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Agricultural Price Distortions: Trends and Volatility, Past and Prospective

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Abstract

Historically, earnings from farming in many developing countries have been depressed by a pro-urban bias in own-country policies, as well as by governments of richer countries favouring their farmers with import barriers and subsidies. Both sets of policies reduced global economic welfare and agricultural trade, and added to global inequality and poverty. Over the past three decades, much progress has been made in reducing agricultural protection in high-income countries and agricultural disincentives in developing countries. However, plenty of price distortions remain; and the propensity of governments to insulate their domestic food market from fluctuations in international prices has not waned. Such insulation contributes to the amplification of international food price fluctuations, yet it does little to advance national food security when food-importing and food-exporting countries equally engage in insulating behaviour. Thus there is still much scope to improve economic welfare in developing countries via multilateral agreement not only to remove remaining trade distortions but also to desist from varying trade barriers when international food prices gyrate. This paper summarizes indicators of trends and fluctuations in farm trade barriers before examining unilateral or multilateral trade arrangements, together with complementary domestic measures, that could lead to better food security outcomes without risking sociopolitical unrest.

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Agricultural Price Distortions:

Trends and Volatility, Past and Prospective

The responses of numerous governments to recent spikes in international food prices have brought agricultural price and trade policies back into the spotlight. Food-importing developing countries have accused agricultural-exporting countries of exacerbating food security concerns by restricting exports, while other exporters fear this will lead to a retreat from reliance on international markets as food-deficit countries seek greater self-sufficiency when prices return to trend. Meanwhile, food-importing countries have reduced their import restrictions and a few have even subsidized imports of their staple food, adding to the international food spike.

These recent short-run responses and their possible long-run protectionist consequences beg the question of how governments responded in the past to international food price trends and fluctuations. Figure 1 shows there was a long downward trend until the mid-1980s, apart from a spike around 1974, then a flat period for twenty years, and then an upward trend with spikes in 2008 and 2011. This paper reviews past policies by drawing on a global database on agricultural price distortions to see how governments dealt with those price trends and spikes.

Agricultural protection and subsidies in high-income (and some middle-income) countries have been depressing international prices of farm products for many decades, thereby lowering the earnings of farmers and associated rural businesses in developing countries (Johnson 1991; Tyers and Anderson 1992). Those policies almost certainly added to global inequality and poverty, since historically at least three-quarters of the world's poorest people have depended directly or indirectly on agriculture for their main income (Ravallion, Chen and Sangraula 2007; World Bank 2007). As well as this external adverse influence on incomes of farmers in developing countries, their own governments taxed them during most of the past half-century. This involved both directly taxing farm exports and in some cases production (in-kind), as well as harming farmers indirectly by pursuing an import-substituting industrialization strategy, predominantly by restricting imports of manufactures and overvaluing their exchange rates (Krueger, Schiff, and Valdés (1988, 1991). Another consequence of those price-distorting policies was that they reduced the

quantity of farm products traded internationally. Such ‘thinning’ of the international market meant that its prices have been more volatile than they otherwise would have been, adding to the influence of the ‘insulating’ feature of farm policies.

Since the mid-1980s, however, many developing country governments have been reforming their agricultural, trade and exchange rate policies, thereby reducing their anti-agricultural bias, and some high-income countries have reduced their farm price supports too, making it easier for developing countries to compete in the international market. Plenty of diversity in distortions remains across countries and across commodities within each country though, so a continuation of the reform process would still expand farm trade, ‘thicken’ international food markets, and thus not only raise the mean but also lower the volatility of prices in those markets. Moreover, the ‘insulating’ feature of farm policies has not diminished in either high-income or developing countries, so that continues to contribute non-trivially to the volatility to international food prices too.

The purpose of this paper is to review evidence compiled and recently updated by the World Bank on those evolving patterns of distortions to agricultural incentives. The empirical indicators provided in that database are first outlined, before providing a brief history of policies distorting farmer incentives. The paper then summarizes trends since the mid-1950s in national distortions and their poverty and inequality consequences, followed by a review of government responses to fluctuations and their effects on international food prices. This is followed by a brief assessment of how the changing structure of the world economy and international trade will affect the likely patterns of national trade-related policies over the next decade or two. The paper concludes that new domestic social protection policy options are now available to reduce poverty and food insecurity in developing countries, making it more feasible for multilateral action to phase out remaining distortionary farm trade policies.

Indicators of National Distortions to Agricultural Prices

To gauge how farmer incentives in high-income and developing countries have evolved since the 1950s, we draw on time series evidence from a recent World Bank study compiled by Anderson and Valenzuela (2008), summarized in Anderson (2009), and updated to 2009/10 by Anderson and Nelgen (2012b). These estimates cover 82 countries which together account for more than 90 percent of global agriculture, population, employment, GDP and poverty. The key indicator is the nominal rate of assistance (NRA), defined as the percentage by

which national government policies raise gross returns to farmers above what they would be without the government's intervention – or lowered them, if $NRA < 0$ (see Anderson et al. 2008 for methodological details).

If a trade measure is the sole source of government intervention for a particular product, then the measured NRA will also be the consumer tax equivalent (CTE) rate at that same point in the value chain for that product. But where there are also domestic producer or consumer taxes or subsidies, the NRA and CTE will no longer be equal and at least one of them will be different from the price distortion at the border due to trade measures. Both are expressed as a percentage of the undistorted price. Each industry is classified either as import-competing, or a producer of exportables, or as producing a nontradable (with its status sometimes changing over the years), so as to generate for each year the weighted average NRAs for the two different groups of tradables.

In the Anderson and Valenzuela (2008) database, which covers up to 2004 for developing countries and to 2007 for high-income and transition economies, it turns out that the NRA and CTE are very highly correlated for most products in all countries. For that reason, only producer distortions were estimated in the update to 2009 for developing countries by Anderson and Nelgen (2012b). For high-income and transition economies the update is to 2010 and, as with the earlier Anderson/Valenzuela database, is based on the OECD's PSE/CSE estimates.

The coverage of products for NRA estimates averages around 70 percent of the gross value of farm production in each country. Authors of the country case studies also provide 'guesstimates' of the NRAs for non-covered farm products. Weighted averages for all agricultural products are then generated, using the gross values of production at unassisted prices as weights. For countries that also provide non-product-specific agricultural subsidies or taxes (assumed to be shared on a pro-rata basis between tradables and nontradables), such net assistance is then added to product-specific assistance to get a NRA for total agriculture. Also provided, but as a separate add-on, are so-called decoupled measures such as whole-farm payments that in principle do not distort prices.

Farmers are affected not just by prices of their own outputs but also by the incentives nonagricultural producers face. That is, it is *relative* prices and hence *relative* rates of government assistance that affect producer incentives. More than 75 years ago Lerner (1936) provided his Symmetry Theorem to show that in a two-sector economy, an import tax has a similar effect to an export tax. This carries over to a model that also includes a third sector producing only nontradables, to a model with imperfect competition, and regardless of the

economy's size (Vousden 1990, pp. 46-47). If one assumes that there are no distortions in the markets for nontradables and that the value shares of agricultural and non-agricultural nontradable products remain constant, then the economy-wide effect of distortions to agricultural incentives can be captured by the extent to which the tradable parts of agricultural production are assisted or taxed relative to producers of non-farm tradables. By generating estimates of the average NRA for non-agricultural tradables, it is then possible to calculate a Relative Rate of Assistance, RRA, defined in percentage terms as:

$$RRA = 100[(1+NRA_{ag}^t/100)/(1+NRA_{nonag}^t/100) - 1]$$

where NRA_{ag}^t and NRA_{nonag}^t are the weighted average percentage NRAs for the tradable parts of the agricultural and non-agricultural sectors, respectively. Since the NRA cannot be less than -100 percent if producers are to earn anything, neither can the RRA (assuming NRA_{nonag}^t is positive). And if both of those sectors are equally assisted, the RRA is zero. This measure is useful in that if it is below (above) zero, it provides an internationally comparable indication of the extent to which a country's policy regime has an anti- (pro-) agricultural bias (Anderson et al. 2008).¹

In summarizing pertinent empirical findings from that World Bank study, it is helpful to begin with NRA estimates for the farm sector and then turn to RRA estimates.

The Evolution of Policies Distorting Farmer Incentives: Brief History

The first country to have an industrial revolution was Britain. Prior to that revolution—from the late 1100s to the 1660s—Britain used export taxes and licenses to prevent domestic food prices from rising excessively. But during 1660–90 a series of Acts gradually raised food import duties (making imports prohibitive under most circumstances) and reduced export restrictions on grain. These provisions were made even more protective of British farmers by the Corn Laws of 1815. True, the famous repeal of the Corn Laws in the mid-1840s heralded a period of relatively unrestricted food trade for Britain,² but then agricultural protection returned in the 1930s and steadily increased over the next five decades.

¹ In calculating the NRA for producers of agricultural and non-agricultural tradables, the methodology also includes the implicit trade tax distortions generated by dual or multiple exchange rates, drawing on Dervis, de Melo and Robinson (1981).

² Exceptions were high specific taxes on wine imports from France and high excises on some other exotic imported food items (Nye 2007).

Similar tendencies evolved in many other West European countries, although on the Continent the period of free trade in the 19th century was considerably shorter, and agricultural protection levels there during the past 150 years have been somewhat higher on average than in Britain.

Kindleberger (1975) describes how the 19th-century free-trade movements in Europe reflected the national economic, political, and sociological conditions of the time.

Agricultural trade reform was less difficult for countries such as Britain with overseas territories that could provide the metropolis with a ready supply of farm products. The fall in the price of grain imports from America in the 1870s and 1880s provided a challenge for all West European countries, however. Denmark coped well by moving more into livestock production to take advantage of cheaper grain. Italians coped by sending many of their relatives to the New World. Farmers in France and Germany successfully sought protection from imports, however, and so began the post-Industrial Revolution growth of agricultural protectionism in densely populated countries. Meanwhile, tariffs on West European imports of manufactures were progressively reduced after the General Agreement on Tariffs and Trade (GATT) came into force in 1948, thereby adding to the encouragement of agricultural relative to manufacturing production (Lindert 1991; Findlay and O'Rourke 2007; Swinnen 2010).

Japan provides an even more striking example of the tendency to switch from taxing to increasingly assisting agriculture relative to other industries. Its industrialization began later than in Europe, after the opening up of the economy following the Meiji Restoration in 1868. By 1900 Japan had switched from being a small net exporter of food to becoming increasingly dependent on imports of rice (its main staple food and responsible for more than half the value of domestic food production). This was followed by calls from farmers and their supporters for rice import controls. Their calls were matched by equally vigorous calls from manufacturing and commercial groups for unrestricted food trade, since the price of rice at that time was a major determinant of real wages in the non-farm sector. The heated debates were not unlike those that led to the repeal of the Corn Laws in Britain six decades earlier. In Japan, however, the forces of protection triumphed, and a tariff was imposed on rice imports from 1904. That tariff then gradually rose over time, raising the domestic price of rice to more than 30 percent above the import price during World War I. Even when there were food riots because of shortages and high rice prices just after that war, the Japanese government's response was not to reduce protection but instead to extend it to its colonies and to shift from a national to an imperial policy of rice self-sufficiency. That involved accelerated

investments in agricultural development in the colonies of Korea and Taiwan behind an ever-higher external tariff wall that by the latter 1930s had driven imperial rice prices to more than 60 percent above those in international markets (Anderson and Tyers 1992). After the Pacific War ended and Japan lost its colonies, its agricultural protection growth resumed and spread from rice to an ever-wider range of farm products.

The other high-income countries were settled by Europeans relatively recently and are far less-densely populated. They therefore have had a strong comparative advantage in farm products for most of their history following European settlement, and so have felt less need to protect their farmers than Europe or Northeast Asia. Indeed Australia and New Zealand until the late 20th century tended to adopt policies that discriminated against their farmers (Anderson, Lloyd and MacLaren 2007). They, like many independent land-abundant developing countries, were discouraged by the declining real prices of farm products in international markets, to which the growth of agricultural protection in more-densely populated countries contributed. They therefore opted to support import-substituting industrialization. That was further encouraged by the post-World War II writings of Prebisch and Singer who hypothesized that prices of primary products were destined to decline inexorably relative to those of manufactures (United Nations 1949; Singer 1950).

Newly independent Korea and Taiwan in the 1950s also adopted an import-substituting industrialization strategy which harmed agriculture. But in those two economies it was replaced in the early 1960s with a more neutral trade policy that resulted in very rapid export-oriented industrialization. That development strategy in those densely populated economies imposed competitive pressure on the farm sector which, just as in Japan in earlier decades, prompted farmers to lobby (successfully, as it happened) for ever-higher levels of protection from import protection (Anderson, Hayami and Others 1986, ch. 2).

Many less-advanced and less-rapidly growing developing countries not only adopted import-substituting industrialization strategies in the late 1950s or early 1960s (Little, Scitovsky, and Scott 1970; Balassa and Associates 1971) but also imposed direct taxes on their exports of farm products. The latter practice was especially rife in newly independent African countries (Bates 1981). It was also common in the 1950s and 1960s, and in some cases even in the 1970s and 1980s, to use dual or multiple exchange rates so as to tax indirectly both exporters and importers (Bhagwati 1978; Krueger 1978, 1984). This added to the anti-trade bias of developing countries' trade policies.

Numerous emerging economies have belatedly followed the examples of Korea and Taiwan in abandoning industrial import-substitution and opening their economies. Some (for

example Chile) started in the 1970s, while others (for example India) did not do so in a sustained way until the 1990s. Some have adopted a very gradual pace of reform, with occasional reversals, while others have moved rapidly to open markets. Some have reduced export taxes but simultaneously raised import barriers. And some have adopted the rhetoric of reform but in practice have done little to free up their economies. To get a clear sense of the overall impact of these reform attempts on trend levels of national price distortions, there is no substitute for empirical analysis that quantifies over time the types of indicators noted in the previous section, to which we now turn.

National Distortions to Farmer Incentives: Trends Since the mid-1950s

Japan continued to raise its agricultural protection following post-World War II reconstruction, just as had been happening in Western Europe but to even higher levels. Domestic prices exceeded international market prices for grains and livestock products in both Japan and the European Community in the 1950s, although by less than 40 percent. However, by the early 1980s the difference was more than 80 percent for Japan but was still around 40 percent for the EC—and was still close to zero for the agricultural-exporting rich countries of Australasia and North America (Anderson, Hayami and Others 1986, Table 2.5). Virtually all of that assistance to Japanese and European farmers in that period was due to restrictions on imports of farm products.

Since 1986 the OECD has been computing annual producer and consumer support estimates by member countries. For member countries as a whole (see OECD 2011), producer support rose between 1986–88 and 2008–10 in US dollar terms (from \$239 to \$246 billion) but, when expressed as a share of support-inclusive returns to farmers, it has come down (from 37 to 20 percent). Because of some changes in support instruments, including switching to measures that are based on non-current production or on long-term resource retirement, the share of that assistance provided via market price support measures has fallen from three-quarters to one-half. When the PSE payment is expressed as a percentage of undistorted prices to make it like an NRA, the fall is from 59 to 25 percent between 1986–88 and 2008–10 (OECD 2011). This indicator suggests high-income country policies have become considerably less trade-distorting, at least in proportional terms, even though farmer support in high-income countries has continued to grow in dollar terms because of growth in the value of their farm output.

As for developing countries outside Northeast Asia, the main comprehensive set of pertinent estimates over time was, until recently, for the period just prior to when reforms became widespread. They were generated as part of a major study of 18 developing countries from the 1960s to the mid-1980s by Krueger, Schiff, and Valdés (1988, 1991). That study by the World Bank, whose estimates are summarized in Schiff and Valdés (1992), shows that the depression of incentives facing farmers has been due only partly to various forms of agricultural price and trade policies, including subsidies to food imports. Much more important in many cases have been those developing countries' non-agricultural policies that hurt their farmers indirectly. The two key ones have been manufacturing protectionism (which attracts resources from agriculture to the industrial sector) and overvalued exchange rates (which attract resources to sectors producing non-tradables, such as services).

The more-recent World Bank database, as updated by Anderson and Nelgen (2012b), covers 45 developing countries but also 13 European transition economies as well as 24 high-income countries. The results from that study³ do indeed reveal that there have been substantial reductions in distortions to agricultural incentives in developing countries over the past two to three decades. They also reveal that progress has not been uniform across countries and regions, and that—contrary to some earlier claims (for example from Jensen, Robinson, and Tarp 2002)—the reform process is far from complete. More specifically, many countries still have a wide dispersion in NRAs for different farm industries and in particular have a strong anti-trade bias in the structure of assistance within their agricultural sector; and some countries have “overshot” in the sense that they have moved from having an average relative rate of assistance to farmers that was negative to one that is positive, rather than stopping at the welfare-maximizing rate of zero. Moreover, the variance in rates of assistance across commodities within each country, and in aggregate rates across countries, remains substantial.

The global summary of those new results is provided in Figure 2. It reveals that the nominal rate of assistance (NRA) to farmers in high-income countries rose steadily over the post-World War II period through to the end of the 1980s, apart from a dip when international food prices spiked around 1973-74. After peaking at more than 50 percent in the

³ A global overview of the results to 2007 is provided in Anderson (2009), and the detailed country case studies are reported in four regional volumes covering Africa (Anderson and Masters 2009), Asia (Anderson and Martin 2009), Latin American (Anderson and Valdés 2008), and Europe's transition economies (Anderson and Swinnen 2008). Background papers and databases, including for the updated estimates by Anderson and Nelgen (2012b), are freely available at www.worldbank.org/agdistortions, as are e-book versions of the regional volumes. A comparison of these estimates with the earlier ones by Krueger, Schiff, and Valdés is available in Anderson (2010a).

mid-1980s, when international food prices were at a near-record low, the average NRA for high-income countries has fallen substantially. This is so even when the new farm programs that are somewhat ‘decoupled’, in the sense of no longer influencing production decisions, are included.⁴ For developing countries, too, the average NRA for agriculture has been moving towards zero, but from a level of around –25 percent between the mid-1950s and early 1980s. Indeed it ‘overshot’ in the 1990s although it is still less than half the average NRA for high-income countries.

The developing country average NRA conceals the fact that the exporting and import-competing subsectors of agriculture have very different NRAs. While the average NRA for exporters in developing countries has been negative throughout (coming back from –50 percent in the 1960s and 1970s to almost zero in 2000–09), the NRA for import-competing farmers in developing countries has fluctuated around a trend rise from 10 and 30 percent (and it even reached 40 percent in the years of low international prices in the mid-1980s). This suggests that export-focused farmers in developing countries are still discriminated against in two respects: by the anti-trade structure of assistance within their own agricultural sectors, and by the remaining protection afforded farmers in high-income countries. That anti-trade bias also means that NRAs are not uniform across commodities, which indicates that the resources that are being used within the farm sector of each country are not being put to their best use. The extent of that extra inefficiency, over and above that due to too many or too few resources in aggregate in the sector, is indicated by the standard deviation of NRAs among covered products in each focus country. This dispersion index has fluctuated between 43 and 60 percent throughout the covered period, and has not diminished as NRAs have approached zero over the past 25 years (Anderson 2009, Table 1.6).

The improvement in farmers’ incentives in developing countries is understated by the above NRA estimates, because those countries have also reduced their assistance to producers of non-agricultural tradable goods, most notably manufacturers. The decline in the weighted average NRA for the latter, depicted in Figure 3, was clearly much greater than the increase in the average NRA for tradable agricultural sectors for the period to the mid-1980s, consistent with the finding of Krueger, Schiff, and Valdés (1988, 1991). For the period since the mid-1980s, changes in both sectors’ NRAs have contributed almost equally to the improvement in farmer incentives. The Relative Rate of Assistance for developing countries

⁴ Not included are estimates of the subsidy equivalent of irrigation water or biofuel subsidies. On the difficulties of measuring these excluded items, see Dinar (2012) and de Gorter, Drebbik and Klika (2011), respectively. Their exclusion is unlikely to make a discernible difference to the global NRA trends depicted here though.

as a group went from –46 percent in the second half of the 1970s to just above zero in the first decade of the present century. This increase (from a coefficient of 0.54 to 1.01) is equivalent to an almost doubling in the relative price of farm products, which is a huge change in the fortunes of developing country farmers in just a generation. It needs to be kept in mind, however, that within the developing country group the spectrum of national RRA estimates remains very wide (Figure 4), indicating great scope still for global economic welfare gains from further trade liberalization.

To estimate the effects of distortions in the early 1980s, Tyers and Anderson (1986, 1992) built a dynamic, stochastic model of the world's seven most important traded food products. They found that the international price-depressing effect of agricultural protection dominated the international price-raising effect of developing countries' direct agricultural taxes, although only slightly: farm protection policies of high-income countries lowered the weighted average of international prices of those key foods by 20 percent, while the agricultural export taxes imposed by developing countries offset all but 1 of those 20 percentage points. That study also found that both sets of policies shrunk international food trade: by an estimated 25 percent because of industrial country policies, but by 56 percent when developing country policies were added (Tyers and Anderson 1992, Tables 6.9). Their study also estimated the extent to which this 'thinning' of the international food market added to its price volatility. By running 200 repeated simulations with random weather shocks, they found that the coefficient of variation of international food prices would have fallen by two-thirds, from 34 to 10 percent, if all countries had agreed in 1990 to cease their domestic price-insulating practice of varying their trade restrictions and instead maintain constant ad valorem trade tax rates (Tyers and Anderson 1992, Tables 6.14).

Poverty and inequality effects of trade policies as of 2004

Despite the comprehensiveness of trade reforms since the 1980s, they have raised only very slightly the global extent to which farm products are traded: the share of primary agricultural production exported globally, including intra-European Union trade, rose only slightly in the two decades to 2000-04 (Sandri, Valenzuela and Anderson 2007). One reason for this small aggregate global response is that high-income countries lowered not only their import restrictions but also their export subsidies. A second reason is that while developing countries phased out their farm export taxes, they also raised their tariffs on farm imports. As a result,

international food markets were not much ‘thicker’ in 2004 than they were a quarter-century earlier.

According to global economy-wide modelling results reported in Valenzuela, van der Mensbrugghe and Anderson (2009), liberalization of remaining trade barriers as of 2004 would raise the share of farm production exported globally from 8 to 13 percent. Thus plenty of scope still remains for trade reform to ‘thicken’ international food markets and thereby make them less volatile. That study also suggests the developing countries’ share of global exports of farm products would rise from 55 to 64 percent, suggesting more of those countries would become net food exporters and thus would be net beneficiaries of the recent rise in international food prices.

Even if trade policies were not contributing to international food price volatility (of which more below), what can be said about their poverty and inequality effects as of 2004, before international food prices began rising steeply? A recent detailed study addresses that issue using numerous global and national economy-wide models, all calibrated to 2004 and incorporating the same World Bank estimates of national price distortions as discussed above (provided for modelers by Valenzuela and Anderson 2008). The results are reported in Anderson, Cockburn and Martin (2010) and are summarized in Anderson, Cockburn and Martin (2011).

The World Bank’s global Linkage model results suggest the incidence of poverty would be reduced under the full merchandise trade reform: there would be 2.7 percent fewer people living on less than US\$1 a day in developing countries, and 3.4 percent fewer on less than US\$2 per day – a fall of close to 100 million people.

Also reported in that source are results from ten more-detailed individual country case studies. These case studies focus on price-distorting policies as of 2004 too, but they are able to include more sectoral and product disaggregation than can global models, and they make use of national survey data to consider multiple types of households and types of labor. When all merchandise trade is liberalized in each of these country case studies, the poverty reduction ranges from close to zero to about 3.5 percentage points, except for Pakistan where it is more than 6 points. On average nearly two-thirds of the alleviation is due to non-farm trade policy reform, and the contribution of own-country reforms to the reduction in poverty appears to be equally as important as rest-of-world reform.

The estimated national poverty alleviation is also sub-divided into rural and urban sources in those studies. In every case rural poverty is reduced much more than urban poverty. This is true for both farm and non-farm trade policy reform, and for own-country as

well as rest-of-world reform. Since the rural poor have been and are much poorer on average than the urban poor, this would lead one to expect trade policy reform to also reduce inequality – and that is indeed what the results show for this sample of countries, as measured by the Gini coefficient.

Government Responses to Fluctuations and Spikes in International Food Prices

National governments evidently dislike domestic food price volatility, since they tend to transmit less than fully any fluctuations around trend levels of international food prices. This tendency means the estimated NRA for each product also fluctuates from year to year around its long-run trend, and in the opposite direction to the international price. This propensity has not diminished as part of the trade-related policy reforms that began in the mid-1980s. Table 1 focuses on the NRA's annual average deviation from trend in the two decades before 1985 versus the period after. That average deviation from trend NRA is more than one-tenth higher in the latter 25 years than in the earlier two decades in just as many cases as it is more than one-tenth lower. Nor is there much difference as between developing and high-income countries. Notice too that the deviations are non-trivial: except for rice in high-income countries, the average deviation is well above the mean NRA for each product (reported in the right-hand half of Table 1).

To estimate the proportion of any international price fluctuation that is transmitted to domestic markets within twelve months, Anderson and Nelgen (2012a) follow Nerlove (1972) and Tyers and Anderson (1992, pp. 65-75) in using a partial-adjustment geometric distributed lag formulation to estimate short-run transmission elasticities for each product for all focus countries for the period 1985 to 2010. Table 2 summarizes those estimates for nine key traded foods. The average of the estimates for the short-run elasticity over the 25 years to 2010 ranges from 0.73 for soybean down to just 0.43 for sugar. The unweighted average across those nine products is 0.56, suggesting that, within one year, barely half the movement in international prices of primary food products is transmitted to domestic markets on average.

When some governments alter the restrictiveness of their food trade measures to insulate their domestic markets somewhat from international price fluctuations, the volatility faced by other countries is amplified. That reaction therefore prompts more countries to follow suit. The irony is, however, that when both food-exporting and food-importing countries so respond, each country group undermines the other's attempts to stabilize its

domestic markets. That is to say, what seems like a solution to each importing (or exporting) country's concern *if it were acting alone* turns out to be less effective, the more exporting (or importing) countries respond – presumably for the same political economy reasons – in a similar way.

To see this more clearly, consider the situation in which a severe weather shock at a time of low global stocks causes the international food price to suddenly rise. National governments wishing to avert losses for domestic food consumers typically alter their food trade restriction so that only a fraction of that price rise is transmitted to their domestic market. For example, imposing or raising an export tax on food exports would ensure the domestic price in a food-surplus country rose less than the border price. Similarly, lowering any import tax on food would mean the domestic price in a food-deficit country would rise less than the border price. Hence it is not surprising that governments, in seeking to protect domestic consumers from an upward spike in international food prices, consider a variation in their degree of trade restriction as an appropriate response. That response raises the consumer subsidy equivalent/lowers the consumer tax equivalent of any such trade measure, and does the opposite to producer incentives.

However, if such domestic market insulation using trade measures is practiced by similar proportions of the world's food-exporting and -importing countries, it turns out to be not very effective in keeping domestic price volatility below what it would be in the international marketplace if no governments so responded.

To see why this can lead to ineffective outcomes when both food-deficit and food-surplus country groups respond, it is helpful to refer to Figure 5, which depicts the international market of food. In a normal year, the excess supply curve for the world's food-exporting countries is ES_0 and the excess demand curve for the world's food-importing countries is ED_0 . In the absence of any trade costs such as for transport, equilibrium in a normal year would be at E_0 with Q_0 units traded at international price P_0 .

An adverse season in some exporting countries at a time when global stocks are low would shift the excess supply curve leftwards to ES_1 . If there were no policy responses, the equilibrium would shift from E_0 to E_1 , and the international price and quantity traded across national borders would change from P_0 and Q_0 to P_1 and Q_1 . However, if the higher price prompts governments to alter their trade restrictiveness, there will be additional effects.

On the one hand, suppose some of the food-exporting countries choose to impose or raise a food export tax. That would move the excess supply curve further to the left, say to ES_2 . This would move the equilibrium to E_2 and raise the international price further, to P_2 --

but the domestic price in those export-restricting countries would be P_x which is below P_1 . Such a reaction thus provides partial insulation in those exporting countries from the initial exogenous shock to the international market. Furthermore, their combined actions reduce aggregate exports to Q_2 and cause the international terms of trade to turn further in their favor, because of the additional reduction in available supplies on the international market. That means, however, that food-importing countries face an even higher international price, at P_2 instead of P_1 .

On the other hand, suppose some protective food-importing countries were to reduce their barriers to food imports in response to the international price rising from P_0 to P_1 . That would shift the excess demand curve to the right, say to ED' . In that case the new equilibrium would be at E' , involving Q' units traded at international price P' . That response would provide partial insulation in those food-importing countries from the initial exogenous shock to the international market: their domestic price would rise by only MN instead of by ME' in Figure 5. However, the combined actions of those importing countries would cause the international terms of trade to turn further against them.

What if both country groups intervene, each seeking to at least offset the effect on their domestic price of the other country group's policy response? In practice, the more one group seeks to insulate its domestic market, the more the other group is likely to respond. The example of such actions shown in Figure 5 involves the curves shifting simultaneously to ES_2 and ED' , in which case the international price is pushed even higher to P_3 while the domestic price in each country group would be lower by E_3E_1 . That is, in that particular case the domestic price (and the quantity traded internationally, Q_1) would be exactly the same as if neither country group's governments had altered their trade restrictions. The terms of trade would now be even better for the food-exporting country group, and even worse for food-importing countries. Aggregate global welfare would be the same as it would be if neither country group so intervened, but there would be an economic welfare transfer from food-importing to food-exporting countries, via the terms of trade change, equal to areas $P_1E_1E_3P_3$.

Conversely, if the exogenous weather shock was of the opposite sort (a bumper global harvest) which depressed the international price even after purchases by stockholders, and if governments sought in that case to protect their farmers from the full force of the price fall, the international price fall would be accentuated to the benefit of food-importing countries.

Clearly, both such attempts at domestic price insulation exacerbate international price volatility while doing little or possibly nothing to assist those most harmed by the initial exogenous weather shock.

More than that, this use of trade measures can be inefficient and possibly inequitable, and it may even *add to* global poverty despite a possible part of its motivation being to reduce the risk of a rise in national poverty. To see that, note that an import tax is the equivalent of a consumer tax and a producer subsidy, hence lowering it also reduces the extent to which the measure assists producers of the product in question. Likewise, an export tax is the equivalent of a consumer subsidy and a producer tax, so raising it not only helps consumers but also harms farmers. If farming is thereby discouraged, the demand for labor on farms falls, and with it the wages of low-skilled workers not only in farm jobs but also in non-farm jobs – and more so the more agrarian is the economy. Thus while poor households may benefit on the expenditure side from a measure that reduces the extent to which the cost of food consumption would otherwise rise, they could be harmed on the earnings side if they are sellers of food or suppliers of low-skilled labor. Such trade policy responses therefore could add to rather than reduce poverty (Ivanic and Martin 2008; Aksoy and Hoekman 2010). That could therefore add to food insecurity.

Martin and Anderson (2012) point out that, with the help of some simplifying assumptions, it is possible to get at least a back-of-the-envelope estimate of the extent to which government trade policy reactions contribute to an international price spike such as in 2008. They do so by assuming a homogenous product whose global market equilibrium condition, assuming perfect competition and zero trade costs, is:

$$(1) \sum_i (S_i(p_i) + v_i) - \sum_i D_i(p_i) = 0$$

where S_i is the supply in country i ; p_i is the country's domestic price; v_i is a random weather-related exogenous production shift variable for that country; and D_i is demand in country i (assumed to be not subject to shocks from year to year). They assume further that border measures are the only price-distorting policy intervention used, in which case one can define a single variable for the power of the trade tax equivalent, $T_i = (1+t_i)$ where t_i is country i 's rate of tax on trade. Totally differentiating equation (1), rearranging it, and expressing the results in percentage change form yields the following expression for the impact of a set of changes in trade distortions on the international price p^* , assuming the policy changes are independent of the exogenous supply shocks:

$$(2) \hat{p}^* = \frac{\sum_i H_i \hat{v}_i + \sum_i (H_i \gamma_i - G_i \eta_i) \cdot \hat{T}_i}{\sum_i (G_i \eta_i - H_i \gamma_i)}$$

where \hat{p}^* is the proportional change in the international price; \hat{v}_i is an exogenous stochastic shock to output such as might result from above or below average weather; η_i is the price elasticity of demand; γ_i is the price elasticity of supply; G_i is the share, at the international

price, of country i in global demand; and H_i is the share of country i in global production. That is, the impact on the international price of a change in trade distortions by country i depends on the importance of that country in global demand and supply (G_i and H_i), as well as the responsiveness of its production and consumption to price changes in the country (as represented by γ_i and η_i).

If it is assumed that output cannot respond in the short run, and that inventory levels are low enough that stock adjustments have limited effect (as is typically the case in a price spike period – see Wright 2011), then $\gamma_i=0$. If one further assumes that the national elasticities of final demand for the product (η_i) are the same across countries, then equation (2) reduces to:

$$(3) -\sum_i G_i \hat{T}_i = \hat{T}$$

which is just the negative of the consumption-weighted global average of the \hat{T}_i 's, call it \hat{T} . However, if the changes in trade restrictiveness are not independent of the exogenous supply (or any other) shocks, then

$$(4) \hat{p}^* = \hat{T} + R + (\hat{T} * R),$$

from which it follows that $R = (\hat{p}^* - \hat{T})/(1 + \hat{T})$, where R refers to the rest of the influences on \hat{p}^* . In that case, and if the interaction term is distributed proportionately, the contribution of the changes in trade restrictiveness to the international price change, in proportional terms, is $\frac{\hat{T}}{\hat{T} + R}$.

Estimates of those indicators are summarized for the key grains in Table 3. For rice, $-\hat{T}$ (the cumulative proportional decline in the Nominal Assistance Coefficient, where $NAC = 1 + NRA/100$) is shown in the first row of Table 3 to be 0.37 between 2006 and 2008. The comparable numbers for wheat and maize are 0.12 and 0.08, respectively. According to World Bank data, the international price of rice increased by 113 percent between 2006 and 2008, and the prices of wheat and maize by 70 and 83 percent, respectively (middle rows of Table 3). Thus these estimates suggest that altered trade restrictions during the 2006-08 period caused international prices to be higher by 0.40 for rice, 0.19 for wheat, and 0.10 for maize (bottom third of Table 3). The unweighted average of these three, at 0.23, is the same as for 1972-74 (first column of Table 3), although the price spikes were somewhat larger then.

It is possible to apportion those policy contributions between country groups. Table 4 reports the contributions of high-income versus developing countries, and also of exporting versus importing countries. During 2006-08, developing countries were responsible for the

majority of the policy contribution to all three grains' price spikes, whereas in 1972-74 the opposite was the case except for rice. As for exporters versus importers, it appears exporters' policies had the majority of the influence, other than for wheat in the 1970s, but importers made a very sizeable contribution as well.

Finally, it is now possible, in the light of these estimates, to get a sense of how effective were changes in trade restrictions in limiting the rise in domestic prices. The proportional rise in the international price *net of* the contribution of changed trade restrictions is $R/(\hat{T} + R)$. That fraction, when multiplied by the international price rise shown in the middle part of Table 3, is reported in the second column of Table 5, where it is compared with the proportional rises in the domestic price in the sample countries. The numbers for 2006-08 suggest that, on average for all countries in the sample, domestic prices rose slightly more than the adjusted international price change for wheat, and only slightly less for maize and just one-sixth less for rice. These results suggests that the combined responses by governments of all countries have been sufficiently offsetting as to do very little to insulate domestic markets from this recent international food price spike.

How Might Trade Policies Develop Over the Next Decade or Two?

With the above insights it is now possible to turn to the question of how the changing structure of the world economy and international trade will affect the patterns of national trade-related policies in the coming years. The global financial crisis and the on-going economic recession in Europe seem set to ensure that emerging economies will continue to grow faster than high-income countries. The rapid growth (doubling) of the developing economies' share of global exports since the mid-1990s, led by China and India, also looks like continuing, as does the growth in relative importance of South-South trade (ADB 2011, Anderson and Strutt 2012a,b; Hanson 2012). Industrialization in those emerging economies is deepening global production networks and contributing to greater trade in intermediate inputs, but it is also continuing to drive the strong demand for farm products and industrial raw materials, including for energy production. If this, together with only slow increases in the taxing of carbon emissions globally, holds fossil fuel prices at current high levels as expected, the United States and the European Union are likely to retain their biofuel subsidies and mandates for energy self-sufficiency reasons. This would mean prices for food and fuel

will remain closely linked – in both height and volatility (Hertel and Beckman 2011). Food production variability is expected to increase too, thanks to climate change.

What should one expect in terms of trend and volatility of rates of assistance to agriculture under that scenario of a continuation of historically high and variable food prices in international food markets? In terms of the long-run trend in NRAs, if international food prices stay high then high-income countries are unlikely to return to their former agricultural protection growth path. However, people and governments in emerging/industrializing economies – especially large ones such as China, India and Indonesia – may well feel more food-insecure as their farm sectors become less competitive while their food and feed demands grow. Continuing growth in their agricultural protection cannot be ruled out therefore, even if international food prices remain high (Anderson and Nelgen 2011). That will raise their domestic prices of foods increasingly above those at their borders,⁵ thereby undermining food security for all their households except those that are net sellers of food. The latter group will become an ever-smaller share of the population and workforce in the course of economic growth, but whether they become a smaller share of the poor in those countries is difficult to anticipate. Hence it is unclear what impact agricultural protection growth would have on the national poverty rate in these and other countries. Certainly their per capita food consumption would grow less rapidly, and their farm protection growth would dampen international food prices somewhat.

As for fluctuations in NRAs around trend, past behavior leads one to expect both high-income and developing country governments to continue to alter their food trade restrictions so as to insulate their domestic markets somewhat from international food price volatility. For the reasons laid out in the previous section, this behavior will continue to amplify price fluctuations in the international market and, if both exporting and importing countries continue to respond similarly, such interventions will keep being rather ineffective in preventing fluctuations in domestic food prices. How severe such volatility might be will depend on the size of any unanticipated exogenous shocks to world food markets and the global stocks-to-use ratios of the affected products at the time of any such exogenous shocks. If stocks were to be very low when harvests failed in significant regions, food price spikes of the magnitude experienced in mid-2008, early 2011 and mid-2012 (See Figure 1(b)) could

⁵ Such a trend is already evident for China: its agricultural NRA rose from -3 to 21 percent between 1999 and 2010 (Anderson and Nelgen 2012b, based on PSE estimates by OECD 2011). This has been sufficient to maintain self sufficiency in all key farm products except soybean (whose tariff is bound in the WTO at 3 percent and which mostly goes into livestock feed and so helps maintain apparent self sufficiency in meat and milk).

well be repeated if countries do not agree multilaterally in the meantime to desist from altering their trade restrictions at such times.

Policy Implications

The above empirical evidence supports the view that national trade restrictions add non-trivially to international food price volatility in at least two ways: through ‘thinning’ international food markets, and through ‘insulating’ domestic food markets from international price fluctuations. Together those policy attributes magnify the effect on international prices of any shock to global food supply or demand.

The solution to the first (‘thinning’) problem is simple economically if not politically: it is for countries to open further their markets to food trade. The political difficulty and the adjustment costs associated with doing that are minimized if countries can agree to liberalize their food and agricultural markets multilaterally, and to do so at the same time as non-agricultural markets are liberalized. That was what happened in the Uruguay Round, and it is what has been aspired to by members of the World Trade Organization (WTO) via their Doha Development Agenda (DDA). After more than a decade of negotiating, the DDA has come to a standstill. While prospects look dim (see Bureau and Jean 2012), there is still some hope that the talks will be revived. Meanwhile, various plurilateral negotiations on options for regional integration and free-trade areas are under discussion, but the benefits from them are always far smaller than those from a multilateral agreement – and often agriculture is the sector liberalized least (Anderson 2013).

The optimal solution to the second (‘insulating’) problem also involves the WTO. In a many-country world, it is clear from the above analysis that the trade policy actions of individual countries can be offset by those of other countries to the point that the interventions become ineffective in achieving their stated aim of reducing domestic food price volatility. This is a classic international public good problem that could be solved by a multilateral agreement to restrain the variability of trade restrictions.

One of the original motivations for the Contracting Parties to sign the General Agreement on Tariffs and Trade (GATT, WTO’s predecessor) was to bring stability and predictability to world trade. To that end the membership adopted rules to encourage the use of trade taxes in place of quantitative restrictions on trade (Article IX of the GATT), and managed to obtain binding commitments on import tariffs and on production and export

subsidies as part of the GATT's Uruguay Round Agreement on Agriculture. However, those bindings continue to be set well above applied rates by most countries, leaving plenty of scope for varying import restrictions without dishonoring those legal commitments under WTO. Meanwhile, there are no effective disciplines on export taxes, let alone bindings.

In the current Doha round of WTO negotiations there are proposals to phase out agricultural export subsidies as well as to bring down import tariff bindings, both of which would contribute to global economic welfare, to a sustainable 'thickening' of food and agricultural markets, and thereby to more-stable international food prices. However, proposals to broaden the Doha agenda to also introduce disciplines on export restraints have struggled to date to gain traction. Strong opposition to the inclusion of this export item on the Doha Development Agenda has come from several food-exporting developing countries, led by Argentina (whose farm exports have been highly taxed since its large currency devaluation at the end of 2001 – see Sturzenegger and Salizna (2008)). Yet the above analysis reveals the need for symmetry of treatment of export and import disciplines in the WTO.⁶

Whether or not WTO member countries liberalize their food trade and bind their trade taxes on exports as well as imports at low or zero levels, there would still be occasions when international food prices spike. What alternative instruments could governments use to avert losses for significant groups in their societies?

A standard answer from economists is that food security for consumers, most notably food affordability for the poor, is best dealt with using generic social safety net measures that offset the adverse impacts of a wide range of different shocks on poor people – net sellers as well as net buyers of food – without imposing the costly by-product distortions that necessarily accompany the use of n^{th} -best trade policy instruments for social protection. That might take the form of targeted income supplements to only the most vulnerable households, and only while the price spike lasts.

This standard answer has far greater power now than just a few years ago, thanks to the digital information and communication technology (ICT) revolution. In the past it has

⁶ Such symmetry also would be helpful in times of downward price spikes. Some developing countries have added to the WTO's Doha Agenda a proposal for a Special Safeguards Mechanism (SSM) that would allow them to raise their agricultural import barriers above their bindings for a significant proportion of farm products in the event of a sudden international price fall or an import surge. This is the exact opposite of what is needed by way of an international public good to reduce the frequency and amplitude of downward food price spikes (Hertel, Martin and Leister 2010). Evidence provided by Anderson and Nelgen (2012a) for the mid-1980s suggests that if food-importing countries were to exercise that proposed freedom when international prices slump, food-surplus countries would respond by lowering their export restrictions – thereby weakening the efforts of the food-importing countries to insulate their domestic markets from the international price fall – *and* further depressing that price.

often been claimed that such payments are unaffordable in poor countries because of the fiscal outlay involved and the high cost of administering such handouts. However, recall that in half the cases considered above, governments *reduce* their trade tax rates, so even that intervention may require a drain on the budget of many finance ministries. In any case, the option of using value-added taxes in place of trade taxes to raise government revenue has become common practice in even low-income countries over the past decade or two. Moreover, the ICT revolution has made it possible for conditional cash transfers to be provided electronically as direct assistance to even remote and small households, and even to the most vulnerable members of those households (typically women and their young children – see, e.g., Fiszbein and Schady (2009), Adato and Hoddinott (2010) and Skoufias, Tiwari and Zaman (2010)).

What if countries are still unsatisfied with the contribution of their farmers to national food security, as reflected in food self-sufficiency ratios, or feel their farmers are missing out on the benefits of rapid economic growth and industrialization? Again agricultural import protection measures are far from first-best ways of dealing with these socio-political concerns. Alternative measures include subsidizing investments in agricultural R&D, in rural education and health, and in roads and other rural infrastructure improvements. If the social rates of return from those investments are currently high and above the private rates of returns, as is typically the case in developing countries, expanding such investments will be economically beneficial. So too could be improvements in land and water institutions that determine property rights and prices for those key farm inputs. Such investments almost certainly would reduce poverty and boost food security, including through raising net farm incomes while lowering the consumer price of food in towns and cities.

The challenge of encouraging countries to switch from trade to domestic policy instruments for addressing non-trade domestic concerns is evidently non-trivial. Yet the evidence summarized above shows some reform has been possible during the past three decades. With luck, the emergence of new, lower-cost social protection mechanisms involving conditional cash e-transfers might edge governments one more step away from the use of beggar-thy-neighbor trade measures.

Areas for Future Research

Plenty of scope remains for further economic research to contribute to better policy choices in the future. With the large panel dataset of agricultural price distortions now available at www.worldbank.org/agdistortions, political econometricians could add to our understanding of the political economy forces behind different countries' experiences at reform (building on the initial studies in Anderson 2010b). If that dataset's update were to be replaced with more detailed estimates of NRAs and CTEs for the period 2005 to 2012, by collating prices for the farmgate, wholesale and retail levels, it would be possible to more fully analyse not only government responses to the three price spikes in that short period but also how those responses were transmitted along the value chain to farmers and final consumers. In any such analysis it would be important to bear in mind the imperfect competition, product differentiation and vertical coordination that now characterize such chains (Sexton 2012). With the help of household income and expenditure survey data it would then be possible to assess the national welfare, distributional and poverty effects of those policy actions.⁷ That would then allow easy comparison with the socio-economic effects of alternative domestic social protection instruments such as conditional cash e-transfers.

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⁷ One such attempt to estimate the poverty consequences in 29 developing countries of the food price spike of 2006-08 is provided by Anderson, Ivanic and Martin (2012).

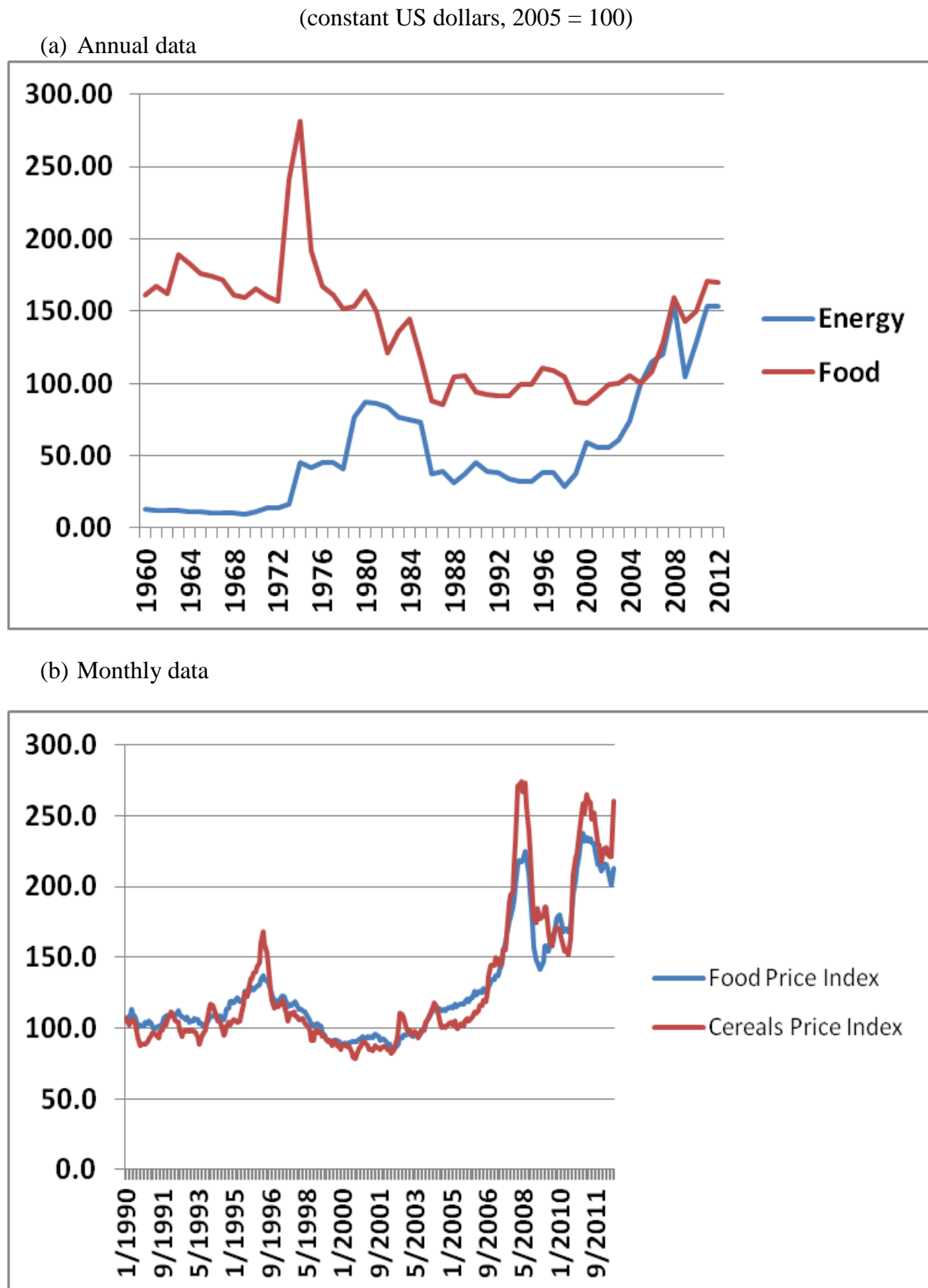
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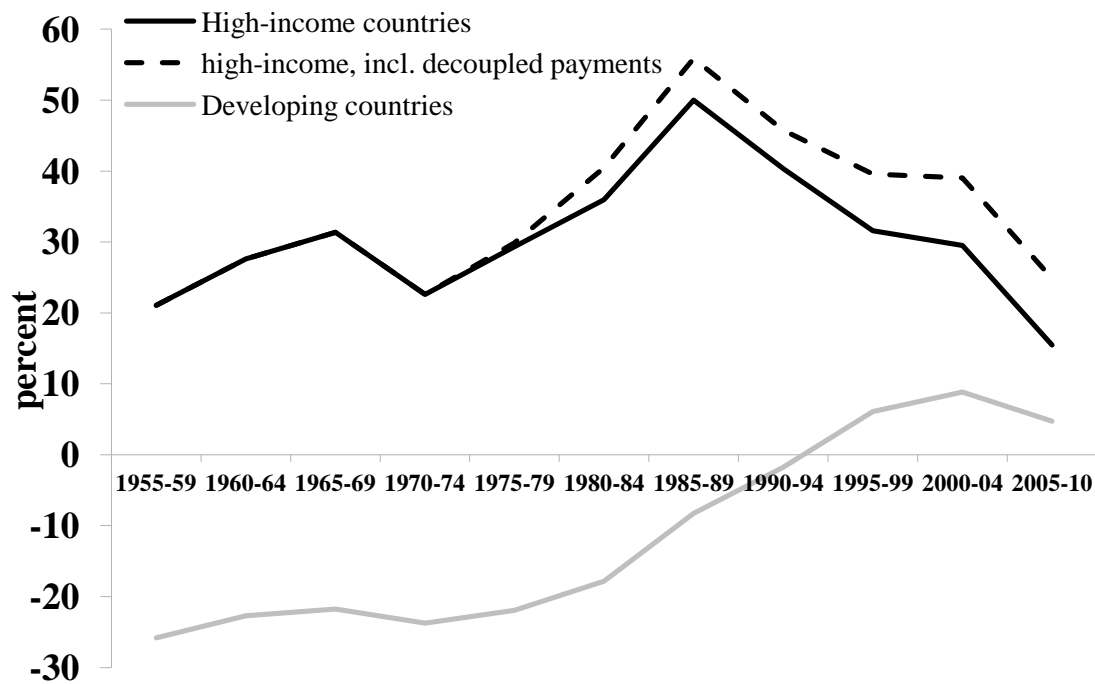
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Figure 1: Real international food and fossil fuel price indexes, 1960 to July 2012



Source: World Bank (2012)

Figure 2: NRAs to agriculture in high-income developing countries,^a 1955 to 2010
(percent)

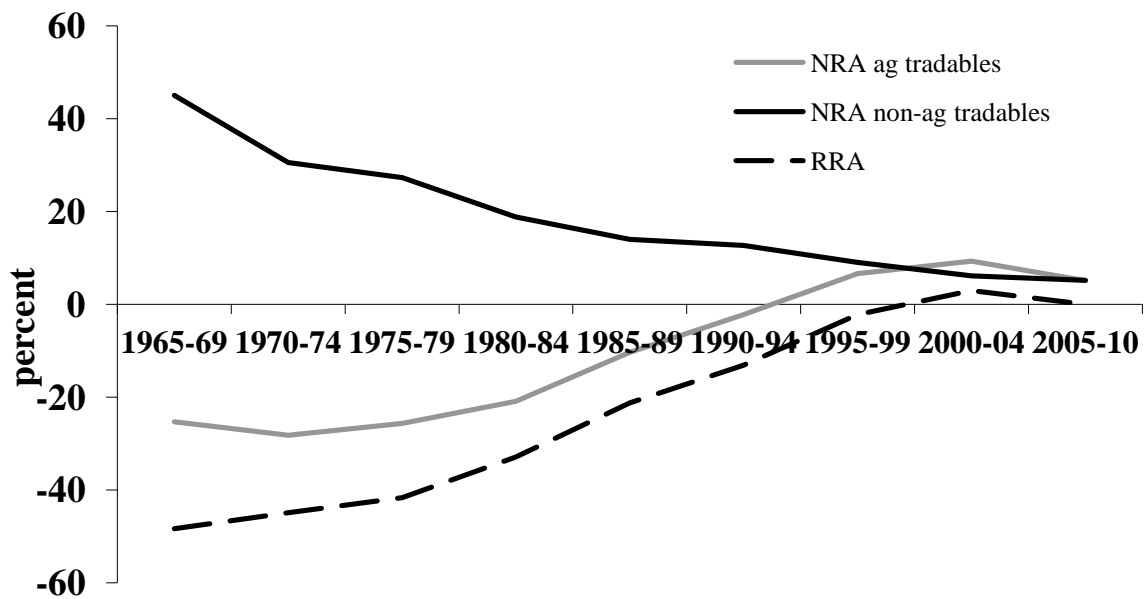


^a Five-year weighted averages, with decoupled payments included in the dashed line. The non-EU transitional economies of Central and Eastern Europe and Central Asia (ECA) are included in the high-income country group.

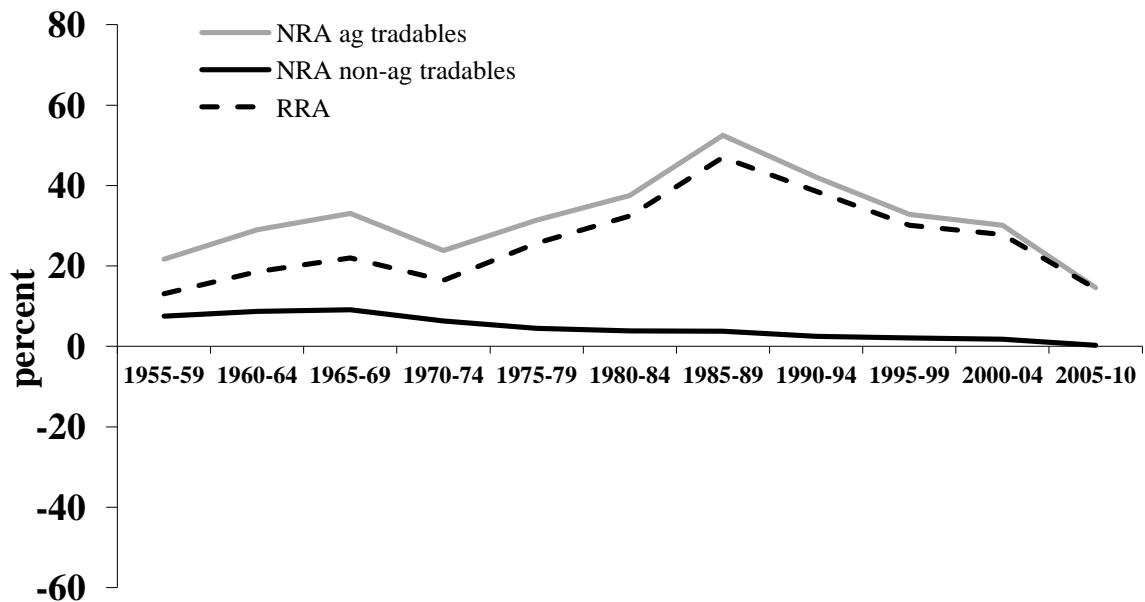
Source: Anderson (2009, Ch. 1), updated from estimates in Anderson and Nelgen (2012b).

Figure 3: Developing and high-income countries' NRAs to agricultural and non-agricultural tradable sectors, and RRAs,^a 1955 to 2010 (percent)

(a) Developing countries



(b) High-income countries

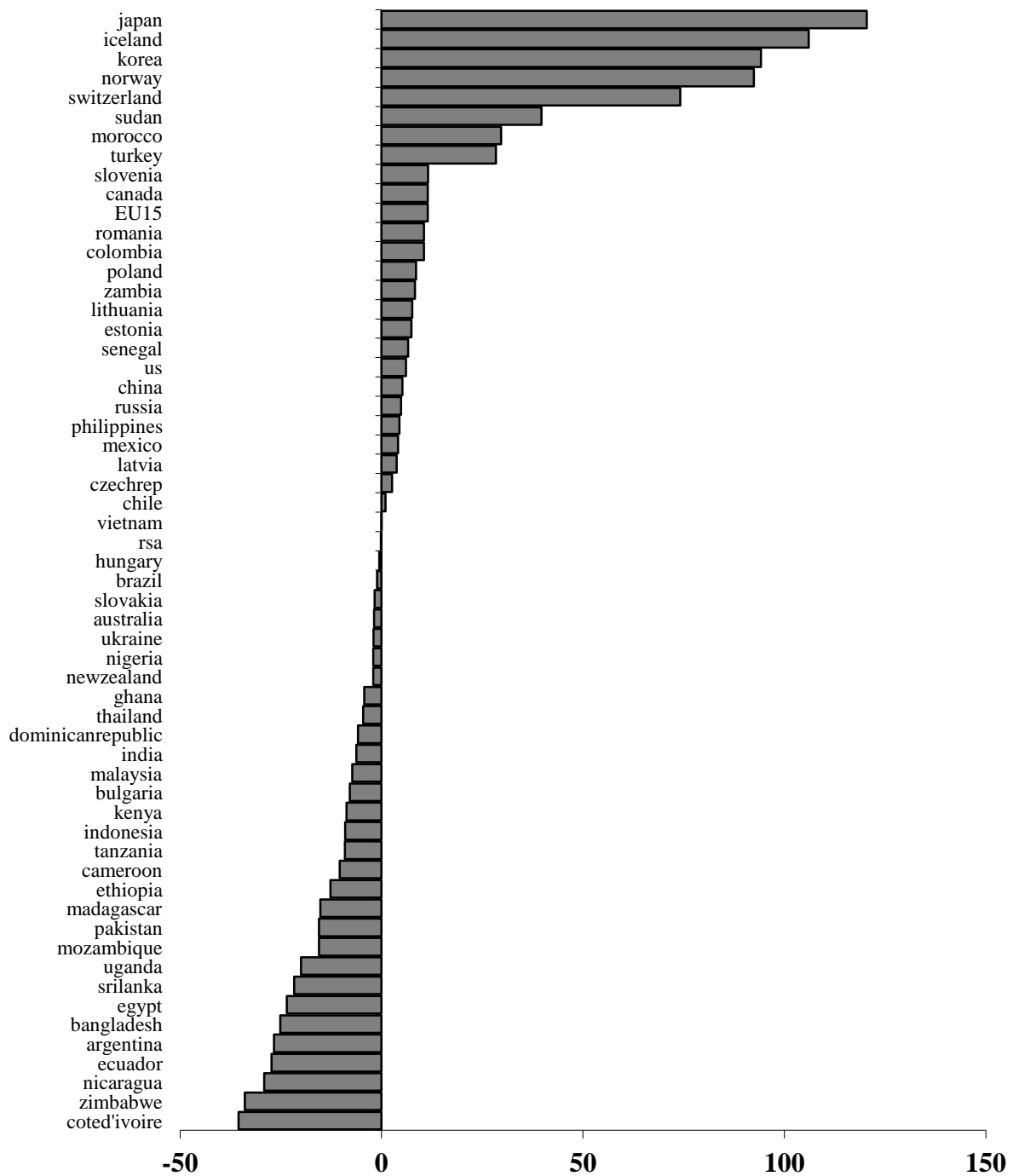


^a Calculations use farm production-weighted averages across countries. RRA is defined as $100 \times [(100 + \text{NRA}_{\text{ag}}^t) / (100 + \text{NRA}_{\text{nonag}}^t) - 1]$, where NRA_{ag}^t and $\text{NRA}_{\text{nonag}}^t$, respectively, are the NRAs for the tradable segments of the agricultural and non-agricultural sectors.

Source: Anderson (2009, Ch. 1), updated from estimates in Anderson and Nelgen (2012b).

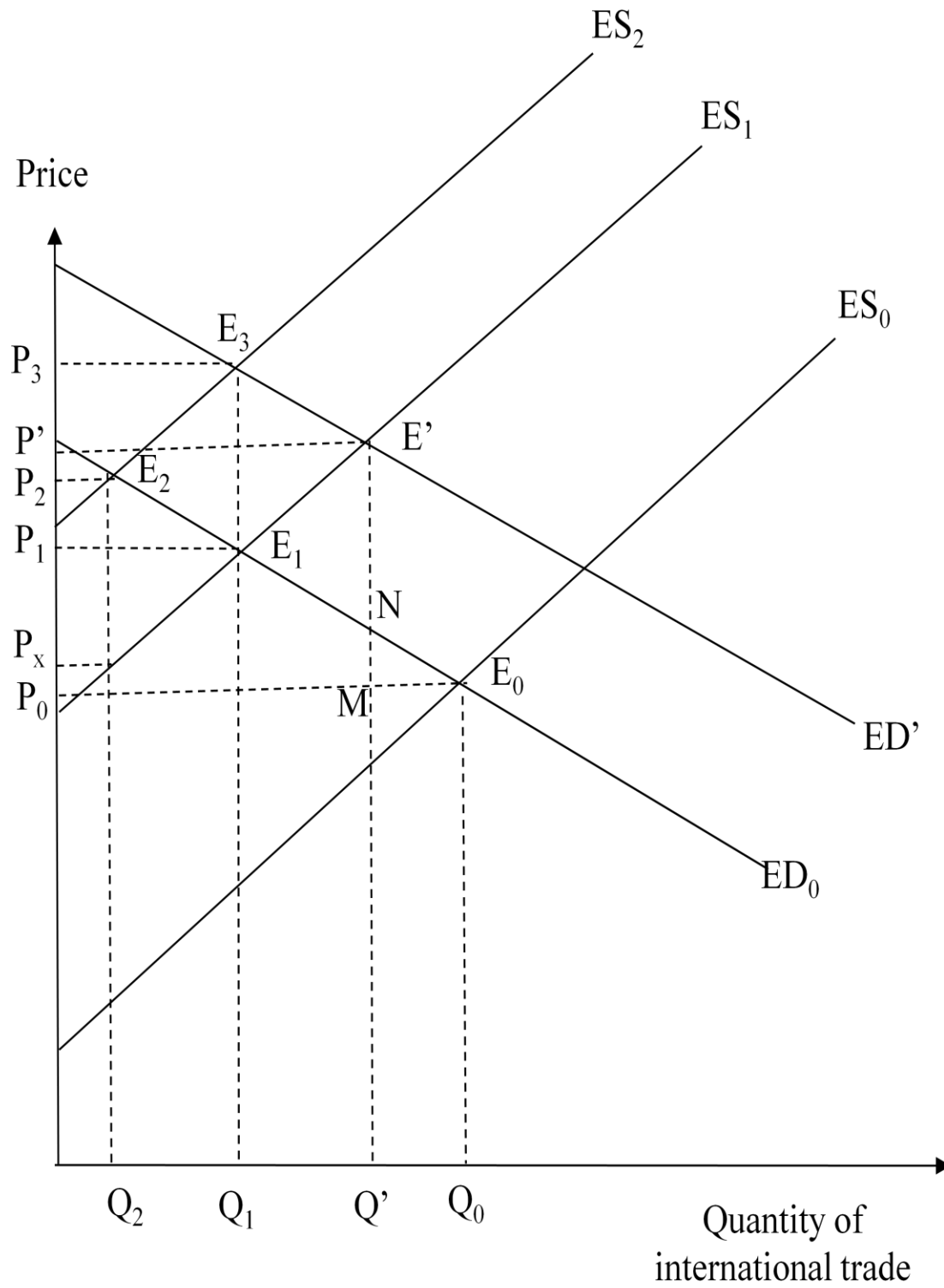
Figure 4: Relative rate of assistance to farmers (RRA),^a by country, 2000-04

(percent)

^a See footnote 2 for the formal definition of the relative rate of assistance

Source: Based on the RRA estimates in Anderson and Valenzuela (2008)

Figure 5: Effects of offsetting export barrier increases and import barrier reductions in the international market for food in response to an exogenous supply shock from ES_0 to ES_1



Source: Anderson and Nelgen (2012a)

Table 1: Deviation of national NRA around its trend value,^a key farm products,^b developing and high-income countries, 1965–84 and 1985–2010

(percent)

	Deviation of national NRAs				Weighted average of NRAs			
	Developing countries		High-income countries		Developing countries		High-income countries	
	1965–84	1985–09	1965–84	1985–10	1965–84	1985–09	1965–84	1985–10
Rice	32	59	66	186	-20.1	0.9	136.8	351.8
Wheat	33	43	52	76	5.5	9.1	12.2	20.5
Maize	36	33	40	48	-3.4	2.3	6.9	11.9
Soybean	46	120	75	54	2.7	-2.1	0.1	5.2
Sugar	53	64	168	152	17.2	18.0	107.6	108.1
Cotton	38	32	42	30	-16.0	-2.7	21.3	10.4
Coconut	22	34	na	na	-11.5	1.2	na	na
Coffee	41	29	na	na	-37.3	-11.6	na	na
Beef	45	56	84	109	-12.4	2.6	22.7	37.9
Pork	81	58	73	69	23.6	-4.6	37.1	15.0
Poultry	109	69	91	175	26.3	11.8	24.5	25.4

^a Deviation, measured in NRA percentage points, is computed as the absolute value of (residual – trend NRA) where national trend NRA in each of the two sub-periods is obtained by ordinary least squares linear regression of the national NRA on time.

^b Estimates shown are an unweighted average of national NRA deviations each year, averaged over the number of years in each period.

Source: Updated from Anderson and Nelgen (2012c).

Table 2: Global average short-run price transmission elasticities,^a nine key foods, 1985 to 2010

(weighted average across all of the 82 countries for which NRAs are available, using value of national production at undistorted prices as weights)

Rice	0.49
Wheat	0.55
Maize	0.63
Soybean	0.73
Sugar	0.43
Milk	0.51
Beef	0.66
Pigmeat	0.51
Poultry	0.68
Unweighted average,	
9 foods	0.56

^a The proportion of a change in the international price that is transmitted to the domestic market of a country within a year, estimated using Nerlove's partial-adjustment geometric distributed lag formulation.

Source: Estimated by Nelgen (2012) using data from Anderson and Nelgen (2012b).

Table 3: Contributions of policy-induced trade barrier changes to changes in the international prices of key agricultural products, 1972-74 and 2006-08

	<u>1972-74</u>	<u>2006-08</u>
<i>Consumption-weighted proportional decline in NAC, that is, - \hat{T}^a</i>		
Rice	0.56	0.37
Wheat	0.30	0.12
Maize	0.21	0.08
<i>Proportional international price rise, \hat{p}^*</i>		
Rice	3.00	1.13
Wheat	1.57	0.70
Maize	1.35	0.83
<i>Proportional contribution of changed trade restrictions to the international price change^b</i>		
Rice	0.27	0.40
Wheat	0.23	0.19
Maize	0.18	0.10

^a \hat{T} is the negative of the weighted average of proportional changes in national NACs over the period, using national shares of global consumption valued at undistorted prices (G_i 's) as weights, where $NAC = 1 + NRA/100$.

^b The proportional contribution of altered trade restrictions is $\frac{\hat{T}}{\hat{T} + R}$, where R is 'other' influences and is derived from the equation $\hat{p}^* = \hat{T} + R + (\hat{T} * R)$, from which it follows that $R = (\hat{p}^* - \hat{T}) / (1 + \hat{T})$.

Source: Anderson and Nelgen (2012a).

Table 4: Contributions^a of high-income and developing countries, and of importing and exporting countries, to the proportion of the international price change that is due to policy-induced trade barrier changes, 1972-74 and 2006-08

	TOTAL PROPORTIONAL CONTRIBUTION	High- income countries' contribution	Developing countries' contribution	Importing countries' contribution	Exporting countries' contribution
<u>1972-74</u>					
Rice	0.27	0.04	0.23	0.10	0.17
Wheat	0.23	0.15	0.08	0.18	0.05
Maize	0.18	0.14	0.04	0.06	0.12
<u>2006-08</u>					
Rice	0.40	0.02	0.38	0.18	0.22
Wheat	0.19	0.09	0.10	0.07	0.12
Maize	0.10	0.05	0.05	0.03	0.07

^a Expressed such that the two numbers in each subsequent pair of columns add to the total proportion shown in column 1 of each row.

Source: Anderson and Nelgen (2012a), with the left column coming from bottom one-third of Table 2.

Table 5: Comparison of the domestic price rise with the rise in international grain prices net of the contribution of changed trade restrictions, rice, wheat and maize, 1972-74 and 2006-08

(percent, unweighted averages)

	International price rise		Domestic price rise		
	Including contribution of changed trade restrictions	Net of contribution of changed trade restrictions	All countries	Developing countries	High- income countries
<u>1972-74</u>					
Rice	300	220	59	72	27
Wheat	157	121	64	77	55
Maize	135	111	49	48	52
<u>2006-08</u>					
Rice	113	68	56	48	74
Wheat	70	56	77	65	81
Maize	83	75	73	62	82

Source: Anderson and Nelgen (2012a)