# Projecting agricultural distortions for a 2030 GTAP database

Signe Nelgen and Kym Anderson

School of Economics
University of Adelaide
Adelaide SA 5005 Australia
Phone +61 8 8303 4712
Fax +61 8 8223 1460
signe.nelgen@googlemail.com
kym.anderson@adelaide.edu.au

June 2011

Contributed paper for the 14th Annual Conference on Global Economic Analysis, Venice, 16-18 June 2011. Thanks are due to Anna Strutt and Ernesto Valenzuela for help with GTAP data, and to the Australian Research Council, the Rural Industries Research and Development Corporation and the World Bank for financial assistance. Views expressed are the authors' alone.

## Abstract

When sectoral and economy-wide modelers seek to analyse the effects of prospective structural and policy changes over coming decades, a common assumption in the baseline scenario is that trade-related policies do not change over the projection period. That may be reasonable for manufacturing protectionism, now that most major countries have liberalized most of their industrial market. Agricultural policies, however, remain highly distortive – and they have been evolving in fairly systematic ways. How different might such farm policy interventions be in, say, 2030 from those in 2004 (the base year of the latest GTAP protection database) in the absense of a Doha agreement to undertake multilateral policy reform? This paper addresses that question by drawing on the World Bank's agricultural distortions database for 75 countries, political economy theory, a set of political econometric equations for the  most important agricultural products, and knowledge of current WTO-bound tariffs. With those equations plus projections of pertinent variables from recent GTAP modeling, a set of agricultural price distortions is generated for the world in 2030. This provides an alternative to the common 'business-as-usual' projections approach of assuming the status quo will prevail on the policy front, and thus an opportunity for modelers to explore the extent to which results could differ depending on the chosen counterfactual against which future trade-liberalizing scenarios are compared.

Keywords: agricultural protection, trade policy counterfactuals, economy-wide projections

JEL codes: F13, F14, F17, Q17, Q18

Author contact:
**Signe Nelgen**
School of Economics
University of Adelaide
Adelaide SA 5005 Australia
Phone +61 8 8303 4712
Fax +61 8 8223 1460
signe.nelgen@googlemail.com

# Projecting agricultural distortions for a 2030 GTAP database

In recent years there has been renewed interest in projecting global commodity markets and the overall economy two to four decades ahead. Demand for such long-term projections has been driven by such things as the recent rises in food and energy prices, rapid growth in large emerging economies, and worries about greenhouse gas emissions. Such projections are also sought by trade policy analysts as a baseline for estimating the effects of proposed or alternative trade policy reforms that tend to be phased in over anything up to two decades. The most important of those proposals is the Doha Development Agenda of the World Trade Organization (WTO), but there are numerous regional and other plurilateral economic integration proposals also under discussion, including a Trans-Pacific Partnership.

A common assumption in developing baseline projections for such analytical purposes is that trade-related policies do not change over the projection period. That may be reasonable for manufacturing protectionism, now that most major countries have liberalized most of their industrial market. Agricultural policies, however, remain highly distortive – and they have been evolving in fairly systematic ways. How different might farm policies be in, say, 2030 from those in 2004 (the base year of the latest GTAP protection database) in the absense of a Doha agreement to undertake multilateral policy reform and any other plurilateral trade agreements?

This paper addresses that question by drawing on the World Bank's agricultural distortions database for 75 countries, political economy theory, a set of political econometric equations for the most important agricultural products, and knowledge of current WTO-bound tariffs. With those equations plus projections of pertinent variables from recent GTAP modeling, agricultural price distortion rates are generated for the world in 2030. This provides an alternative to the common 'business-as-usual' projections approach of assuming the status quo will prevail on the policy front. It thereby offers an opportunity for modelers to explore the extent to which results could differ depending on the chosen counterfactual against which future trade-liberalizing scenarios are compared.

The paper begins with a brief summary of the post-World War II history of distortions to agricultural (relative to industrial) incentives globally. The second section draws on political economy theory and institutional history to propose a set of political econometric equations for the most important agricultural products, aimed at providing a means of projecting future agricultural distortions for any country in the absense of further trade reform.[1] Section three presents the results, and the final section draws out some policy implications and areas for further research.

**Brief history of distortions to agricultural incentives globally**

There have been some agricultural and other trade policy developments over the past half century or so that have happened quite suddenly and been transformational, as well as others that have been gradual and so less noticeable. Events surrounding the former include the end of colonization in many of today's developing countries around 1960, the creation of the Common Agricultural Policy in Europe in 1962, the floating of exchange rates and associated liberalization, deregulation, privatization, and democratization from the mid-1980s in many countries, and the opening of markets in China in 1979, Vietnam in 1986, and Eastern Europe following the fall of the Berlin Wall in 1989 and the demise of the Soviet Union in 1991. This section summarizes a new database that sheds light on the combined impact of both types of trade-related policy developments since the 1950s on direct and indirect distortions to agricultural incentives.

For advanced economies, the most commonly articulated reason for farm trade restrictions has been to protect domestic producers from import competition as they come under competitive pressure to shed labor as the economy grows. In the process, however, those protective measures hurt not only domestic consumers and exporters of other products, but also foreign producers and traders of farm products. They also reduce national and global economic welfare. For decades, agricultural protection and subsidies in high-income (and some middle-income) countries have been depressing international prices of farm products,

[1] Bouët and Laborde (2010) also seek to assess the implications for the world economy of protection growth that might result if the WTO's Doha round fails to agree to liberalize trade multilaterally. However, their assumed alternative protection rates are more ad hoc than in the present study.

which lowers the earnings of farmers and associated rural businesses in developing countries. The Haberler (1958) report to GATT Contracting Parties forewarned that such distortions might worsen, and indeed they did between the 1950s and the early 1980s (Anderson, Hayami and Others 1986).

In addition to this external policy influence on developing countries, the governments of many of them have directly taxed their farmers over the past half century. A well-known example is the taxing of exports of plantation crops in post-colonial Africa (Bates 1981). At the same time, many developing countries chose also to overvalue their currency and to pursue an import-substituting industrialization strategy by restricting imports of manufactures. Together, those latter measures indirectly taxed producers of other tradable products in developing economies, by far the most numerous of them being farmers (Krueger, Schiff and Valdés 1988, 1991). Thus the price incentives facing farmers in many developing countries have been depressed by both own-country and other countries' agricultural price and international trade policies.

This disarray in world agriculture, as D. Gale Johnson (1973) described it in the title of his seminal book, means there has been overproduction of farm products in high-income countries and underproduction in low-income countries. During the past twenty-five years, however, numerous countries have begun to reform their agricultural price and trade policies. This has raised the extent to which farm products are traded internationally, but not nearly as fast as globalization has proceeded in the nonfarm sectors of the world's economies.

Empirical indicators of agricultural price distortions (called Producer Support and Consumer Subsidy Estimates or PSEs and CSEs) have been provided in a consistent way for more than twenty years by the Secretariat of the OECD (2010) for its thirty member countries. However, the OECD provides no comprehensive time series rates of assistance to producers of nonagricultural goods to compare with the PSEs, nor of what happened in those advanced economies in earlier decades. As for developing countries, almost no comparable time series estimates were generated in the two decades following the first paper by Krueger, Schiff and Valdes (1988), which covered the 1960-84 period for just seventeen developing countries.[2] However, a new database of agricultural distortions has been developed recently

[2] An exception is a new set of estimates of nominal rates of protection for key farm products in China, India, Indonesia, and Vietnam since 1985, by Orden et al. (2007). The OECD (2009) also has released PSEs for Brazil, China, and South Africa, as well as several East European countries.

by the World Bank (Anderson and Valenzuela 2008) which complements and extends the OECD's PSE/CSE work and the seminal Krueger, Schiff and Valdés (1988, 1991) study. It builds on them by providing similar estimates for other significant (including many low-income) developing economies, by developing and estimating new, more comprehensive policy indicators (defined in the next sub-section), and by providing estimates for nonagricultural tradables to compare with the average for the agricultural sector (summarized in the following sub-section, drawing on Anderson (2009 Ch. 1 and 2010 Ch. 2)).[3]

***Indicators of price distortions***

Trade measures (taxes and non-tariff barriers or NTBs), both agricultural and nonagricultural, plus the use of multiple exchange rates, historically have distorted product prices at the border much more commonly than trade subsidies or direct domestic producer or consumer subsidies or taxes that alter product or input prices. In high-income countries from the 1970s, however, agricultural export subsidies grew in importance, and since the 1980s domestic farm support measures that are decoupled from production to varying extents have begun to play a bigger role. Also, most NTBs were converted to tariffs following the inception of the WTO in 1995. Those tariffs, however, have been legally bound at well above applied rates in many countries, leaving ample room for such countries to continue to vary border measures as international prices (or domestic supplies) fluctuate from year to year or as the demands for protection rise.

Government-imposed distortions that create a gap between domestic prices and what they would be under free markets are indicated by the Nominal Rate of Assistance (NRA). This has been computed for each farm product as the percentage by which government policies have raised gross returns to farmers above what they would be without the government's intervention -- or lowered them, if NRA<0.[4] Included are any product-specific input subsidies. A weighted average NRA for all covered products is derived using the value

[3] The new database includes estimates for 75 countries that together account for between 90 and 96 percent of the world's population, farmers, agricultural GDP, and total GDP. The sample countries also account for more than 85 percent of farm production and employment in each of Africa, Asia, Latin America, and the transition economies of Europe and Central Asia, as well as virtually 100 percent of agriculture in OECD countries. Price distorttions are estimated for more than 70 different products, with an average of almost a dozen per country. That product coverage represents around 70 percent of the gross value of agricultural production in each of the focus countries and just under two-thirds of global farm production valued at undistorted prices over the period covered. Not all countries had data for the entire 1955–2007 period, but the average number of years covered is 41 per country.

[4] Also calculated is a Consumer Tax Equivalent (CTE), which is equal to the NRA if and only if no domestic producer or consumer measures apply.

of production at undistorted prices as product weights. To that NRA for covered products is added a 'guesstimate' of the NRA for noncovered products (which on average around 30 percent of the total in value terms) and an estimate of the NRA from non-product-specific forms of assistance or taxation. Since the 1980s, some high-income country governments have also provided so-called 'decoupled' assistance to farmers. Because that support in principle does not distort resource allocation as much as direct price supports, its NRA has been computed separately and is not included for comparison with the NRAs for other sectors or for developing countries. Each farm 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 covered tradable farm products.

Also generated is a production-weighted average NRA for nonagricultural tradables, for comparison with that for agricultural tradables via the calculation of a Relative Rate of Assistance (RRA), defined in percentage terms as:

$$RRA = 100*[(100+NRAag^t)/(100+NRAnonag^t)-1]$$

where $NRAag^t$ and $NRAnonag^t$ are the percentage NRAs for the tradable parts of the agricultural (including noncovered) and nonagricultural sectors, respectively.[5] Since the NRA cannot be less than -100 percent if producers are to earn anything, neither can the RRA (since the weighted average $NRAnonag^t$ is non-negative in all the country case studies). And if both of those sectors are equally assisted, the RRA is zero.

Anderson and Neary (2005) show that it is possible to develop a single index that captures the extent to which both the mean and the standard deviation of protection rates within a sector each year together contribute to the welfare cost of that sector's distortionary policies. Their index recognizes that the welfare cost of a government-imposed price distortion is related to the square of the price wedge, and so is larger than the mean, and more so the bigger the dispersion of industry protection rates within the sector; and it is positive regardless of whether the government's policy is favoring or hurting producers in that sector. Lloyd, Croser and Anderson (2010) show that, once NRAs and CTEs have been calculated,

[5] The RRA is generated because farmers are affected not just by prices of their own products 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 seventy years ago, Lerner (1936) provided his Symmetry Theorem to prove that in a two-sector economy, an import tax has the same effect as an export tax. This carries over to a model that also includes a third sector producing only nontradables (Vousden 1990).

they can be used to generate such an index even in the more complex situation where there may be domestic producer or consumer taxes or subsidies in addition to not only import tariffs but any other trade taxes or subsidies or quantitative trade restrictions. Lloyd, Croser and Anderson call it a Welfare Reduction Index (WRI), which is the percentage agricultural trade tax (or uniform NRA and CTE) that, if applied equally to all agricultural tradables, would generate the same reduction in national economic welfare as the actual intrasectoral structure of distortions to domestic prices of farm goods. They show that, if the domestic price elasticities of supply (demand) are equal across farm commodities, then the only information needed to estimate the WRI, in addition to the NRAs and CTEs, is the share of each commodity in the domestic value of farm production (consumption) at undistorted prices.

***Sectoral distortion differences across countries***

Historically, national nominal rates of assistance to agriculture (NRAs) have tended to be higher, the higher a country's income per capita and the weaker a country's agricultural comparative advantage. There has also been a (somewhat weaker) tendency for manufacturing protection to be lower, the higher a country's income per capita and the stronger a country's manufacturing comparative advantage. Together these tendencies would expect one to observe the relative rate of assistance to farmers (RRA) to be positively correlated with per capita income and negatively correlated with an index of comparative advantage in farm products. This is indeed what the World Bank's agricultural distortions panel database reveals (Figure 1). Figure 2 shows the RRA has been rising over time for developing countries as a group, and also for high-income countries prior to the 1990s. The developing countries' RRA rose from around -50 percent in the latter 1960s to almost zero in 2000-04, while the RRA for high-income countries rose from 14 percent in the latter 1950s to a peak of just above 50 percent in the latter 1980s. A movement in the RRA towards (away from) zero might indicate an improvement (worsening) in economic welfare, suggesting that the welfare cost of developing country policies may have been falling but may begin increasing if they follow the high-income countries' earlier example in raising their now-positive average RRA further. That is certainly what Korea and Taiwan did in following Japan, and China and India appear to be on a similar trajectory (Figure 3).

A disaggregation of the NRA estimate for the agricultural sector into the NRAs for the export and import-competing sub-sectors, as in Figure 4, reveals that developing country exporters of farm products faced a tax of around 50 percent on average in the first decades of post-colonial government; but that rate of taxation has fallen to almost zero since the mid-1980s. Meanwhile, however, the NRA for import-competing farmers in developing countries has been positive and steadily rising throughout this period (apart from a spike in the mid-1980s when international prices fell to a near-record low as a consequence of a farm export subsidy war between the two sides of the North Atlantic). The trend for exporters could have reduced the welfare cost of agricultural distortions in developing countries, but the fact that import-competing farmers were increasingly assisted reduces that possibility. As for high-income countries, Figure 4(b) shows that their exporters received rising support until the end of the North Atlantic farm export subsidy war, but that import-competing farmers enjoyed higher and faster-rising support over that period than exporters. Together these estimates suggest a mapping of the WRI against the log of per capita income may at first decrease but would then increase beyond some middle-income level. And that is indeed what both the combined panel dataset of national WRIs, and even the set for just developing countries, reveal (Figure 5). When the border component of the WRI for developing countries is tracked across time and broken down by trade policy instrument, it indicates that export taxation contributed increasingly to the welfare cost of agricultural distortions there until the late 1980s, but that the welfare cost of agricultural import restrictions also was sizeable and grew somewhat each decade (Figure 6).

**What determines the evolution of NRAs over time?**

Political economy theory to explain the pattern of agricultural distortions across countries and over time made some progress in the 1980s, but then it stalled. Only now are theorists beginning again to focus on improving our conceptualization of the issue, suggest hypotheses, compile appropriate data and use political econometrics to test those hypotheses (see, e.g., Anderson 2010 and Rausser, Swinnen and Zusman 2011). But even the earlier analysis can take us some way towards understanding the evolution of agricultural price-distorting policies. Anderson (1995), for example, suggests the following factors distinguish the domestic polities of developing and high-income countries.

First, in a poor agrarian economy (PAE), urban wage-earners and hence their employers care a great deal about the price of food, and are relatively well organized. Farmers by contrast, are numerous but poorly organized, and many are so small as to be able to sell only a small share of their output in the market. In a rich industrial economy (RIE), by contrast, farm products (especially net of post-farmgate costs) represent a small fraction of urban household expenditure and hence of real wages. As well, urban households are far more numerous and so suffer from a free-rider problem of collective action in RIEs, just as farmers do in PAEs.

Second, a typical PAE has the majority of its workforce employed in agricultural pursuits and relatively few in manufacturing, whereas in RIEs there could be up to ten times as many engaged in industrial jobs as on farms. Altering the domestic price of farm relative to industrial products thus has a far bigger impact on the price of mobile labor in a poor PAE than in a RIE. Industrial capitalists therefore are more likely to be able to lobby successfully for (and face less opposition to) taxes on agricultural exports and manufactured goods imports in PAEs, whereas agricultural interests are more likely to be able to lobby successfully for (face less opposition to) agricultural subsidies and import tariffs in RIEs.

And third, high costs of collecting taxes other than at the border in PAEs make them much more likely than RIEs to employ trade taxes and thus be prone to an anti-trade bias in their sectoral policies, and less fiscally capable of subsidizing any sector. By definition the PAE has a comparative advantage in agricultural goods, hence this anti-trade bias adds to the anti-agricultural bias in PAE policies.

Together these forces would lead one to expect to observe countries gradually switching from a negative to a positive RRA as their per capita income grows, and more so if their agricultural comparative declines in the process of that development. That is consistent with the evidence presented in Figure 1 above. It is also consistent with a formal econometric test using those two variables for the full sample of countries in the Anderson and Valenzuela (2008) panel dataset, as well as separately for each of the three developing country regions and for high-income countries (Anderson 2010, Table 2.12).

The domestic polity also can come under pressure from outside from time to time. Three sets of external forces during the past quarter-century are worth mentioning. One is the Uruguay Round Agreement on Agriculture, negotiations for which began in 1986 and implementation of which concluded in 2004. That led to agreement to convert non-tariff barriers to tariffs, to set caps (bindings) on those tariffs, and to phase down and cap domestic and export subsidies. The caps were somewhat above applied rates in high-income countries, but they were very much above applied tariffs in the case of middle- and especially low-income countries. Hence those bindings provide little discipline on the agricultural policies of most developing countries.

A second and complementary force in Europe was the likelihood and then reality of an eastern enlargement of the European Union, which required the budget for subsidies under the Common Agricultural Policy gradually to be spread over a dozen more countries. One consequence was a move away from price-support instruments to more-decoupled measures including single farm payments. The reforms came in various stages, under McSharry in 1992 and under Fischler in the early 2000s, which explains the gradual fall in EU and hence high-income agricultural NRAs after the late 1980s (Figure 4(b)). For intra-EU political reasons they are unlikely to trend back upwards in the foreseeable future.

The third external force came from international financial institutions whose loans and other assistance to developing countries became somewhat conditional on better economic governance including more openness of their economies. That helped to bring down their NRAs for non-farm tradable sectors (Figure 2(a)) and to phase out their taxes on farm exports (Figure 4(a)). However, with so little discipline on farm import tariffs coming from the Uruguay Round Agreement on Agriculture, those tariffs have continued to drift upwards for developing countries over the past two decades.[6] It also means it has been difficult for the WTO membership to demand tight constraints on out-of-quota farm tariffs of countries seeking to accede to the WTO, including China.

[6] There are virtually no effective WTO disciplines on export taxes though. Some developing countries have chosen to use that freedom to impose export taxes (and lower import taxes) temporarily when international food price spike upwards, so as to not transmit all of such price spikes to their domestic food market. Likewise, the gap between their applied and bound import tariff gives them latitude to raise applied rates when international prices fall, so as to protect their farmers from that slump. Evidence of extensive use of these freedoms is provided by Anderson and Nelgen (2011).

The above suggests high-income countries (including Eastern Europe's transition economies that are now part of the European Union) are unlikely in the foreseeable future to raise their assistance to farmers via price-distorting measures, developing countries are unlikely to return to farm export taxation (apart from temporarily at times of price spikes, discussed in footnote 5), and all countries are unlikely to return to high levels of protection for the manufacturing sector. But if the WTO's Doha Development Agenda fails to conclude with an agreement to greatly reduce developing countries' bindings on agricultural import tariffs, political economy theory and past experience suggest agricultural protection growth may well continue. More specifically, such protection increases could be expected to be related to growth in per capita income and in agricultural comparative disadvantage, and to be higher for import-competing than exported products. According to the econometric evidence reported in Anderson (2010, Table 2.12), an equation worth considering for projecting each country's tradable food products is the following:

$$(1) \qquad NRA_i = f\,(YPC, LPC, TSI_i)$$

where YPC is the log of real per capita national income, LPC is the log of arable land per capita (an indicator of agricultural comparative advantage), and $TSI_i$ is a trade specialization index for product i (exports minus imports as a fraction of exports plus imports) which, by definition, ranges between minus and plus one.

## Projecting developing country NRAs from 2004 to 2030

Most modelers of trade-related policies for the global economy make use of the GTAP database, the latest version of which is for 2004 (Narayanan and Walmsley 2008).[7] Modelers wishing to estimate the likely effects of a future structural or policy shock need first to project a baseline of the global economy to a target future date such as 2030 in the absence of that shock. This can then serve as the counterfactual against which to compare the economy in

[7] For those with a particular interest in developing country agriculture, an alternative set of distortion estimates has been provided by Valenzuela and Anderson (2008), based on the World Bank distortion database compiled by Anderson and Valenzuela (2008). This alternative set goes beyond the GTAP set, which mainly includes only import tariffs, to incorporate also export taxes, import subsidies, and domestic producer or consumer taxes or subsidies. It is the set adopted in the present study.

that year in the presence of the shock of interest (such as the implementation of a multilateral trade agreement such as that being sought under the WTO's Doha Development Agenda).

Typically modelers would assume for their baseline that trade-related policies remain unchanged over the projection period. The purpose of this section is to provide an alternative counterfactual. It does so by reporting estimates of Equation (1) for ten key traded farm products as of 2004, and projections of NRAs for each of those products to 2030 for each developing country in the World Bank distortion database compiled by Anderson and Valenzuela (2008). The sample for the regression equation is all 75 countries in the World Bank distortion database in 2004. Their NRA means and ranges are shown, along with those of 15 other farm products, for each of the developing country regions and for all 75 countries, in Appendix Figure A.

The regression equations are reported in Table 1. The results are not highly significant, but apart from maize at least one of the 3 explanatory variables is statistically significant in each equation. The insignificant result for maize is not surprising in view of the very small range of its NRAs in the panel data and mean of almost zero (see Appendix Figure A(e)). For the other nine products, the $R^2$ values are between 0.21 and 0.55. All except soybean have a negative coefficient for TSI, consistent with the above theory. Soybean has an even smaller range of NRAs around its mean of zero in the panel data (Appendix Figure A(e)). All product equations have a positive coefficient for YPC and a negative coefficient for LPC, again as predicted by theory.

To use these equations to project NRAs, it is necessary to have projected values for the three exogenous variables. These are taken from a recent exercise that employed the GTAP economy-wide model to project the global economy to 2030 (Anderson and Strutt 2011). Their projection assumes the 2004 stocks of agricultural land and trade-related policies of each country do not change over that 26-year period but that national real GDP, population, unskilled and skilled labor, capital, and other natural resources (oil, gas, coal and other minerals) grow at exogenously set rates. Those exogenous growth rates are based on ADB, OECD, USDA and World Bank projections, plus historical trends in mineral and energy raw material reserves. Given those exogenous growth rates, the model is able to derive implied rates of total factor productivity and GDP per capita growth. For any one country the rate of total factor productivity growth is assumed to be the same in each of its non-primary sectors, and to be somewhat higher in its primary sectors. Higher productivity growth rates for primary activities were characteristic of the latter half of the 20th century (Martin and Mitra 2001), and are necessary in this projection if real international prices of primary products (relative to the aggregate change for all products) are to follow a relatively flat trend.[8] Once those higher TFP growth rates for primary sectors are determined, the uniform rates for non-primary sectors are re-calculated to ensure the targeted GDP levels are obtained.

In addition to taking the real GDP, land and population values for 2030 from the Anderson and Strutt (2011) study, we also use its estimated trade structure for 2030 to estimate a value for TSI for each product and country. That provides all the exogenous variables needed to estimate a potential endogenous value for the NRA for each product and country. That potential value is then subjected to the following series of tests. First, if it was in 2004 and is projected to still be a net export product in 2030 (TSI>0), then its 2030 NRA is assumed to be the lesser of its 2004 NRA or zero. That is, we assume all export taxes will be phased out by 2030, and that no new export subsidies will be introduced. And second, if it is projected to be an import-competing product in 2030 (TSI<0), then its 2030 NRA is assumed to be the lesser of the equation's projected NRA or its WTO-bound tariff rate. That is, we assume all developing countries respect their commitment to WTO not to exceed their tariff bindings but otherwise feel free to allow domestic political forces determine the degree of protection provided to import-competing farm industries.

Using this methodology and set of selection criteria, we obtain projected values for each of the ten products and for each of the 39 developing countries in the World Bank sample. Their averages across countries for each region and across products for each country are reported in Tables 2 and 3, respectively. What do they reveal? For developing countries as a whole, the average NRA for these products is projected to rise from 7 percent in 2004 to 35 percent by 2030. It happens that 35 percent is the 2004 average for high-income countries (including Europe's transition economies). Since we assume the NRAs for the latter countries do not change over the projection period, it means the NRA for these ten products for the

[8] That calibration is consistent with the World Bank projections over the coming decades (see van der Mensbrugghe and Roson 2010). An alternative in which agricultural prices fall is considered unlikely over the next two decades given the slowdown in agricultural R&D investment since 1990 and its consequent delayed slowing of farm productivity growth. It is even less likely for farm products if fossil fuel prices and biofuel mandates in the US, EU and elsewhere are maintained over the next decade.

world as a whole is projected to rise from 20 percent in 2004 to 35 percent by 2030, other things equal. As shown at the end of Table 3, the biggest increase is in developing Asia, where the average NRA rises from 11 to 42 percent over the projection period, followed by Africa (a rise from -9 to 16 percent) and Latin America (a rise from -1 to 17 percent). The biggest rises are in rice and sugar, which is not surprising since they are the most distorted products in high-income countries (see bottom of Table 2).

What would those projected NRAs imply about the cost of agricultural and other price- and trade-distorting policies in the world economy in 2030, compared with assuming no changes in trade policies since 2004? To answer that question requires comparing results from two global trade liberalization simulations with a global economy-wide model that has been projected to 2030 with the 2004 GTAP protection database amended using the alternative fuller agricultural distortions for developing countries in Valenzuela and Anderson (2008). The first experiment would assume those 2004 distortions remain unchanged over the projection period, while the second would assume those 2004 distortions changed in ways reflected in the projections summarized in Tables 2 and 3. Such an exercise has been undertaken by Anderson, Martin and van der Mensbrugghe (2011), using the World Bank's Linkage Model. It is to be expected that the estimated global cost of distortions will be higher in 2030 with the latter assumption than with the standard assumption of no policy changes over the period of the projection, because the benefits from eliminating teh 2004 export taxes will almost certainly be smaller than the gains from the projected rises in import taxes ...

## Conclusions

[to be added once a summary of Linkage model results is inserted at the end of the previous section]

## References

Anderson, J.E. and J.P. Neary (2005), *Measuring the Restrictiveness of International Trade Policy*, Cambridge MA: MIT Press.

Anderson, K. (1995), 'Lobbying Incentives and the Pattern of Protection in Rich and Poor Countries', *Economic Development and Cultural Change* 43(2): 401-23, January.

Anderson, K. (ed.) (2009), *Distortions to Agricultural Incentives: A Global Perspective, 1955-2007,* London: Palgrave Macmillan and Washington DC: World Bank.

Anderson, K. (ed.) (2010), *The Political Economy of Agricultural Price Distortions*, Cambridge and New York: Cambridge University Press.

Anderson, K. and J.L. Croser (2009), *National and Global Agricultural Trade and Welfare Reduction Indexes, 1955 to 2007,* database at www.worldbank.org/agdistortions.

Anderson, K. and J.L. Croser (2011), 'Novel Indicators of the Trade and Welfare Effects of Agricultural Distortions in OECD Countries', *Review of World Economics/ Weltwirtschaftliches Archiv* 147(2), June (forthcoming).

Anderson, K., Y. Hayami and Others (1986), *The Political Economy of Agricultural Protection: East Asia in International Perspective*, London: Allen and Unwin.

Anderson, K. and W. Martin (eds.) (2006), *Agricultural Trade Reform and the Doha Development Agenda***,** London: Palgrave Macmillan and Washington DC: World Bank.

Anderson, K. and W. Martin (eds.) (2009), *Distortions to Agricultural Incentives in Asia*, Washington DC: World Bank.

Anderson, K., W. Martin and D. van der Mensbrugghe (2011), 'Estimating Effects of Price-Distorting Policies Using Alternative Distortions Databases', paper presented at the June 1-3 workshop in Washington DC for inclusion in the *Handbook of Computable General Equilibrium Modeling***,** edited by P. Dixon and D. Jorgenson for Elsevier (forthcoming).

Anderson, K. and S. Nelgen (2011), 'Trade Barrier Volatility and Agricultural Price Stabilization', *World Development* 39, forthcoming. (An earlier version is World Bank Policy Research Working Paper 5511, Washington DC, December.)

Anderson K. and A. Strutt (2011), 'The Changing Geography of World Trade: Projections to 2030', Featured Paper for the 14th Annual Conference on Global Economic Analysis, Venice, 16-18 June.

Anderson, K. and E. Valenzuela (2008), *Global Estimates of Distortions to Agricultural Incentives, 1955 to 2007*, data spreadsheets at www.worldbank.org/agdistortions.

Bates, R.H. (1981), *Markets and States in Tropical Africa: The Political Basis of Agricultural Policies*, Berkeley: University of California Press.

Bouët, A. and D. Laborde (2010), 'Assessing the Potential Cost of a Failed Doha Round', *World Trade Review* 9(2): 319–351.

Croser, J.L. and K. Anderson (2011), 'Changing Contributions of Different Agricultural Policy Instruments to Global Reductions in Trade and Welfare', *World Trade Review* 10 (forthcoming).

Haberler, G. (1958), *Trends in International Trade: A Report by a Panel of Experts*, Geneva: General Agreement on Tariffs and Trade, October.

Huang, J., S. Rozelle, W. Martin and Y. Liu (2008), 'Distortions to Agricultural Incentives in China', Ch. 3 in Anderson, K. and W. Martin (eds.), *Distortions to Agricultural Incentives in Asia*, Washington DC: World Bank.

Johnson, D.G. (1973), *World Agriculture in Disarray*, London: St Martin's Press (revised in 1991).

Krueger, A.O., M. Schiff and A. Valdés (1988), 'Agricultural Incentives in Developing Countries: Measuring the Effect of Sectoral and Economy-wide Policies', *World Bank Economic Review* 2(3): 255–72, September.

Krueger, A.O., M. Schiff and A. Valdés (1991), *The Political Economy of Agricultural Pricing Policy, Volume 1: Latin America, Volume 2: Asia, and Volume 3: Africa and the Mediterranean*, Baltimore: Johns Hopkins University Press for the World Bank.

Lerner, A. (1936), 'The Symmetry Between Import and Export Taxes', *Economica* 3(11): 306–13, August.

Lloyd, P.J., J.L. Croser and K. Anderson (2010), 'Global Distortions to Agricultural Markets: New Indicators of Trade and Welfare Impacts, 1960 to 2007', *Review of Development Economics* 14(2): 141-60, May.

Martin, W. and K. Anderson (2012), 'Export Restrictions and Price Insulation During Commodity Price Booms', *American Journal of Agricultural Economics* 94(1), January (forthcoming).

Martin, W. and D. Mitra (2001), 'Productivity Growth and Convergence in Agriculture and Manufacturing', *Economic Development and Cultural Change* 49(2): 403-22.

Narayanan, G.B. and T.L. Walmsley (eds.) (2008), *Global Trade, Assistance, and Production: The GTAP 7 Data Base*, West Lafayette IN: Center for Global Trade Analysis, Purdue University, downloadable at www.gtap.org.

Nerlove, M. (1972), 'Lags in Economic Behaviour', *Econometrica* 40(2): 221-52, March.

OECD (2009), *Agricultural Policies in Emerging Economies: Monitoring and Evaluation 2009*, Paris: Organization for Economic Co-operation and Development, March.

OECD (2010), *Producer and Consumer Support Estimates* (online database accessed at http://www.oecd.org for 1986–2009 estimates.

Orden, D., F. Cheng, H. Nguyen, U. Grote, M. Thomas, K. Mullen and D. Sun (2007), *Agricultural Producer Support Estimates for Developing Countries: Measurement Issues and Evidence from India, Indonesia, China and Vietnam*, IFPRI Research Report 152, Washington DC: International Food Policy Research Institute.

Rausser, G.C., J. Swinnen and P. Zusman (2011), *Political Power and Economic Policy: Theory, Analysis and Empirical Applications*, Cambridge and New York: Cambridge University Press (forthcoming).

Tyers, R. and K. Anderson (1992), *Disarray in World Food Markets: A Quantitative Assessment*, Cambridge and New York: Cambridge University Press.

Valenzuela, E. and K. Anderson (2008), 'Alternative Agricultural Price Distortions for CGE Analysis of Developing Countries, 2004 and 1980-84', Research Memorandum No. 13, Center for Global Trade Analysis, Purdue University, West Lafayette, December, at www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=2925

van der Mensbrugghe, D. and R. Roson (2010), 'Climate, Trade and Development', Paper presented at the 13th Global Economic Analysis Conference, Penang, 9-11 June.

Vousden, N. (1990), *The Economics of Trade Protection*, Cambridge and New York: Cambridge University Press.

World Bank (2007), *World Development Report 2008: Agriculture for Development*, Washington DC: World Bank.

Table 1: Relationship between NRA and income, arable land endowment and a product's trade status, developing countries, 2004

(endogenous variable: NRA)

| Exogenous variables: | Beef | Cotton | Maize | Milk | Pigmeat | Poultry | Rice | Soybean | Sugar | Wheat |
|---|---|---|---|---|---|---|---|---|---|---|
| YPC | 0.378*** | 0.150** | 0.0222 | 0.198*** | 0.0895 | 0.197** | 0.396*** | 0.330* | 0.268*** | 0.0555* |
| | (0.0662) | (0.0655) | (0.0306) | (0.0594) | (0.0579) | (0.0928) | (0.0891) | (0.173) | (0.0542) | (0.0306) |
| LPC | -0.200** | -0.0477 | -0.0735 | -0.265*** | -0.135* | -0.265* | -0.725*** | -0.849** | -0.122 | -0.122* |
| | (0.0977) | (0.120) | (0.0717) | (0.0817) | (0.0776) | (0.145) | (0.173) | (0.311) | (0.112) | (0.0691) |
| $TSI_i$ | -0.169 | -0.00249 | -0.00486 | -0.0383 | -0.0795 | -0.354* | -0.369** | 0.115 | -0.176 | -0.114 |
| | (0.120) | (0.107) | (0.0747) | (0.101) | (0.0973) | (0.187) | (0.159) | (0.328) | (0.126) | (0.0733) |
| Constant | -2.978*** | -1.227** | -0.141 | -1.483*** | -0.693 | -1.439* | -3.701*** | -3.517** | -1.295*** | -0.481* |
| | (0.592) | (0.552) | (0.261) | (0.530) | (0.522) | (0.833) | (0.766) | (1.561) | (0.482) | (0.271) |
| Observations | 44 | 22 | 56 | 41 | 35 | 42 | 37 | 26 | 57 | 53 |
| R-squared | 0.554 | 0.241 | 0.031 | 0.410 | 0.214 | 0.268 | 0.527 | 0.309 | 0.336 | 0.265 |
| Adj. R-squared | 0.521 | 0.114 | -0.0248 | 0.362 | 0.138 | 0.210 | 0.484 | 0.215 | 0.298 | 0.220 |

Standard errors are shown in parentheses
Significance levels are *** p<0.01, ** p<0.05, * p<0.10

Source: Authors' estimates, based on NRA estimates and other variable data compiled from the World Bank (World Development Indicators) and the United Nations (COMTRADE data) by Anderson and Valenzuela (2008).

Table 2: NRA averages by region and product, estimated 2004 and projected 2030
(percent, using 2004 value of production at undistorted prices as weights)

| **Asia** | **2004** | **2030** |
|---|---|---|
| Beef | 72 | 38 |
| Cotton | 1 | 7 |
| Maize | 7 | 23 |
| Milk | 21 | 14 |
| Pigmeat | 2 | 18 |
| Poultry | 4 | 17 |
| Rice | 14 | 85 |
| Soybean | 9 | 33 |
| Sugar | 49 | 92 |
| Wheat | 13 | 30 |
| **Africa** | | |
| Beef | -23 | 17 |
| Cotton | -35 | 0 |
| Maize | -13 | 12 |
| Milk | -2 | 13 |
| Poultry | 20 | 5 |
| Rice | -5 | 34 |
| Soybean | -49 | 0 |
| Sugar | 51 | 51 |
| Wheat | 2 | 14 |
| **Latin America** | | |
| Beef | -8 | 24 |
| Cotton | 1 | 0 |
| Maize | -9 | 14 |
| Milk | 32 | 51 |
| Pigmeat | -8 | 25 |
| Poultry | 11 | 15 |
| Rice | 31 | 55 |
| Soybean | -8 | 0 |
| Sugar | 22 | 21 |
| Wheat | -7 | 13 |
| **High-income countries** | | |
| Beef | 36 | 36 |
| Cotton | 26 | 26 |
| Maize | 17 | 17 |
| Milk | 62 | 62 |
| Pigmeat | 15 | 15 |
| Poultry | 23 | 23 |
| Rice | 328 | 328 |
| Soybean | 3 | 3 |
| Sugar | 162 | 162 |
| Wheat | 3 | 3 |

Source: Authors' compilation (see text for methodology)

Table 3: NRA ten-product averages by country, estimated 2004 and projected 2030

(percent, using 2004 value of production at undistorted prices as weights)

(a) by country

| | **2004** | **2030** |
|---|---|---|
| Bangladesh | -4 | 172 |
| China | 2 | 30 |
| India | 22 | 27 |
| Indonesia | 15 | 113 |
| Korea | 258 | 166 |
| Malaysia | 65 | 71 |
| Pakistan | -1 | 22 |
| Philippines | 10 | 91 |
| Sri Lanka | -9 | 0 |
| Thailand | 1 | 27 |
| Vietnam | 26 | 48 |
| Benin | 0 | 0 |
| Burkina Faso | 0 | 0 |
| Cameroon | 0 | 12 |
| Chad | 0 | 0 |
| Cote d'Ivoire | 9 | 19 |
| Egypt | -11 | 9 |
| Ethiopia | -2 | 15 |
| Ghana | 46 | 20 |
| Kenya | 7 | 15 |
| Madagascar | 11 | 30 |
| Mali | 43 | 1 |
| Mozambique | 65 | 55 |
| Nigeria | -16 | 32 |
| Senegal | 4 | 27 |
| South Africa | 4 | 26 |
| Sudan | -15 | 9 |
| Tanzania | -1 | 22 |
| Togo | 6 | 1 |
| Uganda | 6 | 34 |
| Zambia | -41 | 16 |
| Zimbabwe | -75 | 15 |
| Argentina | -23 | 0 |
| Brazil | 5 | 4 |
| Chile | 0 | 72 |
| Colombia | 25 | 67 |
| Dominican Rep. | 24 | 11 |
| Mexico | 0 | 43 |
| Nicaragua | -6 | 8 |

Table 3 (cont.): NRA ten-product averages by country, estimated 2004 and projected 2030

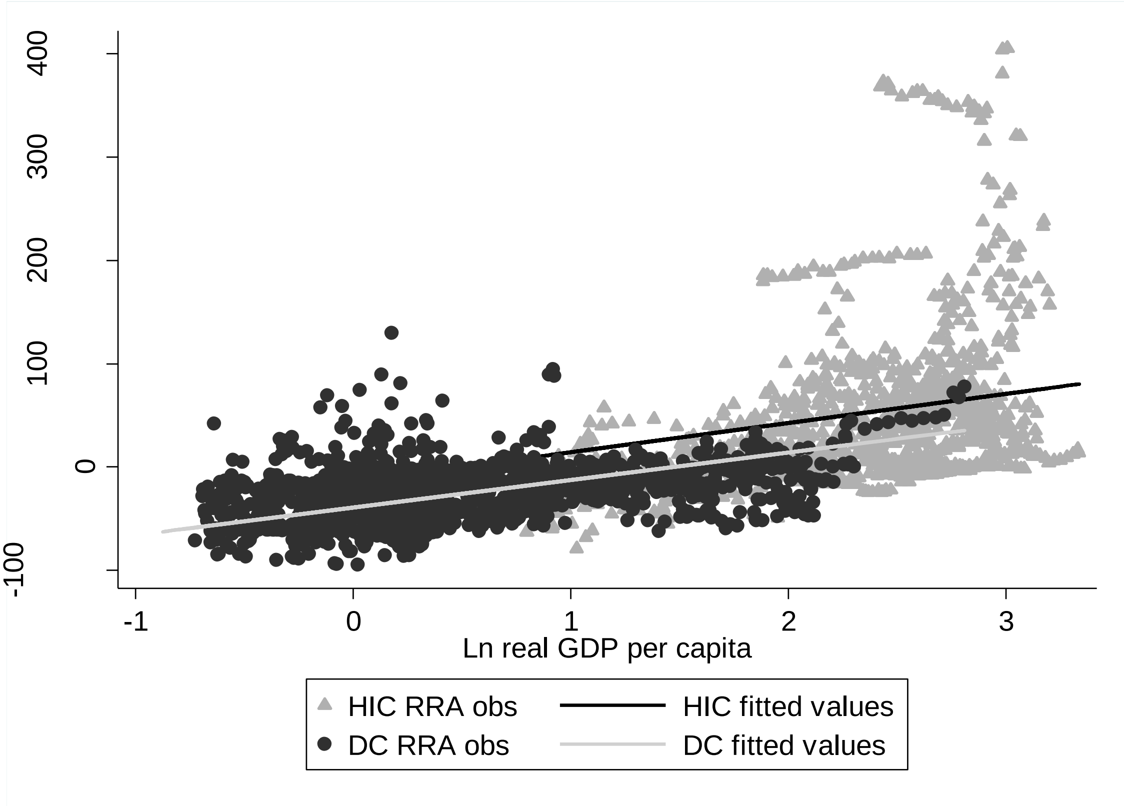
(percent, using 2004 value of production at undistorted prices as weights)

(b) by region

| | **2004** | **2030** |
|---|---|---|
| Asia | 11 | 42 |
| Africa | -9 | 16 |
| Latin America | -1 | 17 |
| **All developing** | **7** | **35** |
| **All high-income** | **35** | **35** |
| **World** | **20** | **35** |

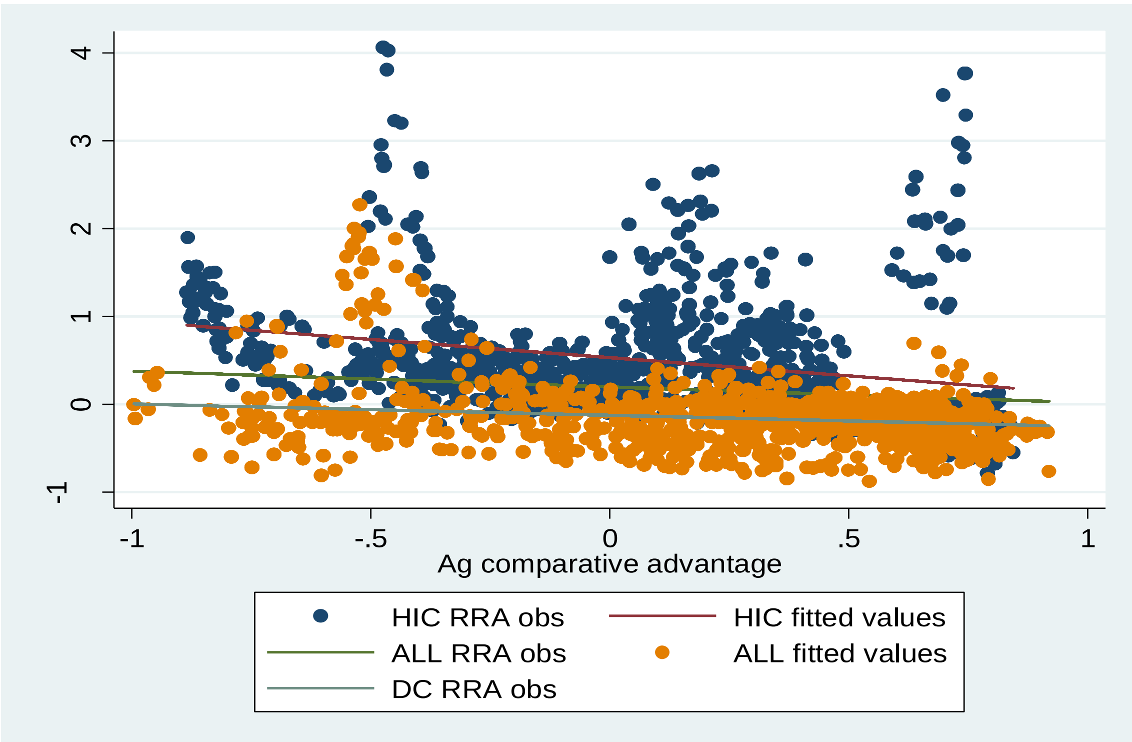
Source: Authors' compilation (see text for methodology)

Figure 1: RRA mapped on real income and agricultural comparative advantage,[a] 1955 to 2007
(a) RRA (%) mapped on log of real GDP per capita




(b)

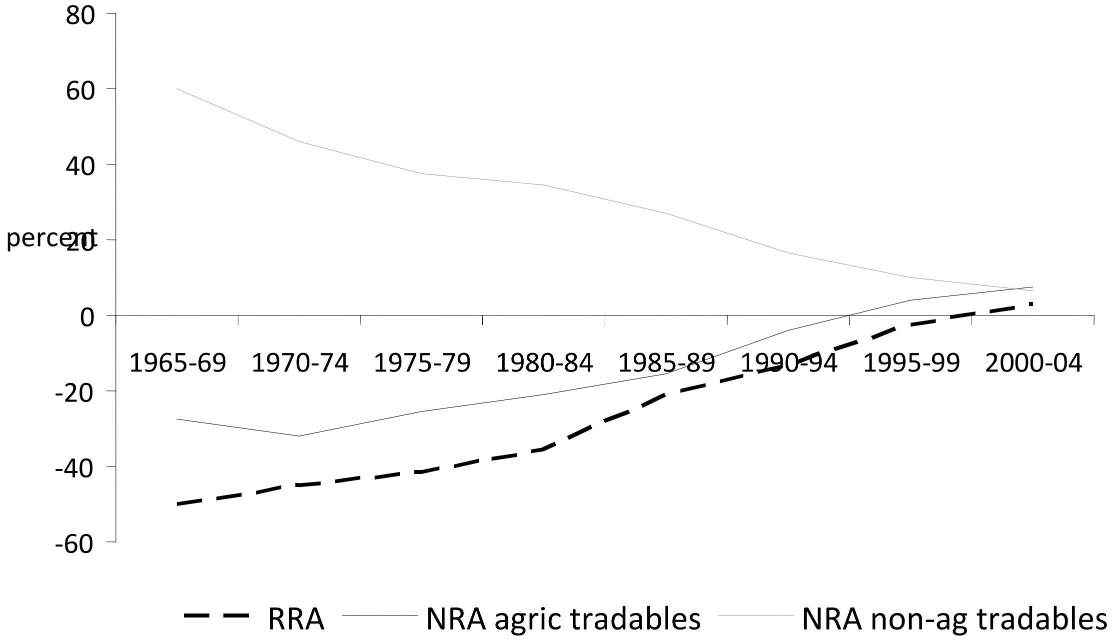
(b) RRA (%) mapped on agricultural comparative advantage[a]



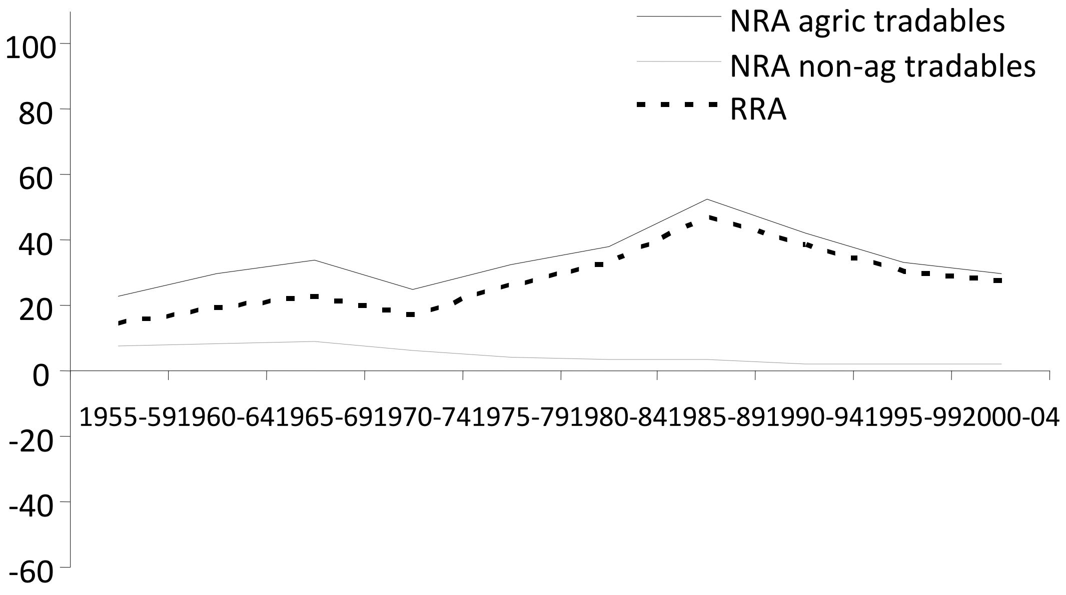

[a] Defined as agricultural net exports divided by the sum of agricultural exports and imports.
Source: Anderson (2010, Figures 2.2 and 2.3)

Figure 2: Nominal rates of assistance to agricultural and non-agricultural tradable sectors and relative rate of assistance,[a] developing and high-income countries, 1955 to 2004
(percent, farm production-weighted averages across countries)

(a) Developing countries



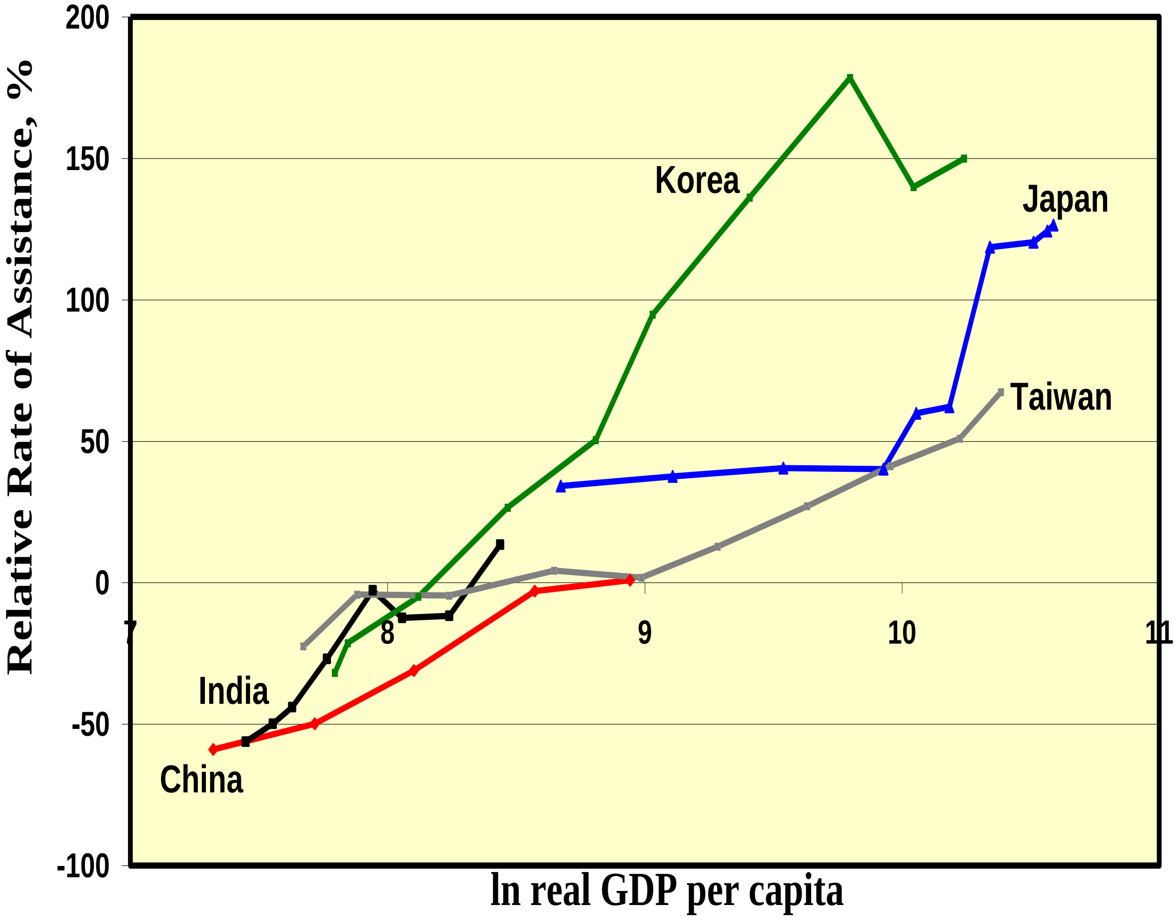

(b) High-income countries




[a] The RRA is defined as $100*[(100+NRAag^t)/(100+NRAnonag^t)-1]$, where $NRAag^t$ and $NRAnonag^t$ are the percentage NRAs for the tradables parts of the agricultural and non-agricultural sectors, respectively.

Source: Anderson (2009, Ch. 1), based on estimates in Anderson and Valenzuela (2008).

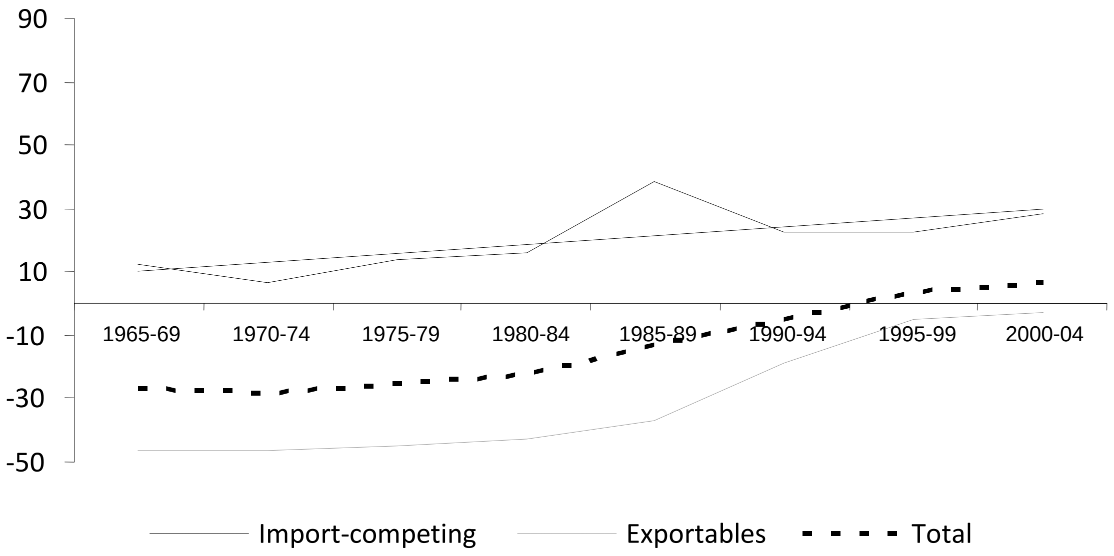
Figure 3: RRAs and log of real per capita GDP, India and Northeast Asian focus economies, 1955 to 2005



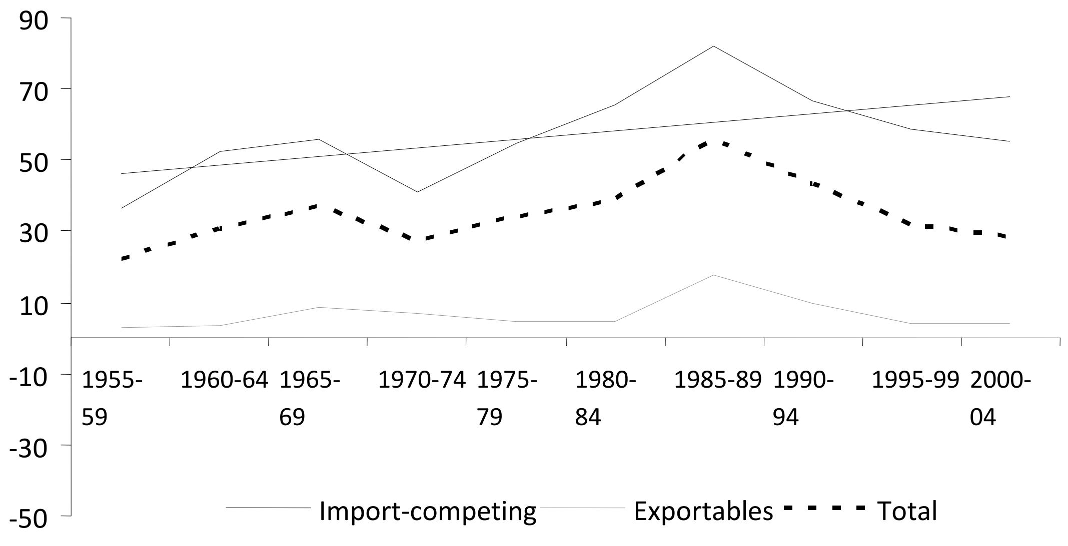

Source: Anderson and Martin (2009, Ch. 1).

Figure 4: Nominal rates of assistance to exportable, import-competing and all covered agricultural products,[a] high-income, transition and developing countries, 1955 to 2004 (percent, 5-year weighted averages)

(a) Developing countries




(b) High-income countries plus Europe's transition economies

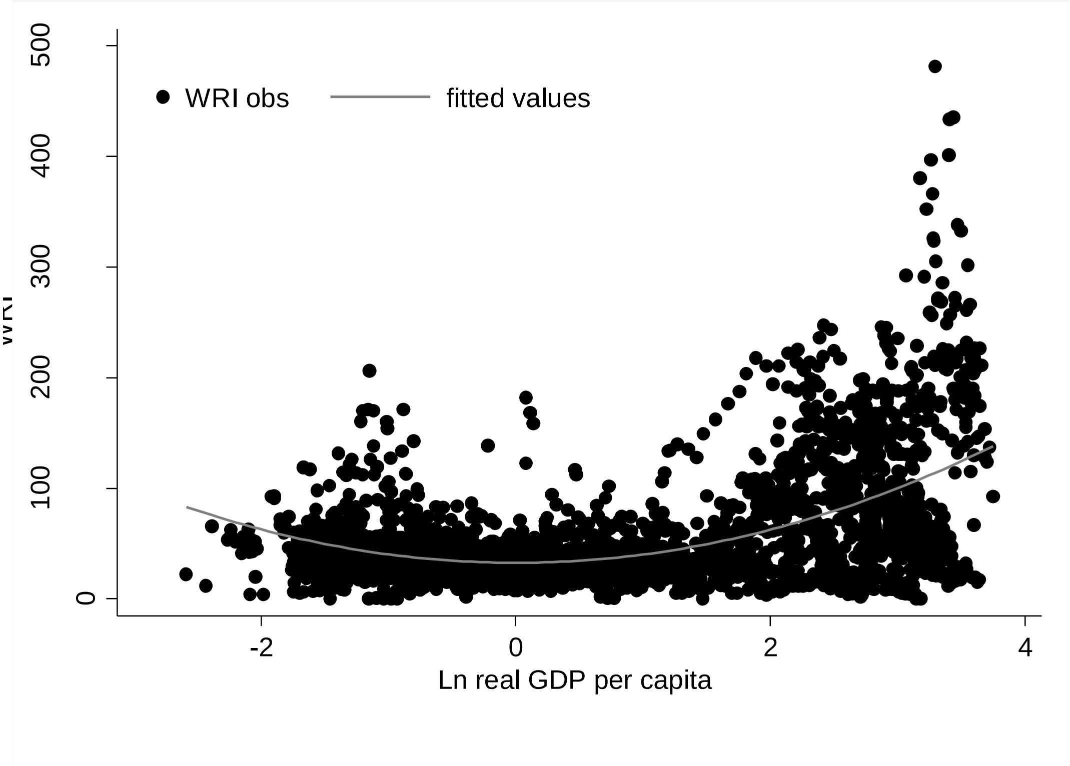



[a]Covered products only. The total also includes nontradables. The straight line in the upper segment of each graph is from an ordinary-least-squares regression based on annual NRA estimates for agriculture's import-competing sub-sector.

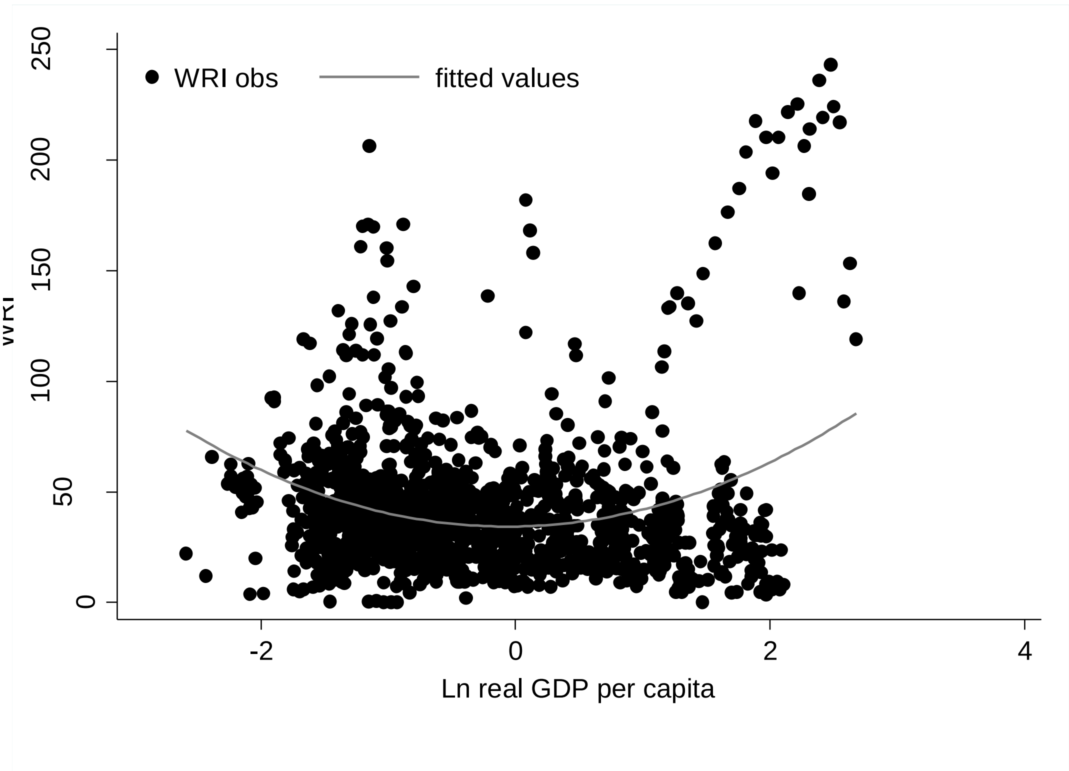
Source: Anderson (2009, Ch. 1), based on estimates in Anderson and Valenzuela (2008).

Figure 5: Agricultural WRI mapped on per capita income, 1955 to 2007

(a) All focus countries



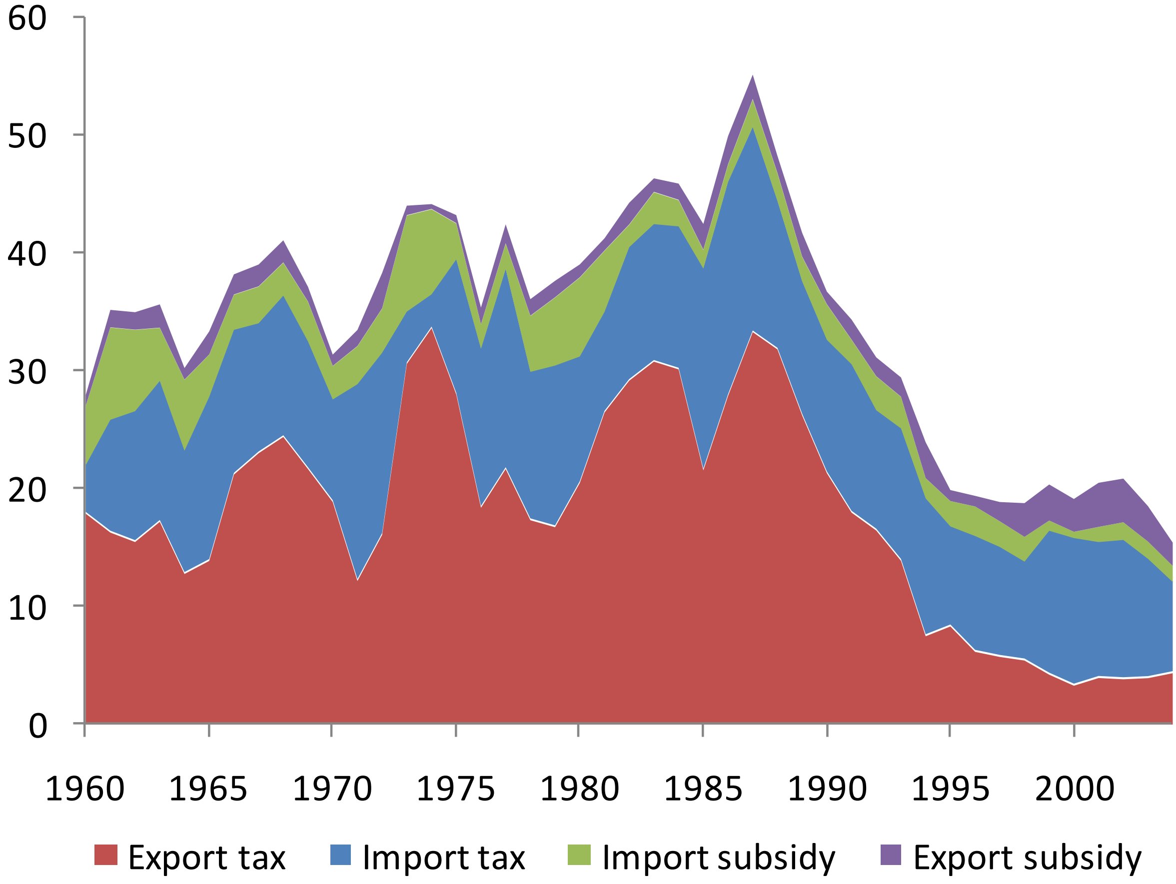

(b) Developing countries only




Source: Authors' derivation, based on WRI estimates in Anderson and Croser (2009).

Figure 6: Contributions of different instruments to the border component of the WRI for developing countries, 1960 to 2004

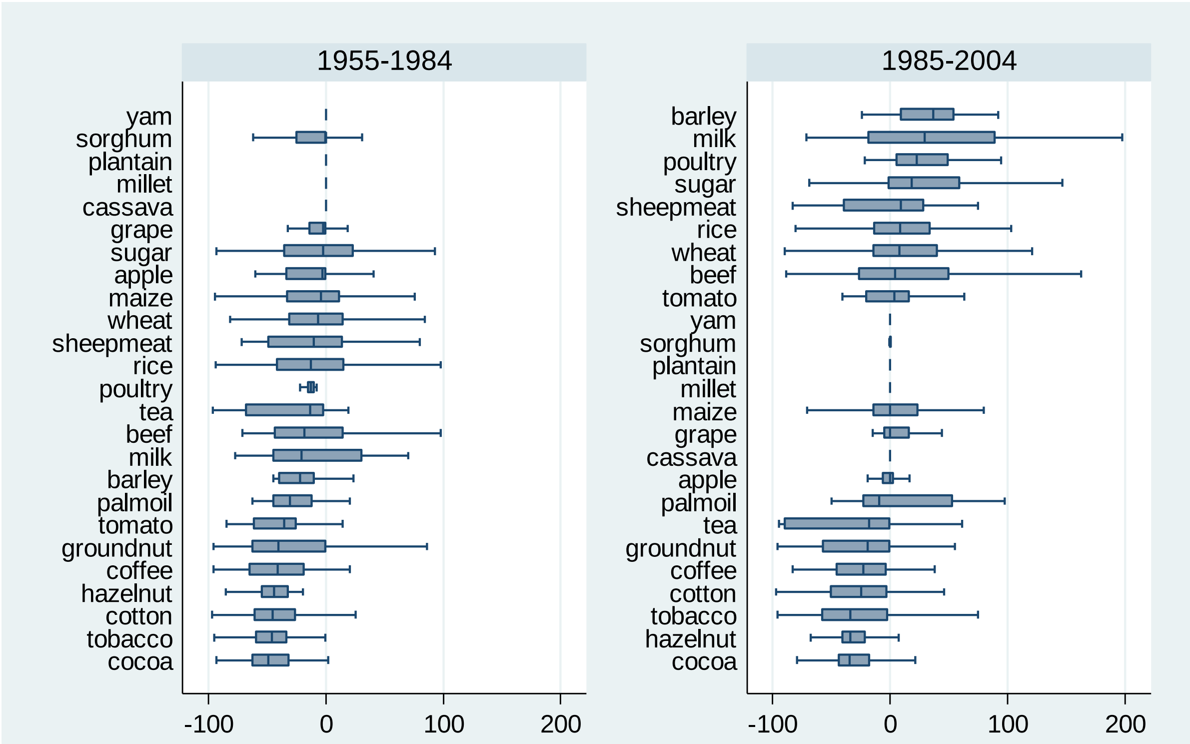
(percent)



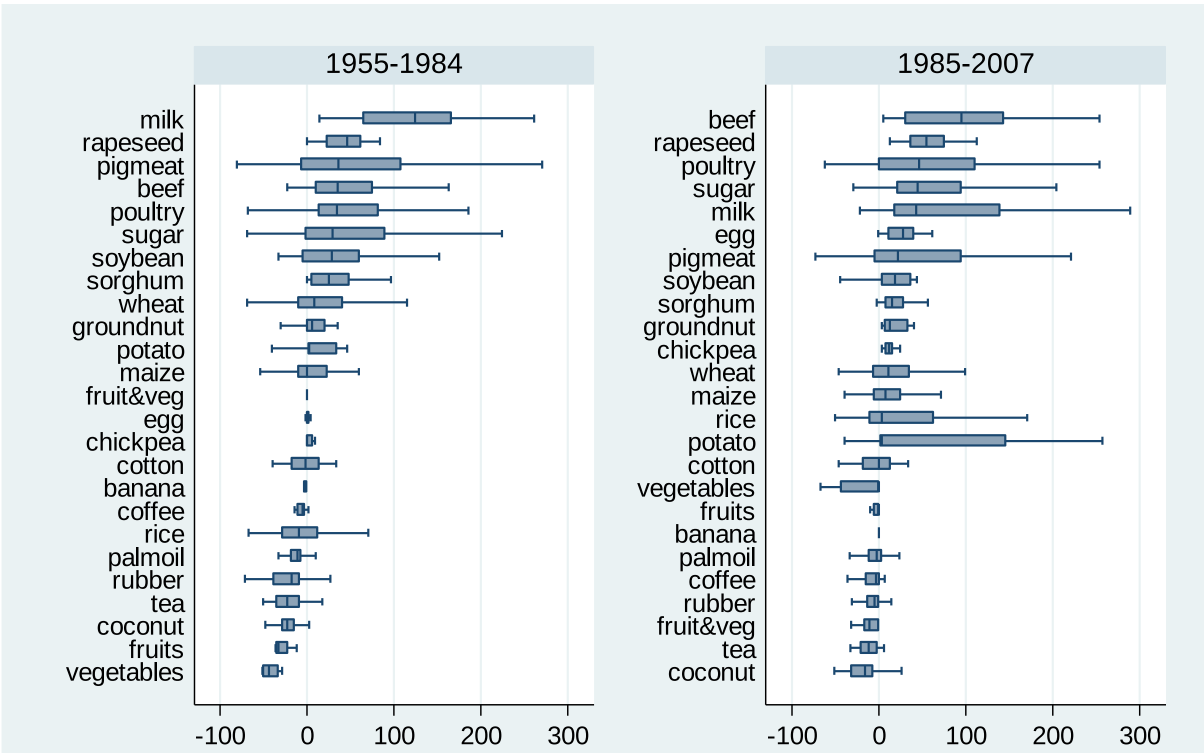

Source: Authors' derivation, based on estimates reported in Croser and Anderson (2010).

Appendix Figure A: Box plot distributions of NRAs for 25 major agricultural products, various regions of the world, 1955 to 2007
(long bar shows range within which 95 percent of the NRAs fall: 50 percent fall in the shaded area, and the vertical line within the shaded area is the median NRA for the sample period)

(a) All 21 focus African countries, plus Turkey (n = 7988)

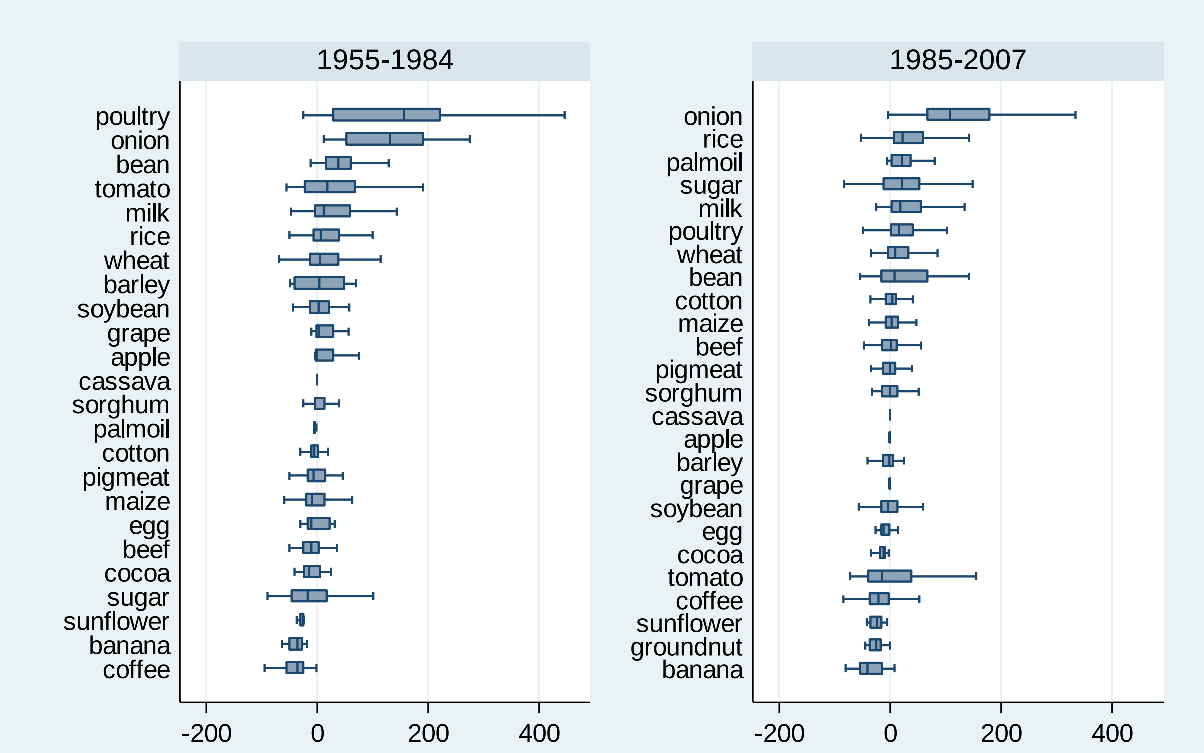



(b) All 12 focus Asian developing economies (excluding Japan) (n = 5410)

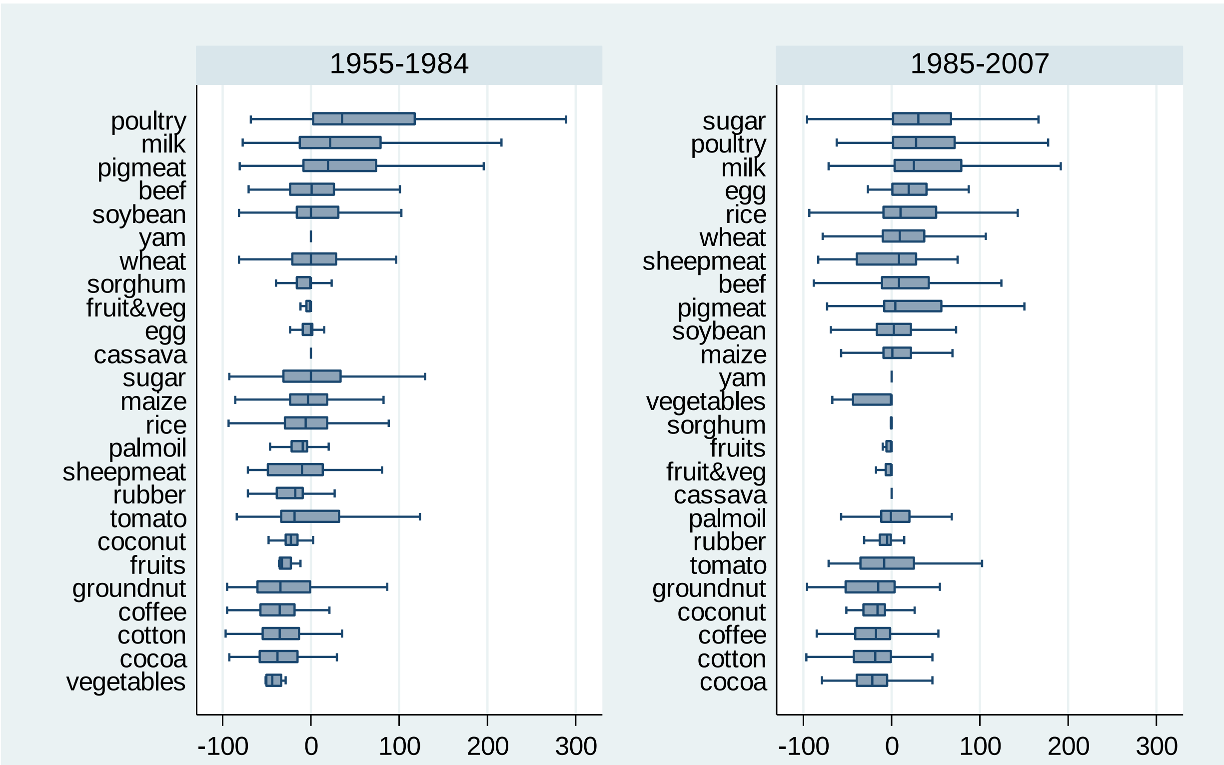


Appendix Figure A (continued): Box plot distributions of NRAs for 25 major agricultural products, various regions of the world, 1955 to 2007

(c) All 8 focus Latin American countries (n = 4180)

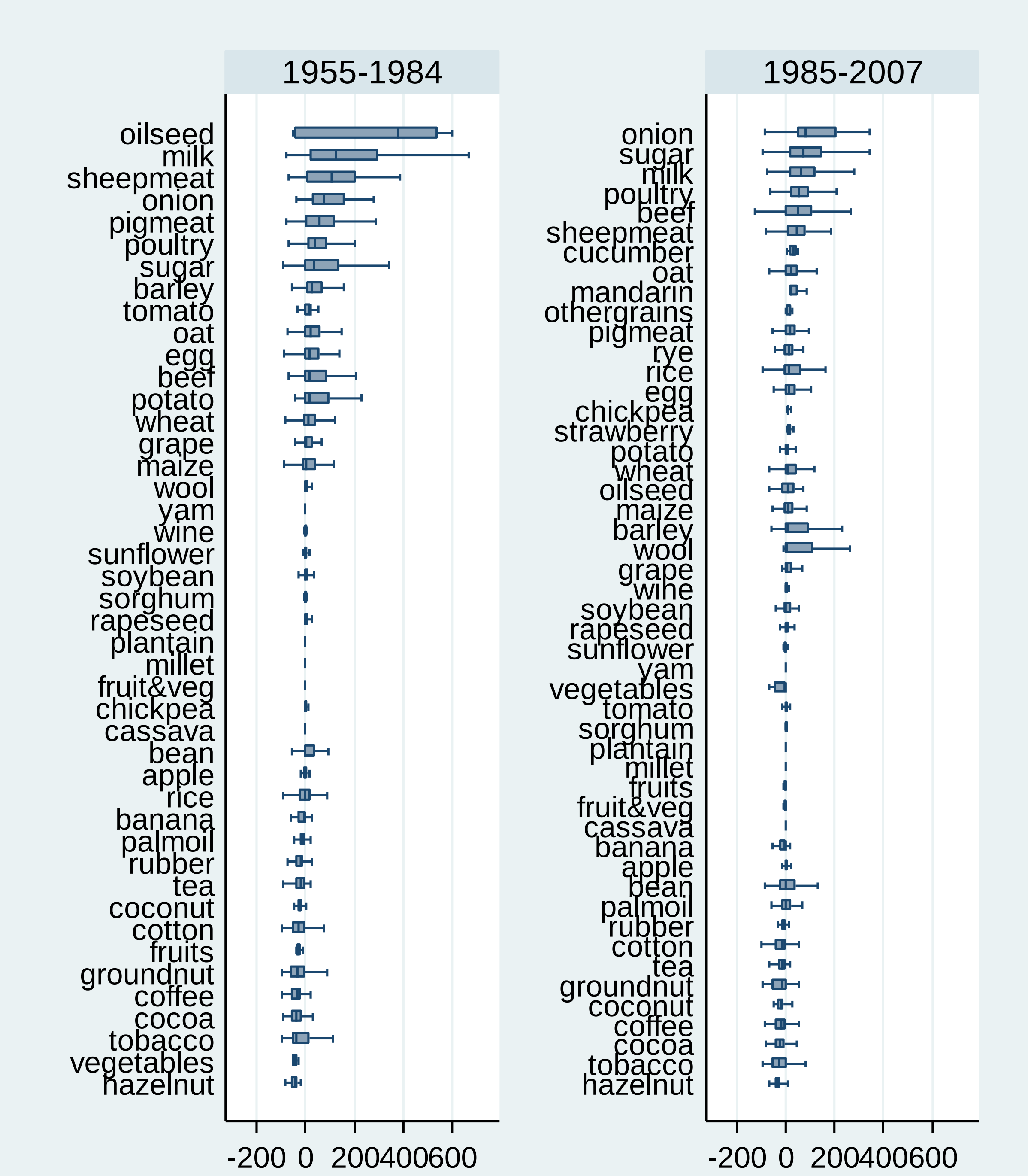



(d) All 41 focus developing economies (including Turkey) (n = 14392)



Appendix Figure A (continued): Box plot distributions of NRAs for 25 major agricultural products, various regions of the world, 1955 to 2007

(e) All 73 focus economies of the world including high-income and transition economies (n = 34833)




Source: Anderson (2010, Appendix), drawn from estimates in Anderson and Valenzuela (2008).