

# Measuring Distortions to Agricultural Incentives: Beyond Tariffs

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# Measuring Distortions to Agricultural Incentives: Beyond Tariffs

Governments have intervened in food and other agricultural markets for millennia, particularly via trade policies.<sup>1</sup> Attempts are often made to justify the interventions on economic, social or environmental grounds, but mostly such trade measures are welfare reducing – both in the country applying them and in the rest of the world – relative to first-best policy instruments for achieving those goals of society (Corden 1997). Through distorting the incentives producers and consumers would otherwise face, they are also welfare-redistributing and inherently discriminatory.

These welfare-reducing and redistributing properties ensure government regulations are the focus of a great deal of attention at home and abroad. In the international arena, food-exporting countries are concerned with access to markets in food-importing countries and unfair competition in third-country markets from other food-exporters, while food-importing countries are concerned with foreign competition in their home market. In the domestic setting, myriad groups are concerned with the efficiency, equity, employment, environmental, poverty, etc. consequences of such measures. Both reformer and reactionary domestic groups, as well as foreign traders and trade negotiators, are therefore keen to understand better the reasons behind and effects of such distortions to incentives. The first step to improving that understanding involves measuring the extent of distortions to incentives faced by producers, consumers and traders in each country.

Many observers thought the Uruguay Round of GATT trade negotiations, which led to the Agreement on Agriculture (URAA) in 1994, would make the task much easier via ‘tariffication’, or the transforming of non-tariff barriers (NTBs) to food and other agricultural imports into tariffs (import taxes) which are inherently more transparent and simpler to negotiate (Winters 1987). Yet a dozen years after the signing of the URAA, younger analysts struggle to imagine that it could have been even more difficult to measure the extent and potential effects of agricultural trade distortions than it is today.

There are two aspects to that measurement complexity. One has to do with tariffs themselves,<sup>2</sup> the other with the remaining (including newly emerging) non-tariff barriers

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<sup>1</sup> The Greek island of Thasos in the second millennium B.C., for example, allowed exports of only those wines sealed with the name of the magistrate. Ostensibly this was to guarantee authenticity, but in addition it allowed the taxation of exports (Robinson 1994, p. 465).

<sup>2</sup> The URAA allows the WTO to discipline not only tariffs but also agricultural domestic and export subsidies. Recent global modeling research suggests that those subsidies contribute only five and two

to trade. In tariffing, not only did countries choose to set specific (e.g., \$x/kg) rather than or in addition to ad valorem (percent) tariffs,<sup>3</sup> but most bound them in the WTO at rates well above those actually being applied. Thus most WTO members retain the freedom to raise applied rates at will – in some cases by several orders of magnitude. Furthermore, most countries offer preferential tariff rates to a subset of supplying countries. Some provide that formally as part of the URAA's two-tier tariff structure known as tariff rate quotas (TRQs). Many others do it via bilateral and regional trading agreements. Still others offer non-reciprocal preferential market access to select developing countries such as under the European Union's ACP and EBA programs. Typically these discriminatory agreements have complex rules of origin that raise the cost of accessing the preferences, sometimes to prohibitive levels. The challenges these and other features of tariffs raise for ex ante analysis of the possible effects of tariff-cutting agreements are well canvassed in Jank et al. (2006). Given the NTB focus of this symposium, they need not be rehearsed here. But clearly with a wide array of bilateral tariffs in place in most countries for agricultural products, there is no obvious single tariff rate that can serve as a measure of tariff protection actually delivered to any particular industry: the marginal rate is likely to vary though time as market circumstances change even if the various set rates themselves are not changed. While heroic attempts have been made to deal with this using trade-weighted averages (the best example perhaps being by Bouët et al. 2004), problems remain for analyzing agreements to lower just a subset of those rates.

The second measurement complexity arises because many non-tariff distortions to agricultural trade are still prevalent, notwithstanding tariffication by WTO members. Indeed they are increasing in number and complexity, and partly in response to agreements to lower tariffs. A recent attempt to indirectly measure them by Kee, Nicita and Olarreaga (2006), using gravity equations and the trade restrictiveness index (TRI) developed by Anderson and Neary (2006), suggests they are nearly as distorting of trade and welfare as are current tariffs (Tables 1 and 2).

Given the continuing and possibly growing importance of agricultural NTBs, it is appropriate that the OECD Secretariat does not rely on explicit tariffs and export subsidies to measure the market price support component of its Producer Support Estimate (PSE). Instead it undertakes careful domestic-to-international price comparisons for the key farm products of OECD countries to calculate that component, thereby capturing also the domestic price effects of NTBs.

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percent, respectively, of the global cost of agricultural tariffs and subsidies combined, the other 93 percent being due to tariffs (Anderson, Martin and Valenzuela 2006). Hence the focus on just trade restrictions in what follows.

<sup>3</sup> Specific tariffs offer (a) more protection against lower-priced substitutes, (b) growing protection against imports whose price is trending downwards over time, and (c) opaqueness because its ad valorem equivalent (AVE) is not evident from the tariff schedule without recourse to cif unit import value data. If ad valorem tariff cutting formulae are to be used in negotiating trade agreements, as under the WTO's Doha Development Agenda (DDA), agreement first has to be reached on what border price to use to calculate the specific tariffs' AVEs. In the DDA that took several months and many meetings during 2005.

Unfortunately there is no such similar comprehensive price-comparison exercise being undertaken for developing countries. The most recent multi-country study was by Krueger, Schiff and Valdes (1988, 1991), for the period from around 1960 to 1984 – and that was for just 16 non-OECD countries plus Portugal and Turkey. Yet according to the GTAP tariff protection database (Table 1), agricultural tariffs in developing countries are very high; and global CGE models suggest they contribute substantially to the welfare cost and net farm income effects of protection in those countries (Anderson, Martin and van der Mensbrugghe 2006; Anderson and Valenzuela 2006). The estimated contribution of trade-restrictive policies would be even greater if NTBs were to be included in those models' base protection rates – and that applies as much to high-income as to developing countries, because the latter's access to rich-country markets is affected not just by the tariffs that are in those global models but also by the NTBs that are not. To complicate matters further, there is the possibility that tariff protection is overstated in such models because of 'water' in the tariff, due for example to duty drawbacks or exemptions (Ianchovichina 2005). Again, price comparisons provide a systematic way to include their effects.

This suggests an agenda for new empirical analysis aimed at systematic estimation of overall actual delivered protection rates for agricultural and food products. Since the OECD has a set of estimates for its member countries, the focus of new research needs to be on developing countries. Only then can the GTAP protection database be amended to represent, in addition to tariffs, the ad valorem equivalent of those NTBs as well as of other missing distortions such as export taxes.<sup>4</sup> The GTAP database amendment is needed not only for developing countries but also for OECD countries, since the only market access restrictions in that database currently are tariffs. Such an amendment will still provide challenges for modelers seeking to estimate the effects of *partial* reform, for example due to a regional or multilateral tariff negotiations (since one needs to know whether the marginal tariff will alter), but models so amended would provide a much better estimate of benefits from full reform – or equivalently, of the cost of current protection – than is currently possible.<sup>5</sup>

Of course not all NTBs are just economic protection devices. Some barriers are there for plant, animal or human health protection or for environmental reasons, for example, as discussed in other papers in this Symposium. In so far as the measures deal efficiently with those non-trade concerns of society, then the NTB estimate would lead to an overestimate of their welfare cost. In practice, however, most of those concerns can be

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<sup>4</sup> Notwithstanding the reform efforts of many developing countries in the past two decades, there is considerable evidence of on-going direct discouragement to agricultural exports in low-income countries. See, for example, OECD (2003), Piermartini (2004) and Thiele (2004). Argentina reverted to using explicit export taxes again from late 2001, some above 20 percent, which Anderson and Valenzuela (2007) show makes a big difference to the estimated effects on that economy of both own- and other country trade and subsidy reforms.

<sup>5</sup> In principle the same issue arises for non-farm goods, but the estimates in Tables 1 and 2 suggest the distortions there are much smaller in magnitude and so omitting them will not bias the results very much.

dealt with more efficiently with non-trade measures, so the extent of overestimation may not be great.<sup>6</sup>

The rest of this paper addresses the practical methodological issues that need to be faced when attempting to undertake such a measurement task in developing countries. This is being used in a new research project convened by the World Bank (in collaboration with the OECD, FAO and IFPRI) that is aiming at applying it in more than 40 developing countries and another 18 transition economies that together with the OECD countries account for around 90 percent of global agricultural employment (Anderson 2006). Specifically, the paper outlines the methodological issues associated with the task of measuring the actual delivered direct protection or taxation to individual primary agricultural industries, as well as indirect protection or anti-protection via distortions in non-agricultural sectors including crucially via distortions to incentives in the food processing part of manufacturing.

## **1. What in principle should be measured?**

Distortion estimates derived from this approach can serve four purposes. One is to provide stand-alone, easily understood, single-indicator measures for monitoring purposes, of direct and indirect assistance to (or taxation of) the farm sector as a whole as well as for individual industries, and also of food consumer prices (since many of the absolute poor are net buyers of food – McCulloch, Winters and Cirera 2001). The second is to provide comparable estimates of trade costs, which also contribute to price gaps between different points in the value chain. The third is to use the direct distortion measures as inputs into various types of partial and general equilibrium economic models for estimating their market, income and welfare effects. And the fourth, which is assisted by the previous ones, is to provide information useful in international trade negotiations. For these purposes the distortions need to be expressed as ad valorem equivalents by policy instrument (consumption, production and trade taxes and subsidies on outputs and intermediate inputs), but they also need to distinguish the shares of the trade measures due to tariffs versus non-tariff governmental barriers (since the former are more amenable to trade negotiations).

A key distinction needs to be made is that between government-imposed distortions, and other developments that change incentives. A distortion can be defined as something that governments impose to create a gap between the marginal social return to a seller and the marginal social cost to a buyer in a transaction. Such a distortion creates an economic cost to society which can be measured using techniques such as those pioneered by Harberger (1971). As Harberger notes, this focus allows a great simplification in evaluating the marginal costs of a set of distortions: changes in economic costs can be evaluated taking into account the changes in volumes directly

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<sup>6</sup> It is even possible that an import ban for quarantine reasons is so costly to consumers relative to the plant-health benefit it provides import-competing producers that national welfare could be improved by abolishing the SPS measure altogether (James and Anderson 1998).

affected by such distortions, ignoring all other changes in prices. In the absence of divergences such as externalities, the measure of a distortion is the gap between the price paid and the price received, irrespective of whether the level of these prices is affected by the distortion.

Other developments that change incentives facing producers and consumers can include indirect consequences of the distortion. If, for instance, a country is large in world trade for a given commodity, imposition of an export tax may raise the price in international markets, reducing the adverse impact on producer incentives in the taxing country of the export tax distortion. Another indirect effect on incentives frequently taken into account in studies of agricultural trade reform is the effect of trade distortions on the real exchange rate—the price of traded goods relative to nontraded goods. These changes in incentives are frequently important. However, the distortions are the primary measures that need to be captured, so that they can be incorporated into an appropriate country or global CGE model which will in turn capture the full general equilibrium impacts of the distortions of interest on producer and consumer incentives.

The total effect of distortions on the agricultural sector will depend not just on the size of the direct agricultural policy measures, but also on the magnitude of distortions generated by policy measures in other sectors. Thus, it is important to take an economy-wide view and seek estimates of the size of distortions in agriculture *relative to* those in other sectors, such as those resulting from industrial import tariffs and nontariff barriers. We begin by focusing first on direct distortions to agricultural incentives, before turning to those indirect ones.

### ***1.1 Direct distortions***

In the simplest of worlds, a small, open, perfectly competitive economy with many firms producing a homogeneous farm product with just primary factors would, in the absence of externalities, processing, producer/importer-to-consumer wholesale plus retail marketing margins, and domestic and international trading costs, maximize national economic welfare by allowing the domestic farm-gate price,  $P_f$ , and the consumer price of that product,  $P_c$  (both measured at the same wholesale/warehouse level in the value chain as imported products), to both equal  $E.P$  which is the domestic currency price of foreign exchange,  $E$ , times the foreign currency price of this identical product in the international market,  $P$ . Our purpose is to measure any government-imposed diversion from that equality because, if there are no market failures or externalities, such intervention by the government is welfare-reducing in a small, open economy.

The most common distortion is an ad valorem tax on competing imports (usually called a tariff),  $t_m$ . Such a tariff on imports is the equivalent of a production subsidy and a consumption tax both at rate  $t_m$ . If that tariff on the imported primary agricultural product is the only distortion, its effect on producer incentives can be measured as the ***nominal rate of direct assistance to farm output (NRA)***, which is the unit value of production at

the distorted price less its value at the undistorted free market price expressed as a fraction of the undistorted price:<sup>7</sup>

$$(1) \quad \text{NRA} = (\text{E.P}(1+t_m) - \text{E.P})/\text{E.P} = t_m$$

The effect of that import tariff on consumer incentives in this simple economy is that it generates a *consumer tax equivalent on the agricultural product (CTE)*:

$$(2) \quad \text{CTE} = t_m$$

The effects of an import subsidy are identical to those in equations (1) and (2) for an import tax, but  $t_m$  in that case would have a negative value.

Governments sometimes also intervene with an export subsidy  $s_x$  (or an export tax in which case  $s_x$  would be negative). If that were the only intervention:

$$(3) \quad \text{NRA} = \text{CTE} = s_x$$

If any of these trade taxes or subsidies were specific rather than ad valorem (e.g., \$/kg rather than z percent), its ad valorem equivalent would first need to be calculated using the border price times the exchange rate, E.P.

Governments sometimes intervene with a direct production subsidy for farmers,  $s_f$  (or production tax, in which case  $s_f$  is negative).<sup>8</sup> In that case, if only this distortion is present, the NRA is as above except  $s_f$  replaces  $t_m$  or  $s_x$ , but the CTE in that case is zero. Similarly, if the government just imposes a consumption tax  $t_c$  on this product (or consumption subsidy, in which case  $t_c$  is negative), the CTE is as above except  $t_c$  replaces  $t_m$  or  $s_x$ , but the NRA in that case is zero. If either of those interventions were additional to a trade measure, however, they would inflate one of the distortion estimates. For example, an import tariff plus a production subsidy/tax would result in:

$$\text{NRA} = (1+t_m)(1+s_f) - 1$$

while an import tariff plus a consumption subsidy/tax would result in:

$$\text{CTE} = (1+t_m)(1+t_c) - 1$$

Should a multi-tier foreign exchange rate regime be in place, then another policy-induced price wedge exists. A simple two-tier exchange rate system creates a gap between the price received by all exporters and the price paid by all importers. Many such schemes are more complicated, with different rates for different products, or

<sup>7</sup> The NRA thus differs from even the simplest producer support estimate (PSE) as calculated by the OECD, in that the PSE is expressed as a fraction of the distorted value. It is thus  $t_m/(1+t_m)$  and so for a positive  $t_m$  it is smaller than the NRA and is necessarily less than 100 percent.

<sup>8</sup> These could include informal taxes by local and provincial governments as in China (Lin et al. 2002) and various countries in Sub-Saharan Africa (Townsend 1999).

categories of traders. Some of these prices generate infra-marginal transfers because the amounts of foreign exchange made available at concessional prices are determined by administrative fiat, rather than by the demand from the groups receiving the concessional prices. Further, foreign currency retention schemes frequently augment the returns available to exporters relative to the official exchange rate.

In the absence of a foreign currency retention scheme, a two-tier exchange rate system will alter the domestic price of the importable by the fraction  $e_m$  and the price of the exportable by the fraction  $e_x$ . In the case of just a two-tier system,  $(e_m + e_x)$  is the percentage by which the black market exchange rate exceeds the official rate (see Appendix 1). The estimated division of the total foreign exchange distortion between an implicit export tax,  $e_x$ , and an implicit import tax,  $e_m$ , will depend on the estimated elasticities of supply of exports and of demand for imports.<sup>9</sup> If scarce foreign exchange is allocated using a secondary market auction under a pure two-tier exchange rate system, then the marginal returns to foreign exchange are likely to be more or less equalized across competing uses, and the gap between official and secondary market exchange provides an indication of the gap between the price received by exporters and the price paid by importers. In the common case where there is a foreign exchange retention scheme allowing exporters to sell some of their foreign exchange earnings on a secondary market, the returns to the exporter become a combination of the official exchange rate and the secondary market rate (Dervis, de Melo and Robinson 1981; Martin 1993).

*What if trade costs are sufficiently high for the product to be not traded internationally?*

If the transport costs of trading are sufficient to make it unprofitable for a product to be traded internationally, then any trade policy measure ( $t_m$  or  $s_x$ ) or the product-specific exchange rate distortion ( $e_m$  or  $e_x$ ) is redundant. In that case, in the absence of other distortions  $NRA = CTE = 0$ , while in the presence of any domestic producer or consumer tax or subsidy ( $s_f$  or  $t_c$ ) the domestic prices faced by both producers *and* consumers will be affected, the extent of which depends on the price elasticities of domestic demand and supply (the standard closed-economy tax incidence issue). To give a specific example in such a closed-economy setting, suppose just a production tax is imposed so  $s_f < 0$  and  $t_c = 0$ . In that case:

$$NRA = s_f / (1 + \varepsilon/\eta)$$

and

$$CTE = -s_f / (1 + \eta/\varepsilon)$$

where  $\varepsilon$  is the price elasticity of supply and  $\eta$  is the (negative of the) price elasticity of demand. If that lowering of the price received by farmers is for the purpose of lowering

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<sup>9</sup> From the viewpoint of wanting to use the NRA and CTE estimates later as parameters in a CGE model, it does not matter what assumptions are made here about these elasticities, as the model's results for real variables will not be affected. What matters for real impacts is the magnitude of the total distortion, not its allocation between an export tax and an import tax. This is simply the traditional incidence result from tax theory.

the price paid by food consumers (see Byerlee and Sain 1986), rather than for raising tax revenue, then if the government food agency had no transaction costs the producer and consumer prices would be equally depressed and:

$$\text{NRA} = \text{CTE} = s_f / (1 + \varepsilon/\eta)$$

This means that to achieve a given reduction in  $P_c$ , the producer tax ( $-s_f$ ) has to be larger the larger is the supply elasticity relative to the demand elasticity ( $\varepsilon/\eta$ ).

*What if production involves not just primary factors but also intermediate inputs?*

Where intermediate inputs are used in farm production, any taxes or subsidies on their production, consumption or trade would alter farm value added and thereby also affect farmer incentives.<sup>10</sup> So too would exceptional tax rates, including exemptions on value added taxes (VAT, a common instrument in developing countries today – see Ebrill et al. 2001), payroll taxes, income taxes, etc. for farmers, and import duty drawbacks or surcharges. Non-product-specific explicit or implicit taxes or subsidies to farming are more difficult to assign to specific products but could be included when estimating the overall sectoral average for agriculture. Some farm products, including some that are not internationally traded such as raw milk, are an input into a food processing industry that is subject to government interventions. In that case the effect of those interventions on the price received by farmers for the primary product also needs to be taken into account (see Section 1.2 below). And likewise if a state trading corporation is charging excessively for its marketing services and thereby lowering the farm-gate price. In principle all these items could be brought together to calculate an effective rate of direct assistance to farm value added (ERA).<sup>11</sup> The nominal rate of direct assistance to farm output is a component of that, as is the nominal rate of direct assistance to farm inputs. In principle, all three rates can be positive or negative.

If ERA estimates are not made but there are significant distortions to input costs or to generally applied taxes (e.g., where the VAT is applied to imported but not domestically produced food), the ad valorem equivalent of that as a fraction of the distorted output price could be added to get the adjusted nominal ***direct rate of assistance to farm production (DRA)***. In cases such as where a fertilizer user subsidy is paid via the

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<sup>10</sup> Sometimes a government will have directly offsetting measures in place, such as a domestic subsidy for fertilizer use by farmers but also a tariff on fertilizer imports (as has been the case in Korea and Turkey). In other situations there will be input subsidies but an export tax on the final product. On this general phenomenon, see Rausser (1982).

<sup>11</sup> This is a generalization of the effective rate of protection concept – see Corden (1971) and Productivity Commission (1995, 1999). Even in the absence of distortions to input prices, there is an important advantage of calculating effective rates for comparing distortions to incentives across sectors if the value added share of output (VASO) varies across sectors. The greater that variance, the less appropriate are nominal rates compared with effective rates. And that variance is indeed considerable: according to the GTAP database for 2001, VASOs for primary agriculture, non-agric primary industries, food processing, other manufacturing, and services were 56, 59, 24, 25 and 53 percent, respectively for developing countries, and they 51, 55, 31, 34 and 60 percent, respectively for high-income countries.

fertilizer plant, the extent to which some of that subsidy is absorbed by that plant rather than passed on to farmers also needs to be taken into account. Bear in mind also that the fertilizer plant (or livestock feedmix plant) might be enjoying import tariff protection that raises the price of fertilizer (feedmix) to farmers by more than any consumption subsidy (as had been the case in Korea – Anderson 1983), in which case the net contribution of this input distortion to DRA would be negative rather than positive.

Having calculated the DRA for each agricultural industry, an average DRA for the agricultural sector as a whole is generated by multiplying industry volume of production valued at border prices by the DRA and adding across industries, then adding non-product-specific assistance to agriculture, and then dividing by the sum of the volume of production valued at border prices (or at the producer price net of subsidies/taxes in the case of nontradables).

### *1.2 Non-distortionary price wedges*

In practice, there are divergences between producer, consumer and border prices for reasons other than subsidies or taxes on production, consumption, trade or foreign currency. These need to be explicitly recognized when using comparisons of domestic and border prices to derive estimates of distortions. Such recognition also offers the opportunity to compare the latter's size with wedges associated with such things as trade and processing costs (used in trade facilitation and value chain analyses, respectively). It may also expose short-term situations where profits of importers or exporters are enhanced by sluggish adjustment by agents in the domestic value chain (as apparently has been the case in Russia in the wake of exchange rate gyrations).

Far from being zero as assumed above, trading costs can be non-trivial both intra- and inter-nationally, especially in developing countries with poorly developed infrastructure.<sup>12</sup> For example, domestic trading costs are involved in getting farm products to overseas or domestic urban consumers (assuming the latter are at the international border). Suppose they are equal to the fraction  $T_f$  of the price received by the farmer.<sup>13</sup> There may also be significant domestic trading costs involved in getting

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<sup>12</sup> On the basic economics of trading costs as affected by such things as infrastructure within the country, at the border (ports, airports) and, in the case of landlocked countries, in transit countries, as well as international freight etc. costs, and their impact on both the aggregate volume and product structure of international trade, see Limao and Venables (2001), Venables and Limao (2002), and Venables (2004). See also the survey by Anderson and van Wincoop (2004), where it is reported that the tax equivalent of trading costs are estimated to be more than 170 percent in high-income countries and higher in developing and transition economies. Especially those that are small, poor and remote. Trade facilitation through lowering those trading costs (e.g., streamlining customs clearance procedures) can be the result not only of technological changes but also of government policy choices such as restrictions on which ships can be used in bilateral trade. For example, Fink, Mattoo and Neagu (2004) estimate that the policy contribution to costs of shipping goods from developing countries to the US is greater than the border import barriers. More generally on imperfect competition in services markets including cartelized international shipping, see Francois and Wooten (2001, 2006).

<sup>13</sup> Trading costs may be unrelated to the product price (i.e., specific rather than ad valorem), in which case the formulae should be adjusted accordingly (e.g.,  $P_f = P_c + T_f$  where  $T_f$  is in dollars per ton). If this were

farm inputs such as fertilizer to farmers, equal to the fraction  $T_c$  of the price paid at the urban point or international border.

Secondly, domestic processing costs and wholesale and retail distribution margins are not zero. Indeed Reardon and Timmer (2006) argue that they are becoming an increasingly important part of the value chain in developing countries as consumers desire ever-more post-farm processing and services added to their farm products, aided by the supermarket revolution's contribution to globalization.<sup>14</sup> Suppose the processing and wholesale and retail distribution margins inflate the consumer price by fractions  $m_p$ ,  $m_w$  and  $m_r$ , respectively, over and above the producer price plus domestic trade cost (or just  $m_r$  and perhaps  $m_w$  above the price of the imported processed product, assuming the processing has to be done prior to the product being internationally tradable).

Thirdly, international trading costs (ocean or air freight, insurance, etc.) raise the domestic price of the import-competing product by a fraction  $T_m$  above what it otherwise would be at the country's border, or mean that the price abroad of the exported product is greater by a fraction  $T_x$  of the fob price. This is not an issue if the international price used is the cif import unit value for an importable or the fob export unit value for an exportable, but it is if there is no trade by this country (because of, say, a prohibitive trade tax on the product) and an international indicator price from the IMF series is used.

And fourthly, the quality of a foreign product is usually considered to be different from that of the domestically produced substitute, with consumers typically having a home-country bias.<sup>15</sup> In that case the import price needs to be deflated by a fraction  $q_m$  which is the extent to which the good imported is deemed by domestic consumers to be inferior in quality to the domestic product (or superior, in which case  $q_m$  would be negative). For exported goods, no adjustment is needed if the fob unit export value is used as the border price. But if trade taxes or non-tariff barriers prevent any exports and an international indicator price has to be used, the border price needs to be inflated by a fraction  $q_x$  which is the extent to which the good is deemed by foreign consumers to be

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the case with international trading costs, the domestic price of importables (exportables) would change less (more) than proportionately with  $P$ . The ad valorem assumption is preferable to the specific one in situations where international price and exchange rate changes are less than fully passed through the domestic value chain to the farmer and consumer because of incomplete market integration caused, for example, by poor infrastructure or weak institutions. Ideally in such cases one would estimate the extent to which the price transmission elasticity is below unity and use it to calculate the margin each year.

Trading costs include storage costs that would be incurred to hold domestic products until the same time in the season when international trade takes place. Any subsidies or taxes on these or any other trading costs should be included in the distortion calculus. On the importance of these domestic trading costs in low-income countries, see the following case studies of Madagascar (Moser, Barrett and Minten 2005) Rwanda (Diop, Brenton and Asarkaya 2005) and Bangladesh (Balkht, Koolwal and Khandker 2006).

<sup>14</sup> The costs of processing and of wholesale/retail distribution, as well as domestic trading costs, change over time not only because of technological advances but also following policy changes. For example, government investment in rural infrastructure can lower trading costs. Reardon and Timmer (2006) argue that the global supermarket revolution is in part driven by the opening of domestic markets following the relaxation of government restrictions on foreign direct investment since the 1980s.

<sup>15</sup> On how and why the quality and variety of traded goods vary by country of origin, see Hummels and Klenow (2005).

inferior in quality relative to the indicator good (or superior, in which case  $q_x$  would be negative).<sup>16</sup>

With all these adjustments, *and so long as the product is still traded internationally*, the relationships between the domestic producer and the international price in the absence of government-imposed price and trade policies become the following for an exportable:

$$(4) \quad E.P = P_f(1+T_f)(1+m_p)(1+T_x)(1+q_x)$$

and for an importable:

$$(5) \quad E.P = P_f(1+T_f)(1+m_p)/(1+T_m)(1-q_m)$$

while the urban consumer price is above the producer price to the following extent:

$$(6) \quad P_c^u = P_f(1+T_f)(1+m_p)(1+m_w)(1+m_r)$$

These elements of the value chain, in an economy with no distortionary policy measures in place, are shown in Figure 1(a).

Thus if the job of measuring the direct trade or price policy-induced distortion to incentives is to be based on domestic-to-border price comparisons for a traded good, it also is likely to involve measuring  $T_m$ ,  $T_x$ ,  $T_f$ ,  $T_c$ ,  $q_m$ ,  $q_x$  and  $m_p$ ,  $m_w$  and  $m_r$ , and adjusting the price ratios accordingly to net out the effects of those other parameters on the price difference. Otherwise, one is likely to overstate the CTE and understate the  $TRA_A$  (Horn and Shy 1996).<sup>17</sup> If the producer and consumer tax or subsidy rates ( $s_f$  or  $t_c$ ) are also known, it is then possible to derive the tax equivalent of all trade measures (including non-tariff barriers); and if the applied import and export tax or subsidy rates are known, it is also possible to derive the ad valorem tax equivalent of all non-tariff barriers to trade (such as the effect of a state trading enterprise buying exportables from farmers at less than the border price or selling the imported product to domestic consumers at above the landed price; or of customs officials requiring bribes or causing undue delays; or of quarantine restrictions on imports which may or may not be reducing an externality).

Both international and domestic trading costs are a function of the quality of hard infrastructure (roads, railways, ports) and soft infrastructure (business regulations, customs clearance procedures at state and national borders), each of which can be affected by government actions. While it may be difficult to allocate those costs between items that are avoidable and those that are unavoidable, measuring their aggregate size in

<sup>16</sup> We assume that the quality difference arises because one good provides more effective units of services than another, so that the relative price is a constant proportion of the value of the first good. When products are simply differentiated, without such a quality dimension (as in Armington 1969), there will be no fixed relationship between the two prices.

<sup>17</sup> For a survey of sources of information on trade costs (and nontariff barriers), see Bagai and Wilson (2006). An example of the effects of trade costs on trade patterns can be found for Central Asia in Raballand, Kunth and Auty (2005).

a comparable way in a range of countries will be helpful for identifying scope for trade facilitation in particular countries.<sup>18</sup> Such information will be timely, given the likely emergence of an aid-for-trade package as a complement to the WTO's Doha Development Agenda outcome. If this ad valorem trade cost information is presented as a separate item, it can then be compared with the measure of price distortions.

*What if trade taxes or exchange rate distortions cause a tradable product to become nontraded?*

Policy measures such as trade taxes add to the reduction in trade caused by trade costs (see Figures 2 and 3). If those trade taxes are sufficiently large as to choke off international trade, then they contribute to the NRA and CTE only to the extent needed to drive that trade to zero. In terms of Figure 4, and in the presence of trade costs  $T_x$  and  $T_m$ , the prohibitive rates are  $t_m$  for the import tax and  $s_x$  for the export tax ( $s_x < 0$ ) so any trade taxes larger than that have an element of redundancy.

If there are trade policy distortions with no trade passing over them (that is, they are prohibitive), then there may still be policy effects that need to be measured but they will differ from those implied by equations (4) and (5). The case of a prohibitive tariff in conjunction with trade costs is shown in Figure 2(b). In this case, the tariff is high enough to take the price of imported goods above the autarchy price  $P_a$ . There are no imports, but the domestic price  $P_a$  is below the import parity price  $E.P(1+T_m)(1+t_m)$ . The distortion that results from the presence of the trade tax is given by  $(P_a/E.P(1+T_m))-1$ . If the world price were higher than in Figure 2(b) such that the country was freely exporting this product, then the domestic price would be determined by the world price less export trade costs. In this case, the import tariff would be irrelevant and there would be no distortion despite the presence of the import tariff measure.

Similar conditions apply to exportable goods, where a prohibitive export tax may create a distortion equal to less than the tax rate. In this case the distortion wedge would be equal to the difference between the autarchy price and the world price less export trade costs; or, if the country were freely importing the good, the export tax would be irrelevant and there would be no distortion despite the presence of the export tax measure. The choice of international price to be compared with domestic prices therefore should not be based just on the current trading status of the country (Byerlee and Morris 1993). Moreover, different prices may be needed for different regions of a large country that simultaneously exports and imports because internal (including coastal shipping) trading costs are so high relative to international trading costs (Koester 1986).

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<sup>18</sup> That these costs vary hugely across countries, and often dwarf trade taxes, is now clearly established. See, e.g., World Bank (2006a,b) and also [www.doingbusiness.org](http://www.doingbusiness.org) and the governance and anti-corruption indicators at <http://info.worldbank.org/governance/kkz2002/>. Also now available is a database on information and communications cost indicators for 144 countries, at [www.worldbank.org/ic4d](http://www.worldbank.org/ic4d)

In some settings trading cost-induced price bands due to missing or imperfect markets in rural areas cause poor farmers to forego cash crop production in order to ensure enough food production for survival (de Janvry, Fafchamps and Sadoulet 1991; Fafchamps 1992). This contributes to a low supply responsiveness of producers to international price changes for those cash crops.

### 1.3 Indirect distortions

In addition to direct assistance to farmers ( $DRA_A$ ), their incentives are also affected indirectly if the nominal *direct rate of assistance to non-agricultural production* ( $DRA_N$ ) in the national economy is non-zero.  $DRA_N$  would include some of the same measures as in  $DRA_A$ , such as non-sector specific energy subsidies. The higher is  $DRA_N$ , the more other sectors will have bid up the value of mobile resources that would otherwise have been employed in agriculture, other things equal. If the average  $DRA_A$  for agriculture is below the average  $DRA_N$  for all non-agricultural sectors, then one might expect there to be fewer resources in agriculture than there would be under free market conditions in this country, notwithstanding any positive direct assistance to farmers (see Figure 5) – and conversely if agriculture's  $DRA_A$  is above  $DRA_N$ . If the non-agricultural sectors were assisted only via import tariffs on manufactures or export taxes on minerals, it would be a relatively easy task to measure  $DRA_N$ . When it involves also the regulation of many services sectors, often producing nontradables, the task is a little more complex (see section 2.4 below for short cuts). It is also more difficult if non-agricultural primary sectors involve resource and environmental externalities that may warrant some government intervention, or if in the place of explicit and transparent export taxes there are corrupt implicit and non-transparent disincentives such as bribery demands.

A particularly important way in which distortions outside primary agriculture affect farmers is via the food processing sector. In their calculation of the market price support component of the PSE for farmers, the OECD assumes any protection to processors if fully passed back to primary agriculture. An example of this is depicted in column 2 of Figure 1(b), where column 1 is the no-distortion base case. In that example a tariff of 33 percent on the processed product translates to a nominal rate of protection of 60 percent for farmers and zero for processors, and a consumer tax equivalent of 25 percent for consumers. The underlying assumptions in that are fourfold: that the processing industry is perfectly competitive, that the primary industry is a monopolist, that the transport and distribution parts of this value chain are also perfectly competitive and face constant costs, and that the primary product is either nontradable or enjoys import-prohibitive tariff or NTB protection. None of those assumptions seem realistic. Three other possibilities also are depicted in Figure 1(b). In column 3 it is assumed there is zero pass-through by the processor up or down the value chain, implying s/he is a monopolist and the other players are perfectly competitive – as they would be if they faced import competition. In that case the tariff of 33 percent on the processed product translates to a nominal rate of protection of zero for farmers and 33 percent for processors, and a consumer tax equivalent of 25 percent for consumers. Then in column 4 it is assumed there is proportional pass-through by the processor up the value chain to farmers and their transporters, implying they are equally competitive but that farmers enjoy primary product protection from import competition at least to the extent of 33 percent. In that case the tariff on the processed product translates to a nominal rate of protection of 33 percent for both farmers and processors, and a consumer tax equivalent

of 25 percent for consumers. The final case in Figure 1(b) assumes there is proportional pass-through by the processor both up and down the value chain, implying all players are equally competitive but again that farmers enjoy primary product protection from import competition at least to the extent of 33 percent. In that case the tariff on the processed product translates to a nominal rate of protection of 33 percent for both farmers and processors, and a consumer tax equivalent of 33 percent for consumers. This set of examples illustrates the importance both of separating the primary and processed activities for the purpose of calculating protection rates, and of being explicit about one's assumptions as to the size and nature of the trade costs and marketing margins in the value chain.

What about foreign exchange rate misalignment relative to what fundamentals would suggest is the value of a country's currency? A real appreciation of the general foreign exchange rate lowers uniformly the price of all tradables relative to the price of nontradables, and conversely for a real devaluation. If a change in the exchange rate is caused by aid or foreign investment inflows, then the excess of tradables consumption over tradables production leads to a new equilibrium (see Appendix 2). Certainly such a new inflow of funds would reduce incentives for farmers producing tradable products, but this is not a welfare-reducing distortion and so does not need to be added to the exchange rate distortion already included in section 1.1 above. Even if the government chose to hold down the value of its currency through, say, accumulating foreign reserves (what has been termed 'exchange rate protection' by Corden 1997), that represents a collective savings choice that is not obviously a distortion. Moreover, that action has an inter-temporal dimension that begs the question as to what the counterfactual would be in any one year if those reserves were not being accumulated over time. Furthermore, fluctuations in market sentiment also can lead to foreign exchange rate misalignment relative to what fundamentals, and again this may be quite independent of distortionary government policy choices. For these reasons there is no need to include any such misalignment in the basic DRA calculations.

#### ***1.4 Total distortions to agricultural incentives***

Given the above possible indirect distortions to agricultural incentives, in addition to the direct distortions outlined in Section 1.1 above, it is possible to subtract the latter element from the former to get a single partial equilibrium estimate of the total distortion to agricultural incentives facing farmers by industry each year, (that is, relative to distortions in the other sectors of the economy). To do so one needs to distinguish between industries producing exports (X), those producing import-competing products (M), and those producing nontradables (H) in both agriculture and non-agriculture.

Consider the simplest example where the only policy distortions are non-prohibitive tariffs on imports of both agricultural and non-agricultural products ( $t_{MA}$  and  $t_{MN}$ ) plus a dual exchange rate system that introduces implicit taxes on all imports and exports ( $e_m$  and  $e_x$ ). In that case, the prices of the two groups of import-competing products have been raised by both the explicit tariffs and the exchange rate-induced

implicit import tax, the price of the two groups of export products have been lowered by just  $e_x$ , and the prices of the two groups of nontradable products have been unaltered. The average proportional change in the producer price of non-agricultural products,  $\hat{P}_N$ , is thus:

$$(7) \quad \hat{P}_N = \alpha_{MN}[(1+e_m)(1+t_{MN}) - 1] + \alpha_{XN}[(1+e_x) - 1] = \alpha_{MN}(e_m + t_{MN} + e_m t_{MN}) + \alpha_{XN}e_x$$

where  $\alpha_{MN}$ ,  $\alpha_{XN}$  and  $\alpha_{HN}$  are the shares of non-agricultural output from the import-competing, export and nontradable industries in that sector divided by one plus the sector's DRA (to express it at border prices), respectively, and  $t_{MN}$  is the tariff on imports of non-agricultural products.

In this example the *total rate of assistance to agricultural output (TRA)* for each of the three agricultural subsectors, and for the sector as a whole, is thus the proportional change in own-price (the direct component) minus  $\hat{P}_N$  (the indirect component):

$$(8) \quad \text{TRA}_{AM} = \hat{P}_{AM} - \hat{P}_N = (1+e_m)(1+t_{MA}) - 1 - \hat{P}_N$$

$$(9) \quad \text{TRA}_{AX} = \hat{P}_{AX} - \hat{P}_N = e_x - \hat{P}_N$$

$$(10) \quad \text{TRA}_{AH} = \hat{P}_{AH} - \hat{P}_N = -\hat{P}_N$$

$$(11) \quad \text{TRA}_A = \hat{P}_A - \hat{P}_N = \alpha_{MA}(e_m + t_{MA} + e_m t_{MA}) + \alpha_{XA}e_x - \hat{P}_N$$

where  $\alpha_{MA}$  and  $\alpha_{XA}$  are the shares of agricultural output from the import-competing and exporting industries in the agricultural sector divided by one plus the sector's DRA (to express it at border prices and thereby be comparable to what is being done in the non-agricultural sector), and  $t_{MA}$  is the tariff on imports of agricultural products. From equation (11) it follows that agriculture as a whole, and each of its three sub-sectors, could be harmed or helped by this policy regime. For those calculating effective rates of assistance, a similar set of indicators can be constructed, using value added as weights.

Were there to be distortions also in markets for nontradables, a little bit more calculus is required because the quantities of each nontradable product supplied and consumed domestically have to be equal. Consider the example of a subsidy  $s_{HN}$  on consumption or production of nontradable non-agricultural products,  $H_N$ . That subsidy will be shared between the producers and consumers of  $H_N$ , the incidence depending on the elasticities of demand and supply of that set of products. To determine the implicit subsidy to each of them, use can be made of the tax incidence formula to obtain:

$$\text{DRA}_{HN} = s_{HN}/(1+\varepsilon_{hn}/\eta_{hn})$$

and

$$\text{CTE}_{HN} = -s_{HN}/(1+\eta_{hn}/\varepsilon_{hn})$$

where  $\varepsilon_{hn}$  is the price elasticity of supply and  $\eta_{hn}$  is the (negative of the) price elasticity of demand for  $N_H$ . If there are no estimates of those elasticities, ‘guestimates’ will need to be made. If one were to assume they are equal, then  $DRA_{HN} = CTE_{HN} = s_{HN}/2$ . Equation (7) would then become

$$\hat{P}_N = \alpha_{MN}(e_m + t_{MN} + e_m t_{MN}) + \alpha_{XN}e_x + \alpha_{HNS_{HN}}/2.$$

If there was also a distortion on nontradable agricultural products,  $A_N$ , such as a production or consumption tax  $s_{HA}$  ( $<0$ ), again that would be shared between domestic producers and consumers of that nontradable food. If the supply and demand elasticities of  $A_N$  were equal, equations (10) and (11) would become

$$TRA_{AH} = \hat{P}_{AH} - \hat{P}_N = \alpha_{HAS_{HA}}/2 - \hat{P}_N$$

and

$$TRA_A = \hat{P}_A - \hat{P}_N = \alpha_{MA}(e_m + t_{MA} + e_m t_{MA}) + \alpha_{XA}e_x + \alpha_{HAS_{HA}}/2 - \hat{P}_N$$

To keep the task manageable, one might simply assume the services sector produces only nontradables and that all non-agricultural nontradable goods and services are undistorted.<sup>19</sup> To see how sensitive  $TRA_A$  results could be to changes in that assumption, and to allowing distortions to nontradable food, consider the following hypothetical three-part example. Suppose a country’s market for foreign currency is undistorted ( $e_m = e_x = 0$ ), its tradable sectors are distorted only by tariffs on imports where  $t_{MA} = 0.1$  and  $t_{MN} = 0.2$ , the value of production shares are  $\alpha_{MA} = 0.4$ ,  $\alpha_{HA} = 0.25$ ,  $\alpha_{MN} = 0.3$  and  $\alpha_{HN} = 0.6$ , and the demand and supply elasticities of each nontradable are equal:

(i) If there were no distortions in the markets for nontradables, then

$$\hat{P}_N = \alpha_{MN}t_{MN} = 0.06$$

and

$$TRA_A = \alpha_{MA}t_{MA} - \hat{P}_N = 0.04 - 0.06 = \mathbf{-0.02}$$

(ii) If there was also a subsidy of 10% ( $s_{HN} = 0.1$ ) on non-agricultural nontradables, then

$$\hat{P}_N = \alpha_{MN}t_{MN} + \alpha_{HNS_{HN}}/2 = 0.06 + 0.03 = 0.09$$

and

$$TRA_A = \alpha_{MA}t_{MA} - \hat{P}_N = 0.04 - 0.09 = \mathbf{-0.05}$$

(iii) If there was also a tax of 20% ( $s_{HN} = -0.2$ ) on agricultural nontradables, then

<sup>19</sup> It is true that some services are tradable, but on average services exports plus imports as a percentage of the value of output in 2001 is only one-fifth that for goods in the case of developing countries, and only one-ninth in the case of high-income countries (according to the GTAP database). The smallness of those ratios may be in part due to higher barriers to trade in services than goods though, and some nonagricultural goods may be nontraded because of high trade barriers too. Hence sensitivity analysis such as above should be undertaken in countries where distortions are known to be prevalent in those industries.

$$\text{TRA}_A = \alpha_{\text{MA}} t_{\text{MA}} + \alpha_{\text{HASHA}}/2 - \hat{P}_N = 0.04 - 0.025 - 0.09 = \mathbf{-0.075}$$

Clearly the changes in the estimated  $\text{TRA}_A$  from  $-2\%$  to  $-5\%$  and then  $-7.5\%$  are non-trivial, so where estimates of sizeable distortions to nontradables are available they would be worth including. The only other parameter that is needed from the non-agricultural nontradable industries is their share of value of national output,  $\alpha_{\text{HN}}$ . The share of services in value added (that is, in GDP) is readily available in time series form, and it is close to the share of value of output according to the GTAP database for 2001. To that services share would need to be added the share of non-agricultural nontradable goods to get  $\alpha_{\text{HN}}$ .

### *Criteria for classifying industries as importable, exportable or non-tradable*

Apart from the complications raised at the end of Section 1.2 above about whether a product is nontraded simply because of trade taxes or NTBs, there will be cases where (a) trade is minimal or (b) the industry is characterized by significant imports *and* exports. If trade is minimal for trade cost rather than trade policy reasons, then it could be classified as nontradable if the share of production exported *and* the share of consumption imported are each less than 2.5 percent.<sup>20</sup> Otherwise, where the share of production exported is more than twice (less than half) the share of consumption imported, that industry can be classified as exportable (importable); and in between, where there are significant exports *and* imports, the value of production should be split according to those shares. For example, if 24 percent of production is exported and 16 percent of consumption is imported, the weights would be 0.6 and 0.4. If the only intervention in this industry is a tariff on imports, the rate of that tariff would be the DRA for the import-competing part, and zero would be the DRA for the other three-fifths of this industry. This split is needed so that a weighted average DRA for each of importables, exportables and nontradables in the economy can be calculated.

### ***1.5 Impact on the real consumer price of staple food***

Politicians and policy analysts are also interested in how the real price of staple food for vulnerable groups is affected by government policies. To estimate that, one also needs to know the shares of the vulnerable groups' expenditure on staple food and other products. Then one can calculate the weighted average CTE for staple food relative to the consumer price of all other products in this economy, using as weights the volume of consumption times the border price.

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<sup>20</sup> For those without easy access to such shares from national sources, time series of the relevant data for many countries are available at <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/TRADE/0,.contentMDK:20914323~menuPK:167374~pagePK:148956~piPK:216618~theSitePK:239071,00.html>

In addition to trade measures affecting the CTE, any direct consumption taxes or subsidies need to be included. Also, if some foods are exempt from the VAT, consumers will share the benefit of that with producers and so that part of it becomes an implicit subsidy to food consumption. If the VAT were to apply only to imported foods and not domestically produced ones, that complication also should be built into the CTE calculations.

A poor rural household may also be a producer of food, in which case one would need to net out the positive effect on their income from any policy-induced rise in food producers' prices from the negative effect on the expenditure side, before beginning to get a sense of its overall impact on particular households (Deaton 1989; Barrett and Dorosh 1996).<sup>21</sup> Given the prevalence of this in low-income countries, separate calculations of the CTE for farm households, for non-farm rural households, and for urban households may be warranted. These can then be inputs into spatially differentiating CGE models used for poverty analysis as, for example, in Jensen and Tarp (2005). Keep in mind that there may also be significant domestic trading costs involved in getting some food products from the port or urban processing plants to rural consumers, equal to the fraction  $T_c$  of the price paid at the urban point or international border. In that case  $P_c^r$  is  $(1+T_c)$  times  $P_c^u$  where the superscripts  $u$  and  $r$  refer to urban and rural points in space.

### ***1.6 Computable general equilibrium (CGE) considerations***

The nominal direct rates of protection/taxation on outputs and inputs for each sector, and consumer taxes on the various food and other products, are used in CGE models to generate the general equilibrium effective protection impacts of the various policy measures singly or collectively. Specifically, it can generate the impact of the policy regime on net farm incomes (agricultural value added) both absolutely and relative to its impact on value added in the non-agricultural part of the national economy. If the model is global, the effects on those two variables of other countries' policies also can be estimated.<sup>22</sup> Such a model will automatically take into account any market power this country or other countries may have in international markets for particular products.

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<sup>21</sup> An additional dimension of this issue is the impact of variability of staple food production and prices over time on the food security of vulnerable households. Policies aimed at insulating the domestic market from international food price variability can sometimes be counter-productive, especially for small price-taking economies (Dorosh 2001). When many countries so insulate, they reduce the global public good that international markets can provide. Anderson, Martin and van der Mensbrugge (2006) find that by removing current distortions as represented in the GTAP database, the share of global production of agricultural products traded would nearly double, thereby adding considerable stability to those markets and reducing the need for countries to insulate their domestic markets. This is consistent with the earlier findings of Tyers and Anderson (1992) using a dynamic stochastic model of the world's food markets.

<sup>22</sup> For examples of global model results of this sort that make use of the GTAP protection database, see Anderson and Valenzuela (2007) using the GTAP-AGR model and Anderson, Martin and van der Mensbrugge (2006) using the Linkage model.

## 2. Some practical considerations for the new World Bank study

Nominal rates are available from as early as 1955 in some cases, and at least from the mid-1960s, to the early or mid-1980s for the 18 countries included in Krueger, Schiff and Valdes (1988, 1991) and those in Anderson, Hayami and Others (1986). Since then much has been done to provide detailed estimates since 1986 of direct distortions to farmer (though not food processing) incentives in the high-income countries that are now members of the OECD, and (since the early or mid-1990s) in selected European transition economies and Brazil, China and South Africa (OECD 2006). As well, at least for direct distortions, the K/S/V measures have been updated to the mid-1990s for some Latin American countries (Valdes 1996) and provided also for some East European countries (Valdes 2000); and a new set of estimates of simplified PSEs for a few key farm products for China, India, Indonesia and Vietnam since 1985 are now available from IFPRI (Orden et al. 2006). Each of these studies provides an invaluable springboard for the new World Bank study.

The agricultural commodity coverage in this new study will include all the major food items (rice, wheat, maize or other grains, soybean or other temperate oilseeds, palm or other tropical oils, sugar, beef, sheep/goat meat, pork, chicken and eggs, milk) plus other key country-specific farm products (e.g., other staples, tea, coffee or other tropical tree crop products, tobacco, cotton, wine, wool). The final three rows of Table 3(a) show that globally, as of 2001, one-third of the value added in all agriculture and food industries is highly processed food, beverages and tobacco, which we will deal with in the same cursory way as for non-agricultural products. Fruit and vegetables are another one-sixth, so the rest constitute the other half. Of that other half, meats are one-third, grains and oilseeds are almost another one-third, dairy products are one-sixth, and sugar, cotton and other crops account for just over one-fifth. When the high-income countries are excluded, those shares change quite a bit: highly processed food, beverages and tobacco is only half as important, fruits and vegetables is somewhat more important and, when those two groups (which together account for 41 percent of the total) are excluded, the residual is equally divided between three groups: meats; grains and oilseeds; and other crops and dairy products. By focusing on all major grain, oilseed and livestock products plus any key horticultural and other crop products (and, where they are a key part of the farming system, shrimp or other fish), the coverage should reach the target of 70 percent of each country's value added in agriculture and lightly processed food excluding fruits and vegetables. Priority should be given to the most-distorted industries though, because then the residual will have not only a low weight but also a low degree of distortion.

On the household food expenditure side, if highly processed food, beverages and tobacco are excluded, fruits and vegetables account for almost one-quarter of that spending in developing countries (Table 3(b)). When they are also excluded, three groups each account for almost 30 percent of expenditure: pig and poultry products, red meat and dairy products, and grains and oilseed products. All other crops account for the

remaining one-eighth. So from the consumer tax viewpoint, the product coverage can be the same as suggested above from a production viewpoint.

As is clear from equations (8) to (11) above, it is crucial to explicitly identify whether each product is import-competing, nontradable, or exporting. For many products that categorization will have changed over time, in some cases moving monotonically through those three categories and in others fluctuating in and out of nontradability. Hence an indication of a product's net trade status may need to be given each year or for sub-periods rather than just one categorization for the whole time series. For seasonal products the status may even vary through the growing season of each calendar year.<sup>23</sup> And for large-area countries with high internal and coastal shipping costs, some regions within that country may be exporting abroad at the same time that other regions are net importers from other countries. In such cases it may be necessary to estimate separate DRAs for each region and then generate a national weighted average, and/or demonstrate that there is a high degree of co-movement of the product's domestic prices across regions within that country (as was done for China by Huang, Rozelle and Chang 2004).

Two final questions. First, in calculating the weighted average rates of assistance for a sub-sector or sector, as in equation (11) above, what DRA and CTE should be assumed for the 30 percent or so of agricultural products for which price comparisons are not calculated? The OECD in its PSE work assumes the not-measured part has the same market price support as the average of the measured part. Another default is to assume the rates are zero. Orden et al. (2006) show that these two alternatives produce significantly different results for India, so it may be better to make informed judgments for the import-competing, exporting and non-tradable parts of those residual groups of farm products. Average applied import tariffs may be the best guess for the import-competing products in that set (as for highly processed food, beverages and tobacco) if there is no evidence of explicit production, consumption or export taxes or subsidies. Even though that will miss non-tariff trade barriers affecting these residual products, the bias will be small if their weight is small.

And finally, how can these price wedges best enhance the GTAP protection database and GTAP policy reform modeling? If the average tariff rate in that database for a particular country and product is below the estimated DRA, one might be tempted to simply inflate that to the higher DRA level. But that average tariff rate is a weighted average across many bilateral trades, a subset of which involves tariff preferences. Distributing the higher DRA in the same pattern as the cross-country tariff distribution would be one solution. However, where NTBs are known to be discriminatory among import suppliers, that also should be taken into account (as with bans on food imports that may contain genetically modified organisms, for example – see Nielsen and Anderson 2001, Anderson and Jackson 2005). Estimating the cost of a country's current policies could then be done by simulating a removal of all of its distortions (bearing in mind that

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<sup>23</sup> In the case of high or prohibitive import tariffs on products just for the post-harvest season months, the in-season NRAO is the appropriate measure of producer protection, but the consumer tax equivalent for that product should be the consumption-weighted twelve-month average of the domestic-to-border price ratio (which will be necessarily lower than the NRAO).

this may overstate the welfare cost if in fact consumers prefer to have no GMOs in their food, for example). But when it comes to modeling, say, *partial* tariff reductions that might follow from the WTO's Doha round, an extra layer of complexity would be added to the pre-modeling tariff simulation work. In recent ex ante analysis of Doha scenarios, tariff-cutting formulae were applied to bound tariffs at the HS6 level of disaggregation to see to what extent if any the applied tariffs should be cut for each import-supplying country (Jean, Laborde and Martin 2006). With an NTB also included, judgments would have to be made by the modeler as to whether that or the applied tariff would then be the binding constraint. If the NTB was in the form of compliance costs to meet a technical standard, the task would be more straightforward than if it was a quantitative restriction for quarantine reasons. As economic analysts there's at least one sense in which we should be thankful for these complexities: they raise the demand for our services!

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Table 1: Import restrictions by sector and region: weighted average applied tariffs 2001

(percent)

<b>Importing region:</b>	<b>Agric and food</b>	<b>Other primary</b>	<b>Other manuf</b>	<b>All tradeables</b>
WORLD	16.8	2.6	4.2	4.9
High-income countries	16.1	1.1	2.0	2.8
Developing countries	17.5	6.7	9.5	9.9

Source: GTAP Version 6.1 database, available at [www.gtap.org](http://www.gtap.org) and Dimaranan (2006)

Table 2: Import restrictions by regions, 2001-05

(percent)

(a) overall trade restrictiveness indexes (OTRI)

<b>Importing region:</b>	<b>Own-region trade restrictions</b>			<b>Restrictions exporters face abroad</b>		
	<b>Agriculture and food</b>	<b>Other manuf</b>	<b>All tradables</b>	<b>Agriculture and food</b>	<b>Other manuf</b>	<b>All tradables</b>
WORLD	37	10	14	37	10	14
High-income countries	38	5	9	35	10	13
Middle-income countries	38	15	18	39	10	14
Low-income countries	36	20	23	37	12	18

(b) relative trade restrictiveness indexes

<b>Importing region:</b>	<b>Own-region trade restrictions</b>			<b>Restrictions exporters face abroad</b>		
	Agric & food rel. to other manuf OTRI	Tariff rel to total OTRI		Agric & food rel. to other manuf OTRI	Tariff rel to total OTRI	
		Agric and food	Other manuf		Agric and food	Other manuf
WORLD	373	55	52	373	55	52
High-income countries	1050	52	29	380	56	43
Middle-income countries	233	57	56	391	56	55
Low-income countries	159	64	66	300	53	60

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Source: Kee, Nicita and Olarreaga (2006), and OTRI excel file, in Data and Statistics part of [www.worldbank.org/trade/](http://www.worldbank.org/trade/)

Table 3: Shares of various agricultural products in total value added and in total household expenditure on agricultural and processed food products, at distorted domestic prices, 2001

(percent)

(a) Product<sup>a</sup> shares of three different totals<sup>b</sup> of agric and food GDP (value added)

	RIC	WHT	CGR	OLS	SUG	OCR	MLK	BSM	PPE	F_V	OPF	
European transition economies												
	1	8	5	3	5	8	9	6	9	24	21	100
	1	9	7	4	6	11	12	7	12	30	—	100
	2	14	10	6	9	15	17	10	17	—	—	100
Asia												
	14	3	2	6	3	9	6	3	15	29	10	100
	16	4	2	7	4	10	7	3	17	32	—	100
	23	5	4	10	5	14	10	5	24	—	—	100
Latin America												
	2	2	5	5	4	11	7	12	10	12	31	100
	2	3	6	7	6	16	10	18	14	17	—	100
	3	3	8	9	7	19	13	21	17	—	—	100
Sub Saharan Africa												
	2	1	12	3	3	19	2	7	7	21	22	100
	3	2	16	4	4	25	3	9	9	27	—	100
	4	2	22	5	5	34	4	12	12	—	—	100
MENA												
	2	10	4	2	4	4	7	10	14	35	9	100
	2	11	5	2	4	4	8	11	15	38	—	100
	3	18	7	4	7	7	13	17	24	—	—	100
<b>All developing (incl. transition) economies</b>												
	<b>8</b>	<b>4</b>	<b>4</b>	<b>5</b>	<b>4</b>	<b>9</b>	<b>7</b>	<b>6</b>	<b>12</b>	<b>24</b>	<b>17</b>	<b>100</b>
	<b>9</b>	<b>5</b>	<b>5</b>	<b>6</b>	<b>4</b>	<b>11</b>	<b>8</b>	<b>8</b>	<b>15</b>	<b>29</b>	—	<b>100</b>
	<b>13</b>	<b>7</b>	<b>7</b>	<b>9</b>	<b>6</b>	<b>16</b>	<b>11</b>	<b>11</b>	<b>21</b>	—	—	<b>100</b>
<b>World</b>												
	<b>5</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>3</b>	<b>9</b>	<b>9</b>	<b>7</b>	<b>10</b>	<b>16</b>	<b>32</b>	<b>100</b>
	<b>7</b>	<b>4</b>	<b>4</b>	<b>6</b>	<b>5</b>	<b>13</b>	<b>13</b>	<b>10</b>	<b>14</b>	<b>23</b>	—	<b>100</b>
	<b>10</b>	<b>5</b>	<b>6</b>	<b>8</b>	<b>6</b>	<b>16</b>	<b>17</b>	<b>13</b>	<b>19</b>	—	—	<b>100</b>

... continued

Table 3 (continued):

(b) Product<sup>a</sup> shares of three different totals<sup>b</sup> of agric and food expenditure by households

	RIC	WHT	CGR	OLS	SUG	OCR	MLK	BSM	PPE	F_V	OPF	
European transition economies												
	1	2	1	3	6	4	12	8	15	14	34	100
	1	3	1	5	9	5	19	12	22	22	—	100
	2	3	2	6	11	7	24	16	29	—	—	100
Asia												
	14	2	1	5	3	3	7	2	18	21	25	100
	18	3	1	7	4	4	9	3	23	27	—	100
	25	4	2	9	6	5	13	4	32	—	—	100
Latin America												
	2	0	2	3	3	3	9	14	12	6	47	100
	3	1	3	6	5	5	18	26	23	11	—	100
	4	1	3	7	6	5	20	29	26	—	—	100
Sub Saharan Africa												
	4	1	9	4	2	8	3	7	8	14	40	100
	7	1	16	6	4	13	5	12	13	24	—	100
	9	2	20	8	5	17	6	15	17	—	—	100
MENA												
	1	7	3	3	5	2	8	10	13	19	29	100
	2	10	5	5	6	2	11	14	18	26	—	100
	2	14	6	6	9	3	16	20	24	—	—	100
<b>All developing (incl. transition) economies</b>												
	<b>7</b>	<b>2</b>	<b>2</b>	<b>4</b>	<b>4</b>	<b>3</b>	<b>8</b>	<b>7</b>	<b>15</b>	<b>16</b>	<b>33</b>	<b>100</b>
	<b>11</b>	<b>3</b>	<b>3</b>	<b>6</b>	<b>5</b>	<b>4</b>	<b>12</b>	<b>10</b>	<b>22</b>	<b>23</b>	<b>—</b>	<b>100</b>
	<b>14</b>	<b>4</b>	<b>4</b>	<b>8</b>	<b>7</b>	<b>6</b>	<b>16</b>	<b>13</b>	<b>29</b>	<b>—</b>	<b>—</b>	<b>100</b>
<b>World</b>												
	<b>4</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>10</b>	<b>7</b>	<b>12</b>	<b>10</b>	<b>46</b>	<b>100</b>
	<b>8</b>	<b>2</b>	<b>2</b>	<b>6</b>	<b>5</b>	<b>5</b>	<b>18</b>	<b>13</b>	<b>23</b>	<b>19</b>	<b>—</b>	<b>100</b>
	<b>10</b>	<b>2</b>	<b>2</b>	<b>7</b>	<b>6</b>	<b>6</b>	<b>22</b>	<b>17</b>	<b>28</b>	<b>—</b>	<b>—</b>	<b>100</b>

<sup>a</sup> RIC=rice, WHT=wheat, CGR=coarse grains, OLS=oilseed products, SUG=raw and refined sugar, OCR=other crops, MLK=milk products, BSM=beef and sheep meats, PPE=pork, poultry and eggs, F\_V=fresh fruits and vegetables. If fresh fish had been included, its percentages in the final 3 rows of Table 3(a) for the world would be 4, 9, 12.

<sup>b</sup> Row 1 includes all primary agriculture and processed food, beverages and tobacco; Row 2 is the same as row 1 except the more highly processed foods and beverages and tobacco are excluded; and Row 3 is the same as row 2 except fruits and vegetables are excluded.

Source: Based on GTAP Version 6.1 database

Figure 1: The value chain for one unit of a farm product that is processed in the urban area before being traded internationally

(a) assuming no distortionary policies are in place and no processing

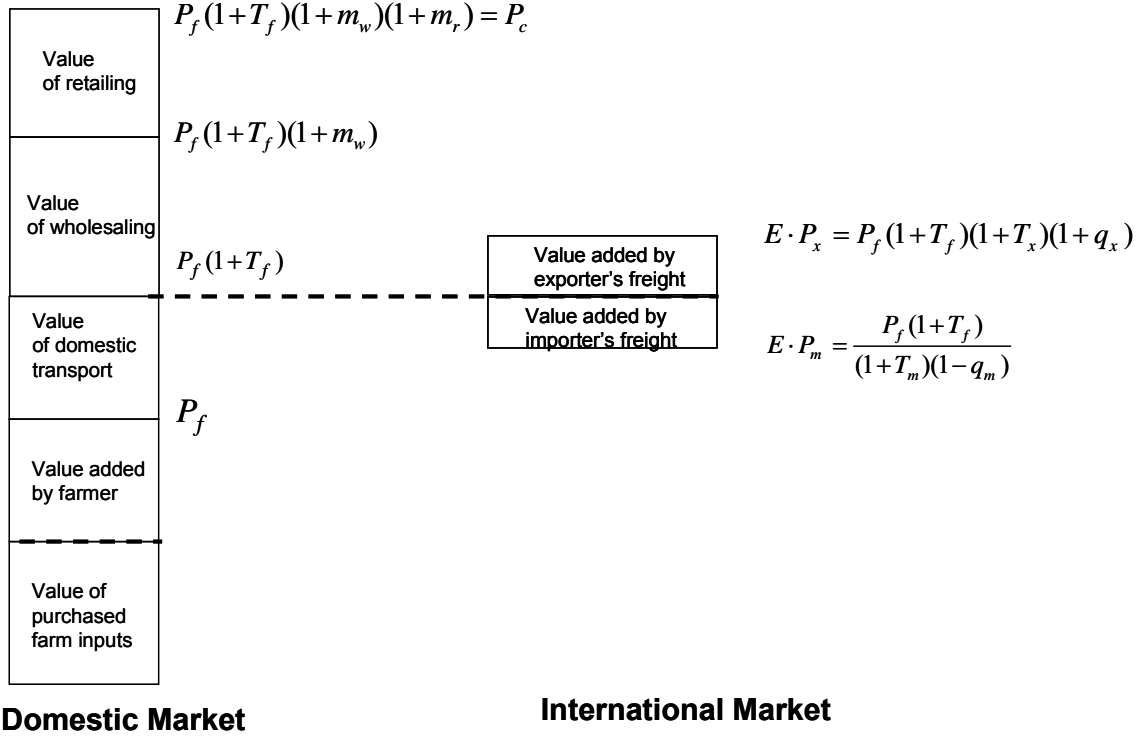


Figure 1: The value chain for one unit of a farm product that is processed in the urban area before being traded internationally

(b) assuming no distortionary policies are in place and processing is required before the product is tradable

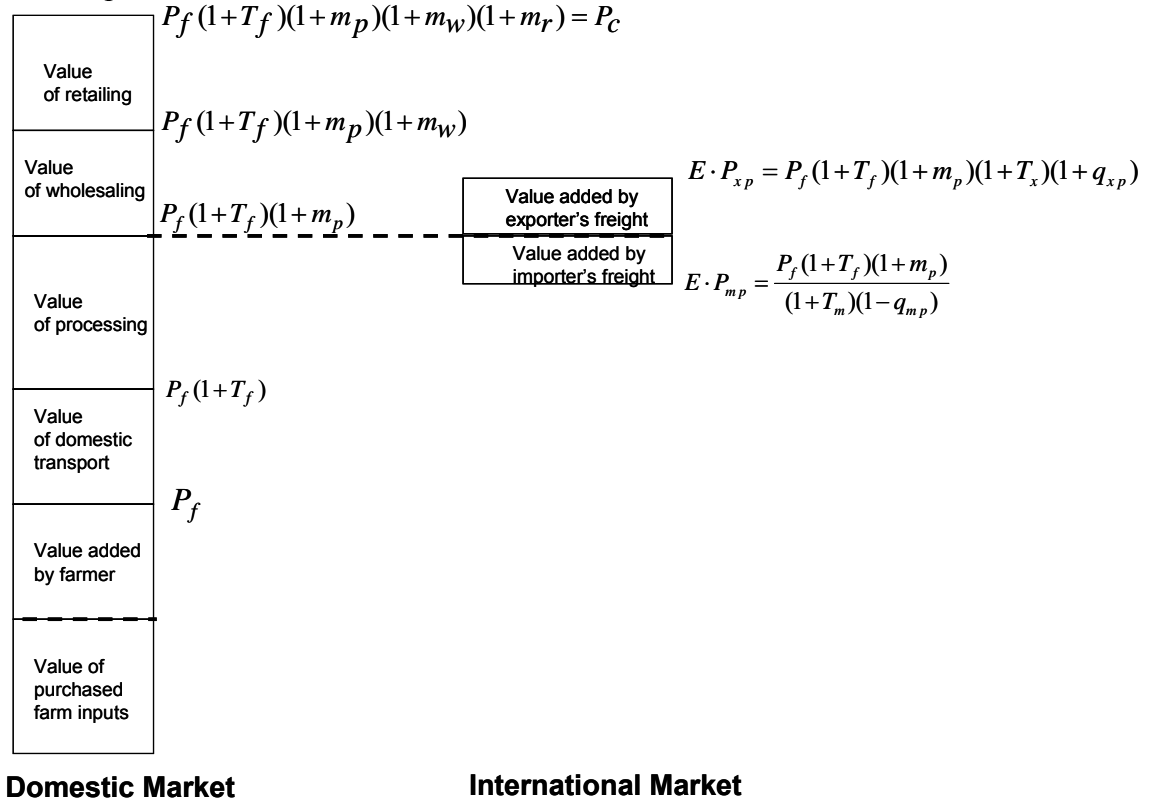
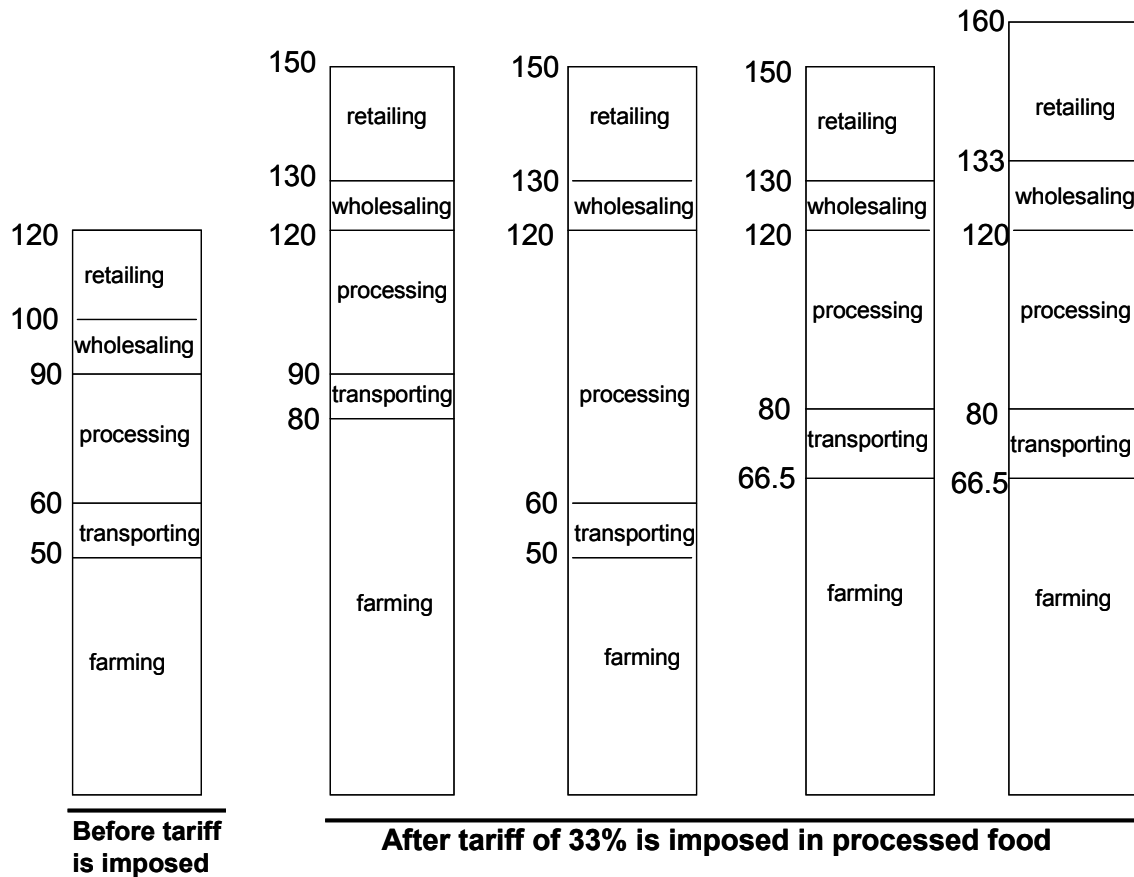


Figure 1: The value chain for one unit of a farm product that is processed in the urban area before being traded internationally

(c) assuming a 33 percent tariff is imposed on the processed product and that the primary product is nontradable



(i) Full pass-through to farmers (as assumed in OECD's PSEs) (fixed transport and distribution margins)	(ii) Zero pass-through to farmers (fixed transport and distribution margins)	(iii) Proportional pass-through to farmers and transporters (fixed distribution margins)	(iv) Proportional pass-through to all agents (proportional distribution margins)
$NRA_A = 0.60$	$NRA_A = 0.00$	$NRA_A = 0.33$	$NRA_A = 0.33$
$NRA_p = 0.00$	$NRA_p = 0.33$	$NRA_p = 0.33$	$NRA_p = 0.33$
$CTE = 0.25$	$CTE = 0.25$	$CTE = 0.25$	$CTE = 0.33$

Figure2(a): Tariff-distorted market for an importable product  
[imports > 0 if  $P_a > E \cdot P(1+t_m)(1+T_m)$ ]

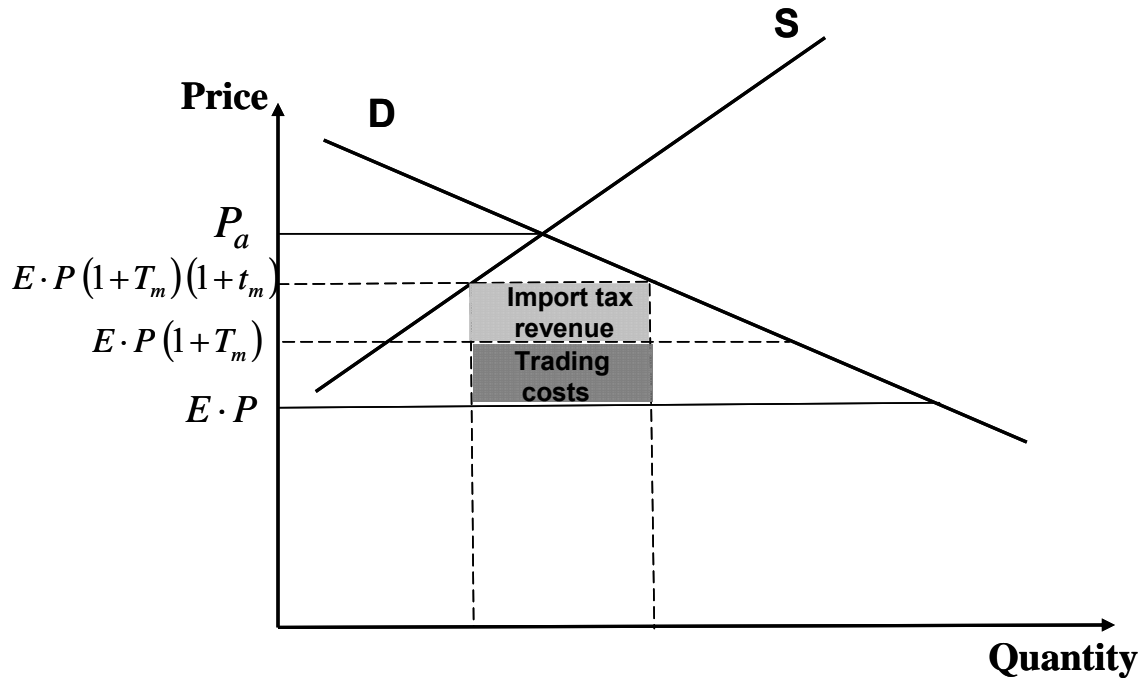


Figure 2(b): Tariff-distorted market for an importable good—no imports

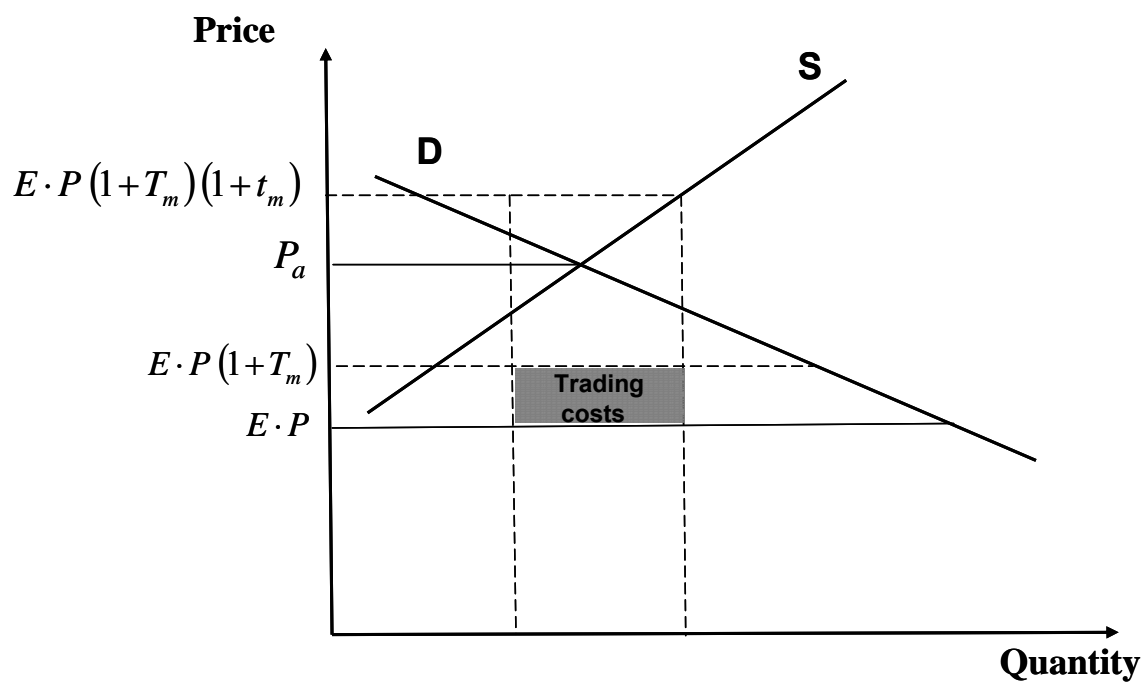


Figure 3: Export tax-distorted market for an exportable product

[exports > 0 if  $P_a < E \cdot P(1 + s_x) / (1 + T_x)$  where  $s_x < 0$  and so is an export tax]

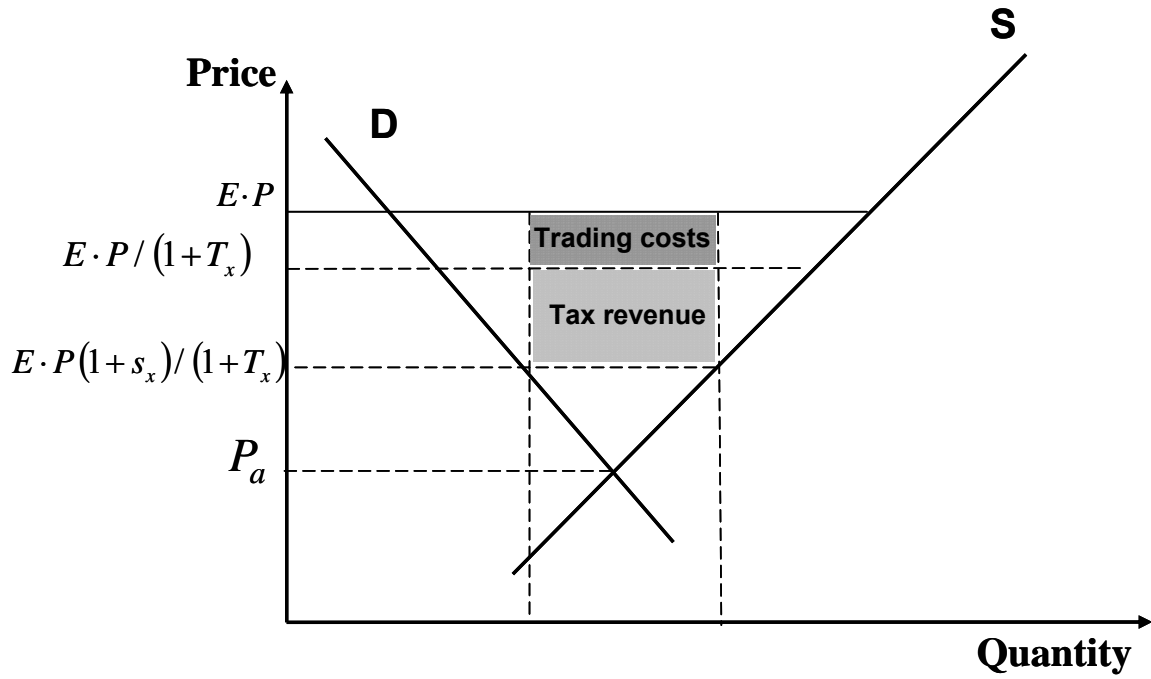


Figure 4: Market for a tradable product in the presence of trading costs ( $T_x$  and  $T_m$ ) and trade taxes (an import tariff of  $t_m$  and an export tax where  $s_x < 0$ )

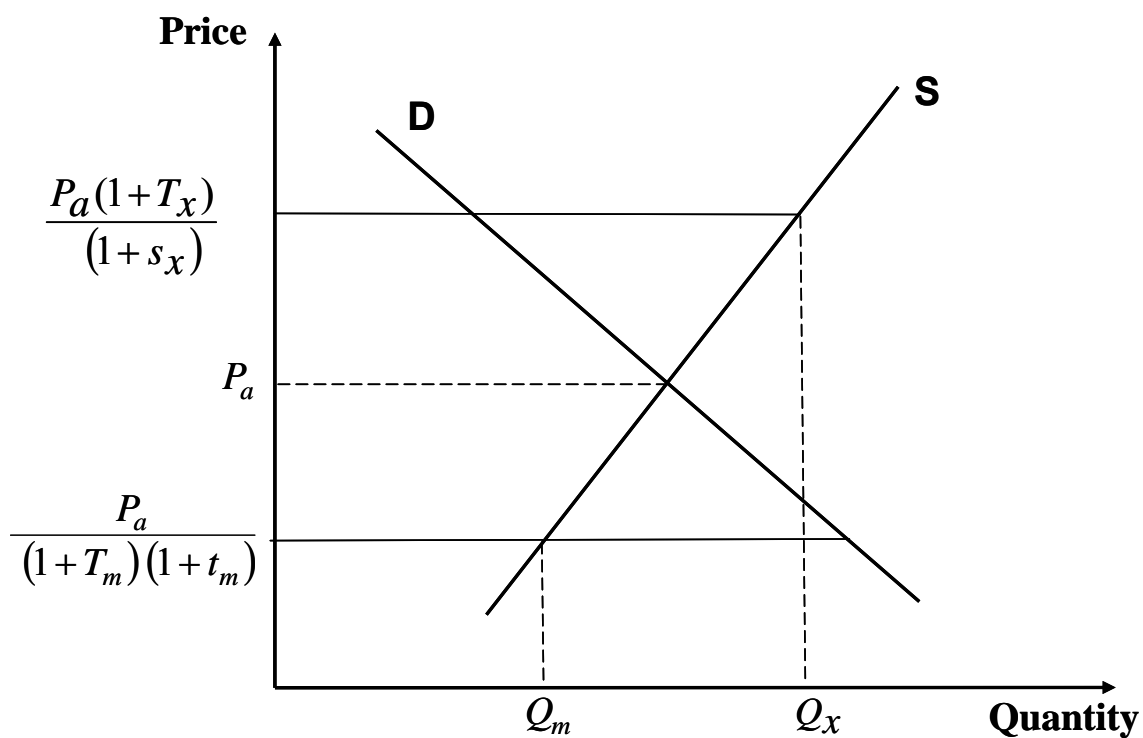
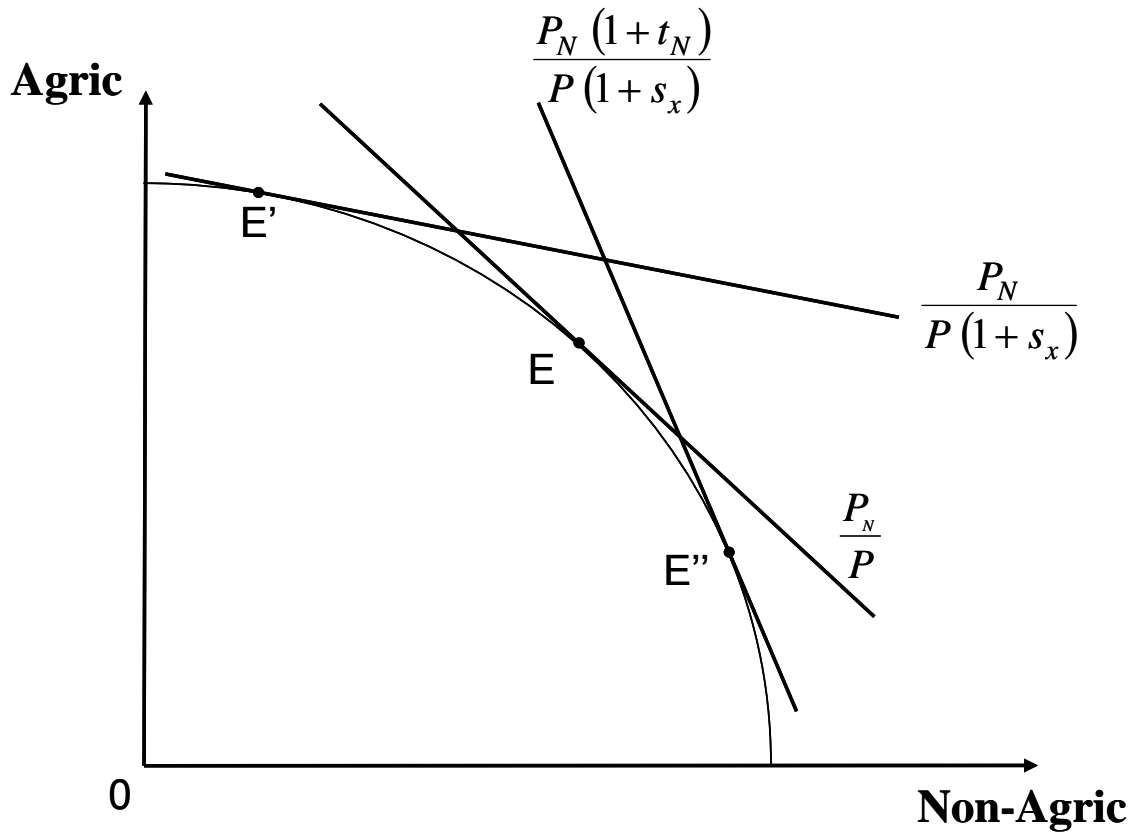


Figure 5: Economy-wide equilibrium without and with (a) an agricultural export subsidy  $s_x$  and (b) also an import tariff on non-agricultural goods  $t_m$  (where  $t_m > s_x$ )



## Appendix 1: Distortions to incentives among tradables via multiple exchange rates

While traditional multiple-tier exchange rates are now relatively rare, they were very important up to the late 1980s, and frequently involved very large distortions. The World Bank (2001, p. 54) estimated the average black market premium associated with developing-country exchange rates to be 82 percent in the 1980s, and these premia were frequently several hundred percent in individual countries. These distortions became much less common in the 1990s partly because of improved understanding of their adverse consequences, and partly because of improved general macro-economic management.

Multiple exchange rate regimes are akin to a tariff and an export tax in that they change the relative prices of importables and exportables, in general raising the price of importables and lowering the price of exportables. Typically they involve an official exchange rate that is overvalued relative to the exchange rate that would balance the demand for and supply of foreign exchange. The overvaluation of the exchange rate reduces the amount of exports, and hence the amount of foreign exchange available to the economy. The combination of the reduced supply of foreign exchange and its artificially depressed price at the official exchange rate causes excess demand for foreign exchange. This excess demand may be dealt with by rationing, but this is difficult to administer and creates enormous incentives for corruption. When a rationing approach is used, a black market in foreign exchange almost always arises in the absence – or even in the presence – of repression.

Exchange rate overvaluation requires strong controls on current account transfers, usually including requirements that exporters surrender their foreign exchange earnings. One way to reduce the adverse impacts of exchange rate overvaluation on incentives to export, and to diminish the shortage of foreign exchange, is to legalize the secondary market for foreign exchange and to allow exporters to retain some fraction of their exchange rate earnings either for their own use or for sale in the secondary market. The existence of a secondary market price helps allocate scarce foreign exchange among competing users. That price also provides researchers with a way to assess the implications of the multi-tier exchange rate for incentives. The right to retain and sell a portion of their foreign exchange receipts increases the incentives to export, and reduces the shortage of foreign exchange, and hence the secondary market exchange rate (Tarr 1990).

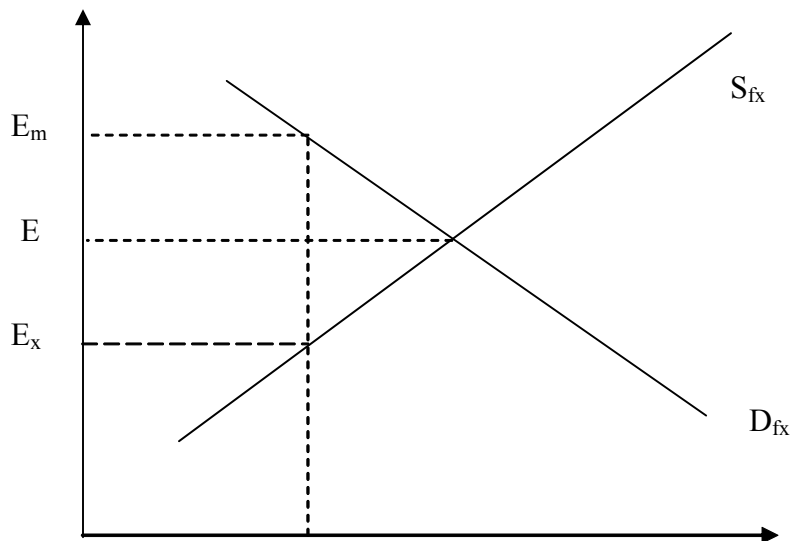
A simple diagram is useful to assess the consequences of a two-tier exchange rate system. In this diagram, we assume that the overall domestic price level is fixed, perhaps by holding the money supply constant. The supply of foreign exchange is given by the upward sloping schedule,  $S_{fx}$ , and the demand by  $D_{fx}$ , the official exchange rate is  $E_x$  and the secondary market rate  $E_m$ .

The gap between the official and the secondary market exchange rate is an indication of the magnitude of the tax imposed on trade by the two-tier exchange rate. We know from the Lerner Symmetry Theorem that it does not matter whether such a tax is imposed as an import duty or an export tax. If we think of it as an export tax, then an average tax rate of 82 percent (World Bank 2001) suggests that an average developing-country exporter in the 1980s needed a price of 182 to obtain a net return of 100 after allowing for the exchange rate overvaluation. In the absence of the exchange rate

distortion, the equilibrium exchange rate in the economy would have been  $E$ . Relative to this equilibrium rate, the price of importables is raised by  $(E_m - E) = e_m E$ , subsidizing their production and taxing their consumption, while the price of exportables is reduced by  $(E - E_x) = e_x E$ , taxing their producers and subsidizing their consumption. If the demand and supply curves in Figure A1 had the same slope then  $e_m = e_x$  and  $(e_m + e_x)$  is the secondary market premium (published since 1946 in *Pick's Currency Yearbook*, now the *World Currency Yearbook*).

One potential complication involved in assessing the effects of two-tier exchange rates arises if there is a foreign exchange retention scheme. As noted above, these schemes reduce the disincentive to export by allowing exporters to sell a portion of their foreign exchange receipts on the secondary market. This raises the weighted-average return from exports to  $w_x E_x + (1 - w_x) E_m$ . This difference must be taken into account when considering the incentive to export, and hence the distortion resulting from the exchange rate system. The foreign exchange retention arrangement can also be expected to reduce the secondary market rate by augmenting the supply of foreign exchange. This, however, poses no problem for measurement of distortions, since it is incorporated in the data on secondary market exchange rates.

Figure A1: Market for foreign exchange in a two-tier system



## **Appendix 2: Altering the price of tradables relative to nontradables via real exchange rate changes**

A change in the real exchange rate alters equally the prices of exportables and importables relative to the prices of nontraded goods. Such a change can arise for many different reasons, including changes in the rate of capital inflows and macroeconomic adjustments. Perhaps the simplest such case is that discussed by Salter (1959) and depicted in Figure A2. The economy has a production possibility frontier producing two goods: a nontradable NT and a composite traded good, T. In the initial equilibrium, consumption and production of NT and T in the home economy are balanced and the real exchange rate is determined by the tangency of the production possibility frontier and the community indifference curve. The initial real exchange rate,  $R_0$  indicating the relative price of T and NT, is given by the common slope of the production possibility frontier and the community indifference curve at their point of tangency.

When the economy receives a windfall – such as a continuing inflow of foreign exchange from foreign aid – the community moves to a higher indifference curve. While net imports of traded goods can change in response to this inflow of foreign exchange, the domestic supply of and demand for nontraded goods must balance. The equilibrating mechanism in this model is the price of nontraded goods. The price of nontraded goods rises to bring forth the needed increase in the supply of nontraded goods, and to reduce the demand for these goods to bring it into line with supply. In the new equilibrium at real exchange rate  $R_1$ , the quantity of the nontraded good demanded and supplied are in balance at  $NT_1$ .

While this type of real exchange change affects the incentive to produce traded goods, it is quite different from the distortion involved in a multiple-tier exchange rate system. The incentives to produce importable and exportable goods are reduced to the same degree by this real exchange rate appreciation. In contrast with the multiple-tier exchange rate case, there is no change in the relative prices of exportable and importable goods. Further, there is no economic distortion of the type measurable using tools such as producer or consumer surplus. Thus, it seems appropriate to consider this type of shock simply as one changing incentives faced by producers, but not one that is distorting those incentives away from where they should be to maximize national economic welfare.

Figure A2: A real exchange rate appreciation

