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

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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. Hence a weighted average across countries of nominal rates of assistance or consumer tax equivalents for a product can be misleading as an indicator of the trade or welfare effects of policies affecting that product's global market. This is especially the case when some countries tax and others subsidize its production or consumption. This article develops a new set of more-satisfactory indicators for that purpose, drawing on the recent literature on trade restrictiveness indexes. It then exploits a global agricultural distortions database recently compiled by the World Bank to generate the first set of estimates of 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. These reveal the considerable extent of reforms in agricultural policies of developing as well as high-income countries over the past two decades.

This paper—a product of the Trade Team, Development Research Group—is part of a larger effort in the department to better understand trends in policy distortions to agricultural incentives globally. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at kym.anderson@adelaide.edu.au or via wmartin1@worldbank.org.

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

For decades the world's agricultural markets have been highly distorted by national government policies, but very differently for different commodities and countries. To compare across countries, it is common to calculate weighted averages of nominal rates of assistance (NRAs) or consumer tax equivalents (CTEs) of those policies across all agricultural products. Those national averages vary considerably across countries, and tend to be high for high-income countries (OECD 2008) and lower or even negative for developing countries (Krueger, Schiff and Valdes 1988).

An alternative way of examining global distortions to consumer and producer prices in agricultural commodity markets is to compare across products. There are at least three reasons as to why 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. 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 that drove a wedge between the producer and consumer domestic price of a farm product. Second, it is not a country's share of world production or consumption but rather the share of world trade that influences the trade effect of price-distorting policies. And third, 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.

These issues would not be a problem if there was a global model of each commodity market (or a global economy wide computable general equilibrium (CGE) model) calibrated for a particular year of interest, since the NRA and CTE estimates for that product could be inserted in such a model to generate partial (or general) equilibrium estimates of the global trade and welfare effects of those distortionary policies in that year. However, global models do not exist for many commodities, and global CGE models typically have to aggregate many of the smaller commodities into groups to keep the model tractable. Moreover, such models are calibrated to a particular year and so are incapable of providing a long time series of estimates of the global trade and welfare effects of distortionary policies affecting particular commodity markets.

The purpose of the present article is to draw on the recently developed literature on trade restrictiveness indexes to provide a more-satisfactory set of indicators of global trade and welfare effects of distortionary commodity policies. The article begins by drawing on the recent literature on the family of trade restrictiveness indexes (TRIs) to develop two new members of that family for individual global commodity markets. The previous 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. The first of the new indexes refers to the volume of trade: it is the ad valorem import tax/export tax rate which, if applied uniformly to that commodity in every country that year would generate the same reduction in trade as the actual structure across countries of NRAs and CTEs for that commodity. The second of the new indexes refers to the partial equilibrium global welfare cost: it is the ad valorem trade tax rate which, if applied uniformly to that commodity in every country that year would generate the same reduction in global economic welfare as the actual structure across countries of NRAs and CTEs for that tradable commodity.

To distinguish the indexes from indexes developed previously, we give these indexes the more-precise descriptive names of the trade reduction index (TRI) and the welfare reduction index (WRI). We show that, if one is willing to assume that the domestic elasticities of supply are equal across countries for a particular commodity, and likewise for the price elasticities of demand for that commodity (as indeed many global commodity modelers 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 TRI and WRI.[1]

Following the theoretical part of the article, we then exploit the recently compiled NRA and CTE estimates in the World Bank's global Agricultural Distortion database to generate estimates of these new indicators for each of 28 key agricultural commodities over the past half century (whose combined share of global agricultural production was 56 percent in 2000-04), based on NRA and CTE estimates for a sample of 75 countries

[1] The analysis follows the same steps as in Lloyd, Croser and Anderson (2009). That paper presents estimates of the reduction in imports and the welfare loss across agricultural commodity markets for individual countries and regions. The present paper, by contrast, focuses on the reduction in imports and the welfare loss across countries for individual commodity markets.

that together account for more than three-quarters of the world's production of those agricultural commodities. The commodity markets examined comprise 7 grains plus cassava, 6 oilseeds, 7 other tropical crops including cotton and sugar, and 7 livestock products. These are the first systematic estimates of such indicators of the effects of producer assistance and consumer taxes/subsidies in agricultural markets on global trade and welfare. Some concluding observations are provided in the final section of the article.

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 series of consistently estimated indexes have yet been estimated across countries or commodities. 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 early 2000s), and their estimates are based only on import barriers. Other studies have been country specific, such as an application to Mexican agriculture in the late 1980s (Anderson and Bannister 1992).

The indexes we estimate for individual commodities are well grounded in this theory: they belong to the family of indexes first developed by Anderson and Neary (2005) under their catch-all name of trade restrictiveness indexes. To avoid confusion with previous measures, we coin terms that are more precise descriptors for the two indexes we define: a trade reduction index (TRI) and a welfare reduction index (WRI). The TRI and WRI are computed from sub-indexes of the NRA and CTE for each commodity. While these versions are less general than the Anderson and Neary indexes, in that they are partial rather than general equilibrium measures,[2] they have the advantage of being more comprehensive in terms of instrument coverage. They are developed for each commodity market, first for the import-competing countries and then for exporting countries.

The import-competing countries

[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.

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 consumers taxes or subsidies or quantitative price controls. The effect of those countries policy induced price distortions on the global import volume of the commodity is captured in our commodity-specific TRI. 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 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 percentage 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 percentage 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 sum of the areas of two rectangles

(1) $$\Delta M_{ij} = p_{ij}^{*} dx_{ij} - p_{ij}^{*} dy_{ij}$$

$$= p_{ij}^{*2} dx_{ij} / dp_{ij}^{c} r_{ij} - p_{ij}^{*2} dy_{ij} / dp_{ij}^{P} s_{ij}$$

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 makes the analysis partial equilibrium.

Strictly speaking, this result holds only for small distortions. In reality rates of distortion are not small. If, however, we assume that the demand and supply functions are linear, the reduction in imports is:

(2) $$\Delta M_{ij} = p_{ij}^{*2} dx_{ij} / dp_{ij}^{c} r_{ij} - p_{ij}^{*2} dy_{ij} / dp_{ij}^{P} s_{ij}$$

with $dx_{ij} / dp_{ij}^{C} = const.$ and $dy_{ij} / dp_{ij}^{P} = const.$

If the functions are not linear, this expression provides an approximation to the loss.

With *n* import-competing countries subject to different levels of distortions, the aggregate reduction in imports for good *i* in all countries, in the absence of cross-price effects, is given by:

(3) $$\Delta M_{iW} = \sum_{j=1}^{n} p_{ij}^{*2} dx_{ij} / dp_{ij}^{c} r_{ij} - \sum_{j=1}^{n} p_{ij}^{*2} dy_{ij} / dp_{ij}^{P} s_{ij}$$

Setting the result equal to the reduction in imports from a uniform tariff for good *i*, T_i, we have

$$\sum_{j=1}^{n} p_{ij}^{*2} dx_{ij} / dp_{ij}^{c} r_{ij} - \sum_{j=1}^{n} p_{ij}^{*2} dy_{ij} / dp_{ij}^{P} s_{ij} = \sum_{j=1}^{n} p_{ij}^{*2} dm_{ij} / dp_{ij} T_i$$

Solving for T_i, we get

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

(4b) $R_i = \left[\sum_{j=i}^{n} r_{ij} u_{ij} \right]$ with $u_{ij} = p_{ij}^{*2} dx_{ij} / dp_{ij}^{C} / \sum_{j} p_{ij}^{*2} dx_{ij} / dp_{ij}^{C}$

(4c) $S_i = \left[\sum_{j=i}^{n} s_{ij} v_{ij} \right]$ with $v_{ij} = p_{ij}^{*2} dy_{ij} / dp_{ij}^{P} / \sum_{j} p_{ij}^{*2} dy_{ij} / dp_{ij}^{P}$ and

(4d) $a_i = \sum_{j} p_{ij}^{*2} dx_{ij} / dp_{ij}^{C} / \sum_{j} p_{ij}^{*2} dm_{ij} / dp_{ij}$

$b_i = \sum_{j} p_{ij}^{*2} dy_{ij} / dp_{ij}^{P} / \sum_{j} p_{ij}^{*2} dm_{ij} / dp_{ij}$

The commodity-specific TRI 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 and S are indices of average consumer and producer price distortions. They are arithmetic means.

Evidently, T can be written as a weighted average of the level of distortions 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 economy 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. These weights can be written as functions of the domestic price elasticities of supply (demand) and the value of domestic production (consumption) at undistorted prices:

(5) $$u_{ij} = \rho^*_{ij}(p^*_{ij}x_{ij}) / \sum_j^n \rho^*_{ij}(p^*_{ij}x_{ij})$$

$$v_{ij} = \sigma^*_{ij}(p^*_{ij}y_{ij}) / \sum_j^n \rho^*_{ij}(p^*_{ij}y_{ij})$$

If, further, we assume domestic price elasticities of supply (demand) are equal across countries for a particular commodity, the elasticities in the numerator and denominator 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.

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 global demand and supply curves have the same slope at the free trade points, then a=b=0.5.

As a special case, if $r_{ij} = s_{ij}$ for all i, that is, if tariff rates are the only distortion, equation (4) reduces to a much simpler form:

(6) $$T_i = \sum_{j=1}^{n} t_{ij} w_{ij} \qquad w_{ij} = \varepsilon_{ij}(p_{ij}^{*} m_{ij}^{*}) / \sum_{j=1}^{n} \varepsilon_{ij}(p_{ij}^{*} m_{ij}^{*})$$

Here t_{ij} is the ad valorem tariff rate for good i in country n, which is equal to the rate of distortion of both consumer and producer prices, and ε_{ij} is the corresponding elasticity of import demand. T_i is the mean of the tariff rates for the import-competing countries. This case can be used to obtain an alternative expression for the general case for the commodity-specific TRI. This alternative form requires computing an import-equivalent tariff rate for each tariff item when there is some distortion other than an ad valorem tariff and using this in place of t_{ij} in equation (6). (See Lloyd, Croser and Anderson 2009 for this concept.) This is a simpler expression than that in equation (4) above but we use the equation (4) method because the data come in the form of separate estimates of the rates of distortion of consumer and producer prices.

Now we turn to the measure of the effect of a commodity's distortions on global welfare, the commodity-specific WRI. The derivation follows the same steps as in the derivation of the commodity-specific TRI. 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 simply by the areas of the two triangles

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

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-small rates of distortion, the welfare losses are defined by the triangular-shaped areas under the demand and supply curves for the good. These areas can be obtained by integration. On the assumption that the demand and supply functions are linear, the welfare loss is again the sum of two triangles:

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

with $dy_{ij}/dp_{ij} = const.$ and $dx_{ij}/dp_{ij} = const.$

If the functions are not linear, this expression provides an approximation to the loss. In the special case where $r_{ij} = s_{ij} = t_{ij}$, the expression reduces to

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

Equation (9) 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 (9) 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 applying different levels of distortions to good *i*, the global welfare loss from distortion to good *i*, in the absence of cross-price effects in all markets, is given by:

(10) $$L_i = \frac{1}{2}\left\{\sum_{j=1}^{n}\left(p_{ij}^{*}s_{ij}\right)^{2} dy_{ij}/dp_{ij}^{P} - \sum_{j=1}^{n}\left(p_{ij}^{*}r_{ij}\right)^{2} dx_{ij}/dp_{ij}^{C}\right\}$$

The uniform import tariff rate that generates a global deadweight loss identical with that of the different country tariffs is determined by the following equation:

(11) $$\sum_{j=1}^{n}\left(p_{ij}^{*}s_{ij}\right)^{2} dy_{ij}/dp_{ij}^{P} - \sum_{j=1}^{n}\left(p_{ij}^{*}r_{ij}\right)^{2} dx_{ij}/dp_{ij}^{C} = -\sum_{j=1}^{n}\left(p_{ij}^{*}W_i\right)^{2} dm_{ij}/dp_{ij}$$

W_i is the uniform tariff which, if applied to good *i* in all countries in place of the actual tariffs and other price distortions, would result in the same aggregate loss of global welfare as the actual distortions. Solving for W_i, we have:

(12a) $$W_i = \{R_i^{'2}a_i + S_i^{'2}b_i\}^{1/2}$$, where

(12b) $$R_i^{'} = \left[\sum_{j=i}^{n} r_{ij}^{2}u_{ij}\right]^{1/2} \text{ with } u_{ij} = p_{ij}^{*2}dx_{ij}/dp_{ij}^{C} / \sum_j p_{ij}^{*2}dx_{ij}/dp_{ij}^{C}$$

(12c) $$S_i^{'} = \left[\sum_{j=i}^{n} s_{ij}^{2}v_{ij}\right]^{1/2} \text{ with } v_{ij} = -p_{ij}^{*2}dy_{ij}/dp_{ij}^{P} / \sum_j p_{ij}^{*2}dy_{ij}/dp_{ij}^{P}$$, and

(12d) $$a_i = \sum_j p_{ij}^{*2}dx_{ij}/dp_{ij}^{C} / \sum_j p_{ij}^{*2}dm_{ij}/dp_{ij}$$

$$b_i = \sum_j p_{ij}^{*2}dy_{ij}/dp_{ij}^{P} / \sum_j p_{ij}^{*2}dm_{ij}/dp_{ij}$$

W_i is the desired commodity-specific Welfare Reduction Index. R_i' and S_i' are measures of the average levels of consumer and producer price distortions, respectively. They are means of order two. In the empirical section, R_i' and S_i' are referred to as the Producer Distortion Index (PDI) and the Consumer Distortion Index (CDI).

Evidently, W_i can be written as an appropriately weighted average of the level of distortions of consumer and producer prices. It too is a mean of order two. As with the index T_i, we can deal with, and analyse, the production and consumption sides of the economy separately.

Comparing the expression for the WRI in equation (12) with that for the TRI in equation (4), we see that the weights in the construction of the R_i' and S_i' and W_i are the same as the weights for R_i and S_i and T_i. The only difference in the expressions for R_i' and S_i' and W_i is that, in the case of the TRI, one constructs arithmetic means (which are the means of order one) whereas in the case of the WRI one constructs means of order two.[3] This difference is all 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 (8)). The tariff rate enters only once in the determination of the import loss, in the base of the rectangle, whereas the tariff rate enters twice in the determination of the welfare loss, once in the base of the triangle and once in its height.

[3] Anderson and Neary (2005, p.21) note that the expressions for their measures of trade restriction and welfare reduction for individual countries use the same weights.

In the special case where $r_{ij} = s_{ij} = t_{ij}$ for all i and all j, equation (12) reduces to a much simpler form:

$$(13) \qquad W_i = \left[\sum_{j=1}^{n} t_{ij} w_{ij} \right]^{1/2} \qquad w_{ij} = \varepsilon_{ij} (p_{ij}^* m_{ij}^*) / \sum_{j=1}^{n} \varepsilon_{ij} (p_{ij}^* m_{ij}^*)$$

Further, if we assume that the elasticities of import demand for good i are equal in all countries, the weights are the share of imports of good i of each country in total imports of good i. This case can be used to obtain an alternative expression of the general case of the commodity WRI.

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. It is necessary to keep track of producers and consumers in import and export countries separately for the purpose of estimating the full global commodity-specific WRI and commodity-specific TRI. This is done by extending the country set and keeping separate track of the importing and exporting countries.

As one example, the commodity-specific WRI for both importing countries (countries *1* to n) and exporting countries (countries $n+1$ to z) can be written as an expansion of equation (12):

(14a) $$W_i = \{(R_{iM}^{'2}\omega_{iPM} + R_{iX}^{'2}\omega_{iPX})a_i + (S_{iM}^{'2}b_{iCM} + S_{iX}^{'2}b_{iCX})b_i\}^{1/2}$$, where

(14b) $$\omega_{iPM} = \frac{\sum_{j=1}^{n} y_{ij}p_{ij}}{\sum_{j=1}^{z} y_{ij}p_{ij}} \qquad \omega_{iPX} = (1-\omega_{iPM}) = \frac{\sum_{j=n+1}^{z} y_{ij}p_{ij}}{\sum_{j=1}^{z} y_{ij}p_{ij}},$$

$$\omega_{iCM} = \frac{\sum_{j=1}^{n} x_{ij}p_{ij}}{\sum_{j=1}^{z} x_{ij}p_{ij}} \qquad \omega_{iCX} = (1-\omega_{iCM}) = \frac{\sum_{j=n+1}^{z} x_{ij}p_{ij}}{\sum_{j=1}^{z} x_{ij}p_{ij}},$$

It can be seen that when including both importing and exporting countries, we continue to first aggregate for producers and consumers separately, where the weight for each country is the share of the country's value of production (consumption) in the total global value of production (consumption). Global producer and consumer distortions are aggregated in the last step with the assumption that the global demand and supply curves for good *i* have the same slope (that is, $a_i = b_i = 0.5$). The resulting commodity-specific WRI measure, W_i, can be regarded as the good *i* import tax/export subsidy which, if applied uniformly across all countries, would give the same loss of welfare as the combinations of individual country measures distorting consumer and producer prices in the importing and exporting countries.

The commodity-specific TRI can be similarly decomposed as follows:

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

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

$$(16) \qquad R_{iX} = \left[\sum_{j=i+n}^{z} - r_{ij} u_{ij} \right]; \; S_{iX} = \left[\sum_{j=i+n}^{z} - s_{ij} u_{ij} \right].$$

The aggregates in equation (16) 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 (16) 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 reduces the reduction index, a lowering of r_{ij} or s_{ij} in the exporting countries increases it.

These extensions of the commodity-specific TRI and the commodity-specific WRI to exporting countries have precisely the same properties as the indexes for the import-competing countries. National commodity-specific TRIs can be aggregated across regions and the world using as weights the value of national trade in the product (measured as the difference between the national values of production and consumption at undistorted prices). National commodity-specific WRIs likewise are aggregated across regions and the world using as weights an average of the values of national consumption and production at undistorted prices. Indexes for the 5-year periods reported below are unweighted averages of the annual indexes.

Decomposing the TRI and WRI

It is possible to quantify the contribution of each country to the reduction in world trade or world welfare as measured by the commodity-specific TRI or WRI. For the TRI, we derive the aggregate reduction in world imports for good *i* from equation (4). 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 (16)), because positive assistance increases rather than reduces world trade.

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

$$(17) \qquad C_{Mi}^{P} = s_{ij}u_{ij}\omega_{iPM}\,; \qquad C_{Xi}^{P} = -s_{ij}u_{ij}(1-\omega_{iPM})$$

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

For the WRI, we use equation (12) to derive a similar decomposition from our data. The contributions are the same as equation (17) with the absolute value of the s_{ij} and r_{ij} terms entering as squared terms, because the WRI is a mean of order 2.

To find the overall contribution to the reduction in trade or welfare, we simply average the production and consumption contributions.

The World Bank's Agricultural Distortions database

The database generated by the World Bank's Agricultural Distortions project (Anderson and Valenzuela 2008), using a methodology summarized in Anderson et al. (2008), provides a timely opportunity to estimate global commodity trade and welfare reduction indexes for individual commodity markets. The database contains consistent estimates of annual nominal rates of assistance (NRAs) and consumer tax equivalents (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.[4]

The range of measures included in the Agricultural Distortions database NRA estimates is wide. By calculating domestic-to-border price ratios the estimates include assistance provided by 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 on inputs. Where multiple exchange rates operate, an

[44] Appendix Tables 1 and 2 report those estimates for 28 major products, whose NRAs and CTEs cover 77 percent of their global production on average.

estimate of the import or export tax equivalents of that distortion are included as well. The range of measures covered in the CTE estimates include both domestic consumer taxes/subsidies plus trade and exchange rate policies, all of which drive a wedge between the price that consumers pay for each commodity and the international price at the border.

Estimates of trade and welfare reduction indexes

Table 1 reports our time series of estimates TRIs for the 28 agricultural commodities, and for four groups of commodities (grains and tubers, oilseeds, tropical crops and livestock products). Generally those TRIs are somewhat above the NRAs and CTEs in Appendix table 1, 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 TRI is generally 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 offsets the trade-reducing effects of tariffs. In some cases (e.g. barley, millet and groundnuts) there are even some five-year periods when the TRI 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 most trade-distorted products are sugar, milk and rice. The differences within the four groups of commodities in the extent to which their global trade has been taxed are considerable (see Appendix Figure 1). 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 began to be implemented in numerous countries (as chronicled in, for example, Anderson and Associates 2009).

In table 2 the 2000-04 TRI estimates are disaggregated to show their production and consumption components. This disaggregation follows equation (4a). Two points are worth noting from that table. 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 TRI 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 from pro-trade production measures (such as have operated in the United States), whereas in the case of millet and groundnuts it is coming 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).

Tables 3 and 4 similarly report the WRI estimates. These are all necessarily positive, given our assumption that each country is a small contributor to the global market of each product. 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 19 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 and cotton (see Appendix Figure 2). Their and the other WRIs for that period are shown in figure 1, together with the (necessarily always lower) TRIs.

When disaggregating those WRIs as in table 5, it is again clear that they differ little as between the production and consumption components. The final two columns of that table also disaggregate the WRIs to show the contribution by the two sub-groups of countries trading these products according to their trade status in a particular product. That disaggregation reveals that countries for which a product is an importable tend to be much greater contributors to the product's global WRI than those countries for which it is an export item. It also reveals that among the exported products shown, cotton is (equal) second only to milk in terms of the size of its WRI, thanks to the huge cotton subsidies in the United States and the cotton export taxes of several developing counties.

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.

The WRI decompositions are necessarily all positive. Like the results for the TRI and WRI more generally, moving from the TRI to the WRI leads to new insights. 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 WRI is a mean of order two, so the large NRAs and CTEs of the latter four countries swamp those for India in the WRI decomposition.

Conclusions

The above application of these two commodity-specific additions to the family of so-called trade restrictiveness indexes provides very different 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 TRI offers a much truer indication of the world trade effects of government interventions in the markets for traded products, by properly accommodating trade subsidies alongside trade taxes; and the WRI 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.

The database we have used provides greater coverage in terms of commodities, countries and instruments than in any previous estimates of the effects of distortions of global agricultural commodity markets. They reveal in which markets the reduction in imports and the loss of welfare is greatest, and provide a breakdown into the components due to distortions of producer and consumer prices separately.

True, these two indexes have been calculated with the help of a number of simplifying assumptions, most notably that each country is small and that its price elasticity of supply (demand) for a particular product is the same as that for every other country, and that cross-price elasticities are zero. But that is what trade negotiators typically assume when they attempt to calculate the trade effects of market access 'concessions' they are considering exchanging. It is also commonly what would be assumed when calculating, for the Arbitrator of a trade dispute settlement case, the magnitude of the trade damage from a violation of commitments under a trade agreement. Models of the global market for particular farm products also often adopt such assumptions, for want of reliable or agreed econometric estimates of those elasticities for each country. Moreover, these indexes have the advantage over 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. Once reliable price elasticity estimates do become available, the theory in the first section of the article can be used to provide more accurate estimates of the TRI and WRI.

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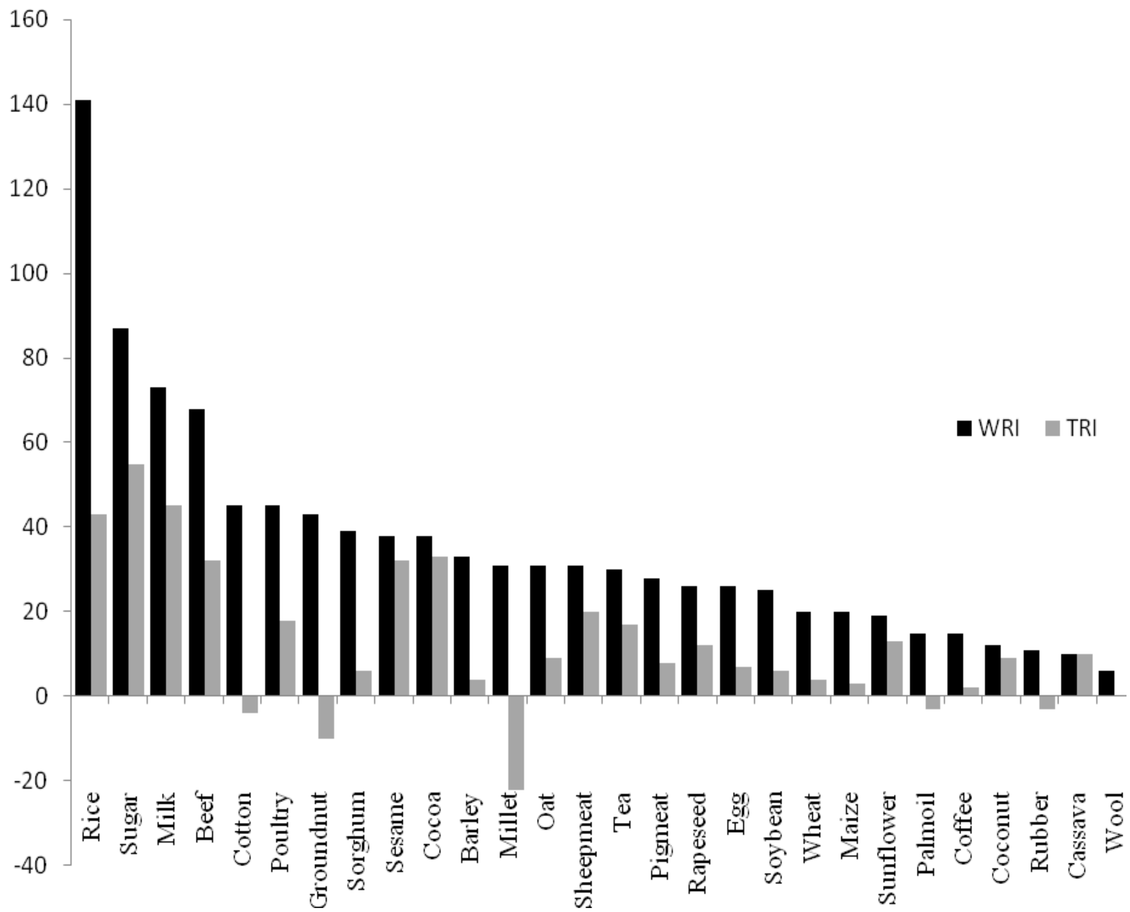


Figure 1. TRIs and WRIs for 28 major agricultural products, 2000-04 (percent)

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

(a) Sugar

(51 countries,
global TRI = 54.8)

(b) Milk

(46 countries,
global TRI = 44.5)

(c) Rice

(36 countries,
global TRI = 42.9)

(d) Beef

(47 countries,
global TRI = 32.0)

(e) Cotton

(19 countries,
global TRI = -4.1)

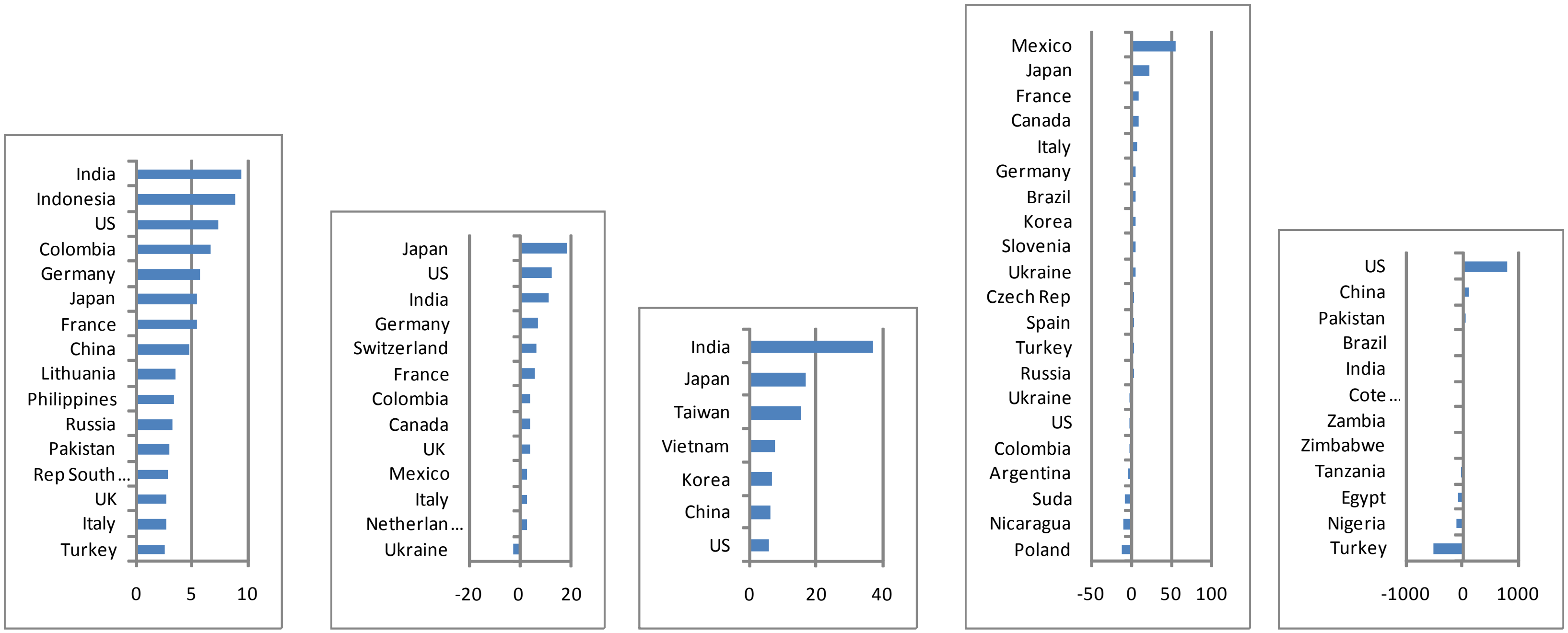


Figure 2. Country Share of the Global Commodity-Specific TRI for Rice, Sugar, Beef, Cotton and Milk, 2000–04

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. Focus countries have been omitted from the above charts if their decomposition share has an absolute value of less than 2 percent.

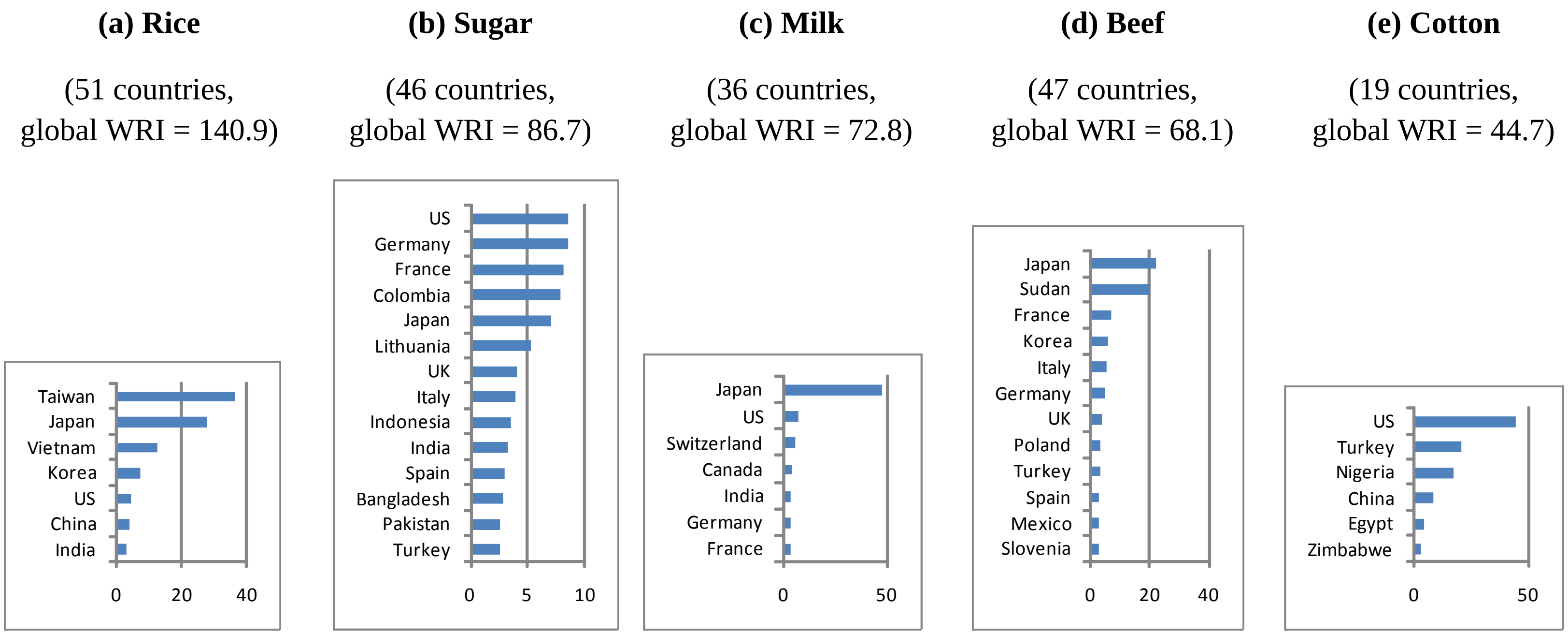


Figure 3. Country Share of the Global Commodity-Specific WRI for Rice, Sugar, Milk, Beef and Cotton, 2000–04

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. 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	**24**	**36**	**20**	**17**	**19**	**28**	**26**	**19**	**10**
Rice	49	50	58	42	41	58	53	32	43
Wheat	15	15	1	1	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	37	33	5	-13	-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	16	10	-5	-1	-10	-2	-2	13	9
Oilseeds	**8**	**6**	**8**	**5**	**3**	**17**	**14**	**10**	**3**
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	**26**	**35**	**23**	**35**	**37**	**28**	**28**	**16**	**11**
Sugar	89	143	27	40	47	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	**23**	**27**	**24**	**34**	**42**	**36**	**33**	**21**	**22**
Pigmeat	27	37	28	25	47	25	11	9	8
Milk	81	83	79	133	131	125	63	53	45
Beef	24	20	17	18	32	47	32	33	32
Poultry	23	22	29	26	24	27	27	18	18
Egg	-9	-5	-6	11	8	13	11	11	7
Sheepmeat	58	70	96	139	83	68	45	24	20
Wool	0	0	-6	-4	-7	-3	-4	0	0
All of the above 28 commodities	**23**	**29**	**20**	**23**	**27**	**28**	**27**	**17**	**12**

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

Table 2. Global Trade Reduction Indexes, Aggregate and Due to Production and Consumption Sides of the Economy, 2000-04 (percent)

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

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

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

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Grains and tubers	**47**	**50**	**48**	**52**	**50**	**97**	**89**	**64**	**62**
Rice	66	65	86	75	75	150	152	116	141
Wheat	42	45	36	30	30	59	47	29	20
Maize	29	29	23	29	30	48	29	21	20
Cassava	na	na	23	9	11	16	10	14	10
Barley	60	57	46	48	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	55	74	67	108	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	**53**	**90**	**46**	**46**	**48**	**60**	**56**	**50**	**55**
Sugar	157	224	58	68	72	99	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	**78**	**80**	**74**	**88**	**85**	**84**	**66**	**53**	**50**
Pigmeat	54	79	66	59	70	42	33	27	28
Milk	162	161	149	218	182	191	111	83	73
Beef	51	43	42	47	66	93	76	72	68
Poultry	44	43	54	48	50	48	54	46	45
Egg	52	48	39	32	28	39	36	36	26
Sheepmeat	95	129	159	190	123	107	75	41	31
Wool	0	0	6	7	11	7	10	8	6
All of the above 28 commodities	**62**	**65**	**57**	**63**	**63**	**82**	**71**	**55**	**52**

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

Table 4. Global Welfare Reduction Indexes, Aggregate, and Due to Production and Consumption Sides of the Economy, and to Exportables and Import-competing Sub-sectors, 2000-04 (percent)

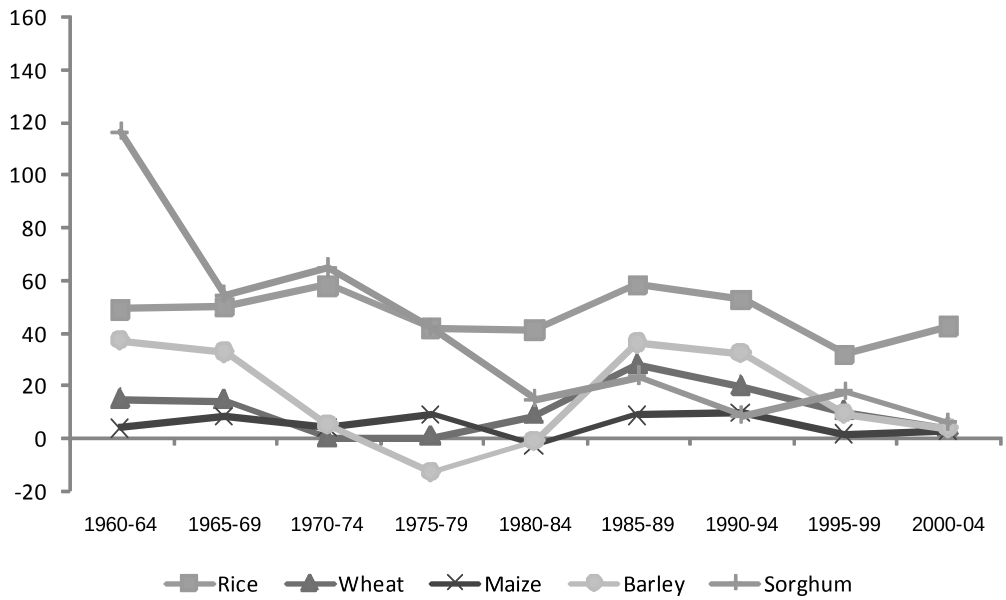
	Aggregate WRI	WRI, production	WRI, consumption	WRI, exportable goods	WRI, import-competing goods
Grains and tubers	**62**	**61**	**63**	**16**	**96**
Rice	141	139	142	20	215
Wheat	20	17	22	9	26
Maize	20	20	19	17	26
Cassava	10	10	9	10	0
Barley	33	31	35	10	85
Sorghum	39	39	38	35	30
Millet	31	7	43	31	0
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**	**16**	**66**
Pigmeat	28	27	28	7	40
Milk	73	76	69	56	75
Beef	68	63	73	21	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**	**73**

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

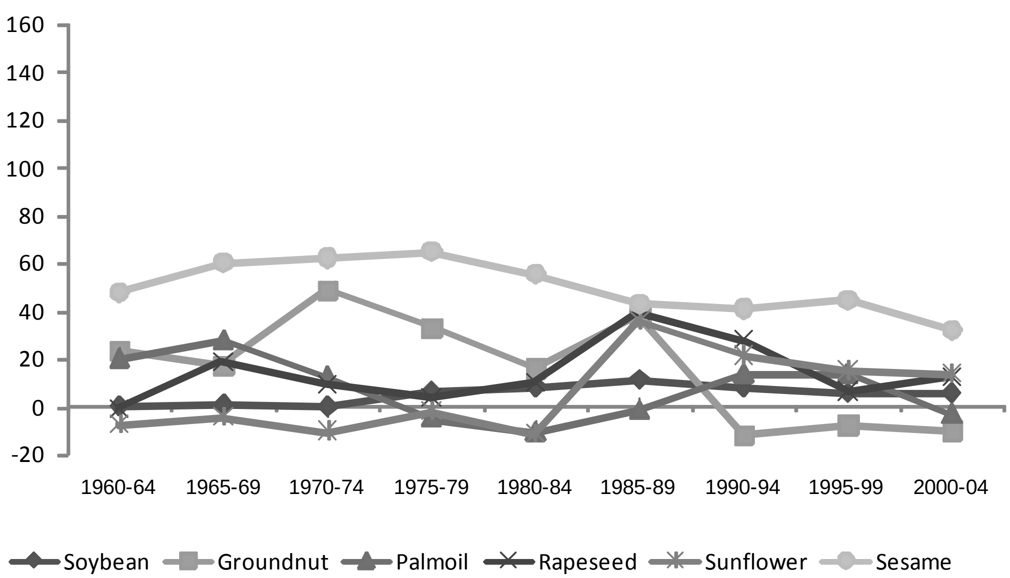
Appendix Figure 1. Global Trade Reduction Indexes, 1960 to 2004

(percent)

(a) Grains



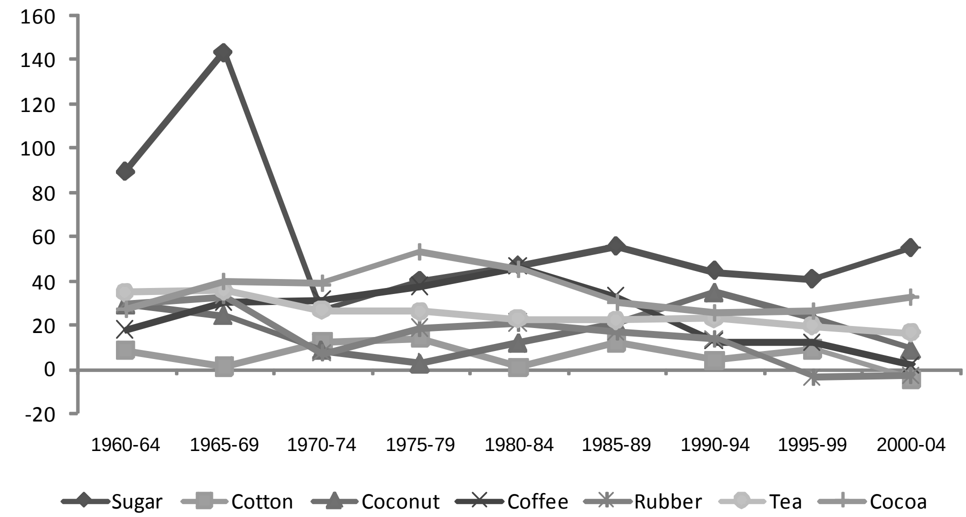
(b) Oilseeds



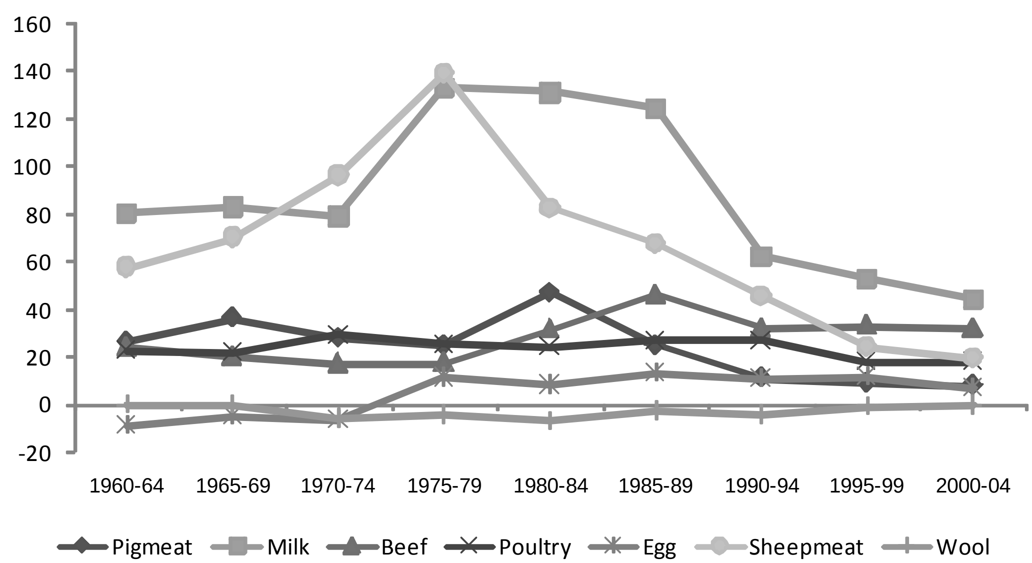
Appendix Figure 1 (continued). Global Trade Reduction Indexes, 1960 to 2004

(percent)

(c) Tropical crops



(d) Livestock products

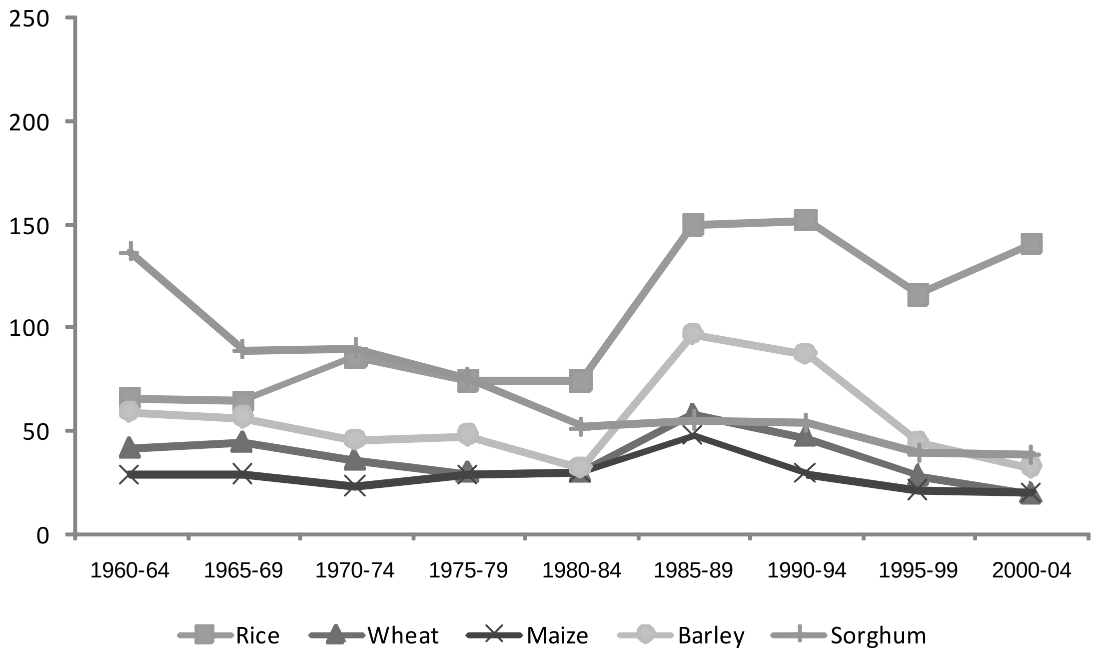


Source: Authors' calculations based on NRA and CTE estimates in Anderson and Valenzuela (2008).

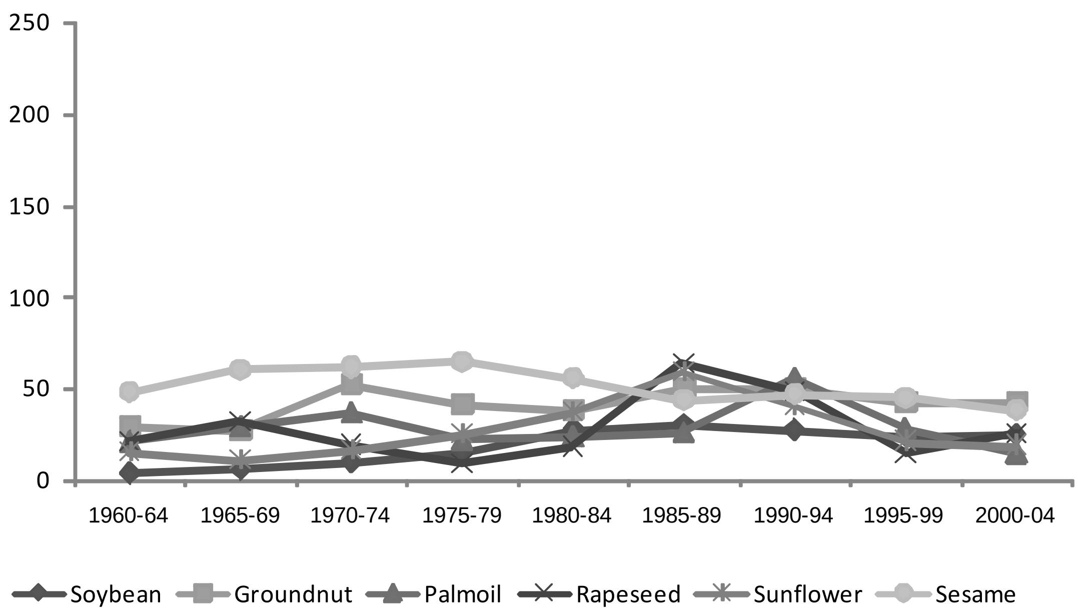
Appendix Figure 2. Global Welfare Reduction Indexes, 1960 to 2004

(percent)

(a) Grains



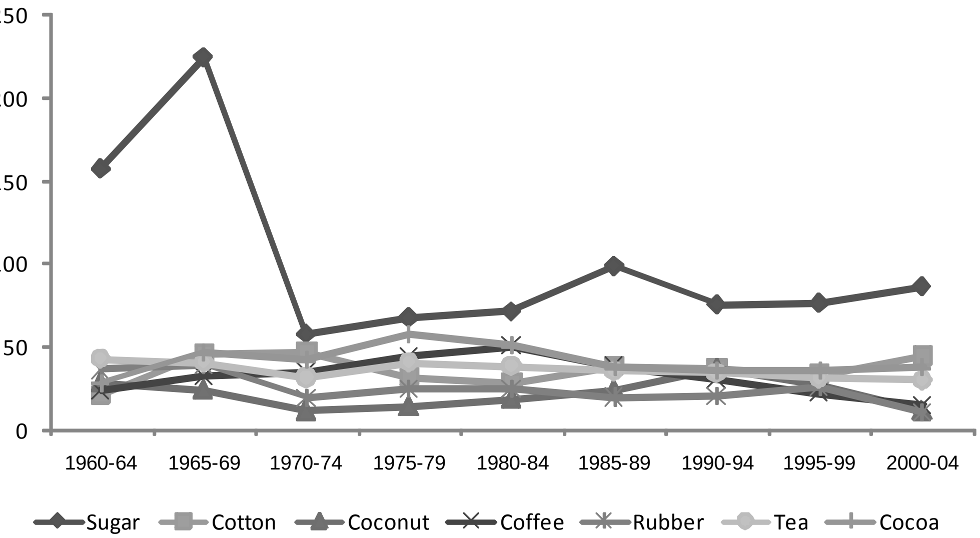
(b) Oilseeds



Appendix Figure 2 (continued). Global Welfare Reduction Indexes, 1960 to 2004

(percent)

(c) Tropical crops



(d) Livestock products

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

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: Country Share of the Global Commodity-Specific TRI for Sugar, Milk, Rice, Beef and Cotton, 2000–04

	Sugar	Milk	Rice	Beef	Cotton
TRI Global Average	**54.8**	**44.5**	**42.9**	**32.0**	**-4.1**
Decomposition					
Argentina		0.1		-4.6	
Australia	0.0	0.5	0.0	0.0	0.0
Austria	0.7	0.8		0.9	
Bangladesh	1.5		0.0		
Benin					
Brazil	0.7		0.2	5.2	16.5
Bulgaria	0.0	-0.1		0.0	
Burkina Faso					
Cameroon					0.1
Canada		3.7		7.6	
Chad					
Chile	0.4	0.1		0.1	
China	4.8	1.3	5.9		109.0
Colombia	6.7	3.9	0.2	-3.8	0.0
Cote d'Ivoire			0.1		-3.7
Czech Rep	0.9	0.5		3.4	
Denmark	0.7	1.1		0.7	
Dominican Republic	0.1		0.1		
Ecuador	0.2	0.1	1.4	0.5	
Egypt	0.3	-0.4	-0.8	0.0	-101.4
Estonia		0.1		0.0	
Finland	0.3	0.6		0.4	
France	5.4	5.9	0.1	7.7	
Germany	5.7	6.7		5.4	
Ghana			0.0		
Hungary	0.4	1.3		0.2	
Iceland		0.1		0.4	
India	9.4	10.8	36.8		-2.8
Indonesia	8.7		1.9		
Ireland	0.4	1.3		1.6	
Italy	2.6	3.0	1.0	6.0	
Japan	5.4	18.3	16.5	21.1	
Kazakhstan	0.6	0.0		-0.2	

Continued over

	Sugar	Milk	Rice	Beef	Cotton
TRI Global Average	**54.8**	**44.5**	**42.9**	**32.0**	**-4.1**
Kenya	0.4				
Korea		1.3	6.5	4.9	
Latvia	1.6	0.0		0.0	
Lithuania	3.5	-0.2		1.4	
Madagascar	0.0		0.0		
Malaysia			0.1		
Mali					
Mexico		3.0	0.0	55.8	
Mozambique	0.6		0.0		-0.1
Netherlands	1.5	2.6		1.7	
New Zealand		0.1		0.9	
Nicaragua	0.3	0.0	0.0	-11.3	
Nigeria			0.0		-125.6
Norway		1.1		1.0	
Pakistan	3.0	0.8	1.0		35.0
Philippines	3.4		1.4	0.2	
Poland	1.2	1.8		-13.4	
Portugal	0.4	0.5	0.1	0.7	
Romania	0.2	1.5		0.3	
Rep South Africa	2.8			-0.3	
Russia	3.2	2.3		2.8	
Senegal			0.0		-0.2
Slovakia	0.2	0.4		0.0	
Slovenia	0.0	0.4		4.7	
Spain	2.0	1.9	0.7	3.1	
Sri Lanka			0.0		
Sudan	1.5	1.3		-9.1	-0.7
Sweden	0.6	0.9		1.0	
Switzerland	0.9	6.4		1.0	
Taiwan			15.4	0.4	
Tanzania	0.1		0.0		-30.9
Thailand	1.6		-2.0		
Togo					
turkey	2.6	1.6	0.1	3.1	-530.3
Uganda	0.1		0.0		0.0
UK	2.7	3.7		4.3	
Ukraine	0.9	-2.9		-2.7	

Continued over

	Sugar	Milk	Rice	Beef	Cotton
TRI Global Average	**54.8**	**44.5**	**42.9**	**32.0**	**-4.1**
US	7.3	11.9	5.5	-3.2	769.3
Vietnam	1.5		7.6		
Zambia			0.0		-8.3
Zimbabwe					-26.0
Sum	100.0	100.0	100.0	100.0	100.0

Source: Derived from Anderson and Croser (2009), based on CTE estimates reported in national studies covering 75 focus countries.

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.

Appendix Table 4: Country Share of the Global Commodity-Specific WRI for Sugar, Milk, Rice, Beef and Cotton, 2000–04

	Rice	Sugar	Milk	Beef	Cotton
WRI global average	**140.9**	**86.7**	**72.8**	**68.1**	**44.7**
Decomposition					
Argentina			0.0	0.2	
Australia	0.0	0.0	0.1	0.0	0.0
Austria		1.1	0.4	0.8	
Bangladesh	0.0	2.8			
Benin					0.0
Brazil	0.0	0.1		0.2	0.4
Bulgaria		0.0	0.0	0.0	
Burkina Faso					0.1
Cameroon					0.0
Canada			4.3	0.0	
Chad					0.0
Chile		0.1	0.0	0.0	
China	3.9	2.4	0.4		8.2
Colombia	0.1	7.8	2.5	1.4	0.3
Cote d'Ivoire	0.0				0.1
Czech Rep		0.9	0.3	1.6	
Denmark		1.0	0.6	0.6	
Dominican Republic	0.0	0.1			
Ecuador	0.4	0.1	0.0	0.1	
Egypt	1.4	0.2	0.1	0.1	4.3
Estonia			0.0	0.0	
Finland		0.4	0.3	0.4	
France	0.1	8.0	3.3	6.8	
Germany		8.4	3.7	4.8	
Ghana	0.0				
Hungary		0.7	0.7	0.5	
Iceland			0.2	0.2	
India	3.0	3.2	3.8		0.6
Indonesia	0.1	3.5			
Ireland		0.6	0.7	1.5	
Italy	0.3	3.9	1.6	5.3	
Japan	27.8	7.0	46.9	21.8	
Kazakhstan		0.1	0.0	0.2	

Continued over

	Rice	Sugar	Milk	Beef	Cotton
WRI global average	**140.9**	**86.7**	**72.8**	**68.1**	**44.7**
Kenya		0.3			
Korea	7.1		1.9	5.6	
Latvia		1.8	0.0	0.0	
Lithuania		5.2	0.2	0.5	
Madagascar	0.0	0.0			
Malaysia	0.0				
Mali					0.1
Mexico	0.0	1.6	1.7	2.7	
Mozambique	0.0	0.5			0.0
Netherlands		2.2	1.5	1.5	
New Zealand			0.0	0.0	
Nicaragua	0.0	0.1	0.0	0.9	
Nigeria	0.0				17.0
Norway			1.6	2.1	
Pakistan	1.5	2.5	0.2		0.2
Philippines	0.2	2.3		0.0	
Poland		1.3	1.0	3.2	
Portugal	0.1	0.6	0.3	0.6	
Romania		0.3	1.4	0.2	
Rep South Africa		1.7		0.1	
Russia		1.8	0.7	0.8	
Senegal	0.0				0.0
Slovakia		0.2	0.2	0.0	
Slovenia		0.0	0.2	2.6	
Spain	0.2	3.0	1.1	2.8	
Sri Lanka	0.0				
Sudan		1.5	0.5	19.9	0.2
Sweden		0.9	0.5	0.9	
Switzerland		1.7	6.2	1.2	
Taiwan	36.1			0.2	
Tanzania	0.0	0.1			1.7
Thailand	0.6	0.2			
Togo					0.0
Turkey	0.0	2.5	0.9	3.0	20.1
Uganda	0.0	0.0			0.0
UK		4.0	2.1	3.8	

Continued over

	Rice	Sugar	Milk	Beef	Cotton
WRI global average	**140.9**	**86.7**	**72.8**	**68.1**	**44.7**
Ukraine		0.3	0.4	0.9	
US	4.5	8.5	7.2	0.2	43.8
Vietnam	12.5	2.0			
Zambia	0.0				0.3
Zimbabwe					2.6
Sum	100.0	100.0	100.0	100.0	100.0

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

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.