Methodology for Measuring Distortions to Agricultural Incentives

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The World Bank's two-stage project on "*Poverty Alleviation Through Reducing Distortions to Agricultural Incentives*" begins with five premises:

- Three-quarters of the world's poor (<$1/day) live in developing countries and depend directly or indirectly on agriculture for their livelihood;
- Poverty can be alleviated by economic growth (Dollar and Kray 2002, 2004);
- In addition to the comparative static welfare costs of price and trade policy interventions by governments (Bhagwati 1971, Corden 1997), economic growth also is inhibited by them (Easterly 2001; Winters 2002, 2004)
  - and those interventions are becoming ever-more costly in the case of agriculture when they blunt producers' responsiveness to consumers' strengthening preferences for quality, variety and safety attributes of food (Reardon and Timmer 2007);
- In many developing countries their government policies have depressed farm incomes, while in many high-income (and some developing) countries government policies have raised those countries' prices and outputs of farm products and thereby depressed the cash earnings of farm households in other developing countries; and
- The ostensible national objectives of those government interventions in both developing and high-income countries, including poverty alleviation, could be achieved more efficiently and effectively with other policy instruments than (or even just without) the ones chosen.

One of the reasons for the present research project is to see to what extent these last two premises still hold. Reasons to re-evaluate them include significant unilateral agricultural, trade and exchange rate policy reforms in numerous low-, middle- and high-income countries over the past two decades (Valdes 1998; Jensen, Robinson and Tarp 2002; Akiyama et al. 2003), including the de-coupling of some farm-support programs

from production and the provision by some high-income countries of preferential market access for selected low-income country exporters. For the countries where those premises are no longer true, when were the turning points, what form did they take, and how close are those countries now to free trade? For the countries where the above premises still hold, what is the nature and extent of the remaining distortions, and what could be gained in terms of raising the level and growth of national economic welfare and reducing poverty and inequality by liberalizing either developing or high-income countries' policies? For any particular developing country, what would be the relative contribution of own-reform, reform by other developing countries, and reform by high-income countries; and how important are the potential direct contributions from agricultural policy reform relative to the indirect contributions from non-agricultural policy reforms?[1] How much of the benefit or cost of 'agricultural and food' policies (which are negotiated in the WTO and hence analyzed by trade economists as a package) accrues to farmers as distinct from food processors? What explains the pattern of distortions to farmers and food consumers across countries and over time, both within the agricultural sector and between it and other sectors, and the range of choices of (often sub-optimal) policy instruments for achieving each nation's objectives?

These types of questions cannot be answered without accurate estimates of the changing extent of distortions to incentives over an extensive time period in a broad sample of countries at various stages of development. The first part of this project is aimed at providing such a time series of estimates for a large sample of countries, and then using it as the basis for an analytical narrative of the history and reasons behind the evolution of distortions in that economy (bearing in mind that getting markets right requires a focus not only on incentives but also on institutions and infrastructure). The empirical estimates will build on the pioneering work to the mid-1980s by Krueger,

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[1] These questions have been addressed recently by global CGE modelers (e.g., Anderson and Valenzuela (2007) using the GTAP-AGR model for 2001, and Anderson, Martin and van der Mensbrugghe (2006) using the Linkage model projected to 2015. Both models suggest that agricultural value added (i.e. net farm incomes) would rise in developing countries if high-income countries were to remove their agricultural protection (despite preference erosion), and that while they would fall a bit from farm policy reform in developing countries, that would be more than offset if all countries were to liberalize all merchandise trade, except in some South Asian and European transition economies. Those results are derived using the GTAP protection database though, which relies mostly on just tariff rates to estimate developing country distortions and so may be misleading. Those studies will be redone once a more-comprehensive distortions database becomes available via the present project.

Schiff and Valdes (1988, 1991) and updates by Valdes (1996, 2000), the work by Anderson, Hayami and Others (1986) for Korea, Taiwan and high-income countries and, for the period since 1986, by the OECD (2007a) for its member countries and select non-member, although the methodology will differ a little from each of those approaches.[2]

The most commonly used distortions for global trade policy modeling are those in the GTAP database (see Valenzuela and Anderson 2006, Table 2), but that set does not include non-tariff barriers to imports and exports (nor all export taxes or consumption taxes/subsidies). A recent study of the overall trade restrictiveness index (developed by Anderson 1998 and Anderson and Neary 2006), albeit using rather crude indicators of non-tariff barriers (NTBs), suggests the latter are as important as tariff barriers (see Valenzuela and Anderson 2006, Tables 3 and 4), so relying on just tariffs may miss many of the distortions in agricultural and food markets.[3] On the other hand, tariffs are redundant in some industries, and so may overstate protection provided to producers in those industries.

This paper outlines the methodological issues associated with the task of measuring that actual delivered direct protection or taxation to individual agricultural industries, as well as the direct protection or anti-protection to non-agricultural sectors (which can have an offsetting effect via Lerner's Symmetry Theorem). It begins with a guide to what elements in principle could be measured. It then discusses the more-limited scope of what measurements in practice we are aiming to include in this study.

Not all aspects of the following will be relevant to every country in the study, as our project includes the full spectrum of countries from richest to poorest, from land-abundant per capita to land- and water-scarce, and from landlocked and small-island economies to the massive countries of China, India and Russia. (Together the included developing, transition and high-income countries account for around 90 percent of global

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[2] Less-careful but longer historical time series of agricultural protection rates can be found in Lindert (1991). Rough cross-country estimates for the early 1980s for ex ante Uruguay Round modeling of distortions to global food markets are available in Tyers and Anderson (1992), as summarized in Figure 1.

[3] Some of the NTBs are in place to (perhaps inefficiently) overcome externalities associated with natural resource depletion (a ban on log exports) or disease importation (SPS or quarantine restrictions). This is but one example of where care is needed to distinguish between distortions and other market intervention measures. Even where the motivation for, say, an import ban might be for plant health reasons, it is possible that the ban 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 (James and Anderson 1998).

GDP, population, trade and agricultural employment and exports – see Sandri, Valenzuela and Anderson 2006).

What theory suggests should be measured

Two key purposes of the distortion estimates being generated by this project are:

- To provide a long annual time series of indicators showing the extent to which price incentives faced by farmers and food consumers have been distorted directly and indirectly by own-government policies in all major developing, transition and high-income countries, and hence for the world as a whole (taking international prices as given); and

- To attribute the price distortion estimates for each farm product to specific border or domestic policy measures, so they can serve as inputs into various types of partial and general equilibrium economic models for estimating the effects of those various policies on such things as national and international agricultural markets, farm value added, income inequality, poverty, and national, regional and global welfare.

The first objective, of getting a long time series for a wide range of countries at different stages of development and hence with different complexities and qualities of data, requires that the indicators be simple. That would also make it easier to update them subsequently for policy monitoring purposes. The third purpose, of making them useful for modelers seeking to distinguish market and household welfare effects, requires distortion estimates to be provided also for at least lightly processed foods.[4]

In this project, we follow the Bhagwati (1971) and Corden (1997) concept of a market policy distortion 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 estimated using welfare measures techniques such as those pioneered by Harberger (1971). As

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[4] Although it is not an explicit objective of the project, providing comparable estimates of distortions to lightly processed food industries in addition to primary agricultural industries at the farm gate and to food consumers at the retail level could illuminate trade and processing costs which contribute to price gaps at different points in the value chain.

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 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 flow-on consequences of the distortion, but these should not be confused with the direct price distortion that we aim to estimate. 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 of the distortion on producers in the taxing country. Another flow-on consequence is the effect of trade distortions on the real exchange rate, which is the price of traded goods relative to non-traded goods. Neither of these flow-on effects are of immediate concern, however, because if the direct distortions are accurately estimated, they can be incorporated as price wedges into an appropriate country or global economy-wide computable general equilibrium (CGE) model which in turn will be able to capture the full general equilibrium impacts (inclusive of real exchange rate effects) of the various direct distortions to producer and consumer prices.

Importantly, 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 direct policy measures altering incentives in ***non-agricultural*** sectors. It is *relative* prices and hence relative rates of government assistance that affect producers' incentives. In a two-sector model an import tax has the same effect on the export sector as an export tax: the Lerner (1936) Symmetry Theorem. This carries over to a model that has many sectors, and is unaffected if there is imperfect competition domestically or internationally or if some of those sectors produce only non-tradables (Vousden 1990, pp. 46-47). The symmetry theorem is therefore also relevant for considering distortions *within* the agricultural sector. In particular, if import-competing farm industries are protected, for example via import tariffs, this has similar effects on incentives to produce exportables as does an explicit tax on agricultural exports; and if both measures are in place, this is a double imposition on farm exporters.

In what follows, we begin by focusing first on direct distortions to agricultural incentives, before turning to those affecting the sector indirectly via non-agricultural policies.

Direct agricultural distortions

Consider a small, open, perfectly competitive national economy with many firms producing a homogeneous farm product with just primary factors. In the absence of externalities, processing, producer-to-consumer wholesale plus retail marketing margins, exchange rate distortions, and domestic and international trading costs, that country would maximize national economic welfare by allowing both the domestic farm product price and the consumer price of that product to equal E times P, where E is the domestic currency price of foreign exchange and P is the foreign currency price of this identical product in the international market. That is, any government-imposed diversion from that equality, in the absence of any market failures or externalities, would be welfare-reducing for that small economy.

Price-distorting trade measures at the national border

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 assistance*** to farm output conferred by border price support *(NRA$_{BS}$)*, 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:[5]

$$(1) \qquad NRA_{BS} = \frac{E \times P(1+t_m) - E \times P}{E \times P} = t_m$$

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[5] The *NRA* thus differs from the 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.

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

(2) $CTE = t_m$

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) $NRA_{BS} = CTE = s_x$

If any of these trade taxes or subsidies were specific rather than ad valorem (e.g., $y/kg rather than z percent), its ad valorem equivalent can be calculated using slight modifications of equations (1), (2) and (3).

Domestic producer and consumer price-distorting measures

Governments sometimes intervene with a direct production subsidy for farmers, s_f (or production tax, in which case s_f is negative, including via informal taxes in kind by local and provincial governments). In that case, if only this distortion is present, the effect on producer incentives can be measured as the ***nominal rate of assistance*** to farm output conferred by domestic price support *(NRA$_{DS}$)*, which 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 c_c on this product (or consumption subsidy, in which case c_c is negative), the *CTE* is as above except c_c replaces t_m or s_x, but the *NRA$_{DS}$* in that case is zero.

The combination of domestic and border price support provides the total rate of assistance to output, NRA_o.

(4) $NRA_o = NRA_{BS} + NRA_{DS}$

What if the exchange rate system also is distorting prices?

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 for foreign currency, changing both the exchange rate received by exporters and that paid by importers from the equilibrium rate E that would prevail without this distortion in the domestic market for foreign currency (Bhagwati 1978).

Exchange rate overvaluation of the type we consider here requires controls by the government on current account transfers. A common requirement is that exporters surrender their foreign currency earnings to the central bank for exchange to local currency at a low official rate. This is equivalent to a tax on exports to the extent that official rate is below what the exchange rate would be in a market without government intervention. That implicit tax on exporters reduces their incentive to export and hence the supply of foreign currency flowing into the country. With less foreign currency, demanders are willing to bid up its purchase price. That provides a potential rent for the government, which can be realized by auctioning off the limited supply of foreign currency extracted from exporters or creating a legal secondary market. Either mechanism will create a gap between the official and parallel rates.

Such a dual exchange rate system is depicted in Figure 1, in which is it assumed that the overall domestic price level is fixed, perhaps by holding the money supply constant (Dervis, de Melo and Robinson 1981). The supply of foreign exchange is given by the upward sloping schedule, S_{fx}, and demand by D_{fx}, where the official exchange rate facing exporters is E_0 and the secondary market rate facing importers is E_m. At the low rate E_0, only Q_S units of foreign currency are available domestically, instead of the equilibrium volume Q_E that would result if exporters were able to exchange at the "equilibrium rate" E units of local currency per unit of foreign currency.[6] The gap

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[6] "Equilibrium" in the sense of what would prevail without this distortion in the domestic market for foreign currency. In the diagram, and in the discussion that follows, the equilibrium exchange rate E exactly balances the supply and demand for foreign currency. Taken literally, this implies a zero balance on the current account. The approach here can readily be generalized to accommodate exogenous capital flows

between the official and the secondary market exchange rates is an indication of the magnitude of the tax imposed on trade by the two-tier exchange rate: relative to the equilibrium rate E, the price of importables is raised by $e_m \times E$, which is equal to $(E_m - E)$, while the price of exportables is reduced by $e_x \times E$, which is equal to $(E - E_0)$, where e_m and e_x are the fractions by which the two-tier exchange rate system raises the domestic price of the importable and lowers the domestic price of the exportable, respectively. 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.[7] If the demand and supply curves in Figure 1 had the same slope, then $e_m = e_x$ and $(e_m + e_x)$ is the secondary market premium or proportional rent extracted by the government or its agents.[8]

If the government chooses to allocate the limited foreign currency to different groups of importers at different rates, that is called a multiple exchange rate system. Some lucky importers may even be able to purchase it at the low official rate. The more that is allocated and sold to demanders whose marginal valuation is below E_m, the

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and transfers, which would shift the location of Q_E. With constant-elasticity supply and demand curves all of the results would carry through, and any exogenous change in those capital flows or transfers would imply a shift in the D_{fx} or S_{fx} curves.

[7] From the viewpoint of wanting to use the NRA_o and CTE estimates later as parameters in a CGE model, it does not matter what assumptions are made here about these elasticities, as the CGE 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: the traditional incidence result from tax theory that also applies to trade taxes (Lerner 1936). For an excellent general equilibrium treatment, using an early version of the World Bank's 1-2-3 Model, see de Melo and Robinson (1989). There the distinction is made between traded and non-traded goods (using the Armington (1969) assumption of differentiation between products sold on domestic as distinct from international markets), in contrast to the distinction between tradable and non-tradable products made below.

[8] Note that this same type of adjustment could be made where the government forces exporters to surrender all foreign currency earnings to the domestic commercial banking system and importers to buy all foreign currency needs from that banking system where that system is allowed by regulation to charge excessive fees. This apparently occurs in, for example, Brazil, where the spread is reputedly 12 percent. If actual costs in a non-distorted competitive system are only 2 percent (as they are in the less-distorted Chilean economy), the difference of 10 points could be treated as the equivalent of a 5 percent export tax and a 5 percent import tax applying to all tradables (but, as with non tariff barriers, there would be no government tariff revenue but rather rent, in this case accruing to commercial banks rather than to the central bank). This is an illustration of the point made by Rajan and Zingales (2004) of the power of financial market reform in expanding opportunities.

greater the unsatisfied excess demand at E_m and hence the stronger the incentive for an illegal or 'black' market to form, and for less-unscrupulous exporters to lobby the government to legalize the secondary market for foreign exchange and to allow exporters to retain some fraction of their exchange rate earnings for sale in the secondary market. Providing such a right to exporters to retain and sell a portion of foreign exchange receipts increases their incentives to export, and thereby reduces the shortage of foreign exchange and hence the secondary market exchange rate (Tarr 1990). In terms of Figure 1, the available supply increases from Q_S to Q_S', bringing down the secondary rate from E_m to E_m' such that the weighted average of the official rate and E_m' received by exporters is E_x' (the weights being the retention rate r and $(1-r)$). Again, if the demand and supply curves in Figure 1 had the same slope, then the implicit export and import taxes resulting from this regime would be each equal to half the secondary market premium.

In the absence of a secondary market and with multiple rates for importers below E_m and for exporters below E_0, a black market often emerges. Its rate for buyers will be above E by more the more the government sells its foreign currency to demanders whose marginal valuation is below E_m and the more active is the government in catching and punishing exporters selling in that illegal market. If the black market was allowed to operate 'frictionlessly' there would be no foreign currency sales to the government at the official rate and the black market rate would fall to the equilibrium rate E. So even though in the latter case the observed premium would be positive (equal to the proportion by which E is above nominal official rate E_0), there would be no distortion. For present purposes, since the black market is not likely to be completely 'frictionless', it can be thought of as similar to the system involving a retention scheme. In terms of Figure 1, E_m' would be the black market rate for a proportion of sales and the weighted average of that and E_0 would be the exporters' return. Calculating E_x' in this case (and hence being able to estimate the implicit export and import taxes associated with this regime) by using the same approach as in the case with no illegal market thus requires not only knowing

E_0 and the black market premium but also guessing the proportion, r, of sales in that black market.

In short, where a country has distortions in its domestic market for foreign currency, the exchange rate relevant for calculating the NRA_o or CTE for a particular tradable product depends, in the case of a dual exchange rate system, on whether the product is an importable or an exportable, while in the case of multiple exchange rates it depends on the specific rate applying to that product each year.

What about real exchange rate changes?

A change in the real exchange rate alters equally the prices of exportables and importables relative to the prices of nontradable goods and services. Such a change can arise for many different reasons, including changes in the availability of capital inflows, macroeconomic policy adjustments, or changes in the international terms of trade. When the economy receives a windfall – such as a greater inflow of foreign exchange from remittances or foreign aid or a commodity boom – the community moves to a higher indifference curve (Collier and Gunning 1998). While net imports of tradables can change in response to this inflow of foreign exchange, the domestic supply of and demand for nontradables must balance. The equilibrating mechanism is the price of nontradables. The price of nontradables rises to bring forth the needed increase in the supply of nontradables, and to reduce the demand for these products to bring it into line with supply (Salter 1959).

While this type of change in the real exchange rate affects the incentive to produce tradables, it is quite different from distortions in the market for foreign currency analyzed above, in two respects. First, this real exchange rate appreciation reduces the incentives to produce importables and exportables to the same degree. In contrast with the multiple-tier exchange rate case, that appreciation does not generate any change in the prices of exportables relative to importables. Second, most such changes do not involve direct economic distortions of the type measurable using tools such as producer or consumer surplus. If the government, or the private sector, chooses to borrow more from abroad to increase domestic spending, this may raise the real exchange rate, but such an outcome is not obviously a distortion. Moreover, symmetric treatment of any such

"overvaluation" during periods of high foreign borrowing would require taking into account exchange rate "undervaluation" during periods of low foreign borrowing or repayment of foreign debt. For these reasons, we do not follow Krueger, Schiff and Valdes (1988) and Orden et al. (2007) in including deviations of real exchange rates from benchmark values, unless these deviations arise from direct exchange rate distortions such as multiple-tier exchange rates.[9]

What if trade costs are sufficiently high for the product to be not traded internationally? Suppose the transport costs of trading are sufficient to make it unprofitable for a product to be traded internationally, such that the domestic price fluctuates over time within the band created by the cif import price and the fob export price. Then any trade policy measure (t_m or s_x) or the product-specific exchange rate distortion (e.g., e_m or e_x) is redundant. In that case, in the absence of other distortions, $NRA_o = 0$, and the $CTE = 0$. However, 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 the impact depends on the price elasticities of domestic demand and supply for the non-tradable (the standard closed-economy tax incidence issue).

To give a specific example, suppose just a production tax is imposed on farmers producing a particular nontradable, so $s_f < 0$ and $t_c = 0$. In that case:

(5) $\qquad NRA_{DS} = \dfrac{s_f}{1 + \dfrac{\varepsilon}{\eta}}$

and

(6) $\qquad CTE = \dfrac{-s_f}{1 + \dfrac{\eta}{\varepsilon}}$

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[9] Results from a multi-country research project that has had macro policy as its focus are reported in Little et al. (1993).

where ε is the price elasticity of supply and η is the (negative of the) price elasticity of demand.[10]

What if farm 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. 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. In other situations there will be farm input subsidies but an export tax on the final product.[11] In principle all these items could be brought together to calculate an effective rate of direct assistance to farm value added (ERA). The nominal rate of direct assistance to farm output, NRA_o, is a component of that, as is the sum of the nominal rates of direct assistance to all farm inputs, call it NRA_i. In principle, all three rates can be positive or negative.

Participants were not required to estimate ERAs in this project because to do so requires knowing each product's value added share of output. Such data are not available for most developing countries even every few years, let alone for every year in the time series. And in most developing countries distortions to farm inputs are very small compared with distortions to farm output prices and those purchased inputs are a small fraction of the value of output. But where there are significant distortions to input costs, their ad valorem equivalent is accounted for by summing each input's NRA times its input-output coefficient to obtain the combined NRA_i, and adding that to the farm industry's nominal rate of direct assistance to farm output, NRA_o, to get the total nominal rate of assistance to farm production, call it simply NRA. [12]

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[10] As in the two-tier exchange rate case, the elasticities are used merely to identify the incidence of these measures: as long as both the NRAo and the CTE are included in any economic model used to assess the impact of the production tax, the real impacts will depend only on the magnitude of the total distortion, s_f, not on the estimated NRA and CTE.

[11] On this general phenomenon of offsetting distortions for outputs and inputs (and even direct payments or taxes), see Rausser (1982).

[12] Bear in mind that a fertilizer plant or livestock feedmix plant might be enjoying import tariff protection that raises the domestic price of fertilizer or feedmix to farmers by more than any consumption subsidy (as had been the case for fertilizer in Korea – Anderson 1983), in which case the net contribution of this set of input distortions to the total *NRA* for agriculture would be negative.

(7) $NRA = NRA_o + NRA_i$.

What about post-farmgate costs?

If a state trading corporation is charging excessively for its marketing services and thereby lowering the farm-gate price of a product, for example as a way of raising government revenue in place of an explicit tax, the extent of that excess should be treated as if it is a tax.

Some farm products, including some that are not internationally traded, are inputs into a processing industry that may also be 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. Before explaining how, it is helpful first to review the role that the value chain's marketing and distribution margins can play in the calculation of distortions to primary agricultural activities, so as to ensure non-distortionary price wedges are not inadvertently included in any distortions calculation.

Non-distortionary price wedges

So far it has been assumed there are no divergences between farmer, processor/wholesaler, consumer and border prices other than because of subsidies or taxes on production, consumption, trade or foreign currency. In practice this is not so, and these costly value chain activities need to be explicitly recognized and netted out when using comparisons of domestic and border prices to derive estimates of government policy induced distortions.[13] Such recognition also offers the opportunity to compare the *NRA*'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 amplified by less-than-complete adjustment by agents in the domestic value chain.

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[13] That is not to say there is no interest in comparisons across countries or over time in, say, the farm-gate price as a proportion of the fob export price, which summarizes the extent to which the producer price is depressed by the sum of internal transport, processing and marketing costs plus such things as explicit or implicit production or export taxes. Prominent users of that proportion – which can be less than half in low-income countries even where there is little or no processing – include Bates (1981) and Binswanger and Scandizzo (1983). Users need to be aware, though, that this ratio understates the extent of farmer assistance (that is, it understates the rate of protection or overstates the rate of dis-protection to farmers), possibly by a large margin.

Domestic trading costs

Trading costs can be non-trivial both intra- and inter-nationally, especially in developing countries with poorly developed infrastructure.[14] For example, domestic trading costs are involved in getting farm products to the port or to the domestic wholesaler (assuming the latter are at the international border, otherwise another set of domestic transport costs need to be added to obtain a relevant price comparison). Suppose domestic transport costs are equal to the fraction T_f of the price received by the farmer.

Processor/wholesaler costs

Domestic processing costs and wholesale and retail distribution margins can represent a large share of the final retail price. Indeed Reardon and Timmer (2007) 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.[15] We denote the increases in the consumer price due to the processing and wholesaling activities as m_p and m_u, respectively, over and above the farm-gate price plus domestic trade cost (or just m_u above the price of the imported processed product, if the processing

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[14] 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).

[15] 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. These types of government policies are not included in the present project's measurement of distortions.

has to be done prior to the product being internationally tradable) in the absence of market imperfections or government distortions along the value chain.

International trading costs

International trading costs are not an issue in the distortions calculations if the international price used is the cif import unit value for an importable or the fob export unit value for an exportable. But they are relevant if there is no trade (because of, say, a prohibitive trade tax on the product) or those border prices are unrepresentative (because of low trade volumes, e.g.). In those instances, it is recommended to select an international indicator price series (such as from the World Bank or IMF) and to account for international trading costs (ocean or air freight, insurance, etc.).[16] We denote T_m as the proportion by which the domestic price of the import-competing product is raised above what it otherwise would be at the country's border, or equivalently that the price abroad of the exported product is greater by a fraction T_x of the fob price.

Product quality/variety differences

The quality of a product traded internationally is usually considered to be different from that of the domestically sold substitute, with consumers typically having a home-country bias.[17] When appropriate the domestic price should be deflated (inflated) by the extent to which the good imported is deemed by domestic consumers to be inferior (superior) in

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[16] 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., if T_f is in dollars per ton). If this were 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 though 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 econometrically 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).

[17] On how and why the quality and variety of traded goods vary by country of origin, see Hummels and Klenow (2005).

quality to the domestic product.[18] We denote q_m as the deflating fraction to adjust for product quality/variety differences in the case of importables.

Similarly for exported goods, and especially if an international indicator price has to be used in lieu of the fob export unit value (e.g., when exports are close to zero and unrepresentative), the international price needs to be deflated (inflated) by the extent to which the good is deemed by foreign consumers to be inferior (superior) in quality relative to the indicator good. We denote q_x as the deflating fraction to adjust for product quality/variety differences in the case of exportables.

Net effect of non-distortionary influences

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

$$(8) \qquad E \times P = \frac{P_f(1+T_f)(1+m_p)(1-q_m)}{1+T_m}$$

and for an exportable it is:

$$(9) \qquad E \times P = \frac{P_f(1+T_f)(1+m_p)(1+T_x)}{1-q_x}$$

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

$$(10) \qquad P_c = P_f(1+T_f)(1+m_p)(1+m_u)$$

where P_f is the farmgate price.

Impact of distortions to food processing on agricultural NRAs

Some farm products that are not internationally traded in their primary form (e.g., raw milk, cane sugar) are tradable once lightly processed, and the downstream processing

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[18] 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.

industry may also be subject to government interventions. In that case the effect of the latter interventions on the price received by farmers for the primary product also needs to be taken into account, and that primary product should be classified as tradable.

In the past some analysts have assumed any protection to processors if fully passed back to primary agriculture (as may be the case with a farmer-owned cooperative processing plant, for example). That effectively raises the farmers' price by the rise in the processors' price divided by the proportional contribution of the primary product to the value of the processed product. Another equally extreme but opposite assumption is zero pass-through by the processor back down the value chain to the farmer. That is likely to be the case if the raw material can be sourced internationally, but seems unlikely if the primary product is non-tradable and there is a positive price elasticity of farm supply (since an assisted processor would want to expand). A more neutral assumption is proportional pass-through by the processor down the value chain to farmers and their transporters and/or up the value chain to consumers. That is equivalent to an equal sharing of the benefits along the value chain, which is more likely to be the case the more equally market power is spread among the players in that chain.

This trio of examples illustrates the importance both of separating the primary and processed activities for the purpose of calculating agricultural assistance rates, and of being explicit about the extent of pass-through that is occurring in practice and hence its consequences for the *NRAs* in both the primary agricultural and processing activities.[19]

The above examples involving processors also can be generalized to any participants in the value chain. In particular, state trading enterprises and para-statal marketing boards may well intervene significantly, especially if they have been granted monopoly status by the government. Such domestic institutions may explain the econometrically estimated low degree of transmission of price changes at a border to farm-gate domestic prices – even after significant reform of more-explicit price and trade policies (see Baffes and Gardner 2003 and the references cited therein). Where reform also involved freeing up previously controlled parts of the marketing chain, the lowered

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[19] As with the incidence of the exchange rate distortion discussed above, from the viewpoint of wanting to use the *NRA* and *CTE* estimates later as parameters in a CGE model, the assumptions made here about the extent of pass-though along the value chain may not affect greatly the model's results for real variables such as prices, output and value added.

marketing margin can provide a benchmark against which to compare the pre-reform margin (as in Uganda from the mid-1990s, see Matthews and Opolot 2007).

The mean of agricultural NRAs

We need to generate a weighted average NRA for covered products for each country, because only then can we add the NRA for non-covered products to get the NRA for all agriculture. When it comes to averaging across countries, each polity is an observation of interest, so a simple average is meaningful for the purpose of political economy analysis. But if one wants a sense of how distorted is agriculture in a whole region, a weighted average is needed. The weighted average NRA for covered primary agriculture can be generated by multiplying each primary industry's value share of production (valued at the farm-gate equivalent undistorted prices) by its corresponding NRA and adding across industries.[20] The overall sectoral rate, which we denote $NRAag$, can be obtained by adding also the actual or assumed information for the non-covered commodities and, where it exists, the aggregate value of non-product-specific assistance to agriculture.

A weighted average can be similarly generated for the tradables part of agriculture – including those industries producing products such as milk and sugar that require only light processing before they can be traded – by assuming that its share of non-product-specific assistance equals its weight in the total. Call that $NRAag^t$.

The dispersion of agricultural NRAs

In addition to the mean, it is important to provide also a measure of the dispersion or variability of the NRA estimates across the covered products. The cost of government policy distortions to incentives in terms of resource misallocation tend to be greater the greater the degree of substitution in production (Lloyd 1974). In the case of agriculture which involves the use of farm land that is sector-specific but transferable among farm

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[20] Corden (1971) proposed that free-trade volume be used as weights, but since they are not observable (and an economy-wide model is needed to estimate them) the common practice is to compromise by using actual distorted volumes but undistorted unit values or, equivalently, distorted values divided by (1+ *NRA*). If estimates of own-and cross-price elasticities of demand and supply are available, a partial equilibrium estimate of the quantity at undistorted could be generated, but if those estimated elasticities are unreliable this may introduce more error than it seeks to correct.

activities, the greater the variation of $NRAs$ across industries within the sector then the higher will be the welfare cost of those market interventions. A simple indicator of dispersion is the standard deviation of industry $NRAs$ within agriculture.[21]

Anderson and Neary (2006) show that it is possible to develop a single index that captures the extent to which the mean and standard deviation of protection together contribute to the welfare cost of distortionary policies. Once the *NRAs* and *CTEs* have been calculated by country authors, they will be used to generate such an index in a way that allows for the *NRAs* and *CTEs* to be due to domestic or border measures and to be positive or negative and unequal (Lloyd, Croser and Anderson 2008).

Trade bias in agricultural assistance

A trade bias index also is needed, to indicate the changing extent to which a country's policy regime has an anti-trade bias within the agricultural sector. This is important because, as mentioned in the theory section above, the Lerner (1936) Symmetry Theorem demonstrates that a tariff assisting import-competing farm industries has the same effect on farmers' incentives as if there was a tax on agricultural exports; and if both measures are in place, this is a double imposition on farm exports. The higher is the nominal rate of assistance to import-competing agricultural production ($NRAag_m$) relative to that for exportable farm activities ($NRAag_x$), the more incentive producers in that sub-sector will have bid for mobile resources that would otherwise have been employed in export agriculture, other things equal.

Once each farm industry is classified either as import-competing, or a producer of exportables, or as producing a non-tradable (with its status sometimes changing over the years – see next section), it is possible to generate for each year the weighted average $NRAs$ for the two different groups of tradable farm industries. They can then be used to generate an agricultural trade bias index defined as:

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[21] The mean and standard deviations could be captured by a single measure, namely, the trade restrictiveness index (TRI) developed by Anderson and Neary (2005). Calculating the TRI even in its simplest partial equilibrium mode requires knowing the own-and cross-price elasticities of demand and supply (or at least of elasticity of import demand, but that short cut is only usable if the NRA and CTE are identical).

$$(11) \qquad TBI = \left[\frac{1 + NRAag_x}{1 + NRAag_m} - 1 \right]$$

where $NRAag_m$ and $NRAag_x$ are the average $NRAs$ for the import-competing and exportable parts of the agricultural sector (their weighted average being $NRAag^t$). This index has a value of zero when the import-competing and export sub-sectors are equally assisted, and its lower bound approaches -1 in the most extreme case of an anti-trade policy bias.

Anderson and Neary (2006) show also that it is possible to develop a single index that captures the extent to which import protection reduces trade. Once the $NRAs$ and $CTEs$ have been calculated by country authors, they will be used to generate such an index in a way that allows for the trade effects to be due to domestic or border measures and to be positive or negative (Lloyd, Croser and Anderson 2008).

Indirect agricultural assistance/taxation via non-agricultural distortions

In addition to direct assistance to or taxation of farmers, the Lerner (1936) Symmetry Theorem further demonstrates that their incentives are also affected indirectly by government assistance to non-agricultural production in the national economy. The higher is the nominal rate of assistance to non-agricultural production ($NRAnonag$), the more incentive producers in other sectors will have bid up the value of mobile resources that would otherwise have been employed in agriculture, other things equal. If $NRAag$ is below $NRAnonag$, one might expect there to be fewer resources in agriculture than there would be under free market conditions in the country, notwithstanding any positive direct assistance to farmers, and conversely if $NRAag < NRAnonag$. A weighted average can be generated for the tradables part of non-agriculture too, call it $NRAnonag^t$.

One of the most important negative effects on farmers is protection from import competition for industrialists. Tariffs are part of that, but so too – especially in past decades – are non-tariff barriers to imports. Other primary sectors (fishing, forestry and minerals and energy raw material extraction) on average tend to be subject to less direct distortions than either agriculture or manufacturing, but there are important exceptions. One example is a ban on logging, but if such a ban is for genuine natural resource

conservation reasons it should be ignored. Another example is a resource rent tax on minerals. Unlike an export tax or quantitative restriction on exports of such raw materials (which are clearly distortive and would need to be included in the NRA for mining), a resource rent tax, like a land tax, can be fairly benign in terms of resource re-allocation (see Garnaut and Clunies-Ross 1983) and so can be ignored.

The largest part of most economies is the services sector. It produces mostly non-tradables, many of them by the public sector. Distortions in services markets have proven to be extraordinarily difficult to measure, and no systematic estimates across countries are available even for a recent period, let alone over time. The only feasible way forward in generating time series estimates of $NRAnonag$ for this project is to assume all services are non-tradable and that they, along with other non-agricultural non-tradables, face no distortions. All the other non-agricultural products can be separated into exportables and import-competing products for estimating correctly their weighted average $NRAs$, ideally using production valued at border prices as weights (although in practice most authors had to use GDP shares).

As already mentioned in the previous section on agriculture, foreign exchange rate misalignment relative to what fundamentals would suggest is the value of a country's currency will be ignored. This is because 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. Certainly such a new inflow of funds would reduce incentives for farmers producing tradable products, but this is not a welfare-reducing policy distortion. Thus, it is only the exchange rate distortions due to a dual or multiple exchange rate system that need to be included in the calculation of the $NRAs$ for the exportable and import-competing parts of the non-agricultural sector and hence of $NRAnonag^t$, and in the same way as discussed above for their inclusion in the calculation of $NRAag^t$.

Assistance to agricultural relative to nonagricultural production

Given the calculation of $NRAag^t$ and $NRAnonag^t$ as above, it is then possible to calculate a **R**elative **R**ate of **A**ssistance, RRA, defined as:

$$(12) \qquad RRA = \left[\frac{1 + NRAag^t}{1 + NRAnonag^t} - 1 \right]$$

Since an NRA cannot be less than -1 if producers are to earn anything, neither can the RRA. This measure is a useful indicator for providing international comparisons over time of the extent to which a country's policy regime has an anti- or pro-agricultural bias.

How the theory is put into practice in this study

Making the above theory operational in the real world, where data are often scarce especially over a long time period, is as much an art as a science.[22] Thankfully we did not have to start from scratch in many countries. Nominal rates of assistance 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, 1992) and Anderson and Hayami (1986). 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, 2007). 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. 2007). Each of these studies uses variations on the above methodology, but the basic price data at least, as well as the narratives attached to those estimates, are invaluable springboards for the present study.[23]

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[22] In addition to the methodologies of Krueger, Schiff and Valdes (1988, 1991) and the OECD (2006) for estimating agricultural distortion and producer support indicators, see the recent review of methodologies of other previous studies by Josling and Valdes (2004).

[23] Also of great help are some other trade policy studies including importantly for trade and exchange rate distortions the various multi-country studies such as the one summarized in Bhagwati (1978) and Krueger (1978)) and the more-recent ones summarized in Bevan, Collier and Gunning (1989), Michaely, Papageorgiou and Choksi (1991), Bates and Krueger (1993), and Rodrik (2003).

Time period coverage

For Europe's transition economies it is difficult to get meaningful data prior to 1992. For the same reason estimates are not very meaningful before the 1980s for China and Vietnam. For all other countries, the target start date is 1955, especially if that includes some pre-independence years to see what difference independence made, although for numerous developing countries the data simply are not available. The target finish date is 2004, but where available 2005 data are included. In most cases the most recent few years offer the highest quality data.

Farm product coverage

The agricultural commodity coverage includes 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 tree crop products, tobacco, cotton, wine, wool). Globally, as of 2001 (according to the GTAP database, see Dimaranan 2006), 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, the coverage reaches the target of 70 percent of most countries' value added in agriculture and lightly processed food. Priority is given to the most-distorted industries, 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, then fruits and vegetables account for almost one-quarter of that spending in developing countries. 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 desired product coverage is the same as suggested above from a production viewpoint.

Each product is explicitly identified as import-competing, exporting or non-tradable. For many products that categorization changes over time, in some cases moving monotonically through those three categories and, in others, fluctuating in and out of non-tradability. Hence an indication of a product's net trade status is given each year rather than just one categorization for the whole time series. And for large-area countries with high internal and coastal shipping costs, some regions within that country may be exporting abroad even while other regions are net importers from other countries. In such cases it is necessary to estimate separate *NRAs* for each region and then generate a national weighted average.

Farm input coverage

The range of input subsidies considered in any particular country study will depend on the degree of distortions in that country's input markets. In addition to fertilizer, the other large ones are likely to be electric or diesel power, pesticides and credit (including occasionally large-scale debt forgiveness, as in Brazil and Russia, although how that is spread beyond the year of forgiveness is problematic).[24] There are also distortions to water, but the task of measuring water subsidies is especially controversial and complex so they are not included in the *NRA* calculations (just as the OECD has ignored them in its PSE calculations). Similarly, distortions to land and labor markets are excluded, apart from qualitative discussion in the analytical narrative of some country case studies.

Trade costs

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[24] For an analysis of input subsidies in Indian agriculture, see Gulati and Narayanan (2003).

For the international trading costs T_m and T_x, the fob-cif gap in key bilateral trades in the product in years when the product was traded in significant quantities is used. 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. But since it is difficult to allocate those costs between items that are avoidable and those that are unavoidable, measuring the aggregate size of the distortions involved in a comparable way for a range of countries is beyond the scope of this study.[25]

Classifying farm products as import-competing, exportable or non-tradable

The criteria to be used in classifying farm industries as import-competing (M), exportable (X) or non-tradable (H) are not straightforward. Apart from the complications raised above about whether a product is non-traded simply because of trade taxes or non-tariff barriers, there will be cases where trade is minimal, or the trade status has been reversed because of the policy distortions, or the industry is characterized by significant imports *and* exports. A judgment has to be made for each sector each year as to whether it should be classified as M, X or H. In the case of the two tradable classifications, that will determine which exchange rate distortion to use. If trade is minimal for trade cost rather than trade policy reasons, then it is classified as non-tradable if the share of production exported *and* the share of consumption imported are each less than 2.5 percent – except in cases (e.g. rice for China) where it is clearly an exportable year after year even though the self-sufficiency rate is rarely above 101 percent. Otherwise, where the share of production exported is substantially above (below) the share of consumption imported, that sector is classified as exportable (importable).

In cases where the trade status has been reversed because of the policy distortion (e.g. an export subsidy (in combination with a prohibitive import tariff) is sufficiently

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[25] 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 and the governance and anti-corruption indicators at http://info.worldbank.org/governance. Also now available is a database on information and communications cost indicators for 144 countries, at 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 poor producers to international price changes for those cash crops.

large as to encourage production enough to generate an export surplus), that product should be given the classification of the trade status that would prevail without that intervention (i.e., import-competing). The same applies where tariff preferences reverse a country's trade status for a product. Many countries enjoy preferential access for their exports into protected markets of other countries. In some cases these are bilateral or plurilateral free-trade agreements or customs unions. In other cases they are unilaterally offered by higher-income countries to developing countries under schemes such as the Generalized System of Preferences, the Cotonou Agreement (for former colonies of European Union member countries) and the EU's Everything But Arms Agreement with Least Developed Countries. In the few extreme cases where these preferences are such that they (in combination with a prohibitive import tariff) cause the developing country to become an exporter of a product that would otherwise be import-competing (e.g. sugar in the Philippines), the product should nonetheless be classified as import-competing – since it is this developing country's import-restrictive policy that is allowing its domestic price to equal that earned in exporting to the preference-providing country.

Where there are significant exports *and* imports in a given year, closer scrutiny is required. If for example there are high credit or storage costs domestically, a product may be exported immediately following harvest but imported later in the year to satisfy consumers out of season. That would be considered an exportable for purposes of calculating the NRA, because even if there are policies restricting out-of-season imports (which would affect the CTE calculation) they would not be an encouragement to that year's earlier production in the presence of high credit or storage costs.

If trade/exchange rate distortions were sufficiently large as to choke off international trade in a product, then they contribute to the *NRA* and *CTE* only to the extent needed to drive that trade to zero: any trade taxes larger than that have an element of redundancy. Where there are trade policy distortions with no trade passing over them (that is, they are prohibitive), there may still be policy effects that need to be measured – but they will differ from those implied above. One example is where a prohibitive tariff, that is high enough to take the price of imported goods above the autarchy price, results in no imports. In that case the NRA would be less than that prohibitive tariff rate. Another common example is where there is an import tariff but the world price is high

enough that the country is freely exporting this product. In that case the domestic price would be determined by the world price less export trade costs and the import tariff would be irrelevant: 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 is not based just on the actual trading status of the country (Byerlee and Morris 1993). Moreover, different prices may be needed for different regions of a large country that simultaneously export and import because internal (including coastal shipping) trading costs are so high relative to international trading costs (Koester 1986). In that case the value of production is split according to those region's production shares. If the only intervention in this sector is a tariff on imports, that tariff rate is the *NRA* estimate for the import-competing part and zero would be the *NRA* for the other part of that sector, and those different NRAs would be included in the weighted average calculations of the NRAs for the import-competing and exportable sub-sectors of agriculture.

Transmission of assistance/taxation along the agricultural value chain

A crucial aspect of the *NRA* calculation for agricultural products is how any policy measure beyond the farm gate gets transmitted back to farmers and forward to consumers. Various pictorial images of the value chain structure under various circumstances are shown in Figures 4 to 7 of Anderson, Martin, Sandri and Valenzuela (2006). Only a few parameters and exogenous variables are needed to obtain meaningful estimates of an individual agricultural product's *NRA* and *CTE*.

Specifically, to take account of pass-through of distortions along the value chain, the following parameters are identified (although the default is equi-proportionate pass-through):

- θ_f , the extent to which any distortion to a primary farm product at the wholesale level is passed back to farmers; and

- θ , the extent to which any distortion to the downstream processed product is passed back to wholesalers of a primary farm product that is nontradable.

Consumer tax equivalent of the farm product

Many farm products are processed and often used as an ingredient in further manufacturing of a food product before purchased by the final consumer (e.g., wheat is ground to flour and then mixed with other ingredients before being baked and often sliced and packaged for sale as bread). Others are used as inputs into different farm activities, again often after some processing (e.g., soybeans are crushed and the meal is mixed with maize or other feedgrains for use as animal feed while the oil is sold for cooking). Because of these many and varied value chain paths, and because in practice it is difficult anyway to determine the extent to which a change in the primary farm product would be passed along any of those value chains, the OECD expresses its CSE simply at the level at which a product is first traded (e.g., as wheat or soybean or beef). That practice is adopted here too for generating a consistent set of estimates across countries of the *CTE* (even though authors of some individual country studies report CTEs that they may have estimated in a more-sophisticated way further along the value chain). The *CTE* at the point at which a product is first traded will be the same as the NRA_o in the absence of any domestic production or consumption taxes or subsidies directly affecting that product (and recall that the NRA_o in that case also equals the *NRA* if NRA_i is zero).

Key required information

A template spreadsheet has been designed to aid the management of individual country information and ensure a consistent comparison across regions and periods. The precise ways in which parameters and exogenous variables entered each country spreadsheet to generate endogenously the *NRAs* and *CTEs* are mostly straightforward, the main exception being the treatment of exchange rate distortions described below.

The key exogenous variables needed are agricultural quantities produced and consumed (or imported and exported if a proxy for consumption is to be production plus

net imports); wholesale and border prices of primary and lightly processed agricultural goods (and, where relevant, a quality adjustment to match border prices); agricultural input and output domestic subsidies and taxes (the default is zero); if there are distorted farm input markets, the input's share in the value of farm output at border prices (and, if there are only farm-gate rather than wholesale prices for a primary good, the proportion of the farm-gate value in the value at the wholesale level at border price); final food consumer domestic subsidies or taxes (the default is zero); and the official exchange rate (and, where prevalent, the parallel exchange rate and the share of currency going through that secondary or illegal market, plus the product-specific exchange rate if a multiple exchange rate system is in place).

Exchange rate distortions

The treatment of exchange rate distortions is worth spelling out since it differs from the method used by Krueger, Schiff and Valdes (1988, 1991).

If there are no exchange rate distortions, the official exchange rate is used. However, in the presence of a parallel market rate (which could be the black market rate if no legal secondary market exists), this is reported along with an estimate of the proportion of foreign currency which is actually sold by exporters at the parallel market rate. This proportion would be the formal retention rate where a formal dual exchange regime is in place, or otherwise a guesstimate of the proportion traded on the black market (premia for which are provided by Easterly 2006 and International Currency Analysis 1993). The spreadsheet then computes an estimate for the equilibrium exchange rate for the economy, which is the rate at which international prices are converted into local currency to compute each NRA.

Relevant exchange rates for importers and exporters are also then computed endogenously. If they are distorted away from the official exchange rate, the relevant exchange rate for importers and exporters are respectively the discounted parallel market rate and the weighted average of the official exchange rate and the discounted parallel rate according to the proportion of the exporter's currency that is sold on the parallel market. However, if a multiple exchange rate system is in place and that system provides for a specific rate for a product that differs from the general rates automatically calculated

as above, then the automatically computed relevant exchange rate is replaced by that industry-specific rate.

'Guesstimates' of NRAs for the non-covered agricultural products

In calculating the weighted average rates of assistance for a sub-sector or sector, *NRAs* have to be 'guesstimated' for the non-covered (30 percent or so) 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. (2007) show that these two alternatives produce significantly different results for India, so it is preferable to make informed judgments for the import-competing, exporting and non-tradable parts of the residual group of farm products. An average applied import tariff is often the best guess for only the import-competing products in that set 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.

Non-product-specific assistance to agriculture

If there are non-product-specific forms of agricultural subsidies or taxes in addition to product-specific ones, that cannot even be allocated as between importables, exportables and non-tradables, these are included in the *NRAag* in the same way (as a percentage of the total value of production) as done for these types of interventions in the calculation by the OECD (2007a).

No attempt is made to estimate the discouraging effects of under-investment in rural infrastructure and under-development of pertinent institutions. Also important is the structure of that expenditure within the rural sector. This may well be a non-trivial part of the distortions to agricultural incentives, but unfortunately it is not captured in the above measures of distortions.

In some higher-income countries governments also assist farm households with payments that are purported to be 'decoupled' from production incentives. An example is the single farm payment in the European Union. We do not count them as part of *NRAag*

because the latter refers specifically to measures that alter producer incentives. However, we do include the ad valorem equivalent of those payments when discussing assistance to farmers as a social group, so as to be able to compare its order of magnitude with support from measures that alter production incentives.

Assistance to non-agricultural sectors

If the non-agricultural sectors are assisted only via import tariffs on manufactures or export taxes on minerals, it is a relatively easy task to estimate a weighted average $NRAnonag$ once the shares of import-competing, exporting and non-tradables production are determined. In practice, however, there are also non-tariff trade measures to consider among the measures affecting tradables (Dee and Ferrantino 2005, OECD 2005); and most economies have myriad regulations affecting their many service industries. Those regulations can be very complex (see Findlay and Warren 2001). Since most of the outputs of service industries (including the public sector) are non-tradable, the default in this study is to assume their average rate of government assistance – along with that of non-tradable non-agricultural goods – is zero. Then the task of estimating the $NRAnonag$ is reduced to obtaining just the $NRAs$ for producers of import-competing and for export-oriented nonagricultural goods, plus their shares of the undistorted value of production of non-agricultural tradables, in order to obtain the weighted average $NRAnonag^t$ for entering into the RRA calculation.

Use of percentages in the chapters

Just for simplifying the presentation in the country chapters, the NRA_o, NRA_i, NRA, CTE, and RRA are expressed there as percentages rather than proportions.

Dollar values of farmer assistance and consumer taxation

The country authors' estimate of NRA are multiplied by the gross value of production at undistorted prices to obtain an estimate in current US dollars of the direct gross subsidy equivalent of assistance to farmers (GSE). This can then simply be added up across products for a country and across countries for any or all products to get regional and global aggregate transfer estimates for the studied countries. To get an aggregate estimate

for the rest of a region, we assume the weighted average *NRA* for non-studied countries is the same as the weighted average *NRA* for the studied countries in that region, and that the non-studied countries' share of the region's gross value of farm production at undistorted prices each year is the same as its share of the region's agricultural GDP measured at distorted prices.

Just as the *NRA* (the percentage distortion to the gross price of farm products) is used to generate the gross subsidy equivalent of assistance to farmers, so the *RRA* (the percentage distortion to the relative price of farm products as a group) can be made use of to generate a net subsidy equivalent of aggregate assistance to farmers (*NSE*). The same scaling-up technique as for *GSE* is used to get a regional aggregate *NSE* estimate that includes non-studied countries.

To obtain comparable dollar value estimates of the consumer transfer, we have taken the *CTE* estimate at the point at which a product is first traded and multiplied it by the gross value of consumption at undistorted prices (proxied by production at undistorted prices plus net imports) to obtain an estimate in current US dollars of the tax equivalent to consumers of primary farm products (*TEC*). This too can then be added up across products for a country and across countries for any or all products to get regional and global aggregate transfer estimates for the studied countries. We do not attempt to get an aggregate estimate for non-covered products in the studied countries nor for each region's non-studied countries.

The *GSE* and *TEC* dollar values can be illustrated in a supply-demand diagram for a distorted domestic market for a farm product (see Figure 2). In the case of an import-competing product subjected to an import tariff t_m plus a production subsidy s_f and a consumption tax c_c, the *GSE* is the rectangle *abcd* and the *TEC* is the rectangle *ahfg*. The *GSE* estimate is an overstatement to the extent of triangle *cdj* and the *TEC* estimate is an understatement to the extent of triangle *efg*, where those triangles are smaller the more price-inelastic are the supply and demand curves S and D, respectively. In the case of an exportable product subjected to an export tax t_x, the *GSE* is the negative of the rectangle *kruv* and the *TEC* is the negative of the rectangle *nquv*.

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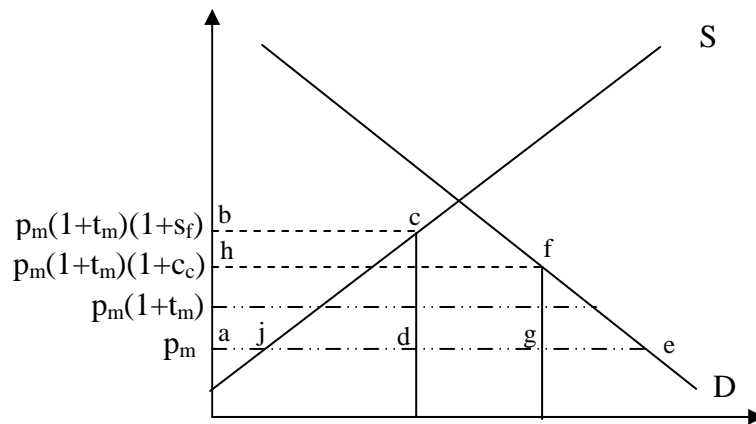
Figure 1: A distorted domestic market for foreign currency
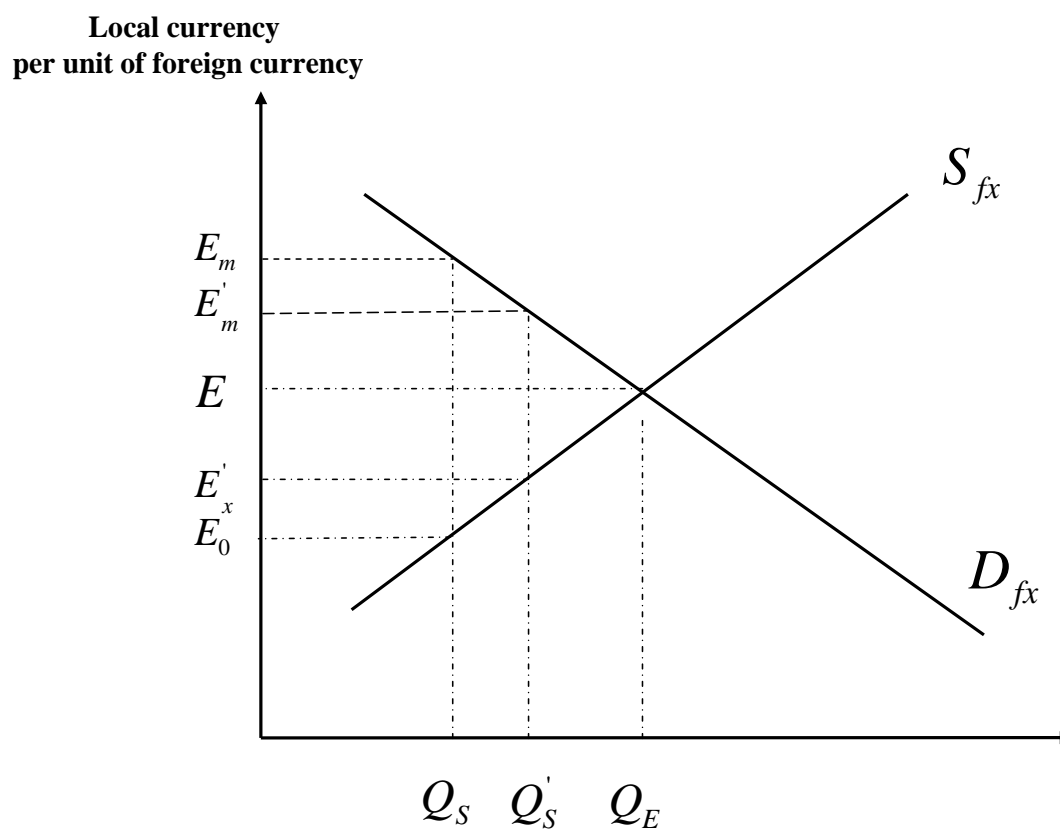
Source: Martin (1993). See also Dervis, de Melo and Robinson (1981), Kiguel and O'Connell (1995, 1997), and Shatc and Tarr (2000).

Figure 2: Distorted domestic markets for farm products

(a) An import-competing product subjected to an import tariff t_m plus a production subsidy s_f and a consumption tax c_c

(b) An exportable product subjected to an export tax t_x