggregation of our global producer and consumer distortion indexes, namely, that the aggregate marginal response of domestic demand to a price change is the same as the aggregate marginal response of domestic supply for the world.

To gauge the potential importance of not allowing differential price responses, we re-computed our two indexes using country- and commodity-specific own-price elasticity of supply and demand estimates available for 8 key farm products from a widely cited source (Tyers and Anderson 1992). In 2000-04 those 8 products accounted for 71 percent of the global value of production of the 28 products listed in the earlier tables. A comparison of those results, reported in Table 5, with those in Tables 1 and 3 reveals little difference in the overall indications of distortions: the averages across the 8 products using the elasticity estimates are 5 percentage points lower than our earlier estimates for one decade but between just 0 and 3 points lower for the other 7 decade averages shown. Not surprisingly the differences are largest for the product with the most diverse NRAs, namely rice, and are larger for the GTRIs than the GWRIs (because the GWRI is a mean of order two and so the weights play a less important role in the determination of its overall index). In all cases, though, the index trends over time are much the same under either set of elasticity assumptions.

Sensitivity analysis was also undertaken with respect to the assumption that the aggregate marginal response of demand to a price change is the same as the aggregate marginal supply response for the world. We did so by re-computed our two indexes assuming that demand was instead twice, or half, as responsive as supply. Despite that wide range, the estimates were almost unchanged at the aggregate level across all 29 products, and even the 5-year averages for each of the four product groups (grains, oilseeds, tropical crops and livestock) changed by no more than 2 percentage points. This benign result is due to the empirical fact that the producer and consumer distortions are similar, reflecting the dominance of border measures in the policy instrument mix.

A third type of sensitivity analysis could be to assume non-zero cross-price elasticities. This is left as an area for further research for two reasons. One is because the cross-price elasticity estimates available from Tyers and Anderson (1992) for the 8 products in Table 5 are at or near zero in most cases, and they would be very low also for the tropical perennial crop products listed in the earlier tables. Hence we do not expect it would alter the index estimates very much. The other reason is that the above algebra becomes much more complex once this simplifying assumption is dropped, in which case the analyst may as well move to a formal multi-commodity modeling framework for the subset of situations where this is considered important enough empirically. Meanwhile, as and when improved econometric estimates of price elasticity estimates become available for each country and commodity, more-accurate estimates of the GTRI and GWRI can be computed using the paper's methodology.

Conclusions

The above application of these two commodity-specific additions to the family of so-called trade restrictiveness indexes provides very different and much larger indicators of distortions to global agricultural markets than standard NRAs and CTEs (and even more so than the OECD's producer and consumer support estimates, which are expressed as a percentage of distorted rather than undistorted prices and so are smaller than their NRA and CTE counterparts). More specifically, the GTRI offers a much truer indication of the world trade effects of government interventions in the markets for particular traded products, by properly accommodating all domestic and border subsidies and taxes; and the GWRI offers a much truer indication of the global welfare effects of government interventions in the markets for traded products, by also properly taking into account the fact that the welfare cost of a price distortion is proportional to the square of the tax or subsidy rate.

With the World Bank's NRA/CTE database, which provides greater coverage in terms of commodities, countries and instruments than in any previous estimates of the extent of distortions of global agricultural markets, we have been able to reveal in which product markets the reduction in trade or the loss of welfare is greatest. These two indexes have an advantage over more-formal supply/demand models in that they can be expressed in time series form and thereby reveal trends and fluctuations over long periods, rather than just providing a snapshot at a point in time which is typical of comparative static commodity models.

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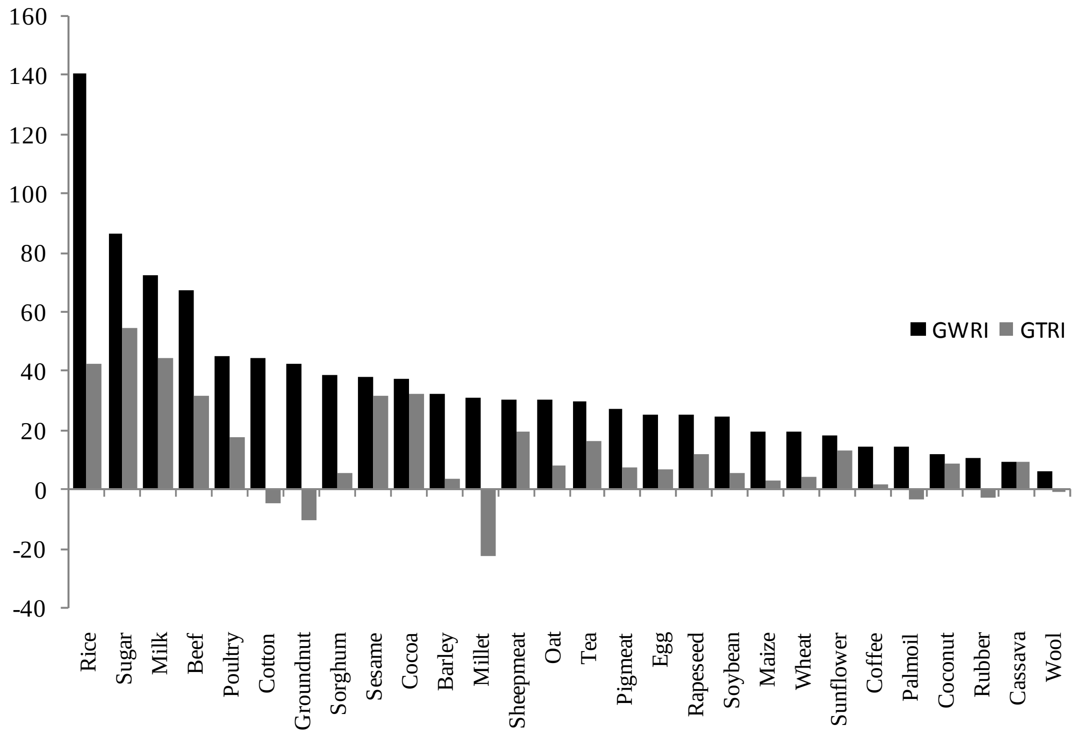

Figure 1. GTRIs and GWRIs for 28 major agricultural products, 2000-04 (percent)

Source: Authors' calculations based on NRA and CTE estimates in Anderson and Valenzuela (2008).

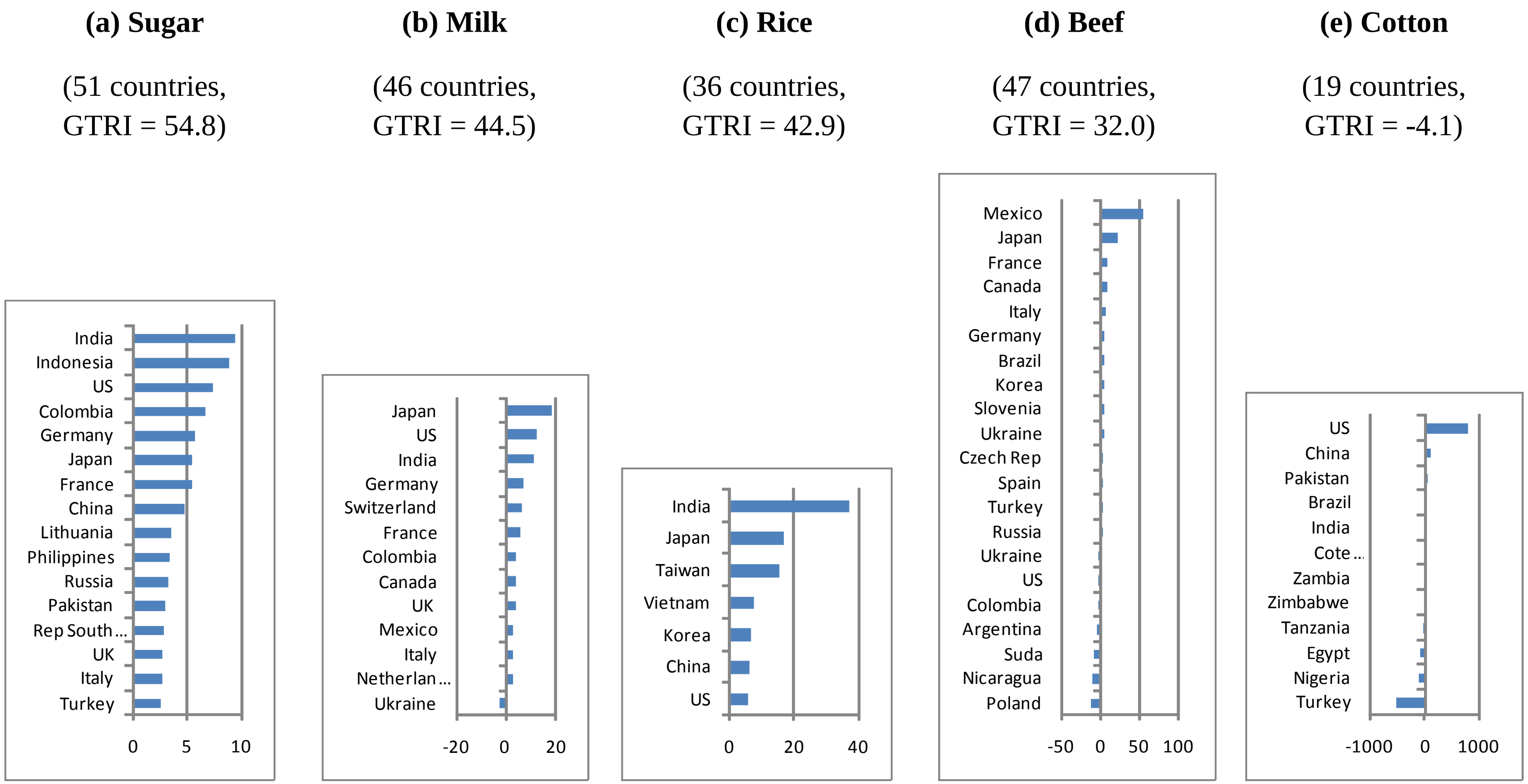

Figure 2. Country Share of the Commodity-Specific GTRI for Rice, Sugar, Beef, Cotton and Milk, 2000–04 (percent)

Source: Authors' calculations based on NRA and CTE estimates in Anderson and Valenzuela (2008).
Notes: The decomposition over the 5-year period can be greater than or less than 100, even though the decomposition sums to 100 in any one year. We have scaled the 5-year averages, so that the decompositions sum to 100 percent. Focus countries have been omitted from the above charts if their decomposition share has an absolute value of less than 2 percent.

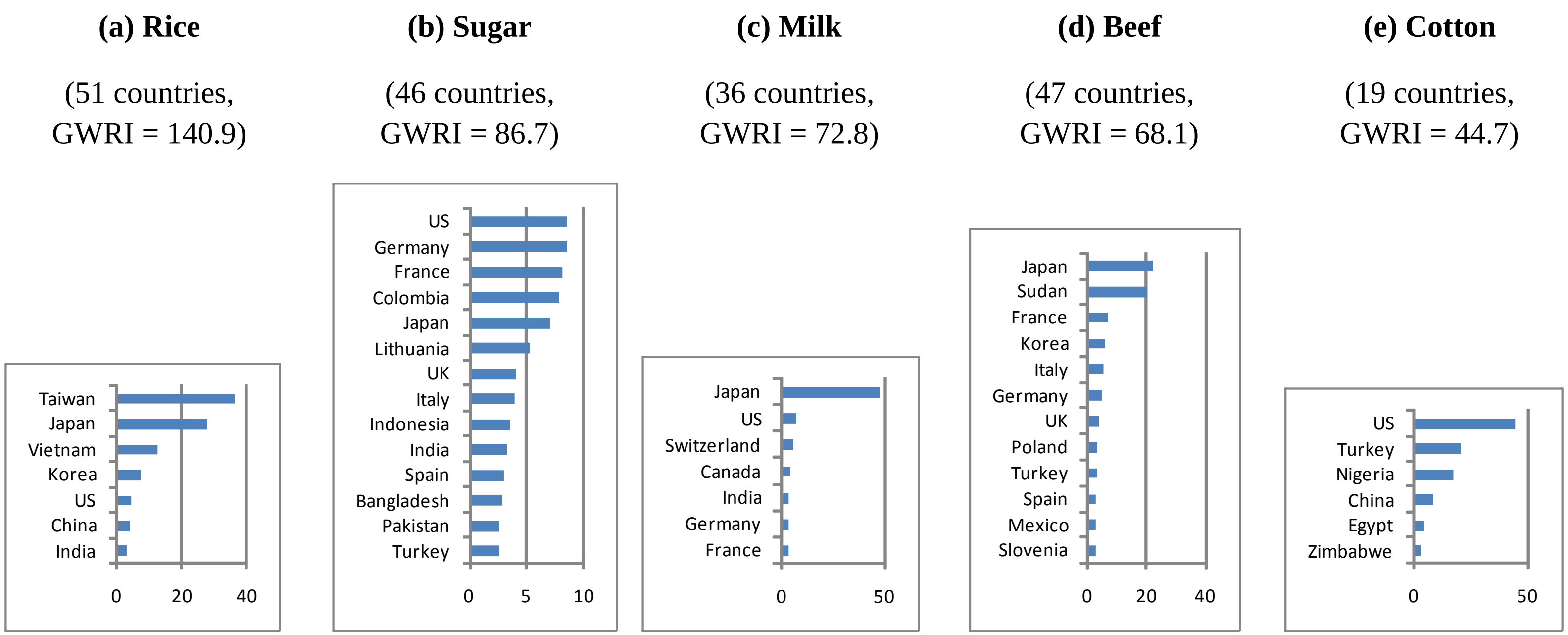

Figure 3. Country Share of the Commodity-Specific GWRI for Rice, Sugar, Milk, Beef and Cotton, 2000–04 (percent)

Source: Authors' calculations based on NRA and CTE estimates in Anderson and Valenzuela (2008).
Note: The decomposition over the 5-year period can be greater than or less than 100, even though the decomposition sums to 100 in any one year. We have scaled the 5-year averages, so that the decompositions sum to 100 percent. Focus countries have been omitted from the above charts if their decomposition share has an absolute value of less than 2 percent.

Table 1. Global Trade Reduction Indexes, by Commodity, 1960 to 2004 (percent)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Grains and tubers	**22**	**27**	**19**	**21**	**20**	**35**	**31**	**17**	**17**
Rice	49	50	58	42	41	58	53	32	43
Wheat	13	13	-1	0	9	28	20	11	4
Maize	4	8	4	9	-3	9	10	2	3
Cassava	na	na	23	0	8	15	10	13	10
Barley	36	31	3	-14	-1	36	32	10	4
Sorghum	117	55	65	42	15	24	9	18	6
Millet	67	66	29	1	-14	-31	-114	-32	-22
Oat	15	9	-8	-3	-10	-2	-2	13	9
Oilseeds	**4**	**9**	**6**	**9**	**7**	**17**	**12**	**7**	**5**
Soybean	0	1	0	6	8	11	8	6	6
Groundnut	24	17	49	33	16	38	-12	-7	-10
Palmoil	20	28	12	-5	-11	-1	14	13	-3
Rapeseed	-1	19	9	4	10	39	28	7	12
Sunflower	-8	-5	-10	-2	-12	36	21	15	13
Sesame	48	60	62	65	55	43	41	45	32
Tropical crops	**28**	**45**	**19**	**28**	**30**	**34**	**28**	**24**	**25**
Sugar	83	140	26	40	49	56	44	41	55
Cotton	9	2	13	14	1	13	4	9	-4
Coconut	29	24	8	3	12	21	35	23	9
Coffee	18	30	31	37	46	33	13	12	2
Rubber	30	33	7	19	21	17	14	-4	-3
Tea	35	36	27	26	23	22	23	20	17
Cocoa	27	40	39	53	45	30	26	27	33
Livestock products	**36**	**37**	**34**	**46**	**54**	**49**	**31**	**26**	**24**
Pigmeat	25	35	26	23	47	25	11	9	8
Milk	84	86	82	135	131	125	63	53	45
Beef	22	19	16	16	32	47	32	33	32
Poultry	21	20	27	24	24	27	27	18	18
Egg	-11	-7	-8	10	8	13	11	11	7
Sheepmeat	57	70	96	140	83	68	45	24	20
Wool	0	0	-6	-4	-7	-3	-4	0	0
All of the above 28 commodities	**29**	**32**	**24**	**31**	**34**	**40**	**29**	**21**	**20**

Source: Authors' calculations based on NRA and CTE estimates in Anderson and Valenzuela (2008).

Table 2. Components of Global Trade Reduction Indexes, 2000-04 (percent)

	Aggregate GTRI	GTRI, production component	GTRI, consumption component	Aggregate GTRI, exporting countries	Aggregate GTRI, import-competing countries
Grains and tubers	**17**	**14**	**19**	**0**	**40**
Rice	43	42	44	-1	102
Wheat	4	2	7	2	6
Maize	3	-1	7	0	11
Cassava	10	10	9	10	0
Barley	4	3	5	0	28
Sorghum	6	3	9	0	14
Millet	-22	0	-43	-22	0
Oat	9	15	3	7	6
Oilseeds	**5**	**3**	**8**	3	13
Soybean	6	2	10	**2**	**18**
Groundnut	-10	-6	-14	24	-36
Palmoil	-3	0	-7	-1	-13
Rapeseed	12	13	12	0	41
Sunflower	13	15	12	18	3
Sesame	32	39	26	32	0
Tropical crops	**25**	**23**	**28**	1	62
Sugar	55	52	58	**-23**	**74**
Cotton	-4	-7	-1	-1	-14
Coconut	9	8	10	9	0
Coffee	2	0	4	2	0
Rubber	-3	-4	-1	-3	0
Tea	17	12	21	17	0
Cocoa	33	35	31	33	0
Livestock products	**24**	**24**	**24**	-1	41
Pigmeat	8	9	7	**-1**	**18**
Milk	45	48	41	-21	53
Beef	32	29	35	7	45
Poultry	18	16	21	-1	57
Egg	7	5	9	0	16
Sheepmeat	20	19	21	4	33
Wool	0	0	0	0	12
All of the above 28 commodities	**20**	**19**	**21**	0	41

Source: Authors' calculations based on NRA and CTE estimates in Anderson and Valenzuela (2008).

Table 3. Global Welfare Reduction Indexes, by Commodity, 1960 to 2004 (percent)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Grains and tubers	**44**	**48**	**45**	**51**	**50**	**94**	**87**	**63**	**61**
Rice	66	65	86	75	75	150	152	116	141
Wheat	34	39	30	25	30	59	47	29	20
Maize	29	29	22	28	30	48	29	21	20
Cassava	na	na	23	9	11	16	10	14	10
Barley	52	49	35	41	32	97	87	45	33
Sorghum	137	89	90	76	52	56	54	39	39
Millet	68	66	34	21	32	59	126	73	31
Oat	52	72	63	105	41	67	70	33	31
Oilseeds	**9**	**16**	**16**	**20**	**28**	**37**	**34**	**24**	**24**
Soybean	4	6	10	16	28	31	27	24	25
Groundnut	29	27	52	41	38	50	50	43	43
Palmoil	21	29	36	22	23	26	55	28	15
Rapeseed	21	32	19	9	18	64	48	15	26
Sunflower	15	11	16	25	37	58	40	21	19
Sesame	48	60	62	65	56	44	47	45	38
Tropical crops	**50**	**89**	**45**	**46**	**50**	**61**	**56**	**50**	**55**
Sugar	149	222	54	66	75	100	76	77	87
Cotton	21	46	47	32	29	39	38	34	45
Coconut	29	24	12	14	19	24	38	27	12
Coffee	23	32	35	44	50	38	31	22	15
Rubber	37	39	19	25	25	20	21	26	11
Tea	43	41	32	41	39	36	35	32	30
Cocoa	28	47	42	58	51	38	36	36	38
Livestock products	**74**	**76**	**69**	**84**	**84**	**84**	**66**	**53**	**50**
Pigmeat	50	77	63	56	69	42	33	27	28
Milk	159	158	145	217	182	191	111	83	73
Beef	45	38	36	43	65	93	76	72	68
Poultry	37	34	46	43	48	48	54	46	45
Egg	45	41	31	19	21	39	36	36	26
Sheepmeat	95	129	160	192	123	107	75	41	31
Wool	0	0	6	7	11	7	10	8	6
All of the above 28 commodities	**58**	**62**	**54**	**61**	**62**	**82**	**70**	**54**	**52**

Source: Authors' calculations based on NRA and CTE estimates in Anderson and Valenzuela (2008).

Table 4. Components of Global Welfare Reduction Indexes, 2000-04 (percent)

	Aggregate GWRI	GWRI, production component	GWRI, consumption component	Aggregate GWRI, exporting countries	Aggregate GWRI, import-competing countries
Grains and tubers	**61**	**60**	**62**	**16**	**91**
Rice	141	139	142	20	215
Wheat	20	17	22	9	26
Maize	20	20	19	17	26
Cassava	10	10	9	10	0
Barley	33	31	35	10	85
Sorghum	39	39	38	35	30
Millet	31	7	43	31	0
Oat	31	41	14	25	28
Oilseeds	**24**	**28**	**20**	**14**	**44**
Soybean	25	29	19	14	51
Groundnut	43	43	43	32	48
Palmoil	15	10	18	16	13
Rapeseed	26	29	22	2	47
Sunflower	19	21	16	22	8
Sesame	38	41	35	38	0
Tropical crops	**55**	**55**	**55**	**33**	**86**
Sugar	87	87	87	47	95
Cotton	45	45	45	47	24
Coconut	12	12	12	12	0
Coffee	15	15	15	15	0
Rubber	11	13	8	11	0
Tea	30	29	32	30	0
Cocoa	38	39	36	38	0
Livestock products	**50**	**49**	**50**	**15**	**66**
Pigmeat	28	27	28	7	40
Milk	73	76	69	56	75
Beef	68	62	73	19	82
Poultry	45	44	47	13	76
Egg	26	25	27	16	36
Sheepmeat	31	30	31	22	36
Wool	6	8	4	6	22
All of the above 28 commodities	**52**	**51**	**52**	**17**	**72**

Source: Authors' calculations based on NRA and CTE estimates in Anderson and Valenzuela (2008).

Table 5: Sensitivity of Estimates of Global Trade and Welfare Reduction Indexes to Price Elasticity Estimates, 8 Major Agricultural Products, 1965 to 2004 (percent)

	GTRI, with elasticity estimates from Tyers and Anderson (1992)				GWRI, with elasticity estimates from Tyers and Anderson (1992)			
	1965-74	1975-84	1985-94	1995-2004	1965-74	1975-84	1985-94	1995-2004
Rice	44	31	38	27	66	59	113	102
Wheat	9	6	33	7	35	30	64	27
Maize	6	4	8	2	27	30	40	22
Sugar	72	38	38	38	125	63	74	69
Pigmeat	31	35	18	10	71	63	37	30
Milk	80	131	94	52	148	194	155	86
Beef	20	28	49	41	41	59	94	77
Poultry	24	24	18	6	40	46	49	56
Average, above products	**31**	**36**	**37**	**22**	**62**	**66**	**80**	**59**
	GTRI from Table 1, with simplifying elasticity assumption				**GWRI from Table 3, with simplifying elasticity assumption**			
	1965-74	1975-84	1985-94	1995-2004	1965-74	1975-84	1985-94	1995-2004
Rice	54	42	56	38	76	75	151	128
Wheat	6	4	24	7	35	28	53	24
Maize	6	3	9	2	25	29	38	21
Sugar	83	44	50	48	138	71	88	82
Pigmeat	31	35	18	9	70	62	38	27
Milk	84	133	94	49	152	200	151	78
Beef	17	24	39	33	37	54	85	70
Poultry	24	24	27	18	40	46	51	46
Average, above products	**32**	**38**	**39**	**24**	**63**	**69**	**85**	**59**
	Difference in 8-product average of GTRI estimates				**Difference in 8-product average of GWTRI estimates**			
Percentage point difference	-1	-2	-3	-2	-1	-3	-5	0
Percentage difference	-4	-6	-7	-7	-1	-5	-6	0

Sources: Authors' calculations based on NRA and CTE estimates in Anderson and Valenzuela (2008) and elasticity estimates in Tyers and Anderson (1992, Appendix Tables A2 to A4).

Appendix Table 1. Nominal Rates of Assistance of Policies Assisting Producers of 28 Covered Farm Products, All 75 Focus Countries, 1960 to 2004 (percent)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Grains and tubers	**20**	**15**	**9**	**9**	**-1**	**25**	**20**	**14**	**17**
Rice	39	6	11	12	-10	26	25	23	39
Wheat	15	22	7	2	9	30	23	12	6
Maize	4	8	5	2	-3	11	3	6	7
Cassava	0	0	-3	1	1	-1	-2	-4	-3
Barley	40	38	23	33	10	85	73	20	2
Sorghum	61	56	47	17	14	24	11	12	9
Millet	-19	-6	-4	-1	1	0	1	-3	-2
Oat	38	52	33	69	12	54	45	28	0
Oilseeds	**-3**	**2**	**-3**	**-7**	**-2**	**10**	**8**	**2**	**1**
Soybean	0	1	0	-2	-1	-2	1	7	4
Groundnut	-21	2	-14	-27	-1	34	3	-10	-14
Palmoil	-20	-24	-23	-15	-4	-5	8	-5	-3
Rapeseed	12	29	14	5	12	72	47	7	13
Sunflower	13	1	-9	-14	-23	46	19	-10	-12
Sesame	-53	-64	-65	-68	-60	-48	-46	-49	-39
Tropical crops	**1**	**22**	**-8**	**-13**	**-10**	**0**	**3**	**9**	**21**
Sugar	78	157	-4	9	15	38	28	39	60
Cotton	-10	0	9	-9	-12	-8	-10	-6	3
Coconut	-29	-24	-8	-3	-11	-19	-34	-22	-8
Coffee	-20	-31	-33	-43	-43	-31	-8	-10	0
Rubber	-16	-14	-8	-19	-19	-14	-16	5	4
Tea	-32	-31	-26	-26	-25	-24	-27	-19	-12
Cocoa	-27	-50	-45	-56	-47	-32	-32	-31	-35
Livestock products	**38**	**41**	**36**	**48**	**29**	**39**	**33**	**28**	**25**
Pigmeat	33	47	36	31	-16	-12	4	10	10
Milk	96	97	91	140	138	152	85	62	53
Beef	15	14	12	13	25	42	29	31	23
Poultry	21	20	26	26	29	20	26	20	19
Egg	-8	-3	-6	12	11	17	15	19	6
Sheepmeat	41	48	61	99	64	51	30	13	11
Wool	0	0	6	4	7	4	5	1	1
All of the above 28 commodities	**26**	**27**	**17**	**19**	**9**	**27**	**23**	**19**	**20**

Source: Anderson and Valenzuela (2008), based on NRA estimates reported in national studies covering 75 focus countries.

Note: The countries for which there are NRA (and CTE) estimates of these commodities account on average for 77 percent of global production (85 percent for grains, 74 percent for oilseeds, 74 percent for tropical crops, and 72 percent for livestock products).

Appendix Table 2. Consumer Tax Equivalents of Policies Assisting Producers of 28 Covered Farm Products, All 75 Focus Countries, 1960 to 2004 (percent)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Grains and tubers	**23**	**7**	**1**	**7**	**4**	**20**	**15**	**10**	**13**
Rice	42	-14	-11	4	1	24	25	22	38
Wheat	19	19	2	3	12	27	16	6	2
Maize	7	11	7	8	2	4	-3	-2	-2
Cassava	0	0	-1	-1	-2	-1	0	3	3
Barley	44	39	24	33	10	28	27	11	6
Sorghum	62	32	43	20	5	17	7	10	7
Millet	-15	-4	-2	0	2	3	4	6	6
Oat	39	54	33	68	11	24	17	4	-3
Oilseeds	**-4**	**-2**	**-8**	**-8**	**0**	**3**	**2**	**4**	**2**
Soybean	0	1	-3	-1	3	1	0	7	4
Groundnut	-21	-8	-20	-30	-7	26	-6	-12	-15
Palmoil	-19	-30	-35	-15	-7	-9	33	-2	-6
Rapeseed	3	13	7	5	9	13	15	5	11
Sunflower	10	1	-9	-17	-23	-2	-6	-5	-8
Sesame	-43	-56	-58	-61	-51	-38	-36	-40	-26
Tropical crops	**28**	**56**	**-2**	**-2**	**-1**	**11**	**19**	**15**	**27**
Sugar	116	175	1	13	19	38	42	44	63
Cotton	-8	0	3	-12	-15	-11	-18	-11	-6
Coconut	-29	-24	-9	-3	-12	-22	-36	-25	-10
Coffee	-16	-30	-30	-32	-49	-35	-18	-14	-4
Rubber	-43	-52	-6	-19	-23	-19	-11	2	1
Tea	-38	-41	-28	-26	-21	-21	-19	-21	-21
Cocoa	-28	-29	-33	-50	-43	-29	-19	-22	-31
Livestock products	**41**	**43**	**37**	**49**	**31**	**39**	**28**	**26**	**24**
Pigmeat	34	47	35	30	-12	-11	0	7	8
Milk	96	98	89	137	130	139	69	54	46
Beef	19	16	14	16	25	46	30	36	31
Poultry	24	23	28	27	28	17	21	18	19
Egg	-6	-1	-6	11	8	17	15	17	8
Sheepmeat	64	77	107	161	94	70	39	19	19
Wool	0	0	6	4	6	2	4	1	0
All of the above 28 commodities	**32**	**26**	**15**	**23**	**15**	**26**	**21**	**18**	**19**

Source: Anderson and Valenzuela (2008), based on CTE estimates reported in national studies covering 75 focus countries.

Appendix Table 3. Elasticities of Supply, 8 key Covered Products, Focus Countries

	Beef	Maize	Milk	Pig-meat	Poul-try	Rice	Soy-bean	Sugar	Wheat
Bangladesh	na	na	na	na	na	0.74	na	0.51	0.67
China	na	0.16	0.80	0.60	0.60	0.12	na	0.88	0.10
India	na	0.21	0.15	na	na	0.29	na	0.46	0.41
Indonesia	na	0.22	na	na	1.00	0.30	na	0.59	na
Korea	0.50	na	0.80	0.85	0.85	0.14	na	na	0.55
Malaysia	na	na	na	na	na	0.08	na	na	na
Pakistan	na	0.19	0.34	na	na	0.07	na	0.13	0.16
Philippines	0.50	0.40	na	1.04	1.04	0.26	na	0.68	na
Sri Lanka	na	na	na	na	na	0.50	na	na	na
Taiwan	0.50	na	0.60	0.93	0.93	0.28	na	na	0.49
Thailand	na	0.46	na	0.91	0.91	0.40	na	1.50	na
Vietnam	na	na	na	3.12	3.12	0.08	na	0.20	na
Cameroon	na	0.40	na	na	na	na	na	na	na
Cote d'Ivoire	na	na	na	na	na	0.50	na	na	na
Egypt	0.72	0.63	0.80	na	na	0.20	na	0.32	1.08
Ethiopia	na	0.40	na	na	na	na	na	na	0.50
Ghana	na	0.40	na	na	na	0.50	na	na	na
Kenya	na	0.40	na	na	na	na	na	0.51	0.50
Madagascar	na	0.40	na	na	na	0.50	na	0.51	na
Mozambique	na	0.40	na	na	na	0.50	na	0.51	na
Nigeria	na	0.22	na	na	na	0.31	na	na	na
South Africa	0.72	0.60	na	na	1.11	na	na	0.30	0.66
Senegal	na	na	na	na	na	0.50	na	na	na
Sudan	0.60	na	0.60	na	na	na	na	0.51	0.50
Tanzania	na	0.40	na	na	na	0.50	na	0.51	0.50
Uganda	na	0.40	na	na	na	0.50	na	0.51	na
Zambia	na	0.40	na	na	na	0.50	na	na	0.50
Zimbabwe	na	0.40	na	na	na	na	na	na	0.50
Argentina	0.72	0.60	0.40	na	na	na	na	na	0.88
Brazil	0.80	0.90	na	0.91	0.91	0.75	na	0.80	0.90
Chile	0.60	0.59	0.30	na	na	na	na	0.59	0.63
Colombia	0.60	0.59	0.30	na	na	0.40	na	0.59	0.63
Dominican Rep.	na	na	na	na	1.00	0.40	na	0.59	na
Ecuador	0.60	0.59	0.30	1.00	1.00	0.40	na	0.59	na
Mexico	0.46	0.60	0.50	0.90	0.90	0.93	na	0.45	0.84
Nicaragua	0.60	0.59	0.30	na	1.00	0.40	na	0.59	na

Continued over

	Beef	Maize	Milk	Pig-meat	Poul-try	Rice	Soy-bean	Sugar	Wheat
Bulgaria	0.30	0.14	0.21	0.77	0.77	na	na	0.08	0.08
Czech Rep.	0.30	na	0.21	0.77	0.77	na	na	0.08	0.08
Estonia	0.30	na	0.21	0.77	0.77	na	na	na	0.08
Hungary	0.30	0.14	0.21	0.77	0.77	na	na	0.08	0.08
Kazakhstan	0.30	na	0.21	0.77	na	na	na	0.08	0.08
Latvia	0.30	na	0.21	0.77	0.77	na	na	0.08	0.08
Lithuania	0.30	na	0.21	0.77	0.77	na	na	0.08	0.08
Poland	0.30	0.14	0.21	0.77	0.77	na	na	0.08	0.08
Romania	0.30	0.14	0.21	0.77	0.77	na	na	0.08	0.08
Russia	0.52	0.27	0.30	1.12	1.12	na	na	0.21	0.18
Slovakia	0.30	0.14	0.21	0.77	0.77	na	na	0.08	0.08
Slovenia	0.30	0.14	0.21	0.77	0.77	na	na	0.08	0.08
Turkey	0.30	0.14	0.21	na	0.77	0.40	na	0.08	0.08
Ukraine	0.30	0.14	0.21	0.77	0.77	na	na	0.08	0.08
Australia	0.27	0.60	0.58	1.09	1.09	0.33	na	0.50	0.88
Austria	1.02	0.92	0.51	1.14	1.14	na	na	0.50	0.90
Canada	0.60	0.68	0.50	0.89	0.89	na	na	na	0.53
Denmark	1.02	na	0.51	1.14	1.14	na	na	0.50	0.90
Finland	1.02	na	0.51	1.14	1.14	na	na	0.50	0.90
France	1.02	0.92	0.51	1.14	1.14	0.40	na	0.50	0.90
Germany	1.02	0.92	0.51	1.14	1.14	na	na	0.50	0.90
Iceland	0.69	na	0.51	1.50	1.50	na	na	na	na
Ireland	1.02	na	0.51	1.14	1.14	na	na	0.50	0.90
Italy	1.02	0.92	0.51	1.14	1.14	0.40	na	0.50	0.90
Japan	0.80	na	0.80	0.99	0.99	0.20	na	0.50	0.60
Netherlands	1.02	0.92	0.51	1.14	1.14	na	na	0.50	0.90
New Zealand	0.20	0.60	0.61	0.60	0.60	na	na	na	0.93
Norway	0.69	na	0.51	1.50	1.50	na	na	na	0.90
Portugal	0.70	0.90	0.39	0.99	0.99	0.40	na	0.70	0.91
Spain	0.70	0.90	0.39	0.99	0.99	0.40	na	0.70	0.91
Sweden	1.02	na	0.51	1.14	1.14	na	na	0.50	0.90
Switzerland	0.69	0.91	0.51	1.50	1.50	na	na	0.32	0.90
UK	1.02	na	0.51	1.14	1.14	na	na	0.50	0.90
US	0.72	0.75	0.85	1.12	1.12	0.75	na	0.28	0.80

Source: Tyers and Anderson (1992, Appendix Tables A2 to A4).

Appendix Table 4. Elasticities of Demand, 8 key Covered Products, Focus Countries

	Beef	Maize	Milk	Pig-meat	Poultry	Rice	Soy-bean	Sugar	Wheat
Bangladesh	na	na	na	na	na	-0.30	na	-1.00	-0.40
China	na	-0.30	-2.00	-1.00	-1.00	-0.20	na	-1.50	-0.30
India	na	-0.35	-1.00	na	na	-0.40	na	-0.80	-0.40
Indonesia	na	-0.35	na	na	-1.40	-0.51	na	-1.20	na
Korea	-1.20	na	-0.80	-1.50	-1.50	-1.18	na	na	-0.36
Malaysia	na	na	na	na	na	-0.20	na	na	na
Pakistan	na	-0.35	-1.00	na	na	-0.35	na	-1.00	-0.40
Philippines	-0.80	-0.25	na	-0.50	-0.50	-0.42	na	-1.40	na
Sri Lanka	na	na	na	na	na	-0.20	na	na	na
Taiwan	-1.50	na	-1.00	-0.80	-0.80	-0.20	na	na	-0.36
Thailand	na	-0.40	na	-1.40	-1.40	-0.05	na	-0.70	na
Vietnam	na	na	na	-1.40	-1.40	-0.20	na	-1.00	na
Cameroon	na	-0.85	na	na	na	na	na	na	na
Cote d'Ivoire	na	na	na	na	na	-0.90	na	na	na
Egypt	-1.30	-0.50	-0.80	na	na	-0.60	na	-0.80	-0.65
Ethiopia	na	-0.85	na	na	na	na	na	na	-1.20
Ghana	na	-0.85	na	na	na	-0.90	na	na	na
Kenya	na	-0.85	na	na	na	na	na	-0.80	-1.20
Madagascar	na	-0.85	na	na	na	-0.90	na	-0.80	na
Mozambique	na	-0.85	na	na	na	-0.90	na	-0.80	na
Nigeria	na	-0.80	na	na	na	-0.61	na	na	na
South Africa	-1.00	-0.30	na	na	-1.20	na	na	-0.60	-0.30
Senegal	na	na	na	na	na	-0.90	na	na	na
Sudan	-1.40	na	-0.80	na	na	na	na	-0.80	-1.20
Tanzania	na	-0.85	na	na	na	-0.90	na	-0.80	-1.20
Uganda	na	-0.85	na	na	na	-0.90	na	-0.80	na
Zambia	na	-0.85	na	na	na	-0.90	na	na	-1.20
Zimbabwe	na	-0.85	na	na	na	na	na	na	-1.20
Argentina	-0.40	-0.50	-0.80	na	na	na	na	na	-0.30
Brazil	-0.70	-0.70	na	-0.90	-0.90	-0.70	na	-0.60	-0.30
Chile	-0.80	-0.40	-0.80	na	na	na	na	-0.60	-0.45
Colombia	-0.80	-0.40	-0.80	na	na	-0.70	na	-0.60	-0.45
Dominican Rep.	na	na	na	na	-1.00	-0.70	na	-0.60	na
Ecuador	-0.80	-0.40	-0.80	-1.00	-1.00	-0.70	na	-0.60	na
Mexico	-1.16	-0.85	-0.50	-1.20	-1.20	-0.50	na	-0.85	-0.35
Nicaragua	-0.80	-0.40	-0.80	na	-1.00	-0.70	na	-0.60	na

Continued over

	Beef	Maize	Milk	Pig-meat	Poultry	Rice	Soy-bean	Sugar	Wheat
Bulgaria	-0.50	-0.20	0.00	-0.75	-0.75	na	na	-0.80	-0.20
Czech Rep.	-0.50	na	0.00	-0.75	-0.75	na	na	-0.80	-0.20
Estonia	-0.50	na	0.00	-0.75	-0.75	na	na	na	-0.20
Hungary	-0.50	-0.20	0.00	-0.75	-0.75	na	na	-0.80	-0.20
Kazakhstan	-0.50	na	0.00	-0.75	na	na	na	-0.80	-0.20
Latvia	-0.50	na	0.00	-0.75	-0.75	na	na	-0.80	-0.20
Lithuania	-0.50	na	0.00	-0.75	-0.75	na	na	-0.80	-0.20
Poland	-0.50	-0.20	0.00	-0.75	-0.75	na	na	-0.80	-0.20
Romania	-0.50	-0.20	0.00	-0.75	-0.75	na	na	-0.80	-0.20
Russia	-0.30	-0.15	-0.50	-0.70	-0.70	na	na	-0.10	-1.00
Slovakia	-0.50	-0.20	0.00	-0.75	-0.75	na	na	-0.80	-0.20
Slovenia	-0.50	-0.20	0.00	-0.75	-0.75	na	na	-0.80	-0.20
Turkey	-0.50	-0.20	0.00	na	-0.75	-0.70	na	-0.80	-0.20
Ukraine	-0.50	-0.20	0.00	-0.75	-0.75	na	na	-0.80	-0.20
Australia	-0.63	-0.30	-0.20	-1.00	-1.00	-0.40	na	-0.18	-0.15
Austria	-0.60	-0.20	-0.40	-0.90	-0.90	na	na	-0.12	-0.30
Canada	-0.65	-0.20	-0.40	-0.75	-0.75	na	na	na	-0.18
Denmark	-0.60	na	-0.40	-0.90	-0.90	na	na	-0.12	-0.30
Finland	-0.60	na	-0.40	-0.90	-0.90	na	na	-0.12	-0.30
France	-0.60	-0.20	-0.40	-0.90	-0.90	-0.80	na	-0.12	-0.30
Germany	-0.60	-0.20	-0.40	-0.90	-0.90	na	na	-0.12	-0.30
Iceland	-0.70	na	-0.20	-0.70	-0.70	na	na	na	na
Ireland	-0.60	na	-0.40	-0.90	-0.90	na	na	-0.12	-0.30
Italy	-0.60	-0.20	-0.40	-0.90	-0.90	-0.80	na	-0.12	-0.30
Japan	-1.00	na	-0.80	-1.40	-1.40	-0.18	na	-0.05	-0.60
Netherlands	-0.60	-0.20	-0.40	-0.90	-0.90	na	na	-0.12	-0.30
New Zealand	-0.60	-0.15	-0.20	-0.80	-0.80	na	na	na	-0.15
Norway	-0.70	na	-0.20	-0.70	-0.70	na	na	na	-0.42
Portugal	-0.90	-0.30	-0.60	-0.70	-0.70	-0.50	na	-0.24	-0.42
Spain	-0.90	-0.30	-0.60	-0.70	-0.70	-0.50	na	-0.24	-0.42
Sweden	-0.60	na	-0.40	-0.90	-0.90	na	na	-0.12	-0.30
Switzerland	-0.70	-0.73	-0.20	-0.70	-0.70	na	na	-0.12	-0.42
UK	-0.60	na	-0.40	-0.90	-0.90	na	na	-0.12	-0.30
US	-0.50	-0.20	-0.30	-0.80	-0.80	-0.20	na	-0.20	-0.12

Source: Tyers and Anderson (1992, Appendix Tables A2 to A4).

[1] The Anderson and Neary (2005) trade restrictiveness index for a country (which they call a TRI) is similar to our GWRI measure for a global commodity market, while their mercantilist trade restrictiveness index (MTRI) for a country is similar to our GTRI measure for a global commodity market. Neither the measures in this paper, nor those in Anderson and Neary's work, are indexes in the true sense of the word but rather uniform welfare- or trade-equivalent tariffs which allow for a theoretically correct ranking of the aggregate welfare- and trade-distorting effects of different policies across countries or across commodity markets.

[2] That is, we ignore indirect effects of sectoral and trade policy measures directed at non-agricultural sectors. We also adopt the standard assumptions in basic trade theory that there are no divergences between private and social marginal costs and benefits that might arise from externalities, market failures, and any other behind-the-border policies not represented in our analysis, including such things as underinvestment in public goods.

[3] With linear demand and supply curves for a global commodity market in aggregate, this equates to an assumption that the aggregate demand and supply curves have the same slope, so that each side of the market contributes equally to the GTRI.