AN EMPIRICAL ANALYSIS OF GLOBAL AGRICULTURAL PRICE DISTORTING POLICIES: 1960 TO 2007

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Abstract

Economists have long been interested in measuring the extent, effects and causes of agricultural price and trade policies. The topic has drawn attention because agricultural trade between countries has almost never been free, and yet it is widely accepted that trade policy distortions affect the incentives of producers and consumers and cause a redistribution of resource use in the economy.

Traditional aggregations of agricultural price and trade distortions can be poor guides to the economic effects of agricultural price and trade policies. Measures without theoretical foundation — such as simple- or trade-weighted average price distortions — may introduce biases in analysis. Recent decades have seen improvements in aggregation theory in the form of scalar index numbers of the trade- and welfare-reducing effects of price and trade policies. Despite the new theory, however, analysts have continued to use less satisfactory measures in practice.

This thesis calculates partial-equilibrium versions of trade restrictiveness indices from the Anderson-Neary family of indices for agricultural policy distortions in 75 developed and developing countries over a period 1960 to 2007. The data for the empirical work are from the recently released World Bank Distortions to Agricultural Incentives database.

The thesis calculates indices at the country level for the sample countries. Two partial-equilibrium indices are calculated — a Trade Reduction Index (TRI) and a Welfare Reduction Index (WRI).[1] The TRI (WRI) is the uniform trade tax that yields the same loss in trade volume (welfare) as the structure of disaggregated distortions. The results of the country-level estimates show that standard weighted averages of price distortions understate the extent of global distortion from agricultural policies. One manuscript of the thesis focuses in particular on the trade restrictiveness of agricultural policy in Sub-Sahara Africa, and finds that weighted averages greatly understate the extent of regional distortion from agricultural policy by netting out offsetting distortions in exportable and import-competing sectors.

The thesis also calculates indices of agricultural policy distortions for individual commodity markets. Whereas all previous work within the trade restrictiveness indices literature has focused on constructing index numbers of distortions from the perspective of a single country, this thesis proposes taking a global view instead for individual commodity markets. Indices are estimated for 28 key agricultural commodities. Generally, the indices are well above weighted-averages of price distortions. The most distorted global markets are the milk, sugar and rice markets.

The thesis also employs the Anderson-Neary framework to consider the trade- and welfare-reducing effect of individual policy instruments. The aim of the work is to determine the relative contributions of different policy instruments to reductions in global trade and welfare over time and across countries. The most significant result empirically

[1] The definition of the acronym TRI in this thesis is different to that used by Anderson and Neary and several others who have adopted their definition.

is the importance of export taxes pre-1990s and their substantial contribution to the fall in global trade- and welfare-restrictiveness of agricultural policy over the past two decades.

Finally, the thesis examines the extent to which the Protection for Sale Model (PFS) of Grossman and Helpman (1994) holds for agricultural sectors at different stages of development. The test uses a new methodology proposed by Imai, Katayama and Krishna (2008). The Distortions to Agricultural Incentives dataset is used for the analysis. The PFS model is estimated in a cross-country setting, which allows for examination of the role of different government institutional factors in PFS framework.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Johanna Louise Croser and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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- Croser, J.L., P.J. Lloyd and K. Anderson (2010), 'How Do Agricultural Policy Restrictions on Global Trade and Welfare Differ Across Commodities?' *American Journal of Agricultural Economics* 92(3) (April 2010), pp. 698–712.

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Acknowledgments

This thesis is part of a larger project on the evolution of distortions to agricultural incentives caused by price, trade and exchange rate policies in a large sample of counties (see www.worldbank.org/agdistortions). The project was implemented under the leadership and guidance of my principal supervisor, Professor Kym Anderson. I would like to acknowledge and sincerely thank Professor Anderson for the opportunity to work on and contribute to this project. Without him, this thesis would not have been possible. I am extremely grateful for his generous and insightful advice and assistance throughout the writing of the thesis. I am also grateful for his willingness to work as a co-author on three of the manuscripts in this thesis. I acknowledge funding from World Bank Trust Funds provided by the governments of the Netherlands (BNPP) and the United Kingdom (DfID), and from the Australian Research Council, which were made possible through my involvement in the project.

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I am grateful to several people who commented on drafts of manuscripts in this thesis at various stages over the past 18 months. I thank Professor Jonathan Pincus for his comments on the first two manuscripts. I thank two anonymous referees for their comments on manuscript 1; and two anonymous referees and the editor of the American Journal of Agricultural Economics for their comments on manuscript 2, all of which significantly improved the quality of the work herein. I thank participants at the Australian Conference of Economists, Adelaide, September 2009, for comments and questions on the first three manuscripts. For detailed comments on manuscript five, I am grateful to Dr Alessandra Olper. I thank the examiners of this thesis for useful comments and suggestions (which have been incorporated into this final work).

On a personal note, several people were instrumental in the completion of this thesis. I owe sincere thanks to my parents for their support and encouragement over a number of years. My heartfelt thanks to Kate and Sandy for exceptional support and many meals. Thanks to Emily and Adam for support from afar. My deepest gratitude to Sarah, who provided many hours of personal support in the last year of writing this thesis. And thanks to Nick, who keeps me grounded, reminds me of the need for a balance between work and life and encourages me to look forward in life.

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Structure of thesis

This thesis is composed of a portfolio of five manuscripts.

The first two manuscripts are joint papers that have been published. Manuscript 1 was published in the *Review of Development Economics* in May 2010. Manuscript 2 was published in the *American Journal of Agricultural Economics* in April 2010. Manuscripts 1 and 2 are on the measurement of the trade- and welfare-effects of policy distortions using scalar index numbers from the Anderson-Neary family of indices.

The third manuscript is single author work on the measurement of the trade- and welfare-effects of policy distortions using scalar index numbers for individual policy instruments. The single author manuscript presented in this thesis was converted to a joint paper with Professor Kym Anderson, which is forthcoming in the Journal of World Trade, October 2010, volume 44(5).

The fourth manuscript is a joint paper that was submitted for publication to a journal in March 2010. The paper is a regional case study of the trade- and welfare-reducing effects of agricultural price and trade policy in Africa over the period 1961 to 2004.

The fifth manuscript is a single author work on the political economy of agricultural trade policy. It is currently being revised for submission to a journal.

Each manuscript is a stand-alone piece of work with self-contained references, tables and figures.

The thesis has a series of appendices, some of which provide tables and figures that were omitted from the published manuscripts to meet publication page-limits.

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Statements of Contributions

Statement of Authorship

Global Distortions to Agricultural Markets:
New Indicators of Trade and Welfare Impacts, 1960 to 2007
Published in the *Review of Development Economics*, May 2010

Johanna Louise Croser

Contributed to methodology, performed empirical analysis of the data, interpreted results and wrote manuscript (Contribution: 50%)

Certification that the statement of contribution is accurate:

Signed ...[redacted]...............................Date...30 May 2010

Peter J. Lloyd

Contributed methodology and editing of manuscript (Contribution: 40%)

Certification that the statement of contribution is accurate and permission is given for the inclusion of the paper in the thesis:

Signed .....[redacted].....................Date...25 May 2010

Kym Anderson

Contributed to planning of article, provided critical evaluation and editing of manuscript (Contribution: 10%)

Certification that the statement of contribution is accurate and permission is given for the inclusion of the paper in the thesis:

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Statement of Authorship

How Do Agricultural Policy Restrictions on Global
Trade and Welfare Differ across Commodities?
Published in the *American Journal of Agricultural Economics*, April 2010

Johanna Louise Croser

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Statement of Authorship

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Trade and Welfare Indicators, 1961 to 2004
Submitted to a journal, March 2010

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Planning and conceptualization of article, provided critical evaluation and editing of manuscript (Contribution 33%)

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AN EMPIRICAL ANALYSIS OF GLOBAL AGRICULTURAL PRICE DISTORTING POLICIES: 1960 TO 2007

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Contextual Statement

Economists have long been interested in measuring the extent, effects and causes of agricultural price and trade policies. The topic has drawn much attention because agricultural trade between countries has almost never been free, and yet it is widely accepted that trade policy distortions affect the incentives of producers and consumers and cause a redistribution of resource use in the economy. It is also well documented that trade policy distortions in general can impact on other aspects of the economy, such as economic growth,[2] wages and employment,[3] and poverty.[4]

Measuring the extent of distortions is an important first step in understanding the effects and causes of agricultural trade policy; and yet comprehensive data on the extent of agricultural trade policy distortions has not been widely available across all countries and over time to enable this. This has meant that questions about the effects and causes of agricultural trade policy have tended to be answered in a piecemeal way, by looking at individual countries, or small groups of countries, and only at the extent of distortion for a limited period of time.

Data for high-income countries became readily available from the latter 1980s, facilitating a greater understanding of the causes and effects of trade policy

[2] See, for example, the following papers on the relationship between openness and economic growth more broadly: Frankel and Romer (1999); Rodriguez and Rodrik (2001); Dollar and Kraay (2003).
[3] See, for example, the articles in Greenaway and Nelson (2001).
[4] See, for example, McCulloch, Winters and Cirera (2001), Hertel and Winters (2006) and Anderson, Cockburn and Martin (2010).

in the developed world. Empirical indicators of farm support (called Producer Support Estimates or PSEs) have been provided in a consistent way for 20 years by the Secretariat of the OECD (2009) for its 30 member countries. However, until very recently, there were no comprehensive time series of rates of assistance to agricultural producers in developing countries, apart from the Kruger, Schiff and Valdes (1988) study, which covered the period 1960–85 for 17 developing countries.[5]

Recently, however, a new World Bank dataset (Anderson and Valenzuela 2008) has been published which contains estimates of nominal rates of assistance (NRAs) to agricultural producers and consumer tax equivalents (CTEs) across 50 years and 75 countries. The database, which has data at the product level, captures both border and domestic distortions in agriculture (together called agricultural distortions) for a sample of countries that account for more than 90 percent of global agriculture and 95 percent of the world‘s economy.[6] The release of this data provides a timely opportunity to consider questions on the effects and causes of agricultural policy distortions.

In this thesis, the newly available dataset is used to investigate a series of questions that require consistent estimates of agricultural distortion across countries, time and products. The thesis examines the effects and causes of agricultural policy over the past half century, for 75 countries in five country groupings: African countries, Asian countries, Latin American and Caribbean countries, Europe‘s transition economics, and high-income countries.

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[5] A nine-year update for the Latin American countries in the Krueger, Schiff and Valdés sample by the same country authors, and a comparable study of seven central and eastern European countries, contain estimates at least of direct agricultural distortions (see Valdés 1996, 2000).
[6] Anderson (2009b).

The thesis comprises five manuscripts. The first four manuscripts are on the trade- and welfare-reducing effects of agricultural policy distortions. The fifth manuscript is on the political economy causes of agricultural protection.

The first four manuscripts are motivated by a single goal. That is, to produce a consistent set of partial-equilibrium estimates of the trade- and welfare-effects of agricultural policies across countries and global commodity markets, which aggregate trade and domestic policy distortions in a theoretically meaningful way. This goal stems from the observation that traditional aggregations of agricultural policy distortion (across countries, commodities or policy instruments) suffer from various defects. For example, the widely-used existing weighted average NRAs or CTEs can mask important information about the variation of distortions across industries (when aggregating to a country level), or countries (when aggregating to a global commodity market level); and positive distortions might be offset by negative distortions within a country, region or globally, giving a misleading measure of agricultural policy distortion overall.

To address the overall goal, the thesis makes use of the Anderson and Valenzuela (2008) database, which is the most comprehensive database available to date, to generate estimates of the trade and welfare effects of agricultural policy. The thesis adopts, develops and uses a methodology that provides for a theoretically meaningful aggregation of agricultural policy distortions. The methodology is based on the Anderson and Neary (2005) trade restrictiveness index concept.

Using the dataset and methodology, the first four manuscripts answer the following series of questions about the trade- and welfare-reducing effects of agricultural policy:

- What are the trade- and welfare-reducing effects of agricultural policies over the time period 1960 to 2007 for the countries studied?
- What are the patterns across time and across geographical groups, and for the world as a whole?
- What individual countries have contributed most to the global trade- and welfare-reduction from agricultural policy over time?
- What are the trade- and welfare-reducing effects of agricultural policies over the time period 1960 to 2007 for individual global commodity markets?
- What are the patterns across time and across commodity groupings?
- What agricultural commodities have contributed most to global trade- and welfare-reduction from agricultural policy?
- What policy instruments have contributed most to the trade- and welfare-reducing effects of agricultural policy?
- What are the relative contributions of border and domestic market support to welfare and trade reduction?

The significance of the questions, their novel elements and how the questions fit into the field of knowledge are examined in greater detail below.

The fifth manuscript of the thesis examines one aspect of the cause of agricultural trade policy using the World Bank dataset. The manuscript is motivated by the observation that what is arguably the most influential theoretical model of the political economy of trade policy in the last 15 years — the

Grossman and Helpman (1994) Protection for Sale (PFS) model — has yet to be tested in a comprehensive way for agriculture across different countries. The reason for this is that the model has previously been thought only to be estimable with data on sectoral lobby contributions to government. However, recently a new methodology has been proposed as a way to test the PFS model which does not require data on lobbying (Imai, Katayama and Krishna 2008). Manuscript 5 combines the new methodology with the recently released Agricultural distortions database. The central questions of the work are whether support can be found for the PFS model in agricultural policy over time and across countries; and the extent to which developed countries are different from developing countries in terms of the PFS model.

The remainder of this contextual statement reviews the literature in the two broad areas of the thesis — trade policy restrictiveness indices and the political economy of agricultural policy — to better explain the aims of the manuscripts and the significance of their contributions.

Trade- and welfare-reducing effects of agricultural policy

Manuscripts 1 to 4 of this thesis examine the trade- and welfare-reducing effects of agricultural policy using the theory of scalar index numbers. The literature on measuring trade policy using such index numbers starts with James Anderson and Peter Neary, who made their first contribution in the early 1990s (Anderson and Neary 1994) and have been advancing the theory for more than a decade, leading to their 2005 book (Anderson and Neary 2005). The Anderson and Neary work demonstrates, within a general equilibrium framework, that it is possible to formulate theoretically correct aggregators of trade policy restrictiveness for individual countries. These measures are path-breaking because previous aggregation measures suffer from several shortcomings.

The shortcomings of other aggregation methods stem from the fact that the aggregation of trade policy for a single country is nontrivial. In any one country, there may be thousands of trade barriers across different industries, as well as domestic policies in place. Researchers and policy advisors often need a single statistic to summarize the state of trade policy regime, and yet formulating the right summary statistic is no small task.

Common aggregations include simple- or trade-weighted average tariffs, non-tariff barrier (NTB) coverage ratios, or trade-to-GDP ratios. Each of these measures suffers from shortcomings, however, which are succinctly summarized by Kee (2007). The simple average gives equal weight to all industries regardless of their different economic significance. The trade weighted average (if the weight is not adjusted to that at the free-trade situation) gives smaller weights for those industries with higher tariffs or higher export taxes, and hence lower import or export shares. Both the simple- and trade-weighted averages can result in offsetting positive- and negative- policy distortions and hence underestimate the degree of overall policy distortion. NTB coverage ratios only focus on one aspect of trade policy and do not capture the strength and effect of such policies on trade. Trade-to-GDP ratios may change as non-trade policy related variables change — such as preferences, endowments, technology. In short, the existing measurements can be misleading as indicators of the state of trade policy regime in a given country.

The approach of Anderson and Neary (2005) overcomes the problems in the common aggregation methods. The approach is based on computing index numbers of the precise trade or welfare consequences from a large number of trade distortions in the same way that a consumer price index gives the changes in the welfare consequences of changes in many consumer prices. The measures are theoretically sound. They are in fact weighted power means of the differentiated distortions with the weights being the marginal welfare (or trade volume) losses associated with a change in the rate of distortion on each good.

There are two main Anderson and Neary indices: (1) The Trade Restrictiveness Index — defined as the uniform equivalent tariff that maintains the welfare of a country at its current level with the differentiated set of tariffs and NTBs; and (2) the Mercantilist Trade Restrictiveness Index — the uniform equivalent tariff that maintains the aggregate import volume of a country at its current level with the differentiated set of tariffs and NTBs.

Feenstra (1995) progresses the Anderson and Neary (1994) framework by simplifying the indices to a partial equilibrium form. The partial equilibrium indices are special cases of the general equilibrium indices in which cross-price effects are zero and the import demand (export supply) functions, as functions of own price alone, are linear.

More recent theoretical developments have been made in the literature on trade restrictiveness indexes. Bach and Martin (2001) generate an aggregator which is a revenue constant uniform tariff. The motivation for their work is to provide better inputs of tariff distortion into computable general equilibrium (CGE) models (which typically aggregate commodities to broad groups).

Anderson (2009a) furthers the Bach and Martin aggregator by developing an aggregation method that is consistent with two common intermediate objectives of modelling empirical work: (1) to preserve the relationship between policy and real income; and (2) to preserve the relationship between policy and the real volume of activities in sectors of the economy that are relevant to the purpose of the work. His theoretical advance is motivated by the fact that both objectives must be achieved when aggregating highly disaggregated data to the sectoral classifications used in typical multi-country models (such as GTAP). His new index, therefore, can be used to aggregate tariff data into product groupings for economy-wide models (such as GTAP) so as to preserve the real income in the general equilibrium of the economy.

In a separate area of theoretical work, Lloyd and MacLaren (2009) ask: What is the bias in partial equilibrium forms of the trade restrictiveness indexes due to the neglect of general equilibrium effects when these are not zero? These authors are motivated by the observation that since mid-2000s several empirical studies (discussed below) have adopted the Feenstra partial-equilibrium form of the indices to generate time-series of the trade restrictiveness indices. The authors find the welfare (or trade volume) loss due to a tariff regime will tend to be understated by the partial equilibrium measure of the loss. This is for two reasons: (1) relationships of substitutability in final demand can be expected to dominate those of complementarity;[7] and (2) the vertical input-output relations across markets mean typically that effective rates of protection of value added per unit of output are greater than the nominal rate of assistance.[8] However, Lloyd and MacLaren note that these are tendencies only and one cannot state that, in general, the partial-equilibrium measure understates the true value of the index. Lloyd and MacLaren (2009) also propose an extended partial equilibrium measure that captures some of the general equilibrium effects without the need for a computable general equilibrium model. They propose a theoretical measure that uses effective rates of assistance rather than nominal rates of assistance.

Notwithstanding the advances in the theoretical literature, few consistently estimated series of trade restrictiveness indices have yet been estimated across time and countries. Most studies have tended to be country specific for a relatively short time period, such as the application to Mexican agriculture in the late 1980s (Anderson, Bannister and Neary 1995).

There are two prominent exceptions, however. Douglas Irwin uses detailed tariff data to calculate the Anderson and Neary Trade Restrictiveness Index for the United States in 1859 and annually from 1867 to 1961 (Irwin 2010). He finds that the import-weighted average tariff understates the trade restrictiveness of policy by about 75 percent, on average. The largest static welfare losses occur in the early 1870s (at about one percent of GDP) and they fall almost continuously thereafter to less than one-tenth of one percent of GDP by the early 1960s.

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[7] Lloyd and MacLaren (2009) distinguish two types of cross-market general equilibrium effects: horizontal and vertical effects. Horizontal effects are the substitute/complement relations among final goods.

[8] Vertical cross-market general equilibrium effects arise in production because many goods use the products of other industries as intermediate inputs.

The other exception is the research by Kee, Nicita and Olarreaga (2009). These authors estimate a series of partial-equilibrium indices for 78 developing and developed countries after estimating the import demand elasticity for each commodity in each country using a modified form of Kohli's (1991) GDP function approach (Kee, Nicita and Olarreaga 2008). The authors provide estimates for a snapshot in time (the mid-2000s) based on import barriers (tariffs and NTBs). The main findings from their work are that the trade restrictiveness indices are on average 80 percent higher than the average tariff because of the variance in tariff rates and the covariance between tariffs and import demand elasticities.

Each of the first four manuscripts of this thesis makes a theoretical and empirical contribution to the literature on trade restrictiveness indices.

Manuscript 1 makes a theoretical contribution by modifying the Feenstra partial equilibrium index so that it can be computed using data on the domestic production and consumption sides of the economy, rather than with the more traditional import demand formulation. This advance has important implications for the computation of indices in agriculture because data are now widely available on the production and consumption sides of the economy.[9] The theoretical measure developed in the paper accounts for all forms of domestic price distortion (on the production and consumption sides separately), as well as incorporating import-competing and exportable industries.

[9] For example, the Secretariat of the OECD publish separate Producer and Consumer Support (PSEs and CSEs) for its 30 member countries (OECD 2009); and Anderson and Valenzuela (2008) contains estimates of nominal rates of assistance and consumer tax equivalents for 75 developed and developing countries.

Empirically, the manuscript's contribution is to apply the methodology to generate a time series of indexes that are well-grounded in trade theory, account for different forms of price distortion, and can be decomposed into their component producer assistance and consumer tax measures. The estimates are provided over the past half-century for 75 developing and high-income countries and for various regions and the world as a whole. The paper presents the first consistently estimated set of time series estimates of aggregated agricultural trade policy. The manuscript analyses the resulting estimates of the trade and welfare effects of agricultural policies over the period 1960 to the present. Findings emerge about the worsening disarray in world food markets in the first half of the period studied, but improvement thereafter. The estimates are used to examine which countries have contributed most to the distortion of global agricultural markets.

Manuscript 2 makes a theoretical contribution by introducing a novel idea to the literature — that of the trade restrictiveness index for a global commodity market (instead of for a single country). Whereas all previous work within the trade restrictiveness indices literature has focused on constructing index numbers of distortions from the perspective of a single country, this manuscript proposes taking a global view instead for individual commodity markets. The manuscript introduces two new measures of trade distortions, equal to the uniform tariff which has the same effect on either global welfare, or global trade volume, as the existing set of distortions in a global commodity market. This is the first time such indexes have been proposed.

The indices are computed using a methodology similar to that in Manuscript 1. They are computed using data on the domestic production and consumption sides of the global commodity market, and the measures account for all forms of border and domestic price distortion in each country for the global commodity market of interest, as well as incorporating import-competing and exportable countries into the measure.

These measures are important in several contexts. Governments and market participants have an interest in understanding how distortions in a specific commodity market vary over time, particularly so they can anticipate what might happen when international prices spike up or down. It might be of interest to unsubsidized exporters of a particular product to know by how much global trade in that product market has been reduced by other countries‘ policies, for that influences the amount they are willing to expend in getting together with similar countries to seek more liberalisation via trade negotiations.

Empirically, too, the contribution of Manuscript 2 is significant. The commodity-specific additions to the family of trade restrictiveness indexes offer a truer indication of the world trade and welfare effects of government interventions in the markets for particular traded products, by properly accommodating all domestic and border subsidies and taxes. The results reveal several interesting findings about which product markets have experienced the biggest reduction in world commodity trade and the loss of global welfare over time.

Manuscript 3 approaches the trade restrictiveness index subject from the perspective of constructing indexes for the contribution of individual policy instruments to distortions within a country. The motivation is that policy analysts, who are often interested in knowing the relative contribution of different policy instruments to the trade- and welfare- losses of agricultural policy; know that comparison of traditional aggregations can give misleading results of these contributions. For example, weighted averages across commodities of nominal rates of assistance (NRAs) or consumer tax equivalents (CTEs) are not very useful, because, among other things, some commodities are taxed and others are subsidised so that positive contributions offset negative contributions and alter relative shares.

The third manuscript adopts a methodology of computing individual instrument indexes for four groups of border measures — taxes and subsidies on import-competing goods, and taxes and subsidies on exportables — and for different domestic measures, including input, production and consumption subsidies and taxes. The individual policy measures are aggregated to determine country trade- and welfare-losses and the relative contributions of different instruments to these losses.

Empirically, the paper is the first to examine the issue of the relative contribution of different policy instruments to trade- and welfare-losses within the trade restrictiveness index literature. Furthermore, for agricultural policy studies, the paper gives the most comprehensive analysis of the relative contribution of different policies to country trade- and welfare-losses because it uses the World Bank‘s database, which provides greater coverage in terms of commodities, countries and instruments than any previous estimates of the extent of distortions to agricultural markets.

The manuscript makes some key findings about the importance of export taxes in the contribution to falls in the global trade- and welfare-restrictiveness of agricultural policy over the past two decades. Such findings can be of assistance, for example, to governments and analysts for further rounds of trade talks and negotiations.

Manuscript 4 ties together the work in the previous three manuscripts and applies it to a regional case study for Sub-Saharan Africa. The manuscript answers questions about the trade- and welfare-reducing effect of agricultural price policies in Africa‘s poorest countries over the past half century.

The manuscript focuses on a sample of 19 of the poorest countries in Africa.[10] The motivation for the regional case study is that while there has been much policy reform over the past two decades, the injections of agricultural development funding, together with on-going regional and global trade negotiations, have brought distortionary policies under the spotlight once again. Given this impetus, Manuscript 4 shows how the tools and methods of trade restrictiveness indexes can be used to assess the benefits and costs of relative reforms in Africa.

The theoretical contribution of this paper is to extend the analysis to include nontradable sectors. The first three manuscripts focus only on the trade- and welfare-reducing effects of price distortions in tradable sectors. Manuscript 4 considers distortions in nontradable sectors too, which are significant in Sub-

[10] The 19 countries are five countries of eastern Africa (Ethiopia, Kenya, Sudan, Tanzania, and Uganda); four countries in southern Africa (Madagascar, Mozambique, Zambia, and Zimbabwe); five large economies in western Africa (Cameroon, Côte d‘Ivoire, Ghana, Nigeria, and Senegal); and five smaller economies of West and Central Africa for which cotton is a crucial export (Benin, Burkina Faso, Chad, Mali, and Togo).

Saharan African's gross value of agricultural production and food consumption.[11] The methodology in manuscripts 1–3, which works with production and consumption sides of the economy separately to construct indices, means the inclusion of nontradable sectors (which may have domestic distortions) can be incorporated easily within the existing methodology.

The empirical contribution of the manuscript is to provide an analysis of agricultural policy in Sub-Saharan Africa using the scalar index number approach. Drawing on the first three manuscripts of the thesis, Manuscript 4 reports three types of indices to analyse the trade and welfare effects of policies in the focus African countries: country level indices, which are aggregated to the regional level; commodity market indices — for individual regional commodity markets in Africa; and policy instrument indices — which give a sense of the importance of different policy instruments in African agriculture. Once again, the importance of export taxes in contributing to falls over the past two decades in regional trade- and welfare-losses from agricultural policy is highlighted.

Political Economy of Agricultural Policy

The fifth manuscript of this thesis examines one aspect of the causes of agricultural policy. It does so within the broad literature on the political economy of government intervention in markets. The political economy of trade protection is a well studied area. Research tends to fall into three broad groups: analysis of the determinants of protection levels across different industries; analysis of the

[11] Anderson and Masters (2009).

determinants of protection levels among countries; and analysis of the determinants of protection levels over time (Rodrik 1995).

In this contextual statement, not all the literature on the political economy of trade policy is reviewed because numerous comprehensive survey articles already exist.[12] Rather, what is noteworthy is that the Agricultural Distortions database (Anderson and Valenzuela 2008) makes it possible to advance the empirical investigation of the political economy of protection in agriculture in ways that were not previously possible. This is because the database provides greater coverage in terms of commodities, countries and instruments than any previous estimates of the extent of distortions of global agricultural markets. As such, it enables analysis of the causes of agricultural policy from any one or combination of the three broad areas identified above. That is, it is possible to test a wide range of hypotheses suggested by the literature over time, over countries and/or over industries. Such research can shed light on the underlying forces that have affected incentives facing farmers in the course of national and global economic and political development, and may provide insights for how policy might evolve in the future.

One strand of the political economy literature involves lobbying models, which posit that governments use trade policy as indirect tools to redistribute income to organised special-interest groups. The most influential model within this literature is the Protection for Sale (PFS) model of Grossman and Helpman (1994). The model falls within the group of models that seek to explain variations in the level of policy protection across industries. The key predictions of the

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[12] Swinnen (2010) provides a good overview of the literature in the context of agriculture.

model relate to economic reasons why certain sectors might have larger or smaller ad valorem deviations from free trade. The model predicts, all else equal, that sectors which have high import demand or export supply elasticity (in absolute value) will have smaller ad valorem deviations from free trade. Governments prefer to raise lobbying contributions from sectors where the costs are small. The model also predicts, all else equal, that ad valorem deviations from free trade are larger in sectors with high domestic output (relative to imports or exports). This is because lobby groups in these sectors have more to gain from an increase in domestic price due to trade policy.

Despite the widespread acceptance of the PFS model and its role in the literature as a defining model, there has been little empirical work to test its hypotheses. The main reason for this is that data on lobbying, which was a key input into the initial empirical specifications of the model, is generally not widely available across industries and time in most countries. However, a new empirical specification of the PFS model (Imai, Katayama and Krishna 2008) has recently overcome this problem, providing an opportunity for more widespread testing of the model. The development of this methodology, coinciding with the release of the Agricultural Distortions database, provides an opportunity to test the PFS hypotheses in agriculture.

Manuscript 5 of this thesis exploits the comprehensive nature of the Agricultural Distortions database to revisit the empirics of the PFS model. The commodity level data are used to test the model‘s key predictions about trade policy choices among sectors within a country. Because the dataset is cross-country, the manuscript also examines the PFS model across countries to test whether there is more support for PFS in developed versus developing countries. It could be that the PFS model is better suited to agriculture in developed countries, where organised farming lobbies almost certainly play a role in agricultural policy; while in developing countries, other policy objectives such as price stability and food security, are more important.

Finally, because the data are cross-country, manuscript 5 incorporates into the PFS empirical specification some of the recent ideas on institutional factors that affect the political economy of trade protection. This empirical extension draws from a number of recent papers that examine the impact of different institutions on agricultural trade policy. For example, Olper and Raimondi (2010) examine the effect of constitutional rules on agricultural policy outcomes. They highlight the important role of the form of democracy, and find that a transition to democracy tends to raise a country‘s aggregate nominal rate of assistance. They also find that transitions to proportional as opposed to majoritarian democracies, have different impacts on that tendency. Dutt and Mitra (2010) find that the political ideology of government matters for the overall level of assistance to agriculture.

Manuscript 5 incorporates institutional theories into the empirical specification through the use of institutional control variables. This is the first work that examines the relationship between institutional factors and the PFS model — which essentially deals with economic reasons why protection ought to be higher or lower in a given sector.[13] The findings of the research suggest ways

[13] Note that Mitra, Thomaklos and Ulubasoglu (2002) examine PFS model under two different government regimes in Turkey: democratic and dictatorship. They find more support in the former

that governments might bring about welfare-improving and sustainable policy reforms in the future.

References

Anderson, J.E. (2009a), “Consistent Trade Policy Aggregation”, *International Economic Review* 50(3): 903–927.

Anderson, J.E., G. Bannister and J.P. Neary (1995), “Domestic Distortions and International Trade”, *International Economics Review* 36(1): 139–57.

Anderson, J.E. and J.P. Neary, (1994) “Measuring the Restrictiveness of Trade Policy,” *The World Bank Economic Review* 8(2): 151-169.

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

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

Anderson, K., J. Cockburn and W. Martin (eds.) (2010), *Agricultural Price Distortions, Inequality and Poverty*, Washington DC: World Bank.

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government regime; which is broadly line with the findings of Olper and Ramondi (2010) reported above.

Anderson, K, and W. Masters (2009), ―Introduction and Summary", chapter 1 in K. Anderson and W. Masters (eds.), *Distortions to Agricultural Incentives in Africa*, Washington DC: World Bank.

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

Bach, C. and W. Martin, (2001), ―Would the Right Tariff Aggregator for Policy Analysis Please Stand Up?" *Journal of Policy Modeling*, 23: 621–635.

Dollar, D and A. Kraay (2003) ―Institutions, Trade and Growth", *Journal of Monetary Economics* 50: 133–162.

Dutt, P. and D. Mitra (2010), ―Impacts of Ideology, Inequality and Democracy on Agricultural Distortion Patterns", chapter 11 in K. Anderson (ed.) *The Political Economy of Agricultural Price Distortions,* Cambridge and New York: Cambridge University Press.

Feenstra, R (1995) ―Estimating the Effects of Trade Policy" in Grossman, G and K. Rogoff (eds.) *Handbook of International Economics*, vol 3, Amsterdam: Elsevier.

Frankel, J. and D. Romer (1999) ―Does Trade Cause Growth?" *American Economic Review* 89(3): 379–399.

Greenaway, D. and Nelson, D. (eds.) (2001) *Globalisation and Labour Markets*, Vols. I and II. London: Edward Elgar.

Grossman, G. and E. Helpman (1994) ―Protection for Sale", *American Economic Review*, 84(4): 833–850, September.

Hertel, T.W. and L.A. Winters (eds.) (2006), *Poverty & the WTO: Impacts of the Doha Development Agenda*, London: Palgrave Macmillan and Washington DC: World Bank.

Imai, S., H. Katayama and K. Krishna (2008), “A Quantile-Based Test of Protection For Sale Model”, NBER Working Paper 13900, March.

Irwin, D. (2010), “Trade Restrictiveness and Deadweight Losses from U.S. Tariffs, 1859-1961”, *American Economic Journal: Economic Policy* 2(3): 111–133, August.

Kee, H. L. (2007), “Measuring the Restrictiveness of International Trade Policy: Book Review”, *Journal of International Economics* 73: 434–441.

Kee, H.L., A. Nicita and M. Olerreaga (2008), “Import Demand Elasticities and Trade Distortions”, *Review of Economics and Statistics* 90(4): 666–82.

Kee, H.L., A. Nicita and M. Olerreaga (2009), “Estimating Trade Restrictiveness Indexes”, *Economic Journal* 119(534): 172–199.

Kohli, U. (1991), Technology, *Duality and Foreign Trade: The GNP Function Approach to Modeling Imports and Exports*, Ann Arbor: University of Michigan Press.

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.

Lloyd, P.J. and D. MacLaren (2009), “Partial and General Equilibrium Measures of Trade Restrictiveness”, working paper, University of Melbourne, Parkville, March.

McCulloch, N., L. A. Winters, and X. Cirera (2001) *Trade Liberalization and Poverty: A Handbook*, London: Centre for Economic Policy Research.

Mitra, D., D.D. Thomaklos and M.A. Ulubasoglu (2002), ‗Protection for Sale in a Developing Country: Democracy vs. Dictatorship", *Review of Economics and Statistics* 84(3): 497–508.

OECD (2009), *Producer and Consumer Support Estimates* (online database accessed at www.oecd.org for 1986-2007 estimates; and OECD files for estimates using an earlier methodology for 1979-85).

Olper, A. and V. Raimondi (2010), ‗Constitutional Rules and Agricultural Policy Outcomes", chapter 14 in K. Anderson (ed.) *The Political Economy of Agricultural Price Distortions,* Cambridge and New York: Cambridge University Press.

Rodriguez, F. and D. Rodrik (2001), ‗Trade Policy and Economic Growth: a Skeptic's Guide to the Cross-National Evidence", *NBER Macroeconomics Annual 2000*, vol 15, Cambridge: MIT Press, pp 261–325.

Rodrik, D. (1995), ‗Political Economy of Trade Policy", in G. Grossman and K. Rogoff (eds.), *Handbook of International Economics*, vol 3, Amsterdam: North-Holland.

Swinnen, J. (2010), ‗Political Economy of Agricultural Distortions: The Literature to Date", chapter 3 in K. Anderson (ed.) *The Political Economy of Agricultural Price Distortions*, Cambridge and New York: Cambridge University Press.

Valdés, A. (1996), ―Surveillance of Agricultural Price and Trade Policy in Latin America During Major Policy Reforms", World Bank Discussion Paper No. 349, Washington DC, November.

Valdés, A. (ed.) (2000), ―Agricultural Support Policies in Transition Economies", World Bank Technical Paper No. 470, Washington DC, May.

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Manuscript 1:

Global Distortions to Agricultural Markets:

New Indicators of Trade and Welfare Impacts

1960 to 2007

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Global Distortions to Agricultural Markets: New Indicators of Trade and Welfare Impacts 1960 to 2007

Abstract

Despite recent reforms, world agricultural markets remain highly distorted by government policies. Traditional indicators of those price distortions such as producer and consumer support estimates (PSEs and CSEs) can be poor guides to the policies‘ economic effects. Recent theoretical literature provides scalar index numbers of trade- and welfare-reducing effects of price and trade policies which this paper builds on to develop more-satisfactory indexes that can be generated using no more than the data used to generate PSEs and CSEs. We then exploit a new Agricultural Distortion database to provide time series estimates of index numbers for 75 developing and high-income countries over the past half century.

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Global Distortions to Agricultural Markets: New Indicators of Trade and Welfare Impacts 1960 to 2007

Despite reforms over the past quarter-century, world agricultural markets remain highly distorted, and international trade in farm products has grown much slower than trade in non-farm goods.[14] Traditional indicators such as the nominal rate of tariff protection from import competition understate the degree of distortion if there are other border taxes or subsidies or quantitative restrictions, and even more so if there are also domestic producer or consumer taxes or subsidies on farm products. Better indicators are provided by the producer and consumer support estimates (PSEs and CSEs) of the OECD (2008) based on domestic to border price comparisons for high-income countries, and by the World Bank‘s new comparable estimates of nominal rates of assistance and consumer tax equivalents (NRAs and CTEs) for both high-income and developing countries as summarized by Anderson (2009).[15] [16] Those estimates can be used in national and global computable general equilibrium models to provide an indication of the true trade and welfare effects of such distortionary policies. However, such models typically are calibrated only for a recent (or not-so-recent) year, and so are

[14] Based on a sample of 75 countries comprising more than 90% of global agriculture and 95% of the world‘s economy, Anderson (2009) estimates that the share of global production of agricultural goods that is exported has increased from 11% in the 1960s and 1970s to just 16% in 1990-2004. When intra-EU trade is excluded, agriculture‘s share of global production exported was just 8% in 2004, compared with 31% for other primary products and 25% for all other goods, according to the GTAP Version 7 database (www.gtap.org).

[15] The main difference between the PSE/CSE and NRA/CTE concepts is that the former are expressed as a percentage of the distorted price whereas the latter are a percentage of the undistorted price (and the CSE has the opposite sign to the CTE). The NRA and CTE values are identical if the only government interventions are at a country‘s border (such as a tariff on imports). In the case of agriculture, however, typically there are some domestic production or consumption taxes or subsidies also in place, so the NRA often differs from the CTE.

[16] Consumer tax equivalents are measured at the farmgate. As such, the concept of consumer throughout this thesis is not a ‗final consumer‘ but the first-stage buyer beyond the farmgate.

incapable of providing estimates of trends over time; and they are not yet available for many smaller and poorer economies.

There is thus a need for better indicators over time of the trade- and welfare-reducing effects of price-distorting policies than the existing weighted average NRA/CTE (or PSE/CSE) estimates for the farm sector of a country. The key reason is that the process of generating those weighted averages can hide the fact that distortions vary across industries within the sector. This is especially problematic in cases where some industry NRAs are negative, as when trade taxes apply also to exports or when dual exchange rates operate. In those cases the sectoral mean NRA may be close to zero even though the trade- and welfare-reducing effects of the sector‘s interventions could be substantial. Further, the sectoral mean NRA may be the same in two countries and yet, if the variance of the NRA across industries within that sector is greater in one country, so too will be the welfare cost of its policies for that sector.

Recent theoretical literature provides partial equilibrium indicators of the trade- and welfare-reducing effects of import policies that belong to a family of indexes under the catch-all name of trade restrictiveness indexes. The purpose of this paper is to draw on that literature in order to develop indexes to capture national, regional and global distortions to sectoral incentives that are based directly on national estimates of individual product NRAs and CTEs. We then exploit the Agricultural Distortion database recently compiled by the World Bank to generate a time series of estimates of consistent indexes for the agricultural sector for both developing and high-income countries over the past half century. The World Bank global panel dataset, compiled by Anderson and Valenzuela

(2008), contains comparable estimates of annual NRAs and CTEs for a wide range of agricultural products (covering around 70 percent of national agricultural production) for around 75 countries that together account for all but one-tenth of the world's population, GDP and agricultural output. Applying our indexes to these new data takes us much closer to understanding the true trade and welfare effects of farm policies without needing a detailed economy wide model.

These better approximations of the trade and welfare effects of sectoral policies are generated with simplifying assumptions about price elasticities that mean we need no more than the same price and quantity data compiled to generate traditional indicators of price distortions such as the NRA and CTE. By assuming domestic price elasticities of supply are equal across commodities within a country, and likewise for elasticities of demand, the formula simplifies to a share-weighted function with shares of production and consumption as weights. This is the main contribution of this paper: to demonstrate how better indicators of sectoral policy distortions can be generated by policy analysts using a simple, elegant and theoretically meaningful methodology and no more data than simpler widely-used indicators. Our aim with these new measures is not to produce a substitute for detailed results from economy wide or sectoral models, but rather to provide better stand-alone indicators of the trade- and welfare-distorting effects of policies than are currently being generated with price and quantity data. Since these new indicators avoid having to select a pair of price elasticity estimates for each product of each country, they could be attractive and politically uncontroversial supplements to the current policy monitoring indicators generated by multilateral institutions such as the OECD and WTO.

The remainder of the paper is structured as follows. After a brief literature review the following section presents the theory for estimating trade- and welfare-reduction indexes in the import-competing sub-sector. This is then extended to cover the exportables sub-sector. The World Bank‘s Agricultural Distortions database is then discussed, followed by presentations of the trade- and welfare-reduction indexes for all 75 countries studied in the Agricultural Distortions project and for key geographic regions and the world as a whole. We also decompose the contributions of individual countries and commodities to the global welfare reduction index. Some concluding observations including caveats and directions for further research complete the paper.

The recent literature

There is a growing theoretical literature that identifies ways to measure the trade- and welfare-reducing effects of international trade policy in scalar index numbers. This literature serves a key purpose: it overcomes aggregation problems (across different intervention measures and across industries) by using a theoretically sound aggregation procedure to answer precise questions regarding the trade or welfare reductions imposed by each country‘s trade policies. The literature has developed considerably over the past two decades, particularly with the theoretical advances by Anderson and Neary (summarized in and extended beyond their 2005 book) and the partial equilibrium simplifications by Feenstra (1995).

Notwithstanding these advances, few consistently estimated indexes have yet been estimated across time, and even fewer across countries. A prominent exception is the work of Kee, Nicita and Olarreaga (2008, 2009) who, following the approach of Feenstra, estimate a series for developing and developed countries. However, those authors provide estimates only for a snapshot in time (the mid-2000s) and based only on import barriers.[17] Most other studies have been country specific, such as an application by Anderson, Bannister and Neary (1995) to Mexican agriculture in the late 1980s.

The indicators we estimate are well grounded in the theory of trade restrictiveness indexes first developed by Anderson and Neary (2005). Specifically, we define two indexes, and coin terms for them that are precise descriptors. The names we provide are a trade reduction index (TRI) and a welfare reduction index (WRI).[18] The TRI and WRI are computed from sub-indexes of the production and consumption sides of the market, which are derived from NRA and CTE estimates, respectively, across product groups. NRAs to producers and CTEs to consumers are required whenever there are domestic subsidies or taxes on production or consumption in addition to border measures – as so often is the case for foods and other farm products. Thus the indexes we estimate capture the aggregate trade- and welfare-reducing effects of all policies directly affecting

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[17] Those estimates, which rely mostly on reported tariff rates but include also estimated tariff equivalents of some non-tariff import measures, have been reported in the World Bank's *Global Monitoring Report* (e.g., World Bank 2008, pp. 121-23). The present estimates, by contrast, rely on domestic to border price comparisons for each product and so directly capture the effects of all border measures as well as domestic behind-the-border price subsidies or taxes.

[18] The definition of the acronym TRI in this thesis is different to that used by Anderson and Neary and several others who have adopted their definition. Our WRI measure is the Anderson and Neary (2005) trade restrictiveness index measure, and our TRI measure is their mercantilist trade restrictiveness index, with an extension to allow for differences between the NRA and the CTE rates for each good.

consumer and producer prices of farm products from all sectoral price-distorting policy measures in place.[19]

Defining the welfare and trade reduction indexes

The initial theoretical work by Anderson and Neary, leading to their 2005 book, sought to derive a general equilibrium measure of the welfare-reducing effects of trade restrictions in a country's import-competing sector. They call this the Trade Restrictiveness Index. The work is important in that it solved the problem of how to aggregate assistance across commodities in a theoretically meaningful way. They do so for a small, open economy in which imports are restricted by tariffs and non-tariff measures (NTMs). They then provide variants of the Trade Restrictiveness Index, including one based not on a welfare criterion but instead on an import volume criterion, which they call the Mercantilist Trade Restrictiveness Index.

We develop versions of each of those two indexes for situations where, in addition to import measures, there may be also export measures and/or direct domestic producer and consumer price distortions resulting from behind-the-border measures.[20] While these versions are less general than the Anderson and Neary indexes, in that they are partial rather than general equilibrium measures, they have the important advantage (particularly for agriculture) of being more

[19] It should be kept in mind that these are partial equilibrium measures: relations of substitutability and complementarity between pairs of goods are all set to zero, and the indirect effects of policy measures applying to non-agricultural sectors are ignored. Also, we assume there are no externalities or market failures, hence no divergences between private and social marginal costs and benefits, including from such things as underinvestment in public goods.

[20] Anderson and Neary (2005, Ch. 12) deal with the theory of domestic distortions in a general equilibrium model, but not in the simplifying partial equilibrium format used here.

comprehensive in terms of policy instrument coverage. Here they are developed first for agriculture's import-competing sub-sector and then for its exporting sub-sector.

The import-competing sub-sector

We take a particular country and assume it has a small open economy in which all markets are competitive. However, the market for an import good may be distorted by a tariff and/or other non-tariff border measures and/or behind-the-border measures such as domestic subsidies and price controls. An example is depicted in Figure 1.

We first measure the effect of a country's distortions on its import volume, the TRI. This is defined as the uniform tariff rate which, if applied to all goods in the place of all actual border and behind-the-border price distortions, would result in the same reduction in the volume of imports (summed across products by valuing them at the undistorted border price) as the actual distortions.

Consider the market for one good, good *i*, which is distorted by a combination of measures that distort its consumer and producer prices. For the producers of the good, the distorted domestic producer price, p_i^P, is related to the border price, p_i^*, by the relation, $p_i^P = p_i^*(1 + s_i)$ where s_i is the rate of distortion of the producer price in proportional terms. For the consumers of the good, the distorted domestic consumer price, p_i^C, is related to the border price by the relation, $p_i^C = p_i*(1 + r_i)$ where r_i is the rate of distortion of the consumer price in proportional terms. In general, $r_i \neq s_i$. Using these relations, the change in the value of imports in the market for good i is given by: [21]

$$\Delta M_i = p_i^* \Delta x_i - p_i^* \Delta y_i$$

$$= p_i^{*2} dx_i / d p_i^C r_i - p_i^{*2} dy_i / d p_i^P s_i \qquad (1)$$

where the quantities of good i demanded and supplied, x_i and y_i, are functions just of their own domestic price: $x_i = x_i(p_i^C)$ and $y_i = y_i(p_i^P)$. (The neglect of cross-price effects, among other things, is what makes the analysis partial equilibrium.)

Strictly speaking, this result holds only for small distortions. In reality rates of distortion may not be small. If, however, the demand and supply functions are linear over the relevant price range, the effect on imports is given by equation (1) with constant slopes of the demand and supply curves in Figure 1 (dx_i / dp_i^C and dy_i / dp_i^P, respectively). If the functions are not linear, this expression provides an approximation to the loss.

With n importable goods subject to different levels of distortions, the aggregate reduction in imports, in the absence of cross-price effects in all markets, is given by:

$$\Delta M = \sum_{i=1}^{n} p_i^{*2} dx_i / d p_i^C r_i - \sum_{i=1}^{n} p_i^{*2} dy_i / d p_i^P s_i \qquad (2)$$

Setting the result equal to the reduction in imports from a uniform tariff, T, we have

[21] If the demand and supply curves happened to be linear, this would be the sum of the areas of the two shaded rectangles in Figure 1.

$$\sum_{i=1}^{n} p_i^{*2} dx_i / d p_i^C r_i - \sum_{i=1}^{n} p_i^{*2} dy_i / d p_i^P s_i = \sum_{i=1}^{n} p_i^{*2} dm_i / dp_i T$$

Solving for T, we get

$$T = \{Ra + Sb\} \tag{3a}$$

where $R = \left[\sum_{i=1}^{n} r_i u_i \right]$ with $u_i = p_i^{*2} \mathrm{dx}_i / \mathrm{d} p_i^C / \sum_i p_i^{*2} \mathrm{dx}_i / \mathrm{d} p_i^C$, (3b)

$$S = \left[\sum_{i=1}^{n} s_i v_i \right] \text{ with } v_i = p_i^{*2} \mathrm{dy}_i / \mathrm{d} p_i^P / \sum_i p_i^{*2} \mathrm{dy}_i / \mathrm{d} p_i^P \text{ , and} \tag{3c}$$

$$a = \sum_i p_i^{*2} \mathrm{dx}_i / \mathrm{d} p_i^C / \sum_i p_i^{*2} \mathrm{d} m_i / \mathrm{d} p_i \text{ and } b = -\sum_i p_i^{*2} \mathrm{dy}_i / \mathrm{d} p_i^P / \sum_i p_i^{*2} \mathrm{d} m_i / \mathrm{d} p_i$$

(3d)

R and S are indices of average consumer and producer price distortions. They are arithmetic means. In the empirical section below, these are based respectively on Consumer Tax Equivalents (CTEs) and Nominal Rates of Assistance (NRAs) of various farm products.

Evidently, the uniform tariff T can be written as a weighted average of the level of distortions of consumer and producer prices. An important advantage of using this decomposition of the index into producer and consumer effects is that it treats correctly the effects of NTMs and domestic distortions that affect the two sides of the market differently.

In equation 3c (equation 3b), the weights for each commodity are proportional to the marginal response of domestic production (consumption) to changes in international free-trade prices. These weights can be written as, among other things, functions of the domestic price elasticities (at the protected trade situation) of supply and demand (σ_i and ρ_i , respectively):[22]

$$(5) \qquad u_i = \rho_i \, (p_i^* x_i) / \sum_i^n \rho_i \, (p_i^* x_i) \quad \text{and} \quad v_i = \sigma_i \, (p_i^* y_i) / \sum_i^n \sigma_i \, (p_i^* y_i) \quad (4)$$

From a practical viewpoint, the next two steps are key to the contribution of this paper. In the first step, if one is willing to assume domestic price elasticities of supply (demand) are equal across commodities — as is implicitly done when calculating the weighted average NRA (CTE) across industries within a sector or sub-sector — then the elasticities in the numerator and denominator of equation 4 cancel. This powerful simplifying assumption allows us (in the empirical section below) to find *R* (*S*) simply by aggregating the change in consumer (producer) prices across commodities and using as weights the sectoral share of each commodity's domestic value of consumption (production) at undistorted prices. That is, with this elasticity assumption, *R* and *S* are attainable with the same information as used to estimate the CTE and NRA – but they provide a better indication of the trade-distorting effect of those producer or consumer price measures.[23]

The second step involves the weights *a* and *b* (equation 3d), which are required in addition to *R* and *S* for estimating T in equation 3a. The weight *a* (*b*) is proportional to the ratio of the marginal response of domestic demand (supply) to a price change relative to the marginal response of imports to a price change. If

[22] These expressions can also be written as functions of, among other things, the domestic price elasticities at the free trade points.
[23] [Footnote added to thesis manuscript and not in joint paper]: Appendix A to this thesis discusses the likely implications of this simplifying assumption on the magnitudes of TRI estimates.

we assume the marginal responses of supply and demand to a price change are the same in aggregate for this country, then a=b=0.5.[24]

With this additional elasticity assumption about the sector's aggregate supply and demand responsiveness to price changes, our methodology is capable of readily providing the net trade-distortion index T as supplement to the traditional NRA/CTE (or PSE/CSE) indicators of agricultural policy distortions. Ideally policy analysts would incorporate elasticity estimates where available but, where they are not available, these three indicators (R, S and T) are nonetheless superior to the existing widely-used agricultural policy measures of trade distortions.

As a special case, if $r_i = s_i$ for all i, that is, if tariff rates are the only distortion, equation (3) reduces to a much simpler form:

$$T = \sum_{i=1}^{n} t_i w_i \qquad w_i = \varepsilon_i^* (p_i^* m_i^*) / \sum_{i}^{n} \varepsilon_i^* (p_i^* m_i^*) \qquad (5)$$

Here t_i is the ad valorem tariff rate, which is equal to the rate of distortion of both consumer and producer prices, and ε_i^* is the elasticity of import demand at the free trade point. T is the mean of the tariff rates. This case can be used to obtain an alternative expression for the general case. But one must be careful, as this alternative form requires computing an import-equivalent tariff rate for each tariff item when there is some distortion other

[24] If the aggregate demand and supply curves are linear, this would equate to an assumption that the aggregate demand and supply curves have the same slope, so that each side of the market contributes equally to the country-specific TRI.

than an ad valorem tariff. (The Appendix in Lloyd, Croser and Anderson (2009) derives the import-equivalent tariff and the alternative expression.[25])

Now we turn to the measure of the effect of a country's distortions on its economic welfare, the WRI. The derivation follows the same steps as in the derivation of the TRI. This leads to a simple comparison of the two indexes.

The distortions in the market for good *i* create a welfare loss, L_i. This loss is given by the sum of the change in producer plus consumer surplus net of the tariff revenue. This loss of producer and consumer surplus is given by:[26]

$$L_i = \tfrac{1}{2}\{(p_i^* s_i)^2 \mathrm{dy}_i / \mathrm{d}p_i^P - (p_i^* r_i)^2 \mathrm{dx}_i / \mathrm{d}p_i^C\} \tag{6}$$

where the quantities of good *i* demanded and supplied, x_i and y_i, are again functions of own domestic price alone.

Strictly speaking, this result too holds only for small distortions. With non-trivial rates of distortion, the welfare losses are defined by the triangular-shaped areas under the demand and supply curves for the good. These areas can be obtained by integration. On the assumption that the demand and supply functions are linear as in Figure 1, the welfare loss is again given by equation (6) with dx_i / dp_i^C and dy_i / dp_i^P being constant. If the functions are not linear, this expression provides an approximation to the loss.

In the special case where $r_i = s_i = t_i$, the expression reduces to

$$L_i = -\tfrac{1}{2}(p_i^* t_i)^2 \mathrm{dx}_i / \mathrm{d}p_i \tag{7}$$

[25] [Footnote added to thesis manuscript and not in joint paper]: Included as Appendix B of this thesis

[26] If the demand and supply curves happened to be linear, this would be the areas of the two triangles *jcd* and *gfe* in Figure 1.

Equation (7) yields the fundamental result that the loss from a tariff is proportional to the square of the tariff rate. This holds because the tariff rate determines both the price adjustment and the quantity response to this adjustment.[27] If $r_i \neq s_i$, as is frequently true in agricultural markets, the expression in equation (6) yields the result that the consumer and the producer losses are each proportional to the square of the rate of distortion of the consumer or producer price, respectively.

With n importable goods subject to different levels of distortions, the aggregate welfare loss, in the absence of cross-price effects in all markets, is given by:

$$L = \tfrac{1}{2}\{\sum_{i=1}^{n}(p_i^* s_i)^2 \mathrm{dy}_i / \mathrm{d}p_\mathrm{i}^\mathrm{P} - \sum_{i=1}^{n}(p_i^* r_i)^2 \mathrm{dx}_i / \mathrm{d}p_\mathrm{i}^\mathrm{C}\} \tag{8}$$

The uniform tariff rate, W, that generates an aggregate deadweight loss identical with that of the differentiated set of tariffs is determined by the following equation:

$$\sum_{i=1}^{n}(p_i^* s_i)^2 \mathrm{dy}_i / \mathrm{d}p_i^P - \sum_{i=1}^{n}(p_i^* r_i)^2 \mathrm{dx}_i / \mathrm{d}p_i^C = -\sum_{i=1}^{n}(p_i^* W)^2 \mathrm{d}m_i / \mathrm{d}p_i \tag{9}$$

W is thus the uniform tariff which, if applied to all goods in the place of all actual tariffs and NTMs and other distortions, would result in the same aggregate loss of welfare as the actual distortions. Solving for W, we have:

$$W = \{R'^2 a + S'^2 b\}^{1/2} \tag{10a}$$

where $R' = [\sum_{i=1}^{n} r_i^2 u_i]^{\frac{1}{2}}$ (10b)

[27] This insight is usually attributed to Harberger (1959). In fact, it was discovered by Dupuit (1844), more than 100 years before Harberger, while analysing the welfare loss resulting from commodity taxation. In his words, ―the loss of utility increases as the square of the tax" (Dupuit 1844, p. 281). Dupuit's contribution to welfare analysis is considered in Humphrey (1992).

$$S' = [\sum_{i=1}^{n} s_i^2 v_i]^{\frac{1}{2}} \qquad (10c)$$

with u_i, v_i, a and b as defined for equation 3 above. W is the desired Welfare Reduction Index, while R' and S' are the contributions to W from consumer and producer price distortions, respectively. They, like their appropriately weighted average W, are means of order two. As with the index T, we can deal with, and analyse, the production and consumption sides of the sector separately. That is, R' and S' are attainable with the same information as used to estimate the CTE and NRA given the earlier price elasticity assumption – but they provide a better indication of the welfare-distorting effect of the traditional consumer or producer price measures.

In equations 3 and 10, the weights in the construction of R', S' and W are the same as the weights for R, S and T except that, in the case of the TRI, arithmetic means of order one are constructed whereas in the case of the WRI they are means of order two.[28] This difference is due to the fact that the losses of import volume in each market are all proportional to the distortion rate whereas the losses of welfare are proportional to the squares of the distortions rates (compare equation 1 with equation 6). The tariff rate enters only once in the determination of the import loss, as the base of the rectangles in Figure 1, whereas the tariff rate enters twice in the determination of the welfare loss, once in the base and once in the height of the triangles *jcd* and *gfe* in Figure 1.

In the special case where $r_i = s_i = t_i$ for all i, equation 10 reduces to a much simpler form:

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

$$W = [\sum_{i=n}^{n} (t_i)^2 w_i]^{1/2} \qquad w_i = \varepsilon_i^* (p_i^* m_i^*) / \sum_{i}^{n} \varepsilon_i^* (p_i^* m_i^*) \qquad (11)$$

Further, if we assume that the elasticities of import demand for the various products are all equal, the weights are the share of imports of each good in total imports. This case can be used to obtain an alternative expression of the general case of the WRI. This is done in the Appendix in Lloyd, Croser and Anderson (2009).[29]

Adding the exportables sub-sector

The indexes can each be extended to include the exportables sub-sector. An export subsidy in the exportable sub-sector reduces welfare in the same way as an import tax in the import-competing sub-sector, but it increases trade whereas the import tariff reduces trade. For this reason, it is necessary to keep track of import and export price distortions separately, for both producers and consumers, for the purpose of estimating the full welfare and trade reduction indexes. In essence, this extension is done by extending the commodity set and keeping separate track of the subsets of import-competing and exportable goods.

The WRI for the whole tradables sector can be written as an expansion of equation 10 in which goods 1 to *n* are import-competing products and goods *n+1* to *z* are exportables:

$$W = \{(R_M'^2 \omega_{PM} + R_X'^2 \omega_{PX})a + (S_M'^2 \omega_{CM} + S_X'^2 \omega_{CX})b\}^{1/2} \qquad (12a)$$

[29] [Footnote added to thesis manuscript and not in joint paper]: Included as Appendix B of this thesis.

where the ω values are shares of the value of production (consumption) imported or exported as defined by:

$$\text{where } \omega_{PX} = \frac{\sum_{i=n+1}^{z} y_i p_i}{\sum_{i=1}^{z} y_i p_i}, \ \omega_{PM} = \frac{\sum_{i=1}^{n} y_i p_i}{\sum_{i=1}^{z} y_i p_i}, \ \omega_{CX} = \frac{\sum_{i=n+1}^{z} x_i p_i}{\sum_{i=1}^{z} x_i p_i}, \ \omega_{CM} = \frac{\sum_{i=1}^{n} x_i p_i}{\sum_{i=1}^{z} x_i p_i}$$

(12b)

It can be seen that when including both import-competing and exportable sub-sectors, we continue to first aggregate for producers and consumers separately, where the weights for each sub-sector are the share of the sub-sectors' value of production (consumption) in the total value of production (consumption). Producer and consumer distortions are aggregated in the last step with the assumption that each of the two sides of the economy contributes equally to the overall WRI.

The resulting measure can be regarded as the import tax/export subsidy which, if applied uniformly to all products in the sector, would give the same loss of welfare as the combination of measures distorting consumer and producer prices in the import-competing and exportable sub-sectors.

The TRI can be similarly decomposed as follows:

$$T = (R_M \omega_{PM} + R_X \omega_{PX})a + (S_M \omega_{CM} + S_X \omega_{CX})b \tag{13}$$

where ω, a and b are as already defined, R_M and S_M are R and S from equation 3b and 3c, and

$$R_X = [\sum_{i=1+n}^{z} -r_i \ u_i \ ] \text{ and } S_X = [\sum_{i=1+n}^{z} -s_i v_i \ ]. \tag{14}$$

The aggregates in equation (14) are the weighted average levels of distortions to consumer and producer prices in the exportables sub-sector, respectively, with weights u_i and v_i given in equation 3b and 3c. Importantly, distortions to the exportables sub-sector enter equation 14 as negative values. This is because whilst a lowering of r_i (the distortion of the consumer price of good *i)* or s_i (the distortion of the producer price of good *i)* in the import-competing sub-sector reduces the trade reduction index, a lowering of r_i or s_i in the exportables sub-sector increases it.

These extensions of the TRI and the WRI for the exportables sub-sector have precisely the same properties as the indexes for the import-competing sector.

World Bank's Distortions to Agricultural Incentives database

The database generated by the World Bank's Agricultural Distortions project compiled by Anderson and Valenzuela (2008), using a methodology summarized in Anderson et al. (2008), provides a timely opportunity to estimate a time series of national, regional and global welfare and trade reduction indexes. The database contains consistent estimates of annual NRAs to the agricultural sector and the same number of CTEs for 75 countries over a time period between 1955 and 2007. The series contains data at the commodity level, for a sub-set of agricultural products (called covered products) that account for around 70% of total agricultural production in the focus countries, which in turn account for 92% of global agricultural GDP. Aggregate NRAs and CTEs for various sectors and sub-sectors (including import-competing and exporting sub-sectors) are estimated, using as weights the values of production and consumption, respectively, at undistorted prices.

The range of measures included in the Agricultural Distortions database NRA estimates is wide. By calculating domestic-to-border price ratios the estimates include assistance provided by all tariff and non-tariff trade measures, plus any domestic price-distorting measures (positive or negative), plus an adjustment for the output-price equivalent of direct interventions on inputs. Where multiple exchange rates operate, an estimate of the import or export tax equivalents of that distortion are included as well. The range of measures included in the CTE estimates include both domestic consumer taxes/subsidies plus trade and exchange rate policies, all of which drive a wedge between the price that consumers pay for each commodity and the international price at the country‘s border.

The most aggregated summaries of NRA and CTE estimates for covered products for developing and high-income countries are presented in Tables 1 and 2.[30] These support the widely held views that developing country governments had in place agricultural policies that effectively taxed their farmers through to the 1980s, and that the extent of those disincentives has lessened since then. The extent of taxation was of the order of 15+% from the early 1960s to the mid-1980s. Since then it has not only diminished but, on average, has become slightly positive. Table 1 also supports the view that the growth of agricultural protection in high-income countries has been going on since the 1950s, and began to reverse only in the latter 1980s. It is clear from

[30] [Footnote added to thesis manuscript and not in joint paper]: Aggregated summaries are presented graphically in Appendix C, Appendix Figures C1 to C4.

Table 2 that consumers have experienced changes similar to producers in recent years. In developing countries, taxation was negative (i.e. consumer subsidization was positive) for most of the last 50 years. This has lessened since the 1990s. In high-income countries, the implicit taxation of consumers from agricultural support rose until the early 1990s but has fallen since then.

Tables 1 and 2 also show the trends in NRAs and CTEs, respectively, for four closely studied regions: Africa, Asia, Latin America and Europe‘s transition economies. On the production side, Africa is where there has been least tendency to reduce the taxing of farmers and subsidizing of consumers of farm products. Indeed its average NRA has been negative in all 5-year periods except in the mid-1980s when international prices of farm products reached an all-time low in real terms. By contrast, for both Asia and Latin America their average NRAs crossed over from negative to positive after the 1980s. And in Europe‘s transition economies, the nominal assistance to farmers has trended upward following their initial shock in the early 1990s. For consumers in all four regions, agricultural policies have almost always involved some consumer subsidization. Since the 1980s, however, food consumer subsidization in Asia, Latin America and Europe‘s transition economies has gradually disappeared and is now replaced by a small degree of taxation on average.

Within the farm sector of all regions, the average NRA for the import-competing sub-sector is well above that for the export sector, meaning there is an anti-trade bias in the structure of distortions. In the case of developing countries where the former NRA is positive and the latter negative, the two tend to offset each other such that the overall sectoral NRA is close to zero. Such a sectoral average can thus be misleading as an indication of the extent of distortion within the sector. It can also be misleading when compared across countries that have varying degrees of dispersion in their NRAs for different farm industries.

Measures of the welfare and trade reduction indexes

Table 3 reports the TRIs for agricultural import-competing products, exportables, and all covered tradable farm products from 1960 to 2007 for the five main studied regions and for the world as a whole.[31] [32] For developing countries as a group, the trade restrictiveness of agricultural policy was roughly constant or slightly rising until the early 1990s and thereafter it declined, for all regions – Africa, Asia and Latin America. For high-income countries the TRI time path was similar. The aggregate results for developing countries are driven by the exportables sub-sector which is being taxed and the import-competing sub-sector which is being protected (albeit by less than in high-income countries – see Tables 1 and 3). For high-income countries, policies support both exporting and import-competing agricultural products and, even though they favour the latter much more heavily, the assistance to exporters offsets somewhat the anti-trade bias from the protection of import-competing producers in terms of their impacts on those countries' aggregate volume of trade in farm products. This is reflected in much smaller TRIs for high-income countries in the third as compared with the first row for high-income countries in Table 3.

The TRI correctly aggregates the restrictiveness of sub-sector policies that are masked in aggregate NRA and CTE measures, because they offset one another. Using the example of Africa in 1985-89 when the NRA was closest to

[31] National TRIs and WRIs are aggregated across countries using an average of the value of consumption and production at undistorted prices. National and regional indexes for the 5-year periods are unweighted averages of the annual indexes.
[32] [Footnote added to thesis manuscript and not in joint paper]: Appendix C, Appendix Figure C6 presents this information graphically.

zero, the TRI peaks at this time in a way that correctly identifies the trade-reducing effect of positive protection to the import-competing sub-sector and disprotection to the exportables sub-sector.

Table 4 reports the WRIs, again for agricultural import-competing products, exportables, and all covered tradable farm products from 1960 to 2007 for the five main studied regions and for the world as a whole.[33] The WRI results for covered products show a similar pattern over the five regions: there is a constant or increasing tendency for policies to reduce welfare from the 1960s to the mid-1980s, but thereafter the opposite occurs in almost all regions. This pattern is generated by different policy regimes in different regions. In high-income countries, agriculture was assisted throughout the period, although it peaked in the 1980s (at around 60%) and thereafter fell. By contrast, in developing countries, agriculture was disprotected until the mid-1980s, and only thereafter did taxation of developing country farmers decline to the point that they received positive assistance by the turn of the century. The first point to note about the WRI, then, is that it has the desirable property of correctly identifying the welfare consequences that result from both positive and negative assistance regimes for the sector.

A second point to note is that the WRI provides a better indicator of the welfare cost of distortions than the average level of assistance or taxation in the Agricultural Distortions database (NRA and CTE in Tables 1 and 2). Although the latter are a significant contribution in their own right, they can be misleading as a pair of indicators of the extent of the welfare costs of assistance or taxation. This

[33] [Footnote added to thesis manuscript and not in joint paper]: Appendix C, Appendix Figure C5 presents the information graphically.

is due to the inclusion in the WRI of the ‘power of two’. That is, a weighted arithmetic mean NRA and CTE does not fully reflect the welfare effects of agricultural distortions because the dispersion of that support or taxation across products has been ignored. By contrast, the WRI captures the higher welfare costs of high and peak levels of assistance or taxation. A good example of this is the WRI for high-income countries: the NRA series for high-income countries is everywhere positive, but the WRI series lies above the NRA series owing to its capturing of the dispersion of the NRA. That is, the WRI captures the so-called ‘disparity’ issue discussed in Lloyd (1974): the larger the variance in assistance levels within a sector, the greater the potential for resources to be used in activities which do not maximize economic welfare.

A third point to note is that the WRI and its two components — unlike the arithmetic mean measures of assistance/taxation (the NRA and CTE) — reflect the true welfare cost of agricultural policies when they have offsetting components. This can be seen most clearly for the case of Africa where, in the latter half of 1980s, it was still taxing exportables but had moved (temporarily) from low to very high positive levels of protection for import-competing farm products (Table 1). In 1985-89 the weighted average NRA for African import-competing and exporting farmers was close to zero, yet the WRI for Africa peaks in that time period. That is, while at the aggregate level African farmers received almost no government assistance then, the welfare cost of the mixture of agricultural programs as a whole was at its highest.

The TRI generally shows greater variance than the WRI series. This is because the TRI measure is sensitive to switches from negative to positive rates of assistance. For example, a move from -30 to +30% rates of assistance would have little or no effect on the welfare consequences of the policy, but it could have a significant effect on trade restrictiveness: net imports of farm products would be greater when the NRA is negative than when it is positive, ceteris paribus.

What can be said about agricultural distortions in the world as a whole? The fact that NRAs for high-income and developing countries diverged (in opposite ways) away from zero in the first half of the period under study, and then converged toward zero in the most recent quarter-century, meant that their weighted average NRA traced out a fairly flat trend for the world, with a dip in the early 1980s. By contrast, Figure 2 shows the WRI and TRI for the world as a whole tracing out a hill-shaped path and thus providing less misleading indicators of the evolving disarray in world agricultural markets. Figure 2 suggests that the global welfare cost of distortions has been much higher than implied by the NRA, but more so in earlier decades than in the current one. Both the WRI and TRI for the world suggest that the disarray in world agricultural markets was slightly less by the early 2000s than it was in the early 1960s.

Which countries or commodities contributed most to the decline in the WRI since the latter 1980s? Overall, the global WRI fell by nearly half from 1985–89 to 2000–04 (46%, whether measured in percentage terms or constant US dollars).[34] Table 5 reports the decomposition of this fall by region, country and agricultural commodity. At a regional level, the fall was due mostly to decreases

[34] To measure the global WRI in constant US dollars, we sum the national WRIs in constant dollars of all countries (obtained by multiplying the country WRIs in percentage terms by the average of the national value of production and consumption in constant 2000 $US, measured at undistorted prices). The fall in the WRI in constant dollar terms could be greater than the fall in the WRI in percentage terms if there was a real increase in the value of global agricultural production over time. Both our percentage and constant dollar falls in the WRI are 46%, indicating that the real value of global agriculture was stable over the period analysed.

in the welfare restrictiveness of policies in high-income countries and Asia. High-income countries contributed over half of the change in the WRI, and Asia more than one-third (last column of Table 5). The higher agricultural output value of high-income countries meant that even though the change in the WRI for Asia was greater at 58%, as compared to 42% for high-income countries, the latter still contributed the most to the global WRI reduction. In high-income countries, the period under analysis was a time of moving some product-specific assistance to decoupled assistance. This potentially explains some of the fall in covered product assistance over the time period. As noted below, one area for further research would be to decompose the WRI by policy instrument, which would shed light on this aspect of the results. Among the Asian developing countries, China (and to a much lesser extent India) contributed most significantly to the reduction in the global WRI, in line with the pursuit of other economic reforms. Some countries contributed to an increase in the global WRI, such as Korea, but their contributions are not listed in Table 5 if they were less than 2% of the overall global change. The bottom part of Table 5 shows that milk, rice and the horticultural sub-sector were the most significant contributors by product to the decline in the WRI globally over the time period shown, accounting for around 70% of the total reduction, with meat accounting for another one-sixth.[35] [36]

[35] To compute the commodity contributions, we first work at the national level to obtain the constant dollar contribution of each commodity to the respective national WRIs. We then sum these contributions in constant dollar terms across all countries for each commodity.
[36] [Footnote added to thesis manuscript and not in joint paper]: Appendix C contains additional results and discussion of results, which are not included in this journal article.

Concluding comments

This paper contributes to the theoretical and empirical literature on trade and welfare reduction indexes. On the theory side, it develops a method of calculating the TRI and WRI directly from estimates of the rates of distortion of producer and consumer prices. The Appendix in Lloyd, Croser and Anderson (2009) shows that these calculations of the TRI and the WRI are equivalent to an alternative method using, for each good, a calculation of the trade-equivalent and the welfare-equivalent rates of trade taxation. The main contribution of the theoretical component of the paper is to demonstrate that policy analysts can estimate national, regional and global measures of distortions to agricultural markets that are superior to and yet use the same data as existing indicators, provided one is willing to make some simplifying assumptions about price elasticities. Furthermore, changes over time in the global indexes can be decomposed to reveal underlying contributions by country and commodity.

Empirically, the paper‘s contribution is to apply the methodology to generate time series of indexes for agricultural goods that are well-grounded in trade theory, account for different forms of price distortions, and can be decomposed into their component producer assistance and consumer tax measures. These indexes – full details of which have been made freely available by Anderson and Croser (2009) for all 75 developing and developed countries over the past half-century – are useful supplements to aggregate NRAs and CTEs (and the PSEs and CSEs generated by the OECD) for monitoring national policy developments and making cross-country comparisons. They also provide better global indicators of the trade and welfare effects of food and agricultural price and trade policies, given that developing and high-income countries‘ NRAs or CTEs have tended in the past to offset each other. Current TRIs could be also useful for trade negotiators seeking trading partner ‗concessions‘ that are equal in terms of trade expansion.

Both the WRI and TRI for the world as a whole trace out a hill-shaped path between 1960 and 2004, suggesting that the disarray in world agricultural markets worsened in the first half of that period but has improved considerably since then such that there are slightly less distortions now than in the early 1960s. Our decomposition underscores the importance of China in reducing global welfare distortions from agricultural policies since the 1980s, but the European Union and Japan have also contributed non-trivially to a fall in the global WRI over the past quarter-century.

Methodologically it would not be difficult to re-calculate the WRIs and TRIs that include actual own-price elasticity of supply and demand estimates once reliable commodity-specific estimates for each country become available.[37] Kee, Nicita and Olarreaga (2009) provide a methodology for estimating trade elasticities, so that may be able to be adapted to the agricultural distortions case. Further complexity could be added by including cross-price

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[37] It is not clear, a priori, what the effect is of this simplifying assumption, because the effects across markets and on the consumption and production sides of the economy could offset each other. However, relaxing the assumption would entail a move to ‗marginal welfare weights‘, instead of production or consumption share weights when estimating the producer or consumer components of the indexes, respectively. The additional assumption that a country‘s sectoral aggregate elasticities of supply and demand are equal (i.e. a=b=0.5) turns out empirically to matter very little because our data are such that estimates of the production and consumption distortion indexes are similar in magnitude (reflecting the fact that the vast majority of distortions come from border measures). Sensitivity analysis undertaken to test the importance of the assumption that *a* equals *b* confirmed that expectation: by assuming instead that *a* is half or twice as large as *b,* the estimated regional TRIs and WRIs were altered by less than one-twentieth.

elasticities, although for agriculture the available estimates suggest that, apart from a few obvious exceptions, these are very low. One example is provided by Tyers and Anderson (1992, Appendix Tables A2 to A4).

In the meantime, we believe the transparency of the method in this paper, notwithstanding its simplifying elasticity assumption, has the potential to add significant value to many policy analyses. In developing countries especially, where input-output tables and associated CGE models are scarce or inaccurate and yet time series indicators of welfare and trade reducing effects of policies are desired for monitoring purposes, our approach could prove to be a very useful and low-cost substitute for such modelling.

An extension to this work could involve using the same methodology to construct index numbers of distortions not from the perspective of a single country but rather from a global view of individual commodity markets. A related extension could be to drill down to further understand the trends in the WRI and TRI presented above. We have decomposed the results to a regional, country and commodity level, but the NRA and CTE measures underlying the WRI and TRI are themselves derived from prices and different policy instruments. The relative contribution of international price movements, and of different instruments, could improve our understanding of the history of food and agriculture policies and provide more insights for on-going national policy dialogues and future rounds of agricultural trade negotiations.

References

Anderson, James E., Geoffrey J. Bannister and J. Peter Neary, ―Domestic Distortions and International Trade", *International Economics Review*, 36(1995): 139–57.

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

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

Anderson, Kym and Johanna L. Croser, ―National and Global Agricultural Trade and Welfare Reduction Indexes, 1955 to 2007", World Bank, Washington DC, available from April 2009 on the Database page at www.worldbank.org/agdistortions.

Anderson, Kym, Marianne Kurzweil, Will Martin, Damiano Sandri and Ernesto Valenzuela, ―Measuring Distortions to Agricultural Incentives, Revisited", *World Trade Review* 7(2008): 1-30, October.

Anderson, Kym and Ernesto Valenzuela, *Estimates of Global Distortions to Agricultural Incentives, 1955 to 2007*, core database at www.worldbank.org/agdistortions, 2008.

Dupuit, Jules, (1844), ―On the Measurement of Utility of Public Works", *Annals des Ponts et Chaussees*, 2nd series, Vol. 8.

Feenstra, Robert C., ―Estimating the Effects of Trade Policy" in Gene N. Grossman and Ken Rogoff (eds.), *Handbook of International Economics*, *Vol. 3*, Amsterdam: Elsevier, 1995.

Harberger, Arnold C., ―Using the Resources at Hand More Effectively”, *American Economic Review* 49(1959): 134-46, May.

Humphrey, Thomas M., ―Marshallian Cross Diagrams and Their Uses Before Alfred Marshall: the Origins of Demand and Supply Geometry”, *Economic Review*, Federal Reserve Bank of Richmond, Richmond VA, 1992.

Kee, Hiau Looi, Alessandro Nicita and Marcelo Olearraga, ―Import Demand Elasticities and Trade Distortions”, *Review of Economics and Statistics* 90(2008): 666-82, November.

Kee, Hiau Looi, Alessandro Nicita and Marcelo Olearraga, ―Estimating Trade Restrictiveness Indexes”, *Economic Journal* 119(2009): 172-99, January.

Lloyd, Peter J., ―A More General Theory of Price Distortions in an Open Economy”, *Journal of International Economics* 4(1974): 365-86, November.

Lloyd, Peter J., Johanna Croser and Kym Anderson, "Global Distortions to Agricultural Markets: New Indicators of Trade and Welfare Impacts, 1960 to 2007", Working Paper 2009-13, School of Economics, University of Adelaide, Adelaide, October 2009, at http://webdev.economics.adelaide.edu.au/research/papers/

OECD, PSE-CSE Database (Producer and Consumer Support Estimates, OECD Database 1986–2007), Organisation for Economic Co-operation and Development, 2008. www.oecd.org/document/55/0,3343,en_2649_33727_36956855_1_1_1_1,00.html

Tyers, Rod and Kym Anderson, *Disarray in World Food Markets: A Quantitative Assessment*, Cambridge and New York: Cambridge University Press, 1992.

World Bank, *Global Monitoring Report 2008,* Washington DC: World Bank, 2008.

Figures and Tables

Table 1: Nominal Rates of Assistance,[a] Africa, Asia, Latin America, European Transition Economies and High-income Regions, All Farm Products, 1960 to 2007 (%)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-07
Covered import-competing products										
Africa	12	4	-7	8	8	65	2	7	3	—
Asia	4	34	26	31	21	45	28	28	35	—
Latin America	20	3	-4	2	10	4	17	9	19	—
All developing countries	11	26	17	23	17	39	22	22	28	—
Europe's transition economies[b]	—	—	—	—	—	—	31	34	34	30
High-income countries	54	59	42	56	70	84	73	64	60	31
World	48	50	37	46	46	66	51	43	44	—
Covered exportables										
Africa	-31	-39	-44	-45	-36	-36	-39	-26	-28	—
Asia	-13	-26	-20	-25	-44	-39	-19	-4	0	—
Latin America	-23	-17	-30	-26	-27	-24	-9	-3	-4	—
All developing countries	-25	-29	-29	-30	-40	-37	-19	-5	-3	—
Europe's transition economies[b]	—	—	—	—	—	—	-4	-1	0	15
High-income countries	4	10	8	7	8	17	13	6	5	3
World	-2	-4	-7	-11	-24	-21	-8	-1	0	—
All covered farm products (incl. nontradables)										
Africa	-13	-18	-22	-20	-12	1	-12	-7	-9	—
Asia	-3	3	0	0	-21	-15	-5	6	10	—
Latin America	-13	-13	-25	-20	-15	-14	1	1	3	—
All developing countries	-9	-5	-9	-8	-20	-13	-5	4	7	—
Europe's transition economies[b]	—	—	—	—	—	—	7	15	15	21
High-income countries	32	39	29	36	43	58	49	36	32	16
World	24	24	15	18	6	16	18	16	16	—

(Continued over)

Table 1 (continued) Nominal Rates of Assistance,[a] Africa, Asia, Latin America, European Transition Economies and High-income Regions, All Farm Products, 1960 to 2007 (%)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-07
All agriculture (incl. non-covered products)										
Africa	-8	-11	-15	-13	-8	-1	-9	-6	-7	—
Asia	-27	-25	-25	-24	-21	-9	-2	8	12	—
Latin America	-8	-7	-21	-18	-13	-11	4	5	5	—
All developing countries	-23	-22	-24	-22	-18	-8	-2	6	9	—
Europe‘s transition economies[b]	—	—	—	—	—	—	10	18	18	25
High-income countries	29	35	25	32	41	53	46	35	32	17
World	22	21	13	15	8	17	18	17	18	—

Source: Anderson and Valenzuela (2008)

[a] Weighted using the value of production at undistorted prices. [b] For Europe‘s transition economies, estimates start only in 1992.

Table 2: Consumer Tax Equivalents[a], Africa, Asia, Latin America, European Transition Economies and High-income Regions, All Covered Farm Products, 1960 to 2007 (%)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-07
Import-competing products										
Africa	7	0	-8	7	3	76	5	9	5	—
Asia	1	14	8	24	24	44	32	27	35	—
Latin America	23	11	0	8	4	1	28	11	18	—
All developing countries	6	11	4	18	17	39	29	22	27	—
Europe‘s transition economies[c]	—	—	—	—	—	—	12	21	31	30
High-income countries	53	56	41	54	65	66	57	55	50	30
World	46	44	32	43	43	55	41	38	39	—
Exportable products										
Africa	-29	-36	-42	-34	-28	-31	-38	-20	-24	—
Asia	-3	-38	-29	-32	-42	-40	-20	-5	0	—
Latin America	-25	-14	-25	-24	-27	-21	-12	1	0	—
All developing countries	-23	-36	-33	-30	-38	-37	-20	-5	-1	—
Europe‘s transition economies[c]	—	—	—	—	—	—	-6	-4	2	-1
High-income countries	4	11	9	9	6	11	8	-2	-3	0
World	0	-8	-9	-11	-24	-24	-11	-4	-2	—
All covered farm products[b]										
Africa	-8	-12	-16	-9	-6	16	-8	0	-3	—
Asia	0	-12	-15	-2	-15	-14	-3	5	10	—
Latin America	-7	-7	-18	-13	-12	-10	13	6	8	—
All developing countries	-5	-12	-16	-5	-14	-10	0	5	8	—
Europe‘s transition economies[c]	—	—	—	—	—	—	-2	9	17	11
High-income countries	35	42	30	40	45	49	41	32	27	16
World	28	23	14	21	10	15	16	15	16	—

Source: Anderson and Valenzuela (2008)

[a] Weighted using the value of consumption at undistorted prices.

[b] Includes nontradables.

[c] For Europe‘s transition economies, estimates start only in 1992.

Table 3: Trade Reduction Indexes, Asian, African, Latin American, Europe‘s Transition Economies and High-income Regions[a], All Covered Tradable Farm Products, 1960 to 2007 (%)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-07
Import-competing products										
Africa	9	2	-7	7	5	71	4	8	4	—
Asia	3	24	17	27	22	45	31	28	36	—
Latin America	22	8	-2	5	7	2	23	10	19	—
All developing countries	8	19	11	21	17	39	26	22	28	—
Europe‘s transition economies[b]	—	—	—	—	—	—	22	28	33	30
High-income countries	51	56	40	54	68	75	66	60	56	31
World	45	46	33	44	45	61	46	41	42	—
Exportable products										
Africa	30	38	43	39	32	33	38	23	26	—
Asia	9	32	24	28	42	40	20	4	0	—
Latin America	24	15	28	24	26	22	10	1	2	—
All developing countries	23	31	30	29	39	37	20	5	2	—
Europe‘s transition economies[b]	—	—	—	—	—	—	5	2	-2	-9
High-income countries	-3	-10	-8	-7	-7	-14	-11	-2	-1	-2
World	2	6	8	11	24	22	10	3	1	—
All covered farm tradables										
Africa	21	22	21	26	18	50	18	14	14	—
Asia	7	29	27	28	35	41	23	12	11	—
Latin America	24	14	21	18	19	14	17	5	8	—
All developing countries	17	26	24	26	31	38	22	11	11	—
Europe‘s transition economies[b]	—	—	—	—	—	—	8	14	14	6
High-income countries	30	33	23	32	40	45	39	33	29	15
World	27	30	23	30	34	41	28	20	18	—

Source: Authors‘ calculations based on product NRAs and CTEs in Anderson and Valenzuela (2008).

[a] Regional aggregates are weighted using the average of the value of production and the value of consumption at undistorted prices.

[b] For Europe‘s transition economies, estimates start only in 1992.

Table 4: Welfare Reduction Indexes, Asian, African, Latin American, Europe‘s Transition Economies and High-income Regions[a], all Covered Tradable Farm Products, 1960 to 2007 (%)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-07
Import-competing products										
Africa	59	52	53	47	51	98	43	32	30	—
Asia	36	45	46	50	48	62	48	44	48	—
Latin America	54	34	27	37	47	40	46	26	32	—
All developing countries	47	45	45	47	48	62	48	40	43	—
Europe‘s transition economies[b]	—	—	—	—	—	—	60	44	45	43
High-income countries	77	85	69	99	106	123	102	91	87	50
World	72	75	64	84	81	100	78	65	65	—
Exportable products										
Africa	37	44	48	49	48	55	58	41	40	—
Asia	24	43	34	34	48	45	24	10	7	—
Latin America	28	22	36	32	36	33	29	12	15	—
All developing countries	31	39	38	36	46	44	27	11	10	—
Europe‘s transition economies[b]	—	—	—	—	—	—	37	33	31	42
High-income countries	11	19	15	12	11	25	22	11	11	10
World	15	26	25	24	34	39	26	13	12	—
All covered farm tradables										
Africa	51	51	52	49	50	80	52	37	36	—
Asia	32	45	44	45	50	51	33	23	21	—
Latin America	37	26	36	35	42	37	39	18	22	—
All developing countries	41	43	44	43	48	51	36	23	22	—
Europe‘s transition economies[b]	—	—	—	—	—	—	47	40	40	44
High-income countries	55	66	54	73	77	95	77	60	58	33
World	53	59	51	62	61	70	54	39	38	—

Source: Authors‘ calculations based on product NRAs and CTEs in Anderson and Valenzuela (2008).

[a] Regional aggregates are weighted using the average of the value of production and the value of consumption at undistorted prices.

[b] For Europe‘s transition economies, estimates start only in 1992.

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Table 5: Decomposition of the Global Reduction in the Welfare Reduction Index, by Region/country and by Commodity,[a] 1985-89 to 2000-04 (%)

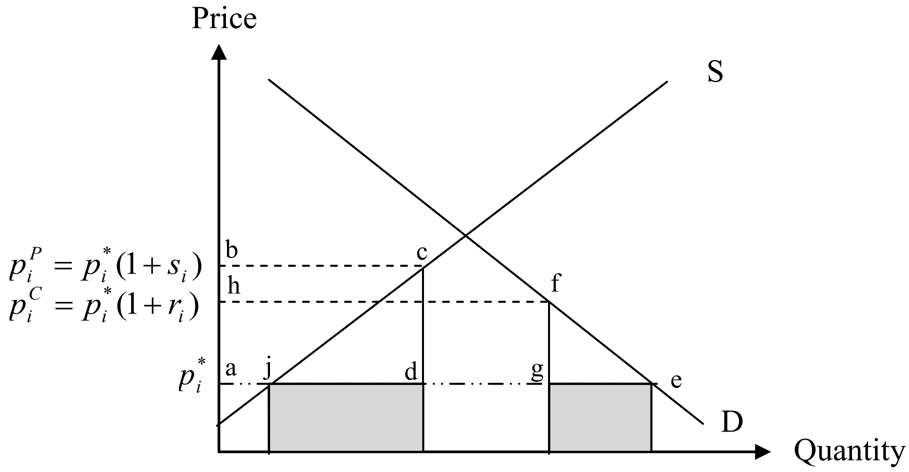
	WRI in 1985-89	WRI in 2000-04	% change in WRI (measured in constant dollars), 1985-89 to 2000-04	% contribution to change in global WRI (measured in constant dollars), 1985-89 to 2000-04
All countries/regions[a]	**70.2**	**37.7**	**-45.9**	**100.0**
High-income countries	95.3	57.5	-41.6	55.0
Asia (excl. Japan)	50.7	21.2	-58.0	38.9
Latin America	36.6	21.6	-34.2	3.3
Africa	79.8	35.9	-52.0	5.6
Specific countries:[b]				
China	47.9	8.0	-84.5	36.0
EU-15	110.8	50.5	-51.4	29.0
Japan	247.5	213.2	-22.0	9.2
US	34.9	24.9	-30.5	5.4
India	86.7	26.7	-44.9	4.3
Egypt	133.4	21.6	-84.6	3.9
Brazil	39.5	6.7	-83.8	3.8
Canada	89.8	42.0	-55.0	2.9
Specific products globally:[b]				
Milk			-66.7	37.4
Fruits and vegetables			-80.0	21.7
Rice			-25.4	12.2
Pigmeat			-74.3	8.6
Wheat			-47.7	4.8
Beef			-28.8	4.7
Barley			-83.1	3.3
Sheepmeat			-87.1	3.0
Sugar			-21.1	2.5

Source: Authors' calculations based on product NRAs and CTEs in Anderson and Valenzuela (2008)

[a] European transition economies are not included as their data are unreliable prior to 1992.

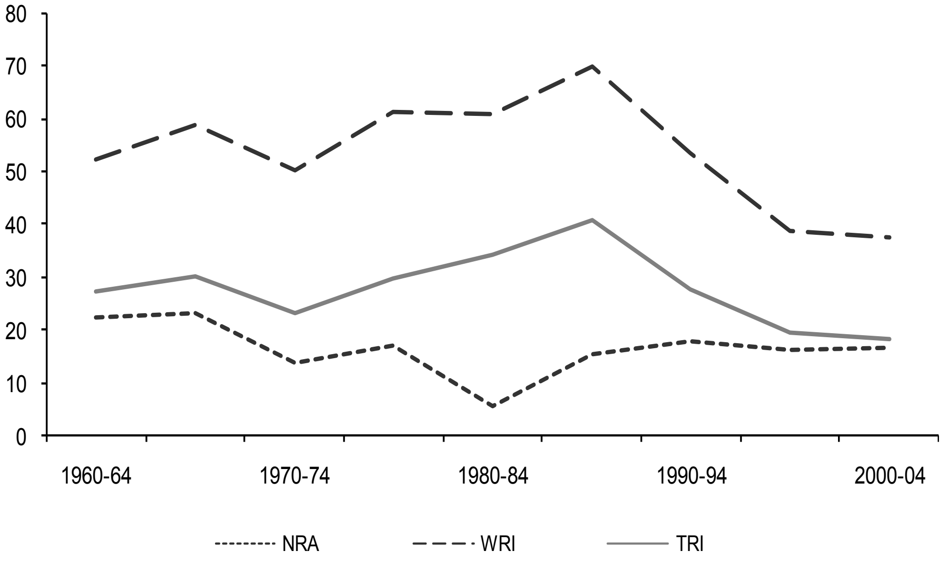
[b] Countries/commodities with a contribution to the decline in the global WRI in the range +2 to -2% are not shown. Some countries and commodities make a negative contribution (though none more than 2%) if their WRI (or share of the global WRI) increases over time, instead of decreasing in line with the overall global reduction. Since we sum across products at the country level to generate the TRI and WRI indexes, there are no estimates to insert in columns 1 and 2.

Figure 1: Trade and Welfare Losses for an Import-Competing Product Subjected to Differing Rates of Distortion to Production and Consumption in a Small Open Economy



Source: Authors‘ depiction.

Figure 2: Nominal Rate of Assistance and Trade and Welfare Reduction Indexes for Covered Tradable Farm Products, World, 1960 to 2004 (%)



Source: Authors' calculations based on product NRAs and CTEs in Anderson and Valenzuela (2008).

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Manuscript 2:

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

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

Abstract

For decades the world‘s agricultural markets have been highly distorted by government policies, but differently for different commodities such that a ranking of weighted average nominal rates of assistance across countries can be misleading as an indicator of the trade or welfare effects of policies affecting global markets. This article develops two theory-based indicators, drawing on the recent literature on trade restrictiveness indexes. It estimates those indicators for each of 28 key agricultural commodities from 1960 to 2004, based on a sample of 75 countries that together account for more than three-quarters of the world‘s production of those agricultural commodities.

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

To compare agricultural distortions across countries, it is common to calculate weighted averages of nominal rates of assistance (NRAs) or consumer tax equivalents (CTEs) of those policies for key products. Those national averages vary considerably, and tend to be high for high-income countries (OECD 2008) and lower or even negative for developing countries (Krueger, Schiff and Valdes 1988). NRAs also vary greatly across commodities. Unsubsidized exporters of a particular product are keen to know by how much global trade in that product has been reduced by other countries' policies, for that influences the amount of effort they are willing to expend in getting together with similar countries to seek more liberalization via trade negotiations.

However, neither the NRA nor the CTE global average is a good indicator of the global trade or welfare effects of policy interventions affecting a particular commodity market, for at least two reasons. First, the fact that there is international trade means each product's production weight differs from its consumption weight for each country and so the global average NRA for any farm product will not be identical to its global average CTE. This will hold even if there were no behind-the-border tax or subsidy policies driving a wedge between the producer and consumer domestic prices. Hence neither can be a true indicator of the global trade effect of distortionary policies. Second, the welfare effect of a policy such as an import tariff is related to the square of that tariff rate, unlike the trade effect which is related just to the rate itself.

Certainly a global modeller in possession of a model for a particular commodity market (or of a global economy wide computable general equilibrium (CGE) model) could insert NRA and CTE estimates and generate partial (or general) equilibrium estimates of the global trade and welfare effects of those distortionary policies in the year for which the model‘s data are calibrated. However, reliable global models do not exist for many commodities, global CGE models typically have to aggregate many of the smaller commodities into groups to keep the model tractable, and both types of model depend on scant econometric estimates of price elasticities. Moreover, such models are calibrated to a particular year and do not provide a long time series of estimates of the global trade and welfare effects of distortionary policies affecting particular commodity markets.

Pending the improvement of that modelling situation, the purpose of the present article is to develop an alternative pair of indicators whose estimation requires no more data than that needed to estimate global NRAs and CTEs but which provide a more precise indication of the trade or welfare effects of global distortions to particular product markets. To do so we draw on the recently developed literature on the family of trade restrictiveness indexes. That literature focuses mostly on policy distortions to imports, but we focus also on policies that distort exports (since the latter are still prevalent in a number of agricultural markets) and policies that drive a wedge between domestic producer and consumer prices.

The first of the new indexes is the ad valorem trade tax rate which, if applied uniformly to a commodity in every country would generate the same reduction in trade as the actual cross-country structure of NRAs and CTEs for that commodity. The second of the new indexes refers to the global welfare cost of that same structure of NRAs and CTEs: it is the ad valorem trade tax rate which, if applied uniformly to that commodity in every country would generate the same reduction in global economic welfare as the actual NRA/CTE structure across countries.

To distinguish the indexes from indexes developed previously, we label these indexes the global trade reduction index (GTRI) and the global welfare reduction index (GWRI). We show that, if one is willing to assume that the domestic cross-price elasticities are zero and that own-price elasticities of supply are equal across countries for a particular commodity, and likewise for the own-price elasticities of demand for that commodity, then there is no need to know the size of those elasticities in order to estimate our GTRI and GWRI.

The next section of the article develops the theory of these indexes. We then exploit recently compiled NRA and CTE estimates in the World Bank's global Agricultural Distortion database to generate estimates of these two new indicators for each of 28 key agricultural commodities over the past half century. These are based on NRA and CTE estimates for a sample of 75 countries. The sensitivity of those estimates to our elasticity assumptions are then tested, before offering concluding observations in the final section.

Defining our trade and welfare reduction indexes

There is a growing theoretical literature that identifies ways to measure the welfare- and trade-reducing effects of international trade policy in scalar index numbers. This literature overcomes aggregation problems (across different forms of policy, and across products or countries) by using a theoretically sound aggregation procedure that answers precise questions regarding the trade and welfare reductions imposed by each country‘s agricultural price and trade policies. The literature has developed considerably over the past two decades, particularly with the theoretical advances by Anderson and Neary (summarized in and extended beyond their 2005 book) and the partial equilibrium simplifications by Feenstra (1995).

Notwithstanding these advances, few estimates of such indexes across countries or commodities have yet been published. A prominent exception is the work of Kee, Nicita and Olarreaga (2008, 2009) who, following the approach of Feenstra, estimate a series for developing and developed countries. However, they provide estimates across commodities for individual countries and only for a snapshot in time (the mid-2000s), and only for import barriers. An early country-specific study is an application to Mexican agriculture in the late 1980s (Anderson, Bannister and Neary 1995).

The indexes we estimate are for individual commodities. They are well grounded in this same theory: they belong to the family of indexes first developed by Anderson and Neary (2005) under their catch-all name of trade restrictiveness indexes. As mentioned above, we label our indicators with terms that are more precise descriptors for the two indexes: a global trade reduction index and a global welfare reduction index. They are computed from sub-indexes of the NRA and CTE for each commodity. While they are partial rather than general equilibrium measures, they have the advantage of being more comprehensive in terms of instrument coverage (as needed when dealing with agricultural policies). They are developed for each commodity market, first for the import-competing countries and then for exporting countries.

The import-competing countries

We consider the market for a particular homogeneous good and assume the good is imported into small open economies that produce the good in a competitive market. However, the individual country markets for this importable good may be distorted by a tariff and/or other non-tariff border measures and/or behind-the-border measures such as domestic producer or consumer taxes or subsidies or quantitative price controls. The effect of those countries' policy-induced price distortions on global imports of the commodity is captured in our GTRI. This is defined as the uniform import tariff rate which, if applied to all countries in place of all actual distortions of consumer and producer prices, would result in the same reduction in the volume of global imports as has resulted from the actual distortions.[38]

[38] [Footnote added into manuscript for thesis and not in joint paper:] This thesis assumes perfectly competitive down-stream sectors from farms for each commodity. In practice, in many instances, especially in high- and middle-income countries, this assumption may not hold, which would have implications for the degree of price transmission and the price behaviour of imports.

Consider the market for one good, good *i*, which is affected in producing and/or consuming countries ($j = 1 \ldots n$) by a combination of policy measures that distort the consumer and producer prices of that good. For the producers of the good, the distorted domestic producer price in each country, p_{ij}^{P}, is related to the world price, p_i^*, by the relation, $p_{ij}^{P} = p_i^*(1 + s_{ij})$ where s_{ij} is the rate of distortion of the producer price in proportional terms. For the consumers of the good, the distorted domestic consumer price, p_{ij}^{C}, is related to the world price by the relation, $p_{ij}^{C} = p_i^*(1 + r_{ij})$ where r_{ij} is the rate of distortion of the consumer price in proportional terms. In general, $r_{ij} \neq s_{ij}$. Using these relations, the change in imports in the market for good *i* in country *j* valued at the current world price is given by:

$$\Delta M_{ij} = p_i^* \Delta x_{ij} - p_i^* \Delta y_{ij}$$

$$= p_i^{*2}(dx_{ij} / dp_{ij}^{C}) r_{ij} - p_i^{*2}(dy_{ij} / dp_{ij}^{P}) s_{ij} \quad (1)$$

where the quantities of good *i* demanded and supplied in country *j*, x_{ij} and y_{ij}, are assumed to be functions of own domestic price alone: $x_{ij} = x_{ij}(p_{ij}^{C})$ and $y_{ij} = y_{ij}(p_{ij}^{P})$. The change is measured from the free trade situation. The neglect of cross-price effects makes the analysis partial equilibrium: relations of substitutability and complementarity between pairs of goods are all set to zero, and indirect effects of policy measures directed at non-agricultural sectors are ignored. (We also adopt the standard assumptions in trade theory that there are no divergences between private and social marginal costs and benefits that might arise from market failures.)

Strictly speaking, this result holds only for small distortions. In reality rates of distortion are not small. If, however, the demand and supply functions are linear, the reduction in imports is given by equation 1 with dx_{ij} / dp_{ij}^{C} and dy_{ij} / dp_{ij}^{P} equal to constants. If the functions are not linear, this expression provides an approximation to the change.

With n import-competing countries, the aggregate reduction in imports for good i is given by:

(2) $$\Delta M_i = \sum_{j=1}^{n} p_i^{*2} (dx_{ij} / dp_{ij}^{C}) r_{ij} - \sum_{j=1}^{n} p_i^{*2} (dy_{ij} / dp_{ij}^{P}) s_{ij}$$

Setting the result of equation 2 equal to the reduction in imports from a uniform tariff, T_i, we have:

(3) $$\sum_{j=1}^{n} p_i^{*2} (dx_{ij} / dp_{ij}^{C}) r_{ij} - \sum_{j=1}^{n} p_i^{*2} (dy_{ij} / dp_{ij}^{P}) s_{ij} = \sum_{j=1}^{n} p_i^{*2} (dm_{ij} / dp_{ij}) T_i$$

Solving for T_i, we get

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

where

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

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

(4d) $$a_i = \sum_j p_i^{*2} (dx_{ij} / dp_{ij}^{C}) / \sum_j p_i^{*2} (dm_{ij} / dp_{ij}),$$

$$b_i = -\sum_j p_i^{*2} (dy_{ij} / dp_{ij}^{P}) / \sum_j p_i^{*2} (dm_{ij} / dp_{ij})$$

a_i and b_i are positive weights that sum to unity.

The GTRI can be regarded as a true index of average tariff rates across countries, since what is held constant is the value of imports in constant prices. R_i and S_i are indices of global average consumer and producer price distortions. They are weighted arithmetic means across countries.

Note that p_i^{*2} appears in both terms in the numerator and denominator of equations 4b and 4c and can, therefore, be cancelled. This tells us that we are dealing with an index that is holding constant the aggregate quantity traded of the (homogeneous) good when we replace a set of nationally differentiated production and subsidy tax/subsidy rates by a uniform global tariff rate. Cancelling the p_i^{*2}, we see that the weights u_{ij} and v_{ij} for the sub-indices of consumer and producer price distortions, R_i and S_i, can be written in terms of shares of quantities. However, we retain the form of a constant price index because this is easier to calculate using value of production and consumption data in the weights. The cancellation of the prices shows us that we can use any price we want. We choose the current situation world price in order to use value statistics in current prices.[39]

Evidently, T_i can be written as a weighted average of the levels of distortion of consumer and producer prices. An important advantage of using this decomposition of the index into producer and consumer effects is that it treats correctly the effects of non-tariff measures and domestic distortions. We

[39] This outcome is possible because of our assumption that the demand and supply curves have constant slopes. If more general functional forms were assumed, it would be necessary to estimate the new world price that would prevail for each commodity in the hypothetical equilibrium following the switch to a uniform trade tax.

can deal with, and analyse, the production and consumption sides of the product market separately.

In equations 4b and 4c, the weights for each commodity are proportional to each country's marginal response of domestic production (or consumption) to changes in domestic prices. It might be convenient to write these weights as functions of, among other things, the domestic price elasticities (at the free trade situation) of supply and demand (σ_{ij} and ρ_{ij}, respectively):

$$(5) \qquad u_{ij} = \rho_{ij}(p_i^* x_{ij}) / \sum_j^n \rho_{ij}(p_i^* x_{ij}) \quad \text{and} \quad v_{ij} = \sigma_{ij}(p_i^* y_{ij}) / \sum_j^n \sigma_{ij}(p_i^* y_{ij})$$

In the absence of estimates of domestic demand and supply elasticities, if we assume domestic price elasticities of supply are equal across countries for a particular commodity, and similarly for the domestic price elasticities of demand for a particular commodity, the elasticities in the numerator and denominator of equation 5 cancel. Thus we can find R_i (S_i) by aggregating the change in consumer (producer) prices across countries, using as weights the share of each country's domestic value of consumption (production) at world prices. We discuss the plausibility and implications of this elasticity assumption below.

Estimating T_i in equation 4a also requires an assumption about the weights *a* and *b* (equation 4d). The weight *a* (*b*) is proportional to the ratio of the marginal response of domestic demand (supply) to a price change relative to the marginal response of imports to a price change. If we assume the marginal responses of supply and demand to a price change are the same in aggregate, then a=b=0.5. With linear demand and supply curves for a global commodity market in aggregate, this equates to an assumption that the aggregate demand and supply curves have the same slope, so that each side of the market contributes equally to the GTRI.

Now we turn to the measure of the effect of a commodity‘s distortions on global welfare, the GWRI. The derivation follows the same steps as in the derivation of the GTRI. The distortions in the market for good *i* in country *j* creates a welfare loss, L_{ij}. In partial equilibrium terms, this loss is given by the sum of the change in producer plus consumer surplus net of the tariff revenue. The loss is given by:

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

where the demand and the supply for good *i* in country *j* are again functions of own domestic price alone.

Strictly speaking, this result too holds only for small distortions. With non-trivial rates of distortion, the welfare losses are defined by the familiar triangular-shaped dead-weight loss areas under the demand and supply curves for the good in a small open economy. These areas can be obtained by integration. If the demand and supply functions are linear, the welfare loss is given by equation 6 where dx_{ij} / dp_{ij}^C and dy_{ij} / dp_{ij}^P are constants. If the functions are not linear, this expression provides an approximation to the loss.

In the special case where $r_{ij} = s_{ij} = t_{ij}$ (and thus $p_{ij}^C = p_{ij}^P = p_{ij}$), the expression reduces to:

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

Equation 6 yields the fundamental result that the loss from a tariff is proportional to the square of the tariff rate. This holds because the tariff rate determines both the price adjustment and the quantity response to this adjustment (Harberger 1959). If $r_{ij} \neq s_{ij}$, the expression in equation 6 yields the result that the consumer and the producer losses are each proportional to the square of the rate of distortion of the consumer or producer price, respectively.

With n countries applying different levels of distortions to good i, the welfare loss for the group of countries, in the absence of cross-price effects, is given by:

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

The uniform import tariff rate, W_i, that generates a global deadweight loss identical with that of the actual distortions of different countries for good i is determined by the following equation:

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

Solving for W_i, we have:

(10a) $W_i = \{R_i'^2 a_i + S_i'^2 b_i\}^{1/2}$, where

(10b) $$R_i' = \left[\sum_{j=i}^{n} r_{ij}^2 u_{ij}\right]^{1/2} \quad \text{and} \quad S_i' = \left[\sum_{j=i}^{n} s_{ij}^2 v_{ij}\right]^{1/2}$$

and u_{ij}, v_{ij}, a_i and b_i are as defined earlier.

R_i' and S_i' are measures of the average levels of consumer and producer price distortions, respectively. They are means of order two. The desired GWRI,

W_i , is an appropriately weighted average of the levels of distortions of consumer and producer prices and so is also a mean of order two. As with the index T_i, we can deal thus with, and analyse, the production and consumption sides of the market separately.

As noted, the weights in the construction R_i' and S_i' and W_i (in equation 10) are the same as the weights for R_i and S_i and T_i (in equation 4) except that, in the case of the GTRI, we construct arithmetic means (which are the means of order one) whereas in the case of the GWRI we construct means of order two. This difference is due to the fact that the losses of import volume in each country are all proportional to the distortion rate whereas the losses of welfare are proportional to the squares of the distortions rates (compare equation 1 with equation 6).

Adding the exporting countries

The indexes can each be written also for countries exporting good *i*. In an exporting country, an export subsidy reduces welfare in the same way as an import tax in the import-competing sector, but it increases trade whereas the tariff reduces trade. As such, we keep separate track of import-competing and exporting countries for the purpose of estimating the GWRI and GTRI. This is done by extending the country set and dealing separately with import-competing countries (hereafter countries 1 to n) and exporting countries (hereafter countries $n+1$ to z).

The GTRI for both importing and exporting countries can be written as an expansion of equation 4:

(11a) $T_i = \{(R_{iM}\omega_{iPM} + R_{iX}\omega_{iPX})a_i + (S_{iM}\omega_{iCM} + S_{iX}\omega_{iCX})b_i\}$

where a_i and b_i are as already defined, R_{iM} and S_{iM} are R_i and S_i from equations 4b and 4c, and

(11b) $R_{iX} = \left[\sum_{j=i+n}^{z} - r_{ij} u_{ij} \right]$ and $S_{iX} = \left[\sum_{j=i+n}^{z} - s_{ij} v_{ij} \right]$

and the ω expressions are shares of the value of production and consumption for import-competing and exporting countries in goods market i at equilibrium prices and quantities:

(11c) $\omega_{iPM} = \frac{\sum_{j=1}^{n} y_{ij} / p_{ij}^{P}}{\sum_{j=1}^{z} y_{ij} / p_{ij}^{P}}$, $\omega_{iPX} = (1 - \omega_{iPM}) = \frac{\sum_{j=n+1}^{z} y_{ij} / p_{ij}^{P}}{\sum_{j=1}^{z} y_{ij} / p_{ij}^{P}}$,

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

It can be seen that when including both importing and exporting countries, we continue to first aggregate for producers and consumers separately. Global producer and consumer distortions are aggregated in the last step with the assumption that the marginal responses of supply and demand to a price change are the same in aggregate (that is, $a_i = b_i = 0.5$). The aggregates in equation 11b are the weighted average levels of distortions to consumer and producer prices in the good i exporting countries, respectively, with weights u_{ij} and v_{ij} given in equation 4b and 4c. Importantly, distortions to exporting countries enter equation 11b as negative values. This is because whilst a lowering of r_{ij} (the distortion of the consumer price of good i in country j) or s_{ij} (the distortion of the producer price of good *i* in country *j)* in the importing countries lowers the trade reduction index, a lowering of r_{ij} or s_{ij} in the exporting countries increases T_i .

The resulting GTRI measure, T_i, can be regarded as the good *i* trade tax rate which, if applied uniformly across all countries, would give the same reduction in trade as the combinations of individual country measures distorting consumer and producer prices in the importing and exporting countries.

The GWRI for import-competing and exporting countries can be written in the same form as 11a as an expansion on equation 10, where the R_i and S_i terms are the mean of order two equivalents:

$$(12) \qquad W_i = \{(R'^2_{iM}\omega_{iPM} + R'^2_{iX}\omega_{iPX})a_i + (S'^2_{iM}\omega_{iCM} + S'^2_{iX}\omega_{iCX})b_i\}^{1/2}$$

These extensions of the GTRI and the GWRI to exporting countries have precisely the same properties as the indexes for the import-competing countries. GTRIs and GWRIs can be aggregated across product groups using as weights an average of the global commodity consumption and production at undistorted prices. Indexes for the 5-year periods reported below are unweighted averages of the annual indexes.

Country contributions to the GTRI and the GWRI

It is possible to quantify the contribution of each country to the reduction in world trade or world welfare as measured by the GTRI or GWRI. The contribution, C_i , of each country to the reduction in world imports for good *i* comes from the decomposition of the element in square brackets in equations 4b and 4c on the consumption and production sides of the economy, respectively.

There are similar decompositions for exporting countries, albeit with the positive assistance measures entering as negative contribution shares (see equation 11) for T_i because positive assistance increases rather than reduces world trade.

The World Bank's Agricultural Distortions database

A new database generated by the World Bank's Agricultural Distortions research project (Anderson and Valenzuela 2008), using a methodology summarized in Anderson et al. (2008), provides a timely opportunity to estimate GTRIs and GWRIs for individual commodity markets. The database contains consistent estimates of annual NRAs and CTEs at the commodity level, for a set of agricultural products (called covered products). These products account for around 70 percent of total agricultural production in 75 countries (called focus countries), which in turn account for 92 percent of global agricultural GDP. The data cover a time period between 1955 and 2007 for the majority of countries, but the country coverage is most complete for the years 1960 to 2004 so only those are used here. Global NRAs and CTEs for various commodities are estimated using as weights the values of production and consumption, respectively, at undistorted prices.

The range of measures included in the Agricultural Distortions database NRA and CTE estimates is wide. By calculating domestic-to-border price ratios the estimates include the price effects of all tariff and non-tariff trade measures, plus any domestic price support measures (positive or negative), plus an adjustment for the output-price equivalent of direct interventions in farm input markets. Where multiple exchange rates operate, an estimate of the import or export tax equivalents of that distortion are included as well.

An important feature of the World Bank dataset is that the reported prices and quantities are the endogenously determined equilibrium prices and quantities. This allows us to estimate GTRIs and GWRIs using observed data.

Estimates of trade and welfare reduction indexes

Table 1 reports our time series of estimated GTRIs for the 28 agricultural commodities, and for four aggregated groups of commodities (grains and tubers, oilseeds, tropical crops, and livestock products). Generally those GTRIs are somewhat above the NRAs and CTEs, and especially for tropical products where the trade-reducing effects of import taxes of some high-income countries are reinforced by the export taxes of some lower-income countries. By contrast, for some other products the global average GTRI is less than the NRA and CTE, reflecting the fact that export subsidies have been in place for some higher-income countries or import subsidies for some lower-income countries, which offset the trade-reducing effects of tariffs. In some cases (e.g., millet) there are even some five-year periods when the GTRI is negative, indicating that policies on net have encouraged international trade in those goods — which can be just as damaging to national and global economic welfare as policies that discourage trade.

The differences within the four groups of commodities in the extent to which their global trade has been taxed are considerable. Among the grains it is rice trade that has been taxed most since the 1970s, while among the oilseeds and tropical crops it is sesame and sugar trade, respectively, that are taxed most. Feedgrain and oilseed trade, especially the major items of maize and soybean, has been taxed least among those crops shown, and at very low rates compared with livestock products, especially milk. Note, however, that the extent of distortions to trade has diminished more for livestock products than for crops since the 1980s when agricultural price and trade reforms (as chronicled in Anderson 2009) began to be implemented in numerous countries.

In table 2 the 2000-04 GTRI estimates are disaggregated to show their production and consumption components. Three points are worth noting. First, the production and consumption components tend to be similar in magnitude, indicating that the main policy interventions are at the national borders of countries rather than behind-the-border domestic measures. Second, for those few products for which the GTRI is negative, indicating that there is still some use of explicit or implicit trade-expanding measures, the disaggregation reveals possible reasons. In the case of cotton it is coming predominantly from pro-trade production measures (such as have operated in the United States), whereas in the case of millet and groundnuts it is coming mostly from pro-trade consumption measures (such as import subsidies in Africa at desperate times of food shortages just prior to the next harvest, when regional prices of food staples are at their highest and well above the preceding season's post-harvest price). And third, the final two columns of Table 2 confirm that countries that are importers of a product assist their producers far more than countries that export that good.

Tables 3 and 4 similarly report the GWRI estimates. These are all necessarily positive; and they are substantially above the NRAs, with 5-year averages across the 28 commodities between 1960 and 2004 in the range of 50 to 80 percent compared with the 9 to 27 percent range for the NRA averages. This greater size is partly because the welfare cost is proportional to the square of the NRA, and partly because some NRAs are negative and so offset positive NRAs in the process of averaging them whereas the welfare cost of those negative and positive NRAs are additive. The most distorted among the 28 commodities in 2000-04 in terms of their global welfare cost are rice, sugar, milk, beef, poultry and cotton. Their and the other GWRIs for that period are shown in Figure 1, together with the (necessarily always lower) GTRIs.

When disaggregating those GWRIs as in Table 4, it is again clear that the sub-indicators differ little as between the production and consumption components, and that countries for which a product is an importable tend to be much greater contributors to the product‘s GWRI than those countries for which it is an export item. The final two columns also reveal that, among the exporting countries shown, cotton is (equal) second only to milk in terms of the size of its GWRI, thanks to the huge cotton export subsidies in the United States and the cotton export taxes of several developing countries.

Figures 2 and 3 present the country contributions to the global reduction in commodity market trade or welfare for the five most distorted farm products. The figures reveal that for some commodity markets such as rice, there are only a handful of countries whose policies are responsible for most of the global distortion, whereas for other commodities such as sugar and beef, a large number of countries' policies contribute more evenly to the reduction in global trade and welfare. Note, however, that the country rankings are different for the two indicators. In the global rice market, for example, India is the main contributor to the distortion to the level of trade whereas Taiwan, Japan, Vietnam and Korea are much more significant contributors to the reduction in global welfare in the rice market. This arises because the effect on GWRI of the large NRAs and CTEs of the latter four countries swamp those for India.[40]

Sensitivity analysis

In this section we consider some important caveats, because the article's two indexes have been calculated with the help of a number of simplifying assumptions. The most noteworthy are that each country's own-price elasticity of supply (and also of demand) for a particular product is the same as that for every other country, and that cross-price elasticities are zero. It is not uncommon for modellers of the global market for particular farm products to adopt these assumptions, for want of reliable or agreed econometric estimates of those elasticities for each country (an early global example being Valdés and Zietz 1980). Even so, these price elasticity assumptions could introduce potential biases into our GTRI and GWRI index estimates, and in either direction. So too could our assumption for simplifying the aggregation of our

[40] [Footnote added into manuscript for thesis and not in joint paper]: Additional Results are reported in Appendix D of this thesis.

global producer and consumer distortion indexes, namely, that the aggregate marginal response of domestic demand to a price change is the same as the aggregate marginal response of domestic supply for the world.

To gauge the potential importance of not allowing differential price responses, we re-computed our two indexes using country- and commodity-specific own-price elasticity of supply and demand estimates available for 8 key farm products from a widely cited source (Tyers and Anderson 1992).[41] In 2000-04 those 8 products accounted for 71 percent of the global value of production of the 28 products listed in the earlier tables. A comparison of those results, reported in Table 5, with those in Tables 1 and 3 reveals little difference in the overall indications of distortions: the averages across the 8 products using the elasticity estimates are 5 percentage points lower than our earlier estimates for one decade but between just 0 and 3 points lower for the other 7 decade averages shown. Not surprisingly the differences are largest for the product with the most diverse NRAs, namely rice, and are larger for the GTRIs than the GWRIs (because the GWRI is a mean of order two and so the weights play a less important role in the determination of its overall index). In all cases, though, the index trends over time are much the same under either set of elasticity assumptions.

Sensitivity analysis was also undertaken with respect to the assumption that the aggregate marginal response of demand to a price change is the same as the aggregate marginal supply response for the world. We did so by re-computed our two indexes assuming that demand was instead twice, or half, as

[41] [Footnote added into manuscript for thesis and not in joint paper]: The Elasticity Estimates are reproduced in Appendix E of this thesis.

responsive as supply. Despite that wide range, the estimates were almost unchanged at the aggregate level across all 29 products, and even the 5-year averages for each of the four product groups (grains, oilseeds, tropical crops and livestock) changed by no more than 2 percentage points. This benign result is due to the empirical fact that the producer and consumer distortions are similar, reflecting the dominance of border measures in the policy instrument mix.

A third type of sensitivity analysis could be to assume non-zero cross-price elasticities. This is left as an area for further research for two reasons. One is because the cross-price elasticity estimates available from Tyers and Anderson (1992) for the 8 products in Table 5 are at or near zero in most cases, and they would be very low also for the tropical perennial crop products listed in the earlier tables. Hence we do not expect it would alter the index estimates very much. The other reason is that the above algebra becomes much more complex once this simplifying assumption is dropped, in which case the analyst may as well move to a formal multi-commodity modelling framework for the subset of situations where this is considered important enough empirically. Meanwhile, as and when improved econometric estimates of price elasticity estimates become available for each country and commodity, more-accurate estimates of the GTRI and GWRI can be computed using the article‘s methodology.

Conclusions

The above application of these two commodity-specific additions to the family of so-called trade restrictiveness indexes provides very different and much larger indicators of distortions to global agricultural markets than standard NRAs and CTEs (and even more so than the OECD‘s producer and consumer support estimates, which are expressed as a percentage of distorted rather than undistorted prices and so are smaller than their NRA and CTE counterparts). More specifically, the GTRI offers a much truer indication of the world trade effects of government interventions in the markets for particular traded products, by properly accommodating all domestic and border subsidies and taxes; and the GWRI offers a much truer indication of the global welfare effects of government interventions in the markets for traded products, by also properly taking into account the fact that the welfare cost of a price distortion is proportional to the square of the tax or subsidy rate.

With the World Bank‘s NRA/CTE database, which provides greater coverage in terms of commodities, countries and instruments than in any previous estimates of the extent of distortions of global agricultural markets, we have been able to reveal in which product markets the reduction in trade or the loss of welfare is greatest. These two indexes have an advantage over more-formal supply/demand models in that they can be expressed in time series form and thereby reveal trends and fluctuations over long periods, rather than just providing a snapshot at a point in time which is typical of comparative static commodity models.

References

Anderson, J.E., G.J. Bannister, and J.P. Neary. 1995. “Domestic Distortions and International Trade.” *International Economic Review* 36(1):139–57.

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

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

Anderson, K., M. Kurzweil, W. Martin, D. Sandri and E. Valenzuela. 2008. “Measuring Distortions to Agricultural Incentives, Revisited.” *World Trade Review* 7(4):1–30.

Anderson, K. and E. Valenzuela. 2008. *Global Estimates of Distortions to Agricultural Incentives, 1955-2007*. Database available at www.worldbank.org/agdistortions.

Feenstra, R.C. 1995. “Estimating the Effects of Trade Policy” in *Handbook of International Economics*, vol. 3, G.N. Grossman and K. Rogoff (Eds.), Amsterdam: Elsevier.

Harberger, A.C. 1959. “Using the Resources at Hand More Effectively.” *American Economic Review* 49(2):134–46.

Kee, H.L., A. Nicita and M. Olarreaga. 2008. “Import Demand Elasticities and Trade Distortions.” *Review of Economics and Statistics* 90(4):666–82.

Kee, H.L., A. Nicita and M. Olarreaga. 2009. ―Estimating Trade Restrictiveness Indexes.” *Economic Journal* 119(534):172–99.

OECD. 2008. PSE-CSE Database (Producer and Consumer Support Estimates, OECD Database 1986–2007. Organisation for Economic Co-operation and Development. www.oecd.org/document/55/0,3343,en_2649_33727_36956855_1_1_1_1,00.html

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

Valdés, A. and J. Zietz. 1980. *Agricultural Protection in OECD Countries: It's Cost to Less-Developed Countries.* Research Report 21. Washington DC: International Food Policy Research Institute.

Figures and Tables

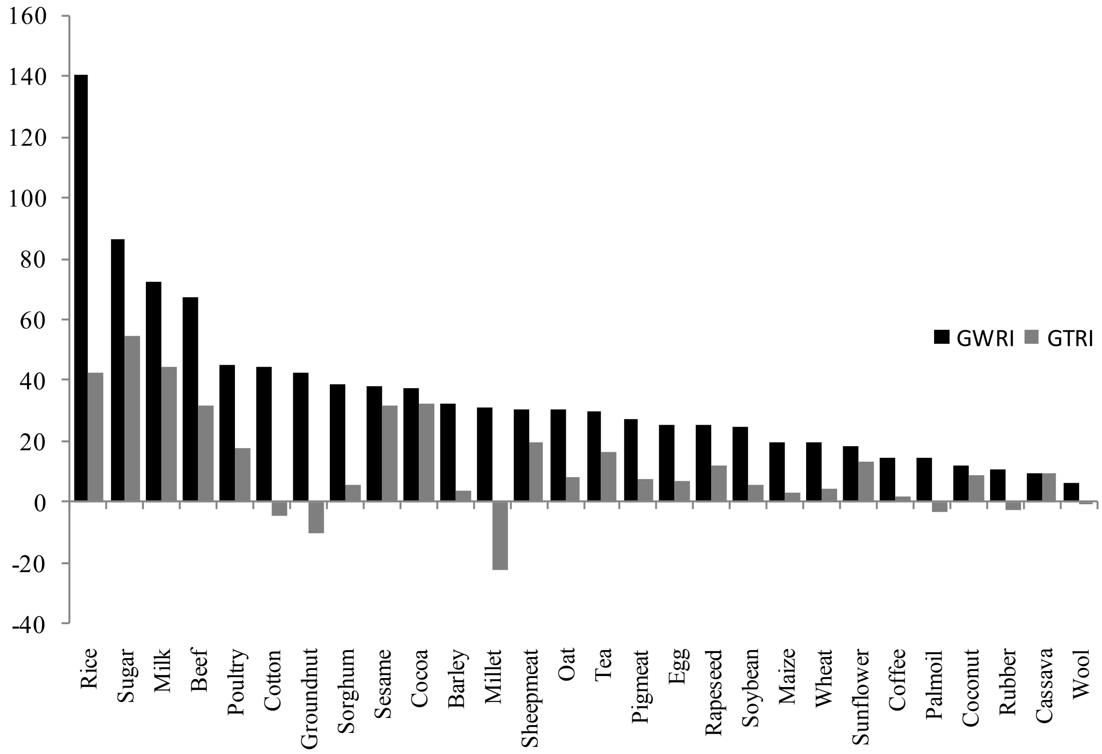

Figure 1. GTRIs and GWRIs for 28 major agricultural products, 2000-04 (percent)

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

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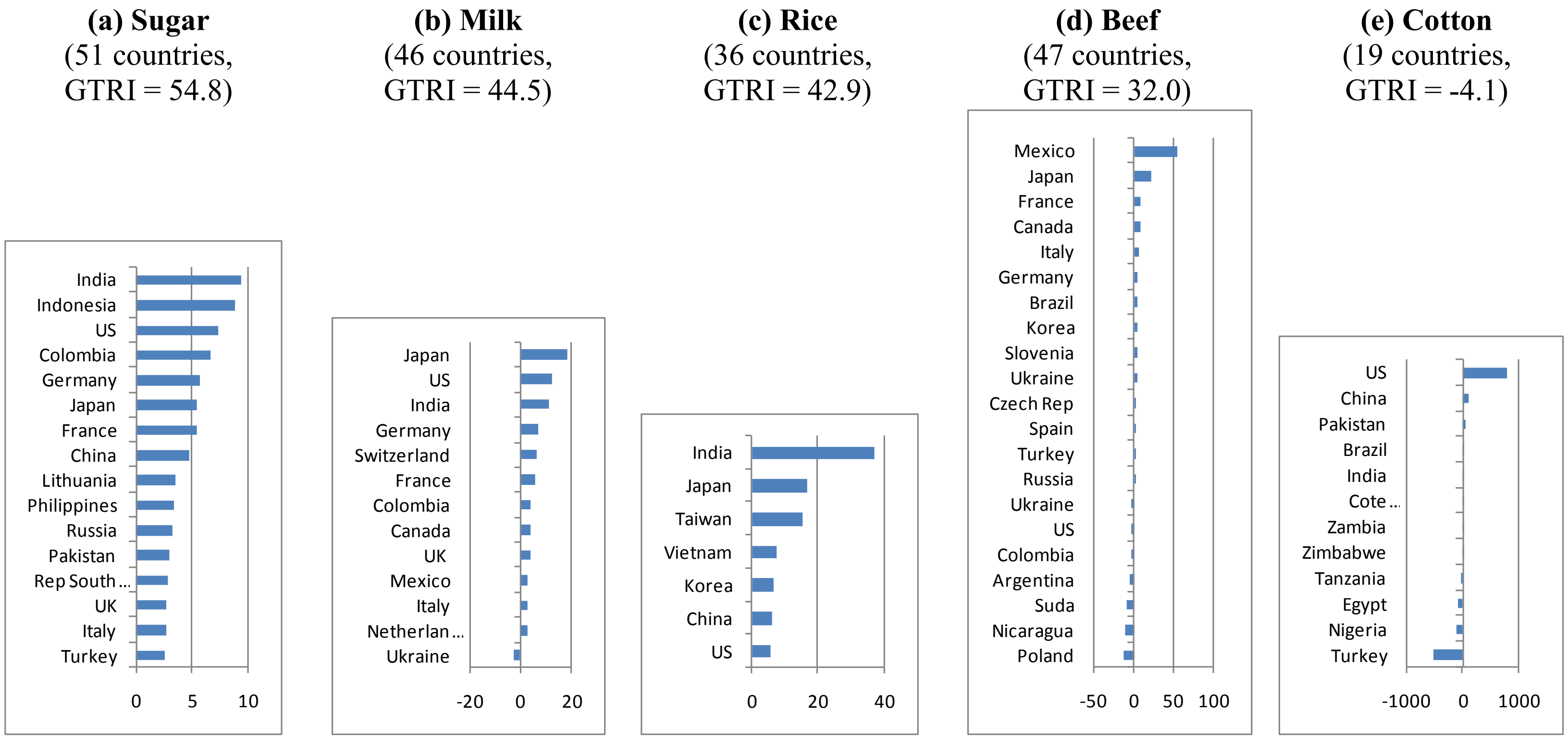

Figure 2. Country Share of the Commodity-Specific GTRI for Rice, Sugar, Beef, Cotton and Milk, 2000–04 (percent)

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

Notes: The decomposition over the 5-year period can be greater than or less than 100, even though the decomposition sums to 100 in any one year. We have scaled the 5-year averages, so that the decompositions sum to 100 percent. Focus countries have been omitted from the above charts if their decomposition share has an absolute value of less than 2 percent.

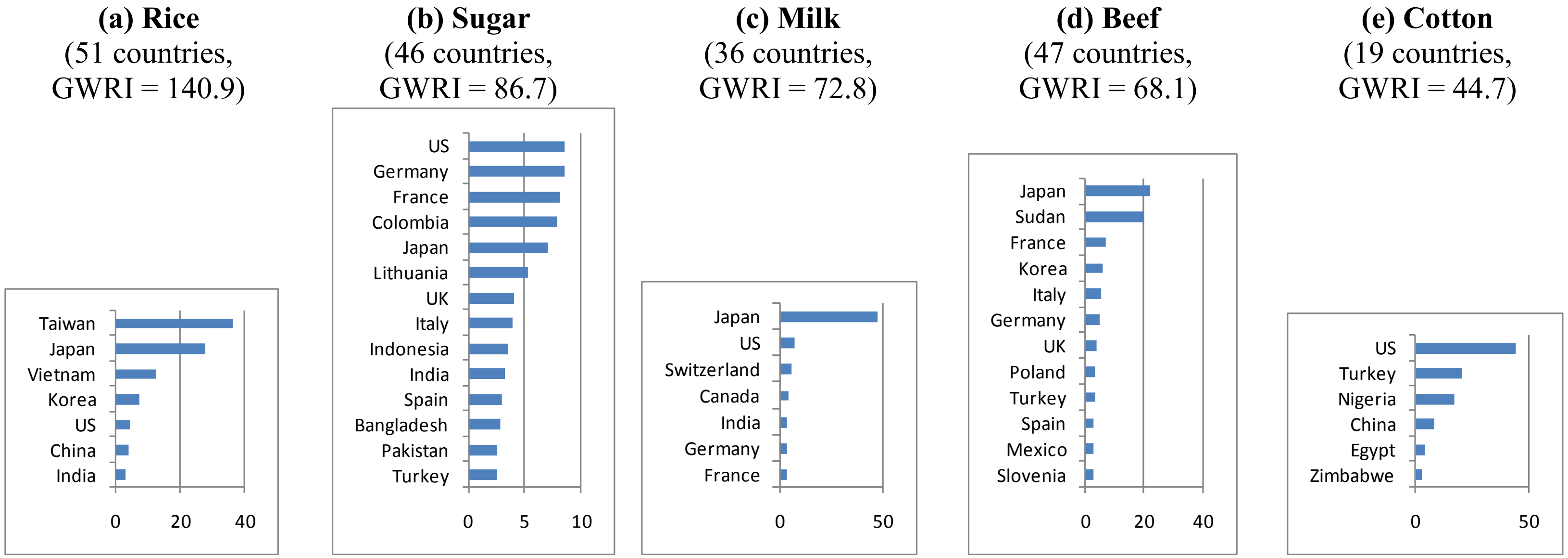

Figure 3. Country Share of the Commodity-Specific GWRI for Rice, Sugar, Milk, Beef and Cotton, 2000–04 (percent)
Source: Authors‘ calculations based on NRA and CTE estimates in Anderson and Valenzuela (2008).
Note: The decomposition over the 5-year period can be greater than or less than 100, even though the decomposition sums to 100 in any one year. We have scaled the 5-year averages, so that the decompositions sum to 100 percent. Focus countries have been omitted from the above charts if their decomposition share has an absolute value of less than 2 percent.

Table 1. Global Trade Reduction Indexes, by Commodity, 1960 to 2004 (percent)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Grains and tubers	**22**	**27**	**19**	**21**	**20**	**35**	**31**	**17**	**17**
Rice	49	50	58	42	41	58	53	32	43
Wheat	13	13	-1	0	9	28	20	11	4
Maize	4	8	4	9	-3	9	10	2	3
Cassava	na	na	23	0	8	15	10	13	10
Barley	36	31	3	-14	-1	36	32	10	4
Sorghum	117	55	65	42	15	24	9	18	6
Millet	67	66	29	1	-14	-31	-114	-32	-22
Oat	15	9	-8	-3	-10	-2	-2	13	9
Oilseeds	**4**	**9**	**6**	**9**	**7**	**17**	**12**	**7**	**5**
Soybean	0	1	0	6	8	11	8	6	6
Groundnut	24	17	49	33	16	38	-12	-7	-10
Palmoil	20	28	12	-5	-11	-1	14	13	-3
Rapeseed	-1	19	9	4	10	39	28	7	12
Sunflower	-8	-5	-10	-2	-12	36	21	15	13
Sesame	48	60	62	65	55	43	41	45	32
Tropical crops	**28**	**45**	**19**	**28**	**30**	**34**	**28**	**24**	**25**
Sugar	83	140	26	40	49	56	44	41	55
Cotton	9	2	13	14	1	13	4	9	-4
Coconut	29	24	8	3	12	21	35	23	9
Coffee	18	30	31	37	46	33	13	12	2
Rubber	30	33	7	19	21	17	14	-4	-3
Tea	35	36	27	26	23	22	23	20	17
Cocoa	27	40	39	53	45	30	26	27	33
Livestock products	**36**	**37**	**34**	**46**	**54**	**49**	**31**	**26**	**24**
Pigmeat	25	35	26	23	47	25	11	9	8
Milk	84	86	82	135	131	125	63	53	45
Beef	22	19	16	16	32	47	32	33	32
Poultry	21	20	27	24	24	27	27	18	18
Egg	-11	-7	-8	10	8	13	11	11	7
Sheepmeat	57	70	96	140	83	68	45	24	20
Wool	0	0	-6	-4	-7	-3	-4	0	0
All of the above 28 commodities	**29**	**32**	**24**	**31**	**34**	**40**	**29**	**21**	**20**

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

Table 2. Components of Global Trade Reduction Indexes, 2000-04 (percent)

	Aggregate GTRI	GTRI, production component	GTRI, consumption component	Aggregate GTRI, exporting countries	Aggregate GTRI, import-competing countries
Grains and tubers	**17**	**14**	**19**	**0**	**40**
Rice	43	42	44	-1	102
Wheat	4	2	7	2	6
Maize	3	-1	7	0	11
Cassava	10	10	9	10	0
Barley	4	3	5	0	28
Sorghum	6	3	9	0	14
Millet	-22	0	-43	-22	0
Oat	9	15	3	7	6
Oilseeds	**5**	**3**	**8**	3	13
Soybean	6	2	10	**2**	**18**
Groundnut	-10	-6	-14	24	-36
Palmoil	-3	0	-7	-1	-13
Rapeseed	12	13	12	0	41
Sunflower	13	15	12	18	3
Sesame	32	39	26	32	0
Tropical crops	**25**	**23**	**28**	1	62
Sugar	55	52	58	**-23**	**74**
Cotton	-4	-7	-1	-1	-14
Coconut	9	8	10	9	0
Coffee	2	0	4	2	0
Rubber	-3	-4	-1	-3	0
Tea	17	12	21	17	0
Cocoa	33	35	31	33	0
Livestock products	**24**	**24**	**24**	-1	41
Pigmeat	8	9	7	**-1**	**18**
Milk	45	48	41	-21	53
Beef	32	29	35	7	45
Poultry	18	16	21	-1	57
Egg	7	5	9	0	16
Sheepmeat	20	19	21	4	33
Wool	0	0	0	0	12
All of the above 28 commodities	**20**	**19**	**21**	0	41

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

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

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Grains and tubers	**44**	**48**	**45**	**51**	**50**	**94**	**87**	**63**	**61**
Rice	66	65	86	75	75	150	152	116	141
Wheat	34	39	30	25	30	59	47	29	20
Maize	29	29	22	28	30	48	29	21	20
Cassava	na	na	23	9	11	16	10	14	10
Barley	52	49	35	41	32	97	87	45	33
Sorghum	137	89	90	76	52	56	54	39	39
Millet	68	66	34	21	32	59	126	73	31
Oat	52	72	63	105	41	67	70	33	31
Oilseeds	**9**	**16**	**16**	**20**	**28**	**37**	**34**	**24**	**24**
Soybean	4	6	10	16	28	31	27	24	25
Groundnut	29	27	52	41	38	50	50	43	43
Palmoil	21	29	36	22	23	26	55	28	15
Rapeseed	21	32	19	9	18	64	48	15	26
Sunflower	15	11	16	25	37	58	40	21	19
Sesame	48	60	62	65	56	44	47	45	38
Tropical crops	**50**	**89**	**45**	**46**	**50**	**61**	**56**	**50**	**55**
Sugar	149	222	54	66	75	100	76	77	87
Cotton	21	46	47	32	29	39	38	34	45
Coconut	29	24	12	14	19	24	38	27	12
Coffee	23	32	35	44	50	38	31	22	15
Rubber	37	39	19	25	25	20	21	26	11
Tea	43	41	32	41	39	36	35	32	30
Cocoa	28	47	42	58	51	38	36	36	38
Livestock products	**74**	**76**	**69**	**84**	**84**	**84**	**66**	**53**	**50**
Pigmeat	50	77	63	56	69	42	33	27	28
Milk	159	158	145	217	182	191	111	83	73
Beef	45	38	36	43	65	93	76	72	68
Poultry	37	34	46	43	48	48	54	46	45
Egg	45	41	31	19	21	39	36	36	26
Sheepmeat	95	129	160	192	123	107	75	41	31
Wool	0	0	6	7	11	7	10	8	6
All of the above 28 commodities	**58**	**62**	**54**	**61**	**62**	**82**	**70**	**54**	**52**

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

Table 4. Components of Global Welfare Reduction Indexes, 2000-04 (percent)

	Aggregate GWRI	GWRI, production component	GWRI, consumption component	Aggregate GWRI, exporting countries	Aggregate GWRI, import-competing countries
Grains and tubers	**61**	**60**	**62**	**16**	**91**
Rice	141	139	142	20	215
Wheat	20	17	22	9	26
Maize	20	20	19	17	26
Cassava	10	10	9	10	0
Barley	33	31	35	10	85
Sorghum	39	39	38	35	30
Millet	31	7	43	31	0
Oat	31	41	14	25	28
Oilseeds	**24**	**28**	**20**	**14**	**44**
Soybean	25	29	19	14	51
Groundnut	43	43	43	32	48
Palmoil	15	10	18	16	13
Rapeseed	26	29	22	2	47
Sunflower	19	21	16	22	8
Sesame	38	41	35	38	0
Tropical crops	**55**	**55**	**55**	**33**	**86**
Sugar	87	87	87	47	95
Cotton	45	45	45	47	24
Coconut	12	12	12	12	0
Coffee	15	15	15	15	0
Rubber	11	13	8	11	0
Tea	30	29	32	30	0
Cocoa	38	39	36	38	0
Livestock products	**50**	**49**	**50**	**15**	**66**
Pigmeat	28	27	28	7	40
Milk	73	76	69	56	75
Beef	68	62	73	19	82
Poultry	45	44	47	13	76
Egg	26	25	27	16	36
Sheepmeat	31	30	31	22	36
Wool	6	8	4	6	22
All of the above 28 commodities	**52**	**51**	**52**	**17**	**72**

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

Table 5: Sensitivity of Estimates of Global Trade and Welfare Reduction Indexes to Price Elasticity Estimates, 8 Major Agricultural Products, 1965 to 2004 (percent)

GTRI, with elasticity estimates from Tyers and Anderson (1992)				
	1965-74	1975-84	1985-94	1995-2004
Rice	44	31	38	27
Wheat	9	6	33	7
Maize	6	4	8	2
Sugar	72	38	38	38
Pigmeat	31	35	18	10
Milk	80	131	94	52
Beef	20	28	49	41
Poultry	24	24	18	6
Average, above products	**31**	**36**	**37**	**22**
GTRI from Table 1, with simplifying elasticity assumption				
	1965-74	1975-84	1985-94	1995-2004
Rice	54	42	56	38
Wheat	6	4	24	7
Maize	6	3	9	2
Sugar	83	44	50	48
Pigmeat	31	35	18	9
Milk	84	133	94	49
Beef	17	24	39	33
Poultry	24	24	27	18
Average, above products	**32**	**38**	**39**	**24**
Difference in 8-product average of GTRI estimates				
Percentage point difference	-1	-2	-3	-2
Percentage difference	-4	-6	-7	-7

GWRI, with elasticity estimates from Tyers and Anderson (1992)				
	1965-74	1975-84	1985-94	1995-2004
Rice	66	59	113	102
Wheat	35	30	64	27
Maize	27	30	40	22
Sugar	125	63	74	69
Pigmeat	71	63	37	30
Milk	148	194	155	86
Beef	41	59	94	77
Poultry	40	46	49	56
Average, above products	**62**	**66**	**80**	**59**
GWRI from Table 3, with simplifying elasticity assumption				
	1965-74	1975-84	1985-94	1995-2004
Rice	76	75	151	128
Wheat	35	28	53	24
Maize	25	29	38	21
Sugar	138	71	88	82
Pigmeat	70	62	38	27
Milk	152	200	151	78
Beef	37	54	85	70
Poultry	40	46	51	46
Average, above products	**63**	**69**	**85**	**59**
Difference in 8-product average of GWTRI estimates				
Percentage point difference	-1	-3	-5	0
Percentage difference	-1	-5	-6	0

Sources: Authors‘ calculations based on NRA and CTE estimates in Anderson and Valenzuela (2008) and elasticity estimates in Tyers and Anderson (1992, Appendix Tables A2 to A4).

Manuscript 3:

Contributions of different policy instruments to trade and welfare effects of price distorting policies

Johanna L Croser

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Contributions of different policy instruments to trade and welfare effects of price distorting policies

Abstract

Agricultural policy analysts are often interested in questions about the relative contribution of different policy instruments to reductions in trade and welfare. Weighted averages across commodities of nominal rates of assistance (NRAs) or consumer tax equivalents (CTEs) are not ideal for answering these questions, especially when some commodities are taxed and others are subsidized in which case positive contributions can offset negative contributions. Further, the welfare effects of border and domestic price distortions are related to the square of the distortions, which is not captured in NRA and CTE aggregates. This paper develops a new set of more-satisfactory scalar index numbers to examine the relative contribution of different policy instruments to trade and welfare reductions, drawing on the recent literature on trade restrictiveness indexes. It exploits the Distortions to Agricultural Incentives database recently compiled by the World Bank to estimate the relative contribution of different policy instruments to the partial-equilibrium trade- and welfare-reducing effect of agricultural policy for 75 developing and high-income countries over the period 1960 to 2004.

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Contributions of different policy instruments to trade and welfare effects of price distorting policies

The relative contribution of different policy instruments to reductions in trade and welfare are of interest to both trade negotiators and agricultural policy analysts. For example, trade negotiations might seek the information to prioritize their negotiating efforts, and policy analysts might use the information as a way of pointing to the inefficiencies in governments' choices of policy measures. The relative contribution of different policy instruments to reductions in trade and welfare has been the subject of particular interest during the Doha round of World Trade organization (WTO) negotiations, especially the relative importance of high-income country agricultural subsidies versus import market access restrictions (Anderson, Martin and Valenzuela 2006).

To compare across policy instruments, economists sometimes calculate weighted averages of the nominal rates of assistance (NRAs) or consumer tax equivalents (CTEs) for various products of different policy instruments. However, aggregates of NRAs and CTEs of different instruments are not able to capture accurately the relative contribution of those different instruments to welfare and trade reductions. This is especially so when some policies (such as import taxes) have negative effects on trade, while other policies (such as export subsidies) have a positive effect on trade. Likewise, if the import-competing and exportables sectors are each subject to trade taxes, aggregate NRAs and CTEs may be close to zero even though both policies are trade- and welfare-reducing. Furthermore, the welfare effect of a policy instrument is related to the square of the individual ad valorem distortion rate, which means aggregates of the NRA (or CTE) fail to capture the fact that widely different interventions across commodities within a policy instrument group have worse welfare effects than if all commodities had similar NRAs or CTEs.

Other studies attempt to measure the relative contributions of different measures to global welfare reduction using CGE models. Two studies use the GTAP model. Dioa, Somwaru and Roe (2001) estimate the short- and long-run welfare gains from agricultural liberalization of 1998 levels of distortions. Their study computes the welfare contribution of three policy instruments and is limited by only having data for domestic support in a handful of high-income countries. Estimates in Hertel and Keeney (2006), also using the GTAP model but with 2001 data, attribute global welfare gains from agricultural liberalization to three types of measures: import tariffs, export subsidies and domestic supports. Rather than being based on historical data, both of these GTAP studies provide estimates of the gains from different policies using simulations of free trade in a particular year. The approach in Anderson, Martin and Valenzuela (2006) is somewhat different. They compute, using a back of the envelope calculation, the historical welfare gains from liberalization of different forms of distortions. The data they use for the calculation is the OECD‘s producer support estimates (PSEs) from 1986 to 2004 (OECD 2004). Because the OECD country set is limited to mostly high-income countries, the authors supplement their findings with the results from agricultural liberalization using the 2001 GTAP database.

The Anderson, Martin and Valenzuela study, whilst the most comprehensive of the three previous studies, still only captures the relative contribution of different policies to global welfare- and trade-reduction for the year 2001, and the methodology offers only an approximation of the relative losses, rather than a more precise theoretical methodology. Most importantly, none of the existing studies consider the role of export taxes, import subsidies and production taxes in reducing global trade and welfare, and new evidence suggests at least export taxes could be a significant part of the story of agricultural distortions prior to the 1990s (Anderson 2009).

This manuscript offers a new approach to the estimation of relative contributions of different policy instruments to welfare and trade reduction. The manuscript makes two contributions over and above existing studies. First, it offers a new methodological approach for estimating the relative contributions of different policy instruments to trade and welfare reductions from agricultural policy. Scalar index numbers developed from the Anderson and Neary (2005) family of trade restrictiveness indexes are estimated for different policy instruments and then compared so as to show their relative contributions. Second, this study applies the methodology to the World Bank‘s new Distortions to Agricultural Incentives dataset (Anderson and Valenzuela 2008) that allows for the estimation of the changing relative contributions over time of a comprehensive set of agricultural policy instruments to national, regional and global trade and welfare losses. The measures include all forms of border measures (import and export taxes and subsidies or the equivalent of non-tariff measures) as well as domestic production and consumption taxes and subsidies and farm input taxes and subsidies.

The indicators estimated in this paper are defined by two descriptors: the instrument trade reduction index (ITRI) and the instrument welfare reduction index (IWRI). The ITRI (or IWRI) is the ad valorem trade tax rate for a particular policy instrument which, if applied uniformly across all tradable agricultural commodities in a country, would generate the same reduction in trade volume (or same economic welfare loss) as the actual cross-product structure of NRAs and CTEs for that instrument in that country. Because the NRAs and CTEs capture the presence of domestic measures that can distort just farmer or consumer incentives (in addition to trade measures that distort both equally), the ITRI and IWRI are computed from sub-indexes that herein are called the instrument producer distortion index (IPDI) and the instrument consumer distortion index (ICDI).

The use of ITRI (or IWRI) for computing the relative contribution of different policy instruments has the advantage of providing a single theoretically sound partial equilibrium indicator of the trade (or welfare) effects of different policy measures that is comparable across time and countries. Because the Anderson and Valenzuela (2008) dataset covers 5 decades (1955 to 2007), the data can indicate trends over time, which a comparative static CGE model can only do if it is calibrated to a series of past years rather than just one particular year.

There are several reasons for working to quantify the relative contribution of different policy instruments to the trade- and welfare-reduction effects of agricultural policy at this time. Since the Uruguay Round, multilateral trade negotiators have been focused on the priorities that should be given to three measures of support: market access, export subsidies and domestic subsidies

(Anderson and Martin 2005). The ease with which agricultural subsidy distortions can be computed for high-income countries — due to the availability the OECD‘s PSE estimates — encouraged a focus on these three measures. Use of this data ignores other types of distortions, however. Furthermore, estimates have not been made for developing countries due to a lack of NRA and CTE data on developing country policy instruments,[42] despite the fact that evidence suggests policies in developing countries are also significantly distortionary (Anderson 2009).

Another reason that this research question is timely is that interest in the degree of global distortion in particular countries is always heightened at times when international prices spike, as happened in 2008. Price spikes can cause changes in the relative contribution of different policies, which is of interest to governments and producer and consumer groups. Unsubsidized exporters in a country, for example, might be keen to know by how much global trade and welfare reduction is mitigated or exacerbated in a product market when prices spike.

The paper is structured as follows: The next section provides the theory for deriving the ITRI and IWRI. The theory is first presented for the import-competing sector of a country and subsequently extended to the exportable sector. This is followed by a description of the World Bank‘s Distortions to Agricultural Incentives database (Anderson and Valenzuela 2008), and the breakdown of the NRA and CTE estimates by instrument. The following section presents and

[42] Some early examples of developing country trade policy distortion datasets include a World Bank study of agricultural distortions to agricultural incentives in 18 developing counties that was published by Krueger, Schiff and Valdes (1988, 1991). That study covered roughly the period 1960–84. Since that time, however, the only studies published were by the International Food Policy Research institute (IFPRI) for key farm products in China, India, Indonesia and Vietnam since 1985 (Orden et al 2007) and the OECD (2009) PSE estimates for Brazil, China and South Africa as well as East European countries.

discusses the estimates of the two indexes by policy instrument. Caveats and sensitivity analysis follows. The final section concludes.

Trade and welfare reduction indexes at the policy instrument level

There is a growing literature that identifies ways to measure the welfare- and trade-reducing effects of international trade policy in scalar index numbers. This literature is traditionally used to overcome aggregation problems across products for a country by using a theoretically sound aggregation procedure that answers precise questions regarding the trade and welfare reductions imposed by each country‘s price and trade-distorting policies. The literature has developed considerably over the past two decades, particularly with advances by Anderson and Neary (summarized and extended beyond their 2005 book) and the partial equilibrium simplifications by Feenstra (1995).

Notwithstanding these advances, there are few series of consistently estimated indexes across countries. A prominent exception is the work of Kee, Nicita and Olarreaga (2008, 2009) who, following the approach of Feenstra, estimate a series for developing and developed countries. However, they provide estimates across commodities for individual countries and only for a snapshot in time (the mid-2000s), and their estimates are based only on import-barriers. Other studies have been country and sector specific, such as an application to Mexican agriculture in the late 1980s (Anderson, Bannister and Neary 1995). All previous work appears to have focused on constructing index numbers of distortions for a single country; and most do not provide them for long time periods, exceptions being Irwin (2010) for U.S. import protection policy and Lloyd, Croser and Anderson (2010) for global agricultural policy (but not disaggregated by instrument).

The Anderson and Neary methodology can be used to construct indexes from different perspectives. One perspective is a global view of individual commodity markets (see manuscript 2), which facilitates the ranking of distortions of different commodity markets in a theoretically meaningful way. One example of the usefulness of this perspective is for unsubsidized agricultural producers of a particular commodity who might be weighing whether to exert effort to get together with similar countries and seek liberalization via trade negotiations.

Another perspective from which to construct Anderson and Neary indexes is individual policy instrument distortions for either a country or a global commodity market. To some extent, constructing policy instrument indexes for a country is recognised in the literature, because the Anderson and Neary methodology was initially applied to import-competing sectors (and initially for import tariffs only), and subsequently extended to exportable sectors, and then to other border and domestic policies. However, the consistent estimation of separate indexes for subsidies and taxes within the import-competing sector of a country, as well as other border measures, and also for domestic subsidies and taxes (on both final goods and inputs) for the purpose of comparison across instruments has not previously been addressed in the literature.

There are several reasons why scalar index numbers are superior measures to compare across instrument groups than aggregates of NRAs and CTEs for different policy instruments. First, to determine the relative contribution of different measures to welfare losses; it is useful to construct indices which have the same sign and therefore readily reveal contributions (summing to 100) of different instruments to country welfare losses. The IWRI, always positive because it is a mean of order two measure (see below), has this desirable attribute. Further, the welfare effects of policies are related to the square of the distortion. The IWRI correctly picks this up. The ITRI correctly assesses the positive and negative impacts on trade volume of different measures, that could be masked in NRA and CTE aggregates. For example, a positive production subsidy in both an import competing and exportable sector have offsetting effects on the volume of trade, but this is not readily observable from NRA data. Finally, the theory of the ITRI and IWRI allows for the differential responses of different products when faced with the same ad valorem rate of policy distortion, because elasticity terms appear in the indices‘ formulae. However, even in the absence of elasticity estimates, where some simplifying assumptions can reduce the complexity of the formulae, the measures are superior.

Indexes for the import-competing sub-sector

The analysis begins with a consideration of scalar indexes for the import-competing sector of a small open economy, in which all markets are competitive. The market for an import good may be distorted by a tariff and/or other non-tariff border measures and/or behind-the-border measures such as domestic producer or consumer taxes or subsidies or quantitative restrictions.

The ITRI, derived in this section, measures the effect of an individual policy instrument in the import-competing sector on a country‘s import volume. The ITRI is the uniform import tariff rate for a particular instrument which, if applied to all commodities in place of the disaggregated policies, would result in the same reduction in the aggregate volume of imports as the actual distortions.

Consider the market for one good, good *i*, which is affected by a combination of measures that distort consumer and producer prices. One type of distorting measure is a border measure (such as an import tariff or import subsidy) which affects producers and consumers of the good. The distorted domestic price in country *j* from a border measure, p_{ij}, is related to the world price, p_i*, by the relation $p_{ij} = p_i^*(1 + t_{ij})$, where t_{ij} is the rate of distortion of the border price in proportional terms. Using this relation, the change in imports in the market for good *i* in country *j* from a border policy instrument, ΔM_{Bij},[43] is given by:

$$\Delta M_{Bij} = p_i^* \Delta x_{ij} - p_i^* \Delta y_{ij}$$

(1) $$= p_i^{*2} dx_{ij} / dp_{ij} t_{ij} - p_i^{*2} dy_{ij} / dp_{ij} t_{ij}$$

where the quantities of good *i* demanded and supplied in country *j*, x_{ij} and y_{ij}, are assumed to be functions of own domestic price alone: $x_{ij} = x_{ij}(p_{ij})$ and

[43] The *B* subscript is used to denote border measures. The border expressions in this section can always be simplified since t_{ij} is the same on the production and consumption sides of the economy. However, throughout the paper production and consumption are kept separate to allow for domestic production or consumption distortions and because the data are available in that form.

$y_{ij} = y_{ij}(p_{ij})$ respectively. The neglect of cross-price effects, among other things, makes the analysis partial equilibrium.

Strictly speaking, this result holds only for small distortions. In reality rates of distortion to agricultural markets are not small. If, however, it is assumed that the demand and supply functions are linear, the reduction in imports is given by equation (1) with dx_{ij} / dp_{ij} and dy_{ij} / dp_{ij} equal to constants. If the functions are not linear, this expression provides an approximation to the loss.

Now consider the same import-competing good to be subject also to domestic distortions to producer and consumer prices. For the producers of the good, the overall distorted domestic producer price in each country, p_{ij}^P, is given by

$p_{ij}^P = p_i^* (1 + (s_{ij} + t_{ij}))$ where s_{ij} is the rate of domestic producer distortion in proportional terms. For the consumers of the good, the distorted domestic consumer price, p_{ij}^C, is given by $p_{ij}^C = p_i^* (1 + (r_{ij} + t_{ij}))$ where r_{ij} is the rate of the domestic consumer distortion in proportional terms. If $r_{ij} = s_{ij} = 0$, then $p_{ij}^C = p_{ij}^P = p_{ij}$. In general, $r_{ij} \neq s_{ij} \neq 0$. An example, with linear demand and supply curves of this situation, is depicted in Figure 1.

With both border and domestic distortions, the change in imports in the market for good i in country j, ΔM_{Tij},[44] is given by:

$$\Delta M_{Tij} = p_i^{*2} dx_{ij} / dp_{ij}^C (t_{ij} + r_{ij}) - p_i^{*2} dy_{ij} / dp_{ij}^P (t_{ij} + s_{ij}) \quad (2)$$

[44] The T subscript is used to denote total (i.e. border plus domestic) measures.

The change in imports from domestic measures alone, ΔM_{Dij},[45] is given by $\Delta M_{Dij} = p_i^* \Delta x_{ij} - p_i^* \Delta y_{ij}$ where Δx_{ij} in this instance is the change in quantity demanded in moving from p_{ij} to p_{ij}^C because of the domestic consumption distortion, r_{ij}, and Δy_{ij} is the change in quantity supplied in moving from p_{ij} to p_{ij}^P because of the domestic production distortion, s_{ij}. This can be written as:[46]

(3) $$\Delta M_{Dij} = p_i^{*2} \cdot dx_{ij} / dp_{ij}^C \cdot r_{ij} - p_i^{*2} \cdot dy_{ij} / dp_{ij}^P \cdot s_{ij}$$

With n import-competing products each subject to different levels of distortions, the aggregate reduction in imports for country j, in the absence of cross-price effects, from border and domestic measures separately can be found by summing equations (1) and (3) across products, respectively:

(4) $$\Delta M_{Bj} = \sum_{i=1}^{n} p_i^{*2} dx_{ij} / dp_{ij} t_{ij} - \sum_{i=1}^{n} p_i^{*2} dy_{ij} / dp_{ij} t_{ij}$$

(5) $$\Delta M_{Dj} = \sum_{i=1}^{n} p_i^{*2} \cdot dx_{ij} / dp_{ij}^C \cdot r_{ij} - \sum_{i=1}^{n} p_i^{*2} \cdot dy_{ij} / dp_{ij}^P \cdot s_{ij}$$

The aggregate reduction in imports from all measures can be found by summing equation (2) across all import-competing products:

(6) $$\Delta M_j = \sum_{i=1}^{n} p_i^{*2} dx_{ij} / dp_{ij}^C (t_{ij} + r_{ij}) - \sum_{i=1}^{n} p_i^{*2} dy_{ij} / dp_{ij}^P (t_{ij} + s_{ij})$$

Setting the result of equations (4) and (5) equal to the reduction in imports from a uniform border measure (B_j) and a uniform domestic measure (D_j) gives:

(7) $$\sum_{i=1}^{n} p_i^{*2} dx_{ij} / dp_{ij} t_{ij} - \sum_{i=1}^{n} p_i^{*2} dy_{ij} / dp_{ij} t_{ij} = \sum_{i=1}^{n} p_i^{*2} dm_{ij} / dp_{ij} B_j$$

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[45] The D subscript is used to a denote domestic measures.
[46] See Appendix F for derivation.

(8) $$\sum_{i=1}^{n} p_i^{*2} \cdot dx_{ij} / dp_{ij}^{C} \cdot r_{ij} - \sum_{i=1}^{n} p_i^{*2} \cdot dy_{ij} / dp_{ij}^{P} \cdot s_{ij} = \sum_{i=1}^{n} p_i^{*2} dm_{ij} / dp_{ij}^{D} D_j$$

where p_{ij}^{D} is the price at the intersection of import demand and export supply where domestic distortions (additional to border distortions) are taken into account.

Solving for B_j and D_j gives an index of average tariff rates across commodities for all border policy instruments and domestic policy instruments, respectively, since what is held constant is the volume of imports at constant prices. For border prices, the scalar indexes are given by:

(9a) $$B_j = \{R_{Bj} a_{Bj} + S_{Bj} b_{Bj}\}, \text{ where}$$

(9b) $$R_{Bj} = \left[\sum_{i=i}^{n} t_{ij} u_{Bij} \right] \text{ with } u_{Bij} = p_i^{*2} dx_{ij} / dp_{ij} / \sum_i p_i^{*2} dx_{ij} / dp_{ij}$$

(9c) $$S_{Bj} = \left[\sum_{i=i}^{n} t_{ij} v_{Bij} \right] \text{ with } v_{Bij} = p_i^{*2} dy_{ij} / dp_{ij} / \sum_i p_i^{*2} dy_{ij} / dp_{ij} \text{ and}$$

(9d) $$a_{Bj} = \sum_i p_i^{*2} dx_{ij} / dp_{ij} / \sum_i p_i^{*2} dm_{ij} / dp_{ij}$$

$$b_{Bj} = -\sum_i p_i^{*2} dy_{ij} / dp_{ij} / \sum_i p_i^{*2} dm_{ij} / dp_{ij}$$

B_j is computed as a weighted average of producer and consumer distortions (equation 9a). R_{Bj} and S_{Bj} are indices of average consumer and producer border distortions, each arithmetic means. Since B_j is an index of border measures, the distortions being aggregated on both the producer and consumer side are t_{ij} values. The weights for each commodity to compute R_{Bj} and S_{Bj}, u_{Bij} and v_{Bij},, are proportional to each country‘s marginal response of domestic production (or consumption) to changes in international trade prices. Each of the weights in (9b) and (9c) can be written as functions of, among other things, the domestic price elasticities at either the protected trade situation, or the free trade situation:

$$(11) \quad u_{Bij} = p_i^* x_{ij} \cdot [\rho_{Bij} /(1+t_{ij})] / \sum_i^n (p_i^* x_{ij}) \cdot [\rho_{Bij} /(1+t_{ij})] \text{ and}$$

$$v_{Bij} = p_i^* y_{ij} \cdot [\sigma_{Bij} /(1+t_{ij})] / \sum_i^n (p_i^* y_{ij}) \cdot [\sigma_{Bij} /(1+t_{ij})]$$

where σ_{Bij} and ρ_{Bij} are elasticities of demand and supply, respectively, at the protected trade situation when border measures are in place.

For domestic policy instruments, the analogous ITRI expressions are given by:

$$(11a) \quad D_j = \{R_{Dj} a_{Dj} + S_{Dj} b_{Dj}\} \text{, where}$$

$$(11b) \quad R_{Dj} = \left[\sum_{i=i}^n r_{ij} \cdot u_{Dij} \right] \text{ with } u_{Dij} = p_i^{*2} dx_{ij} / dp_{ij}^C / \sum_i p_i^{*2} dx_{ij} / dp_{ij}^C$$

$$(11c) \quad S_{Dj} = \left[\sum_{i=i}^n s_{ij} \cdot v_{Dij} \right] \text{ with } v_{Dij} = p_i^{*2} dy_{ij} / dp_{ij}^P / \sum_i p_i^{*2} dy_{ij} / dp_{ij}^P \text{ and}$$

$$(11d) \quad a_{Dj} = \sum_i p_i^{*2} dx_{ij} / dp_{ij}^C / \sum_i p_i^{*2} dm_{ij} / dp_{ij}^D$$

$$b_{Dj} = -\sum_i p_i^{*2} dy_{ij} / dp_{ij}^P / \sum_i p_i^{*2} dm_{ij} / dp_{ij}^D$$

The index D_j gives the reduction in trade associated with a move from border support to border plus domestic support. Analysis of these equations is analogous to that for B_j. The weight u_{Dij} (or v_{Dij}) is proportional to each product‘s response to domestic consumption (or production) to changes in prices from border only distortion to border plus domestic distortion. These weights differ from those in equation (9) because they are computed at different prices. Once again, however, the weights can be written as functions of domestic price elasticities.

Consider now the derivation of the IWRI, which captures the overall effect of an individual policy instrument across many commodities on a economic country's welfare. The derivation follows the same steps as the derivation of the ITRI. It is assumed that a border measure is first implemented, and this may be supplemented by additional domestic protection.[47] The border measure distortion in the market for good *i* in country *j* creates a welfare loss, L_{Bij}. In partial equilibrium terms, this loss is given by the sum of the change in producer plus consumer surplus net of the tariff revenue. The loss of producer and consumer surplus is given by:

$$(12) \qquad L_{Bij} = \frac{1}{2}\left\{ (p_i^* t_{ij})^2 \, dy_{ij} / dp_{ij} - (p_i^* t_{ij})^2 \, dx_{ij} / dp_{ij} \right\}$$

where the demand and the supply for good *i* in country *j* are again functions of own domestic price alone.

Again, this result holds only for small distortions. If, however, it is assumed that the demand and supply functions are linear, the welfare loss is again given by (12) with dx_{ij} / dp_{ij} and dy_{ij} / dp_{ij} equal to constants, in which case welfare losses are defined by the familiar triangular-shaped dead-weight loss areas under the demand and supply curves for the good in a small open

[47] I make this assumption because there is evidence in agricultre that this is what happens in practice. But the assumption does have implications for the estimates of the border and domestic IWRIs. For example, in the simple case presented in Figure 1, the assumption implies that the rectangular areas *bghc* and *dije* are attributed to domestic distortions. The assumption means that the IWRI derived for domestic measures are the upper bound.

economy. On the assumption that the functions are not linear, this expression provides an approximation to the loss.

Equation (12) yields the fundamental result that the loss from a tariff is proportional to the square of the tariff rate. This holds because the tariff rate determines both the price adjustment and the quantity response to this adjustment (Harberger 1959).

With domestic distortions also in place, the welfare loss of producer and consumer surplus is given by:

$$(13) \qquad L_{Tij} = \frac{1}{2}\left\{ (p_i^*(t_{ij}+s_{ij}))^2 dy_{ij}/dp_{ij}^P - (p_i^*(t_{ij}+r_{ij}))^2 dx_{ij}/dp_{ij}^C \right\}$$

Assuming welfare losses from domestic measures are additional losses above those of border measures, the welfare loss from domestic producer and consumer measures is given by the difference between (13) and (12).[48] Algebraically:

$$(14) \qquad L_{Dij} = \frac{1}{2}\left\{ (p_i^*(t_{ij}+s_{ij}))^2 dy_{ij}/dp_{ij}^P - (p_i^* t_{ij})^2 dy_{ij}/dp_{ij} \right\}$$

$$- \frac{1}{2}\left\{ (p_i^*(t_{ij}+r_{ij}))^2 dx_{ij}/dp_{ij}^C - (p_i^* t_{ij})^2 dx_{ij}/dp_{ij} \right\}$$

The aggregate welfare loss for a country from the separate border and domestic measures, in the assumed absence of cross-price effects, can be found by summing equations (12) and (14) across all import-competing products (which gives the left-hand side of equations (15) and (16) below, respectively). Setting the result equal to the welfare loss from a uniform border measure (WB_j), and a uniform domestic measure (WD_j), respectively, gives the following expressions:

[48] In the Figure 1 example, this is the sum of the two quadrangles *bgnc* and *dmje*.

$$(15) \quad \sum_{i=1}^{n}(p_i^* t_{ij})^2 dy_{ij} / dp_{ij} - \sum_{i=1}^{n}(p_i^* t_{ij})^2 dx_{ij} / dp_{ij} = \sum_{i=1}^{n}(p_i^* WB_j)^2 dm_{ij} / dp_{ij}$$

$$(16) \quad \begin{aligned} &\sum_{i=1}^{n}(p_i^*(t_{ij}+s_{ij}))^2 dy_{ij} / dp_{ij}^P - \sum_{i=1}^{n}(p_i^* t_{ij})^2 dy_{ij} / dp_{ij} \\ &-\sum_{i=1}^{n}(p_i^*(t_{ij}+r_{ij}))^2 dx_{ij} / dp_{ij}^C + \sum_{i=1}^{n}(p_i^* t_{ij})^2 dx_{ij} / dp_{ij} \\ &= \sum_{i=1}^{n}(p_i^* WD_i)^2 dm_{ij} / dp_{ij}^D \end{aligned}$$

Solving for the IWRI border measure (WB_j) first gives an expression in a similar form to equation (9):

$$(17) \quad WB_j = \{R'_{Bj} a_{Bj} + S'_{Bj} b_{Bj}\}, \text{ where } R'_{Bj} = \left[\sum_{i=i}^{n} t_{ij}^2 u_{Bij}\right]^{1/2} \text{ and}$$

$$S'_{Bj} = \left[\sum_{i=i}^{n} t_{ij}^2 v_{Bij}\right]^{1/2}$$

and u_{Bij}, v_{Bij}, a_{Bj} and b_{Bj} are as given in equation (9).

WB_j is the uniform tariff that gives the same deadweight loss as that of the actual border distortions in country j. It is an appropriately weighted average of the level of distortions of consumer and producer prices from border measures. It is a mean of order two, which is critically different from the ITRI in equation (9). As with the ITRI, the index is constructed by working with the consumption and production sides of the economy separately, and aggregating the production and consumption indexes in the last step.

The IWRI for domestic measures, WD_j, is given by a more complex expression owing to the need to find the difference in welfare between all measures and border measures. As such the expression has four terms, instead of the usual two:

(18) $$WD_j = \{(R'_{Dj1}a_{Dj1} - R'_{Di2}a_{Dj2}) + (S'_{Dj1}b_{Dj1} - S'_{Dj2}b_{Dj2})\}$$

The individual components of this index are set out in Appendix G, as well as a discussion of several assumptions that can simplify the computation of this index.

Indexes for exportable sub-sector instruments

Each of the ITRI and IWRI measures can be written for exportable products. For an exportable product, a positive price distortion (such as an export subsidy) reduces welfare in the same way as a positive import-competing distortion (such as an import tax), but the positive price distortion for an exportable increases trade whereas a positive import-competing price distortion reduces trade. As such, it is necessary to keep separate track of import-competing and exporting products for the purpose of estimating ITRIs and IWRIs. This is not a problem in the current manuscript because the indexes are estimated separately for import-competing products and exporting products.

The ITRI for border measures for exportable products is the same as that for equation (9) where there are *i* exportable products and R_{BjM} and S_{BjM} are replaced by:

(19) $$R_{BjX} = \left[\sum_{i=i}^{z} - t_{ij}u_{Bij}\right];\ S_{BjX} = \left[\sum_{i=1}^{z} - t_{ij}v_{Bij}\right]$$

As in the previous section, when estimating indexes for exporting products, they are estimated separately for producers and consumers. Producer and consumer distortions are aggregated in the last step. The aggregates in equation (19) are the weighted average levels of distortions to consumer and producer prices for exportable products, respectively, with weights u_{Bij} and v_{Bij} given in equation (9b) and (9c). Importantly, distortions to exportable products enter equation (19) as negative values. This is because whilst a lowering of t_{ij} in the import-competing sector reduces the reduction index, a lowering of t_{ij} in the exporting sector increases it.

The ITRI measure B_j can be regarded as the country j export tax which, if applied uniformly across all products, would give the same reduction in trade as the combination of individual border measures distorting consumer and producer prices in the exporting sector.

The ITRI for domestic measures and the IWRI for border and domestic measures separately can each be adapted to the exportables sector from the import-competing sector expressions in an analogous way. The exporting instrument indexes have the same properties as the indexes for the import-competing instruments. The detail is reported in Appendix H.

In the empirical section of the paper below, ITRIs and IWRIs can be reported not only at the level of the 4 sub-indexes developed above, D_j, B_j, WD_j and WB_j, but they can also be reported individually for positive or negative distortionary measures. This means, for example, that separate indexes can be reported for the trade- and welfare-reducing effects of import taxes, import subsidies, export taxes, export subsidies, and domestic producer and consumer taxes and subsidies on outputs or inputs.

IWRIs and ITRIs can be aggregated across countries using as weights an average of each country‘s value of consumption and production at undistorted prices. In this manuscript, because the focus is on the relative contribution of different instruments to reductions in trade and welfare, each ITRI and IWRI index on the production (consumption) side of a country's economy is converted to a constant dollar value of production (or consumption) index by multiplying the ad valorem index by the value of production (or consumption) at undistorted prices for that instrument group. The dollar values are divided by the country's overall value of production (or consumption) of all covered tradables to recover what can be considered as a decomposition of an overall country-level TRI or WRI. Indexes for 5-year periods are unweighted averages of the annual indexes.

Simplifying assumptions to estimate the indices

In equation (11) it is shown that the weights for the ITRI and IWRI can be written as functions of, among other things, the domestic price elasticities at either the protected trade situation, or the free trade situation. In the absence of estimates of domestic demand and supply elasticities, a simplifying assumption can be made that the domestic price elasticities of supply are equal across products for a particular country, and likewise domestic price elasticities of demand are equal across products for a particular country. In this case, the elasticities in the numerator and denominator of equation (11) cancel. R_{Bj} (or S_{Bj}) can therefore be found by aggregating the change in consumer (or producer) prices across commodities, using as weights shares of each commodity's domestic value of consumption (or production) at undistorted prices. The plausibility and implications of these assumptions are discussed in Appendix A of this thesis, where it is shown that the assumptions should have only a small effect on the overall estimates.

A further necessary step in estimating B_j in equation (9a) requires an assumption about the weights a_{Bj} and b_{Bj}. The weight a_{Bj} (or b_{Bj}) is proportional to the ratio of the marginal response of domestic demand (or supply) to a price change from border distortions relative to the marginal response of imports to the same price change. If one is willing to assume that the marginal responses of supply and demand to a price change are the same in aggregate, then a=b=0.5.[49]

From a practical point of view, B_j can be computed with all the information available for calculating NRAs and CTEs (or the PSEs and CSEs generated by the OECD), provided two assumptions are made: (1) equal domestic price elasticities of supply across products within a country (and the same for domestic price elasticities of demand); and (2) equal responsiveness of aggregate supply and demand for the set of products of concern for an economy to price changes. Ideally policy analysts would incorporate elasticity estimates and information on responsiveness of aggregate supply and demand where available, but where they are not available, estimates of the indices B_j, R_{Bj} and S_{Bj} are nonetheless superior to existing widely-used agricultural policy measures of trade distortions. Analogous assumptions can be made for the domestic measures derived in this manuscript. The assumptions required for the IWRI for domestic measures alone are detailed in Appendix I.

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[49] With linear demand and supply curves for a country's economy, this equates to an assumption that the aggregate demand and supply curves have the same slope, so that each side of the economy contributes 50 percent to the ITRI.

The Distortions to Agricultural Incentives database

A new database (Anderson and Valenzuela 2008), generated by the World Bank's Distortions to Agricultural Incentives research project using a methodology summarized in Anderson et al. (2008), provides a timely opportunity to estimate indexes of the welfare- and trade-reducing effects of different policy instruments. The database includes estimates of different agricultural policy instruments for 75 countries that together account for over 90 percent of the world's population, farmers, agricultural GDP and total GDP. The estimates in the database are consistent estimates of annual nominal rates of assistance (NRAs) and consumer tax equivalents (CTEs) over a time period between 1955 and 2007. The country coverage is most complete for the years 1960 to 2004 so only that period is reported in this manuscript. The series contains data at the commodity level, for a subset of agricultural products (called covered products) that account for around 70 percent of total agricultural production in each of the 75 countries.

The range of measures included in the Distortions to Agricultural Incentives database NRA and CTE estimates is wide. By calculating domestic-to-border price ratios, the overall estimates include the price effects of all tariff and non-tariff trade measures (positive or negative), plus any domestic price support measures (positive or negative), plus an adjustment for the output-price equivalent of direct interventions in farm input markets. Where multiple exchange rates operate, an estimate of the import or export tax equivalents of that distortion are included as well. The database is especially well suited to the analysis in this paper because it separately identifies each of the price effects of the different policy instruments referred to above.

The range of measures included in the CTE estimates include both domestic consumer taxes/subsidies plus trade and exchange rate policies, all of which drive a wedge between the price that consumers pay for each commodity and the international price at the border. The large range of consistent estimates makes computation of the welfare- and trade-reducing effects of different agricultural policy instruments possible. ITRIs and IWRIs can be computed for the following different instruments: import taxes and subsidies, export taxes and subsidies, domestic production taxes and subsidies, domestic consumption taxes and subsidies, and production input subsidies.

Table 1 shows the number of occurrences of each of these instruments in the Distortions to Agricultural Incentives database. For the world as a whole, over the period studied, import taxes account for around 30 percent of all measures, although, there is nearly double the number of import tax observations in high-income (6441 observations) verses developing countries (3195 observations). Export taxes are significant in developing countries, accounting for just under 30 percent of the observations in that region. Among the domestic support measures, consumption and production subsidies feature prominently in high-income countries. Input subsidies are 12 percent of observations in developing countries.

The most aggregated summaries of NRA and CTE estimates for covered products for developing and high income countries are provided in Figures 2 and 3. Figure 2 supports the widely held views that developing country governments had in place agricultural policies that effectively taxed their farmers through to the 1980s, and that the extent of those disincentives has lessened since then. The extent of taxation was of the order of 15+ percent from the early 1960s to the mid-1980s. Since then it has not only diminished but, on average, has become slightly positive. Figure 2 also supports the view that the growth of agricultural protection in high-income countries has been going on since the 1960s, and began to reverse only in the latter 1980s. It is clear from Figure 3 that consumers have experienced changes similar to producers in recent years. In developing countries, taxation was negative (i.e. consumer subsidization was positive) for most of the last 50 years. This has lessened since the 1990s. In high-income countries, the implicit taxation of consumers from agricultural support rose until the late 1980s but has fallen since then.

Figures 4 and 5 show the trends in NRAs and CTEs, respectively, for the four studied regions of Africa, Asia, Latin America and Europe‘s transition economies. On the production side, Africa is where there has been least tendency to reduce the taxing of farmers and subsidizing of consumers of farm products. Indeed its average NRA has been negative in all 5-year periods except in the mid-1980s when international prices of farm products reached an all-time low in real terms. By contrast, for both Asia and Latin America their NRAs crossed over from negative to positive after the 1980s. And in Europe‘s transition economies, the nominal assistance to farmers has trended upward following their initial shock in the early 1990s. For consumers in all four regions, agricultural policies have almost always involved consumer subsidization. Since the 1980s, however, food consumer subsidization in Asia, Latin America and Europe‘s transition economies has gradually disappeared and is now replaced by a small degree of taxation.

Within the farm sector of all regions, the assistance to the import-competing sub-sector is typically well above that for the export sector (Tables 2 and 3), meaning there is an anti-trade bias in the structure of distortions. In the case of developing countries where the former NRA is positive and the latter negative, the two tend to offset each other such that the overall sectoral NRA is close to zero. Such a sectoral average can thus be misleading as an indication of the extent of distortion within the sector. It can also be misleading when compared across countries that have varying degrees of dispersion in their NRAs for different farm industries.

Of most relevance for this paper is the instrument level NRA data. Table 4 shows the contributions of different policy measures in the Distortions to Agricultural Incentives database to the overall estimated NRAs for the two periods 1981-84 and 2000-04. These indicators are based on aggregations of NRAs and CTEs. Trade measures always account for the largest share of the total NRA for both developing and high-income countries. This is even more pronounced in the distortion to consumer prices of food, since direct domestic consumer subsidies (or taxes), as distinct from the indirect ones provided by border measures, are relatively rare (Table 5). The dominance of trade measures in both CTEs and NRAs reflects the fact that the two price distortion indicators are highly correlated. For all focus countries, covered products and available years in the panel set, the coefficient of correlation between NRAs and CTEs is 0.93.

The tables of the decomposition of the NRAs and CTEs do not tell us about the welfare- and trade-reducing effects of the different policies, however. Furthermore, they do not readily reveal the relative contributions of different instruments to the overall NRA because there are offsetting positive and negative NRAs for different instruments. Consider domestic production supports to all countries in 1981–84, for example. Dividing by the overall NRA for that period gives a relative contribution of one eighth. This hides significant information; however, as the 1 percent domestic support is comprised of several components, including an offsetting production tax component. As such, one needs to be careful when interpreting figures which are derived from aggregations of price distortions. By contrast, a decomposition of welfare- and trade-reducing effects of agricultural policies, which uses a theoretically sound aggregation procedure to answer precise questions regarding the welfare and trade distortions imposed by each country‘s price and trade policies is a more satisfactory indicator.

Table 4 indicates that the Distortions to Agricultural Incentives database also includes measures of decoupled support and other non-product specific assistance. These measures account for one third of the aggregate NRA of all focus countries in 2000–04, and more than a quarter in high-income countries. Because decoupled payments and non-product specific supports are not reported at the product level in the database, they are not captured in the ITRI and IWRI estimates. However, they are clearly important for the overall story of agricultural policy — especially in high-income countries where there has been a move to forms of support decoupled from production in recent decades. An attempt is made to gauge the potential importance of these measures using a methodology outlined later in this paper.

Estimates of the instrument indexes

In keeping with the main objective of this paper, the results from estimation of ITRIs and IWRIs are reported in Tables 6 and 7 in terms of their relative contributions to an overall weighted TRI or WRI for the main regions in the Distortions to Agricultural Incentives database. In terms of the ITRI: the first thing to notice is that border measures dominate in terms of the trade-reducing effect of agricultural policies in all regions being studied (Table 6 and Figure 6a). This dominance comes from the dominance of border measures in the NRA/CTE estimates, as well as the fact that there are fewer domestic measures than border measures (Table 1), which means domestic measures get a lower weighting when aggregating the indexes for different instruments.

Within border measures, import taxes are the most significant reducer of global trade, followed by export taxes — which were especially prominent in developing countries through to the 1980s (Figure 7a). The other two categories of border measures (export and import subsidies) expand trade, but the TRI estimates for these instruments are at such low levels that they have little offsetting impact on the trade-reducing effects of the trade taxing border measures.

The breakdown of border measures into high-income countries and developing countries groups indicates the different sources of trade-reducing policy in those two regions (Figure 7). For developing countries, export taxes constitute the main trade-reducing policy, and they have fallen dramatically since the late 1980s, reducing the overall TRI in developing countries by more than half. By contrast, in high-income countries, import taxes have the greatest trade-reducing effect, dominating trade reduction in that region.

Comparing the ITRI results to those reported in Table 4 (contributions to the aggregate NRA for different policy instruments) highlights the usefulness of the TRI approach. First, the ITRI estimates answer a precise question about what happens to trade volumes when distortions are in place. In line with this, the ITRI correctly aggregates measures that expand trade, and those that reduce trade. Whereas in the NRA aggregates, the two most distorting policies (import taxes and export taxes) offset one another, here they compound one another demonstrating how much trade volume has been suppressed by agricultural policy over the past 5 decades.

Relative contributions to the aggregate IWRI are reported in Table 7 and Figure 8 for all focus countries. Once again, for the world as a whole, border measures dominate in all time periods, accounting for between 86 (1965-69) and 96 percent (1980-84) of welfare losses (Figure 8b and 8a). Import taxes contribute most to reductions in global welfare, followed by export taxes (Figure 8c). This is driven by the dominance of import taxes in high-income countries (Figure 9a), and the dominance of export taxes in developing countries (Figure 10a). Within developing countries, welfare losses from export taxes were significant in all regions in the early 1980s, but have been reduced in all regions since that time (Table 7). Export taxes are still the largest share in only one region in 2000–04: Africa, where they contribute twice the welfare loss of import taxes.

A comparison of the results in Table 7 to those in Table 4 for NRA aggregates reveals the usefulness of the IWRI method. Take import taxes in

2000–04, for example: they account for slightly more than 100 percent of border measure NRAs and CTEs globally (Table 4), but according to the IWRI, those taxes account for around only two thirds of global welfare losses from all border measures (Table 7). This is a more meaningful concept when trying to gauge the importance of different policy instruments in the context of trade negotiations or understanding historical patterns of agricultural protection and disprotection.

Figure 8c shows that since the aggregated border measure IWRI peaked for the world in 1985–89, it has nearly halved to just over 30 percent in 2000–04. Table 8 reports the relative contributions of each of the four border measures to this overall reduction for each of the studied regions and globally. Import and export taxes contribute just over and a little under half of the overall reduction, respectively. For developing countries, however, the fall was driven overwhelmingly by falls in export taxes — which account for 86 percent of the reduction. This dramatic result receives no comment in the previous studies cited at the start of this paper, not only because they include no time series but also because they ignore export taxes (as well as production taxes and import subsidies. Dioa, Somwaru and Roe (2001, p 37) find 89 percent of the costs of agricultural policy come from import tariff market access, 10 percent for domestic support and 1 percent for export subsidies. Estimates reported in Anderson and Martin (2005), drawing on results in Hertel and Keeney (2006), suggest 93 percent of the global cost of agricultural tariff protection and subsidies is due to tariffs and the costs of domestic support measures are around 5 percent. Anderson, Martin and Valenzuela (2006) use a back of the envelope calculation to compute the welfare cost of different agricultural distortions. They find 86 percent of the welfare cost of agricultural distortions was due to tariffs and only 6 percent to domestic farm subsidies. This paper therefore makes a significant contribution to the understanding of agricultural distortions story, because it tells us that historically import tariffs are only half the story.

Finally, the results in this study, unlike previous studies, allow one to look at the time series of what happened to the relative restrictiveness of policy. This has already been discussed above in terms of 5-year averages, but annual time series also provide interesting insights. Figure 11 indicates what happens to the relative contributions of different policies when international prices for farm products spike up or down. Insulation of domestic markets from such shocks, by varying border trade restrictions, is a common practice in both developing and high-income countries. The net effect is clear in Figure 11: when international prices spike up, as in 1973–74, the contribution of import tariffs falls dramatically but the contribution of export taxes rises, and conversely when international prices collapse, as in 1986. These changes in the contribution to welfare are important because they have distributional consequences in national and regional economies. They can help to explain why certain interest groups might behave in certain ways.

Caveats and sensitivity analysis

In this section, a number of important caveats on the results are reported along with the results of sensitivity analysis in an attempt to gauge the importance of some of those caveats. Perhaps the most important caveat for the results of this paper is that the differential response of different products to distortions is not captured because the indexes have been computed with simplifying assumptions about elasticities. In particular, for lack of a comprehensive set of country- and commodity-specific own price elasticity estimates, it is assumed that the own-price elasticity of supply (and also of demand) within a country is the same for each farm product. It is not clear what overall effect this will have on the ITRI and IWRI estimates, because the cross-product structure of elasticities will mean some products have a more pronounced effect on trade-volume or welfare than is captured in the main reported series, and others a less pronounced effect. However, there are good reasons for assuming that the effect on the estimated indexes overall will be very small. These reasons are outlined in Appendix A.

Another assumption that places a caveat on the results in this paper is that cross-price effects are zero. The algebra in this paper becomes more complex once this simplifying assumption is dropped, in which case a formal multi-commodity modelling framework is more appropriate than the current methodology.

A further assumption is that in the aggregation of country producer and consumer distortion indexes, the aggregate marginal response of domestic demand to a price change is the same as the aggregate marginal response of domestic supply. Sensitivity analysis was undertaken with respect to this assumption by altering the weights on consumption and production (the a and b terms, respectively) as they enter the ITRI and IWRI formulae. The estimates for border ITRI and IWRI were almost unchanged at the aggregate level for all countries. This is not surprising given the high correlation between the IPDI and ICDI (and equivalents for the ITRI) for policy distortions.

Another caveat on the results for the ITRI and IWRI is that they do not include forms of support that are not given at the product level. In the Anderson and Valenzuela (2008) database, however, non-product-specific (NPS) assistance can be a significant component of overall agricultural sector distortions (Table 4). In the database, NPS is reported in three forms: general non-product-specific assistance, input subsidies for high-income countries (which are not attributed at the product level in the database) and decoupled payments. Recalling that the ITRI (or IWRI) is defined as the ad valorem trade tax rate, which, if applied uniformly across all tradable agricultural commodities in a country would generate the same reduction in trade (or economic welfare loss) as the actual cross-product structure of NRAs and CTEs for that country, it is possible to make a simple assumption to incorporate NPS measures. If one assumes 100 percent pass-through of NPS distortions to producer prices, the upper bound of the contribution of NPS support can be derived.[50] In reality, there might only be a 20 percent pass-through, which is why the estimate of the contribution of decoupled payments to the trade and welfare reducing effects of these payments is an upper bound.

The estimate for each of the three non-product specific types of support is added to the overall IPDI estimate in Table 9. The importance of NPS support in offsetting some of the reduction in the global IPDI is readily seen in Figure 12. This is almost entirely due to NPS assistance in high-income countries

[50] So for example, if the NRA of all border measures is 30 percent, and the country also gives farmers decoupled payment support of 20 perent (which has the effect of expanding trade on the producer side and further reducing welfare on the producer side) it is incorporated by assuming an overall country NRA of 50 percent. The 20 percent decoupled payment support is converted to an IWRI in the usual way, where the variance of the instrument distortion across products is zero.

(Figure 12c): at the same time as import taxes were being reduced, decoupled and other NPS support was increasing in this region. However, NPS support was not sufficient to offset entirely the downward trend in the IPDI since 1985–89. The share of decoupled payments support in the PDI is smaller than its corresponding share in the NRA aggregates because as noted earlier, the decoupled payment supports have zero variance across commodities.

This approximate approach to incorporating the welfare effects of NPS assistance indicates that the main estimates in this manuscript fail to capture some important policy distortions, especially in high-income countries. To better capture the welfare effects of these measures further research is needed. Serra, Zilberman, Goodwin and Featherstone (2006) find, for example, that decoupled payments affect input use and output mean and variance — which have potential welfare effects that are not captured in this simple analysis.

A final consideration in this section is the effect of possible inaccuracies in the estimates of policy instruments in the Distortions to Agricultural Incentives database. For example, Robinson, Govereh and Ndlela (2009) and Ndlela and Robinson (2009) note that when computing NRA and CTE estimates for the countries Zambia and Zimbabwe, respectively, their assumptions might overstate the extent of export taxes or import subsidies. This issue is potentially important in this paper given that one of the key results is the spectacular contribution of a fall in export measure distortions to a fall in global welfare losses from agricultural policy since 1985–89. However, the key result of the manuscript is not being driven by Africa (Table 8), which improves confidence in the results.

Conclusions

This paper contributes to the theoretical and empirical literature on trade and welfare reduction indexes. On the theory side, it develops a method of calculating trade and welfare reduction indexes for individual policy instruments from estimates of the rates of distortions of producer and consumer prices. The main contribution is to show that using the same data as existing indicators — provided one is willing to make simplifying assumptions about price elasticities — superior measures of the relative contribution of different policies to global reductions in trade and welfare can be computed.

Empirically, the paper‘s main contribution is to apply the methodology to generate a time series of indexes for agricultural products that are well-grounded in trade theory and answer precise questions about the trade- and welfare-reducing effects of different policy instruments. These indexes are generated for 75 developed and developing countries over the past half century. They are useful for monitoring national policy developments, making cross-country comparisons, and as input in trade negotiations.

The most significant result empirically is the importance of export taxes pre-1990s and their contribution to the fall in the global trade- and welfare-restrictiveness of agricultural policies over the past two decades. Previous studies measuring the relative contributions of different policy instruments to global welfare reduction ignore export taxes (and import subsidies and production taxes) altogether. They have found that import taxes contribute as much as 85 percent of the reduction to global farm trade and 90 percent of the reduction in global welfare. By contrast, this manuscript finds that export taxes played a significant role in the aggregate reduction of global trade and welfare, contributing as much as one-third in some time periods. It is likely they will continue to do so when international food prices rise — as indeed happened in 2008. The manuscript also finds that export taxes contributed significantly to the almost halving of the global WRI (for border measures) from its peak in 1985–89 to 2000–04. Globally import and export taxes each contributed roughly half to the decline in the IWRI (for border measures). For developing countries, the fall is driven overwhelmingly by falls in export taxes, which account for 86 percent of the reduction. For the most recent period reported above (2000–04), import taxes are the most dominant instrument reducing global trade and welfare, which reinforced the conclusions of earlier studies that import market access is the most important of the ‗pillars' being negotiated in the agricultural part of the WTO's Doha Development Agenda. But the widespread re-emergence of food export taxes in 2008 is a reminder that those measures too need to be disciplined by the WTO if it is to fulfil its welfare-enhancing role of reducing uncertainty in international trade — hence the importance of including such instruments in the estimation of TRIs and WRIs

References

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

Anderson, J.E., G. Bannister and J.P. Neary (1995), ―Domestic Distortions and International Trade", *International Economic Review* 36(1): 139–57.

Anderson, K. (2009), ‗Five Decades of Distortions to Agricultural Incentives', Ch 1 in Anderson, K. (ed.) *Distortions to Agricultural Incentives: A Global Perspective, 1955–2007*, London: Palgrave Macmillan and Washington DC: World Bank.

Anderson, K., J. Croser, D. Sandri and E. Valenzuela (2010) ―Agricultural Distortion Patterns since the 1950s: What Needs Explaining?", Ch. 2 in *The Political Economy of Agricultural Price Distortions*, K. Anderson (ed.), Cambridge and New York: Cambridge University Press.

Anderson, K. and W. Martin (2005), ‗Agricultural Trade Reform and the Doha Development Agenda', *The World Economy* 28(9): 1301–1327.

Anderson, K., W. Martin and E. Valenzuela (2006), ‗The Relative Importance of Global Agricultural Subsidies and Market Access', *World Trade Review* 5(3): 357–376.

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

Diao, X, A. Somwaru and T. Roe (2001). ‗A Global Analysis of Agricultural Policy Reform in WTO Member Countries' in M. Burfisher et al., ‗Agricultural Policy Reform in the WTO: The Road Ahead', Agricultural Economics Report No. 802, Economic Research Services, united States Department of Agriculture, Washington, DC.

Feenstra, R.C. (1995), ―Estimating the Effects of Trade Policy", in *Handbook of International Economics*, vol. 3, edited by G.N. Grossman and K. Rogoff, Amsterdam: Elsevier.

Harberger, A.C. (1959), ―Using the Resources at Hand More Effectively", *American Economic Review* 49(2): 134-46, May.

Hertel, T. W. and R. Keeney (2006), ‗What's at Stake: The Relative Importance of Import Barriers, Export Subsidies and Domestic Support', Ch 2 in K. Anderson and W. Martin (eds.), *Agriculture Trade Reform and the Doha Development Agenda*, London: Pelgrave Macmillian and Washington DC, World Bank.

Kee, H.L., A. Nicita and M. Olearraga (2008), ―Import Demand Elasticities and Trade Distortions", *Review of Economics and Statistics* 90(4): 666-82, November.

Kee, H.L., A. Nicita and M. Olearraga (2009), ―Estimating Trade Restrictiveness Indexes", *Economic Journal* 119(534): 172-99, January.

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

Ndlela, D. and P. Robinson (2009), Zambia, Ch 6 in Anderson, K. and W. Masters (eds.), *Distortions to Agricultural Incentives in Africa*, Washington DC: World Bank.

OECD (2004), *Agricultural Policies in OECD Countries: Monitoring and Evaluation*, Paris: OECD.

OECD (2009), *Agricultural Policies in Emerging Economies: Monitoring and Evaluation 2009*, Paris: OECD.

Orden, D., E. Cheng, H. Ngygen, U. Grote, M. Thomas, R. Mullen and D. Sun (2007), *Agricultural Producer Support Estimates for Developing Countries, Measurement Issues and Evidence from India, Indonesia, China and Vietnam*, Research Report 152, Washington DC: IFPRI.

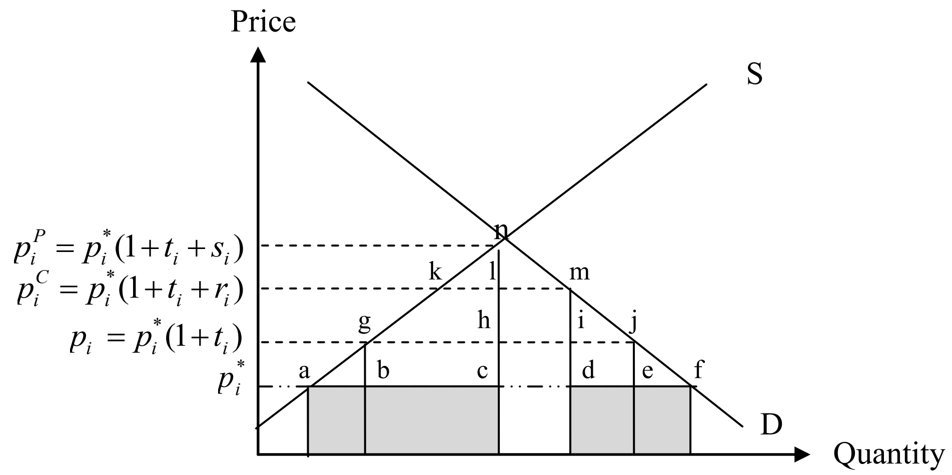
Robinson, P. J. Govereh and D. Ndlela (2009), Zimbabwe, Ch 7 in Anderson, K. and W. Masters (eds.), *Distortions to Agricultural Incentives in Africa*, Washington DC: World Bank.

Serra, T., D. Zilberman, B.K. Goodwin and A. Featherstone (2006) ―Effects of Decoupling on the Mean and Variability of Output", *European Review of Agricultural Economics* 33(3): 269-288.

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

Figures and Tables

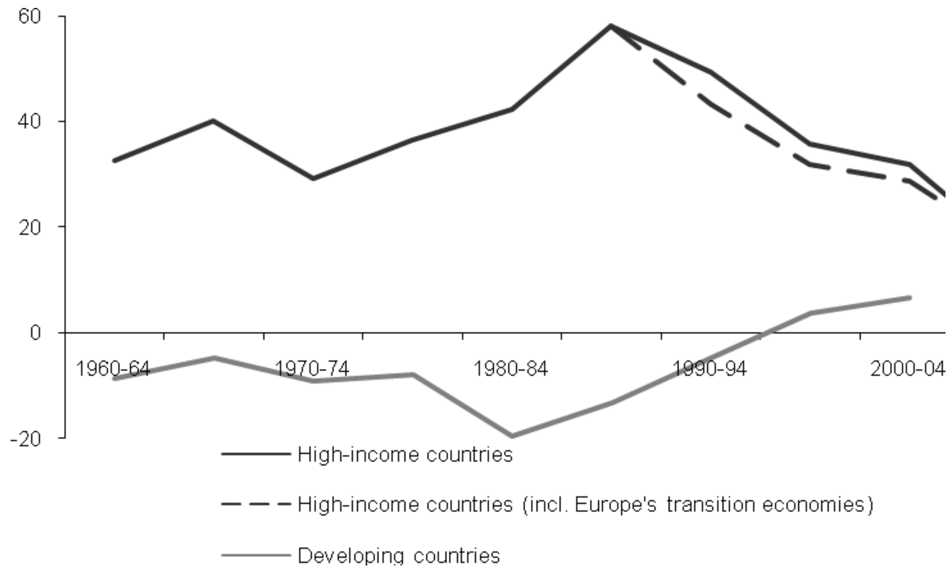
Figure 1: Representation of the import-competing agricultural sector of a small open economy with a border tax and a domestic consumer tax and a domestic producer subsidy



Source: Author's depiction.

Figure 2: Nominal rates of assistance to farmers in high-income and developing countries, all covered farm products, 1960 to 2007

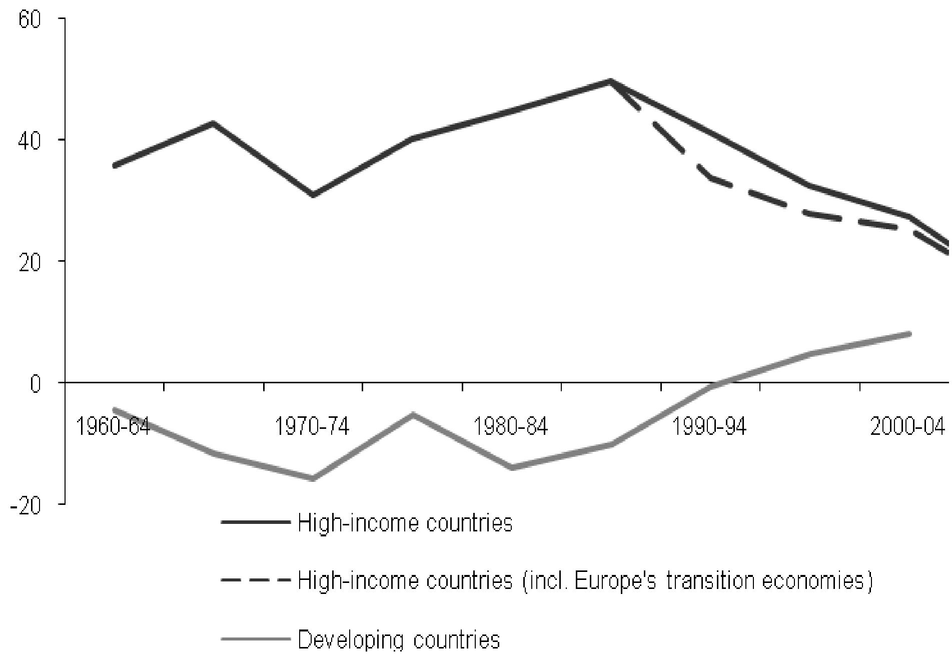
(percent, averaged using weights based on the gross value of agricultural production at undistorted prices)



Source: Anderson and Valenzuela (2008)

Figure 3: Consumer tax equivalents in high-income and developing countries, all covered farm products, 1960 to 2007

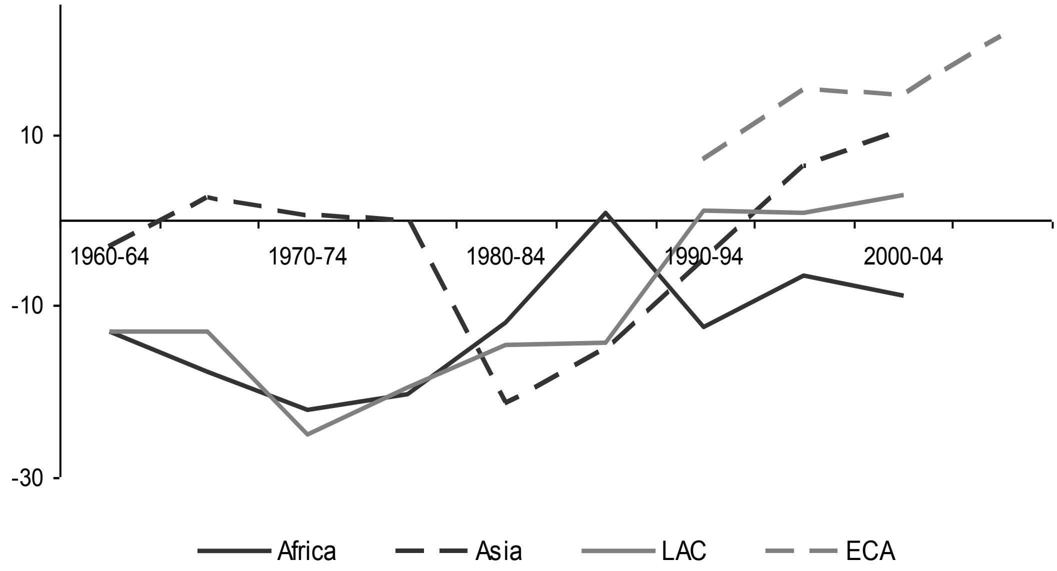
(percent, averaged using weights based on the value of agricultural consumption at undistorted prices)



Source: Anderson and Valenzuela (2008)

Figure 4: Nominal rates of assistance to farmers in developing countries of Africa, Asia, Latin America and in Europe‘s transition economies (ECA), all covered farm products, 1960 to 2007

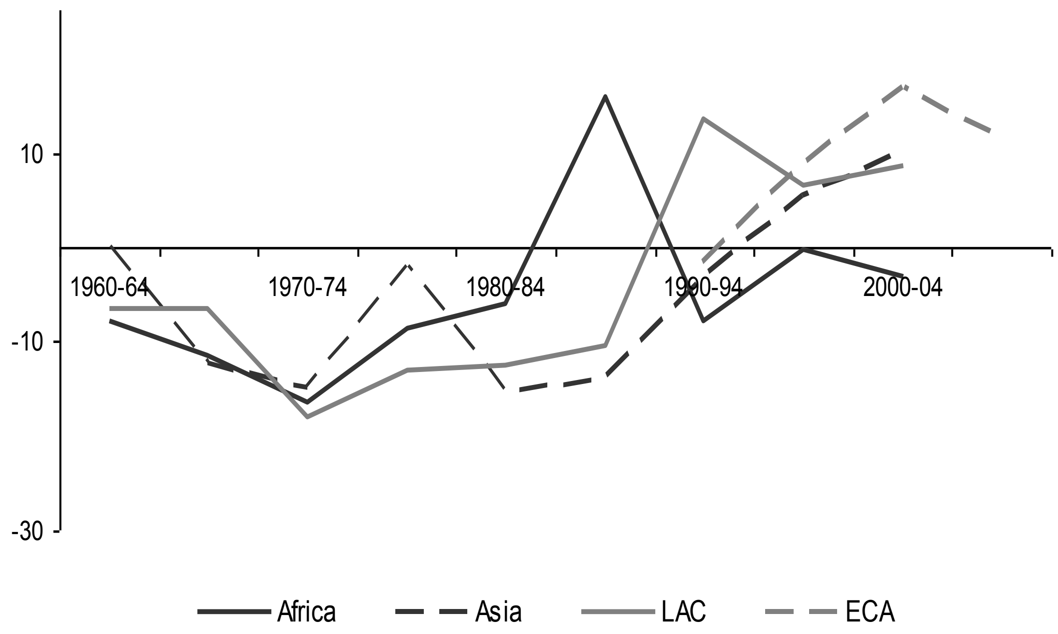
(percent, averaged using weights based on the gross value of agricultural production at undistorted prices)



Source: Anderson and Valenzuela (2008)

Figure 5: Consumer tax equivalents affecting covered farm products in developing countries of Africa, Asia, Latin America and in Europe's transition economies (ECA), 1960 to 2007

(percent, averaged using weights based on the gross value of agricultural consumption at undistorted prices)

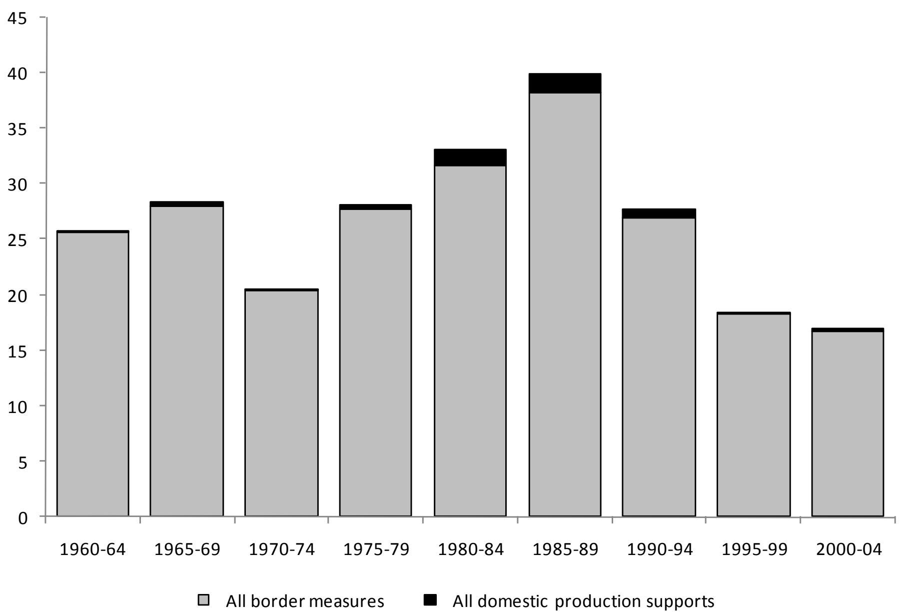


Source: Anderson and Valenzuela (2008)

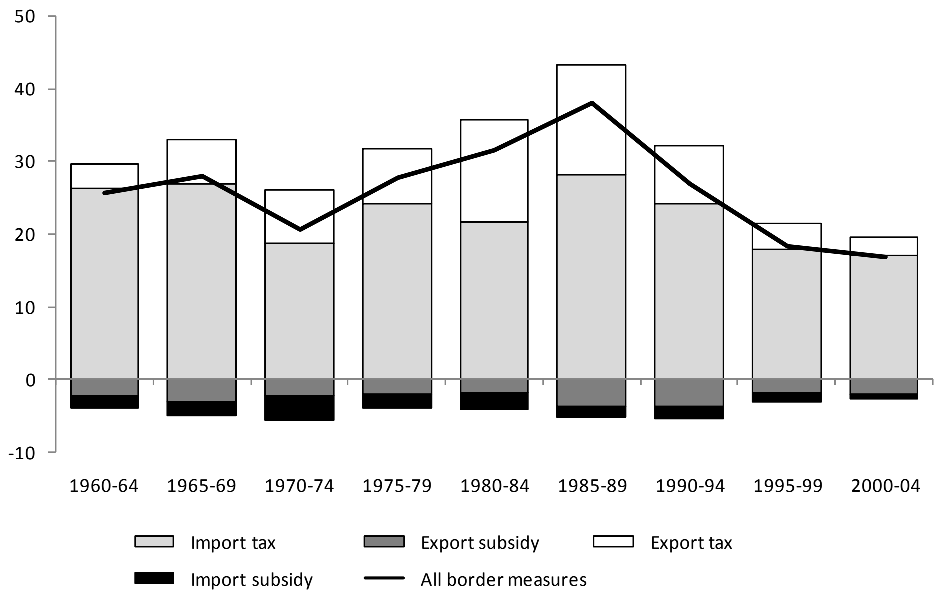
Figure 6: Relative contributions of different policy instruments to trade-reduction from agricultural policy (ITRI), all focus countries, 1960 to 2004

(percent)

(a) All policy measures



(b) Border policy measures

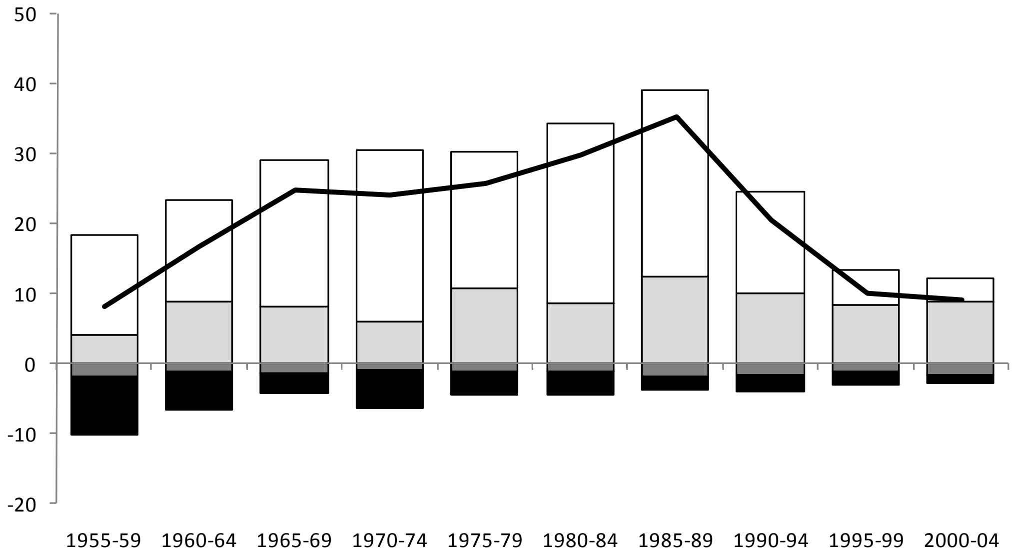


Source: Author's calculations using data in Anderson and Valenzuela (2008).

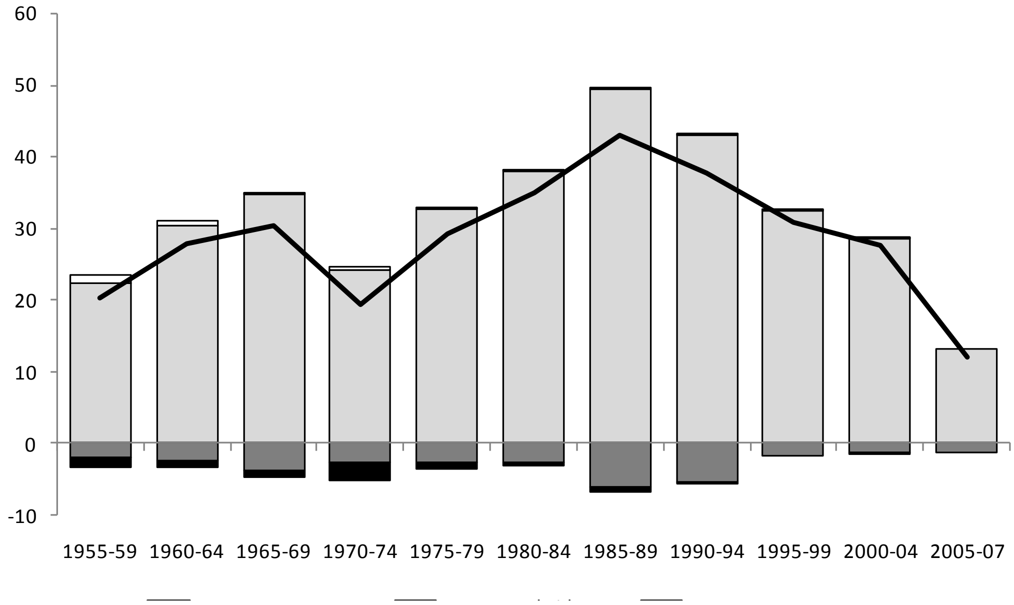
Figure 7: Relative contributions of different border policy instruments to trade-reduction from agricultural policy (ITRI), 1960 to 2004

(percent)

(a) Developing countries



(b) High-income countries

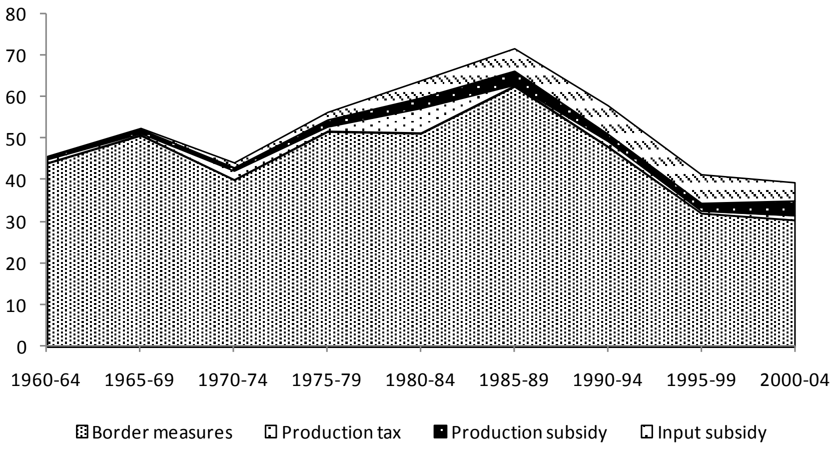


Source: Author's calculations using data in Anderson and Valenzuela (2008).

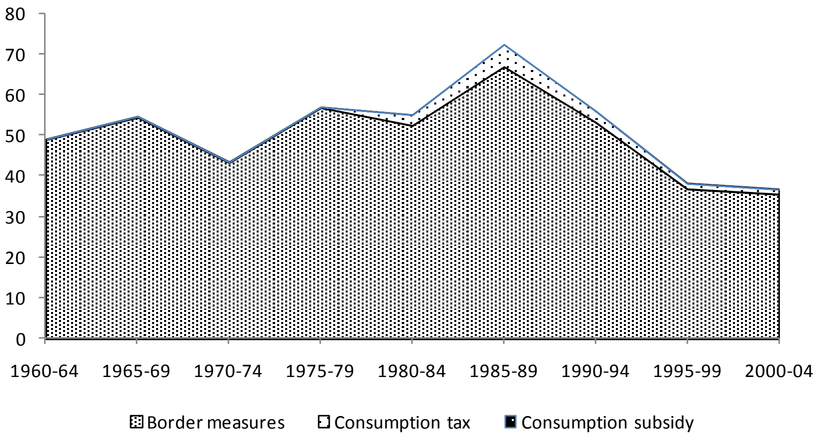
Figure 8: Relative contributions of different policy instruments to welfare-reduction from agricultural policy, all focus countries, 1960 to 2004

(percent)

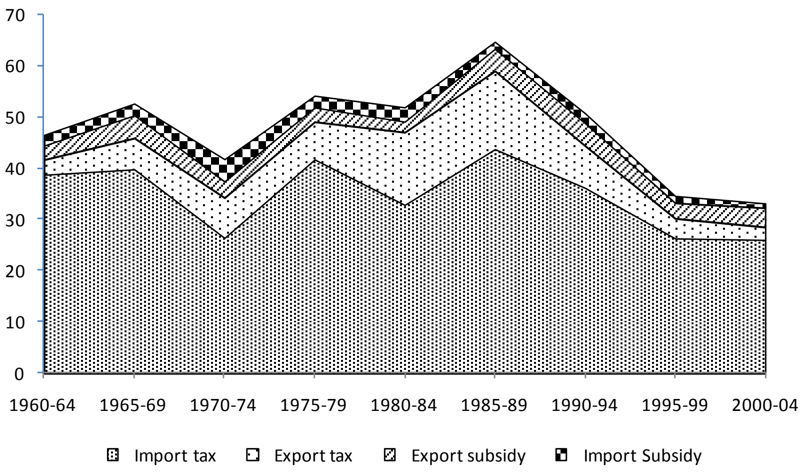
(a) All policy measures, production side of economy (IPDI)



(b) All policy measures, consumption side of economy (ICDI)



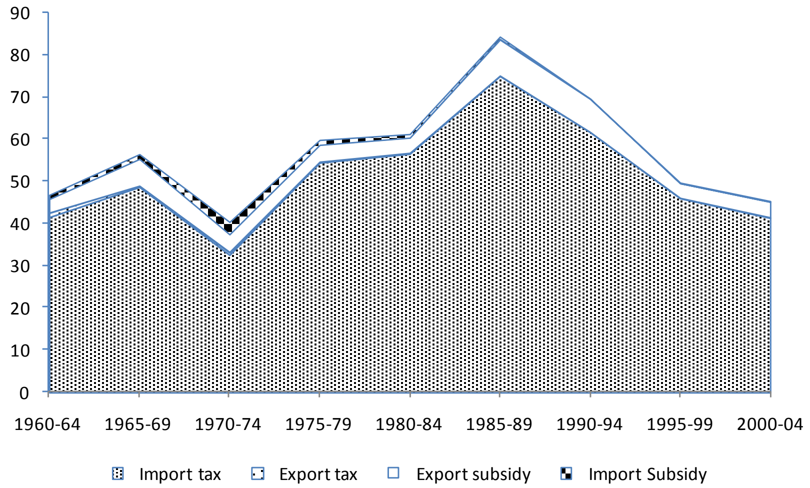
(c) Border policy measures, whole economy (IWRI)



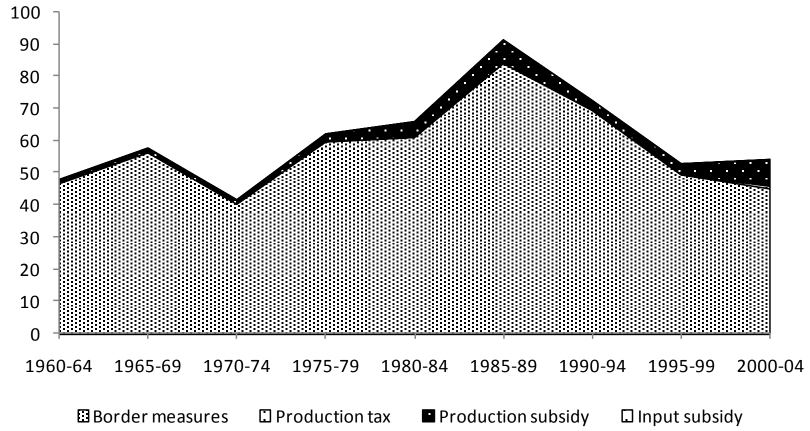
Source: Author‘s calculations using data in Anderson and Valenzuela (2008).

Figure 9: Relative contributions of different policy instruments to welfare-reduction from agricultural policy, high-income countries, 1960 to 2004 (percent)

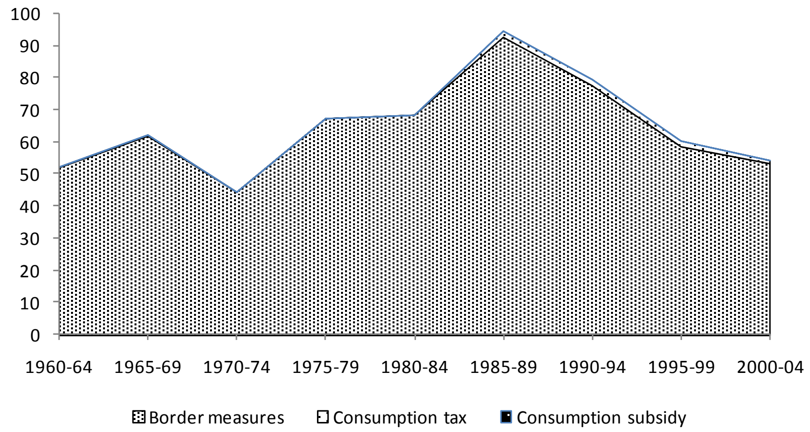
(a) Border policy measures, whole economy (IWRI)



(a) All policy measures, production side of economy (IPDI)



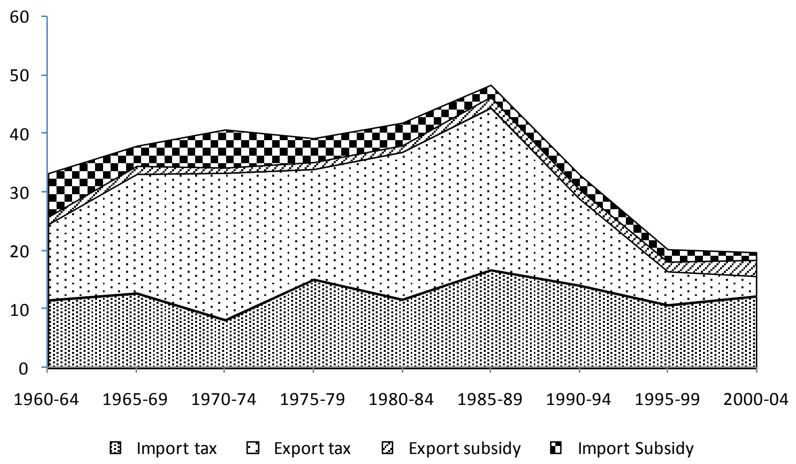
(b) All policy measures, consumption side of economy (ICDI)



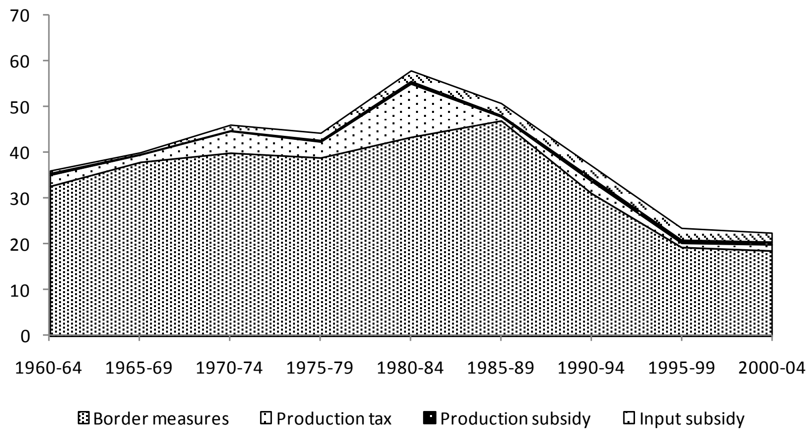
Source: Author's calculations using data in Anderson and Valenzuela (2008).

Figure 10: Relative contributions of different policy instruments to welfare-reduction from agricultural policy, developing countries, 1960 to 2004 (percent)

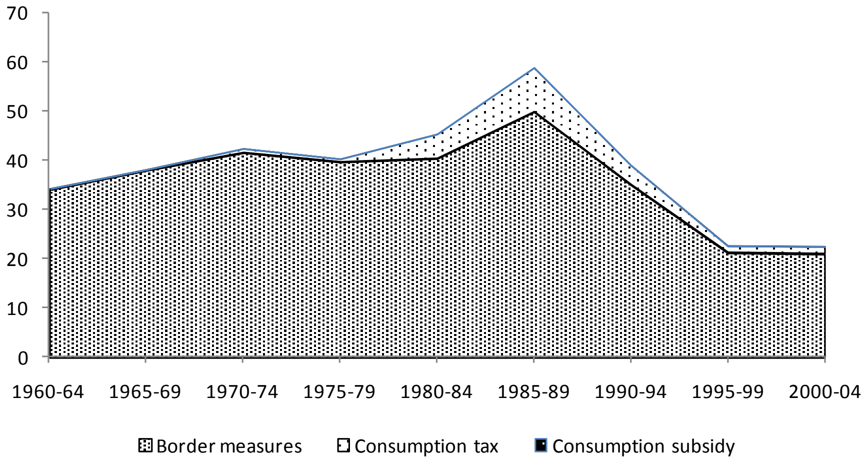
(a) Border policy measures, whole economy (IWRI)



(a) All policy measures, production side of the economy (IPDI)



(b) All policy measures, consumption side of economy (ICDI)

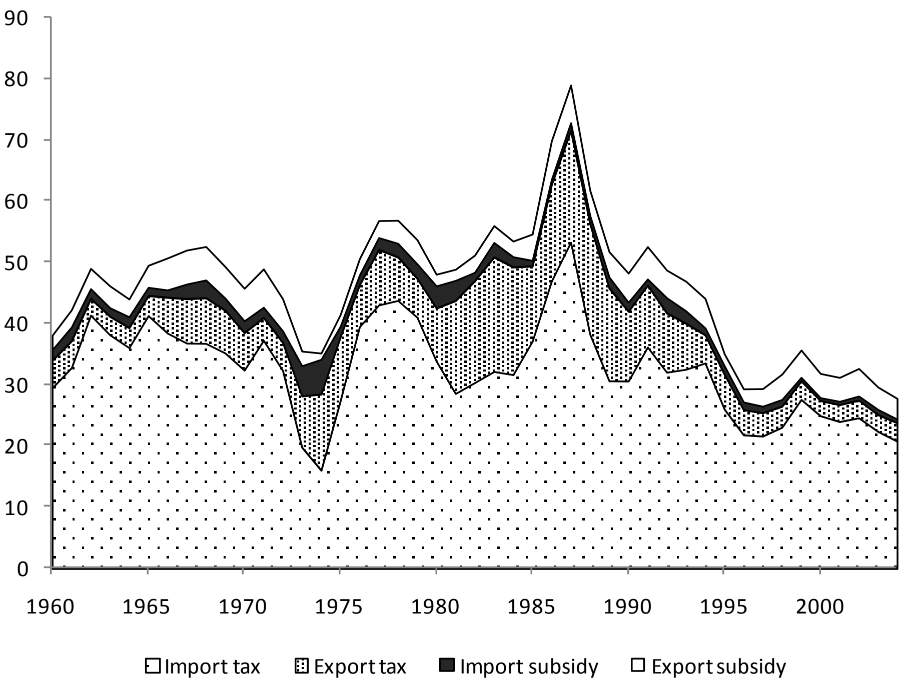


Source: Author's calculations using data in Anderson and Valenzuela (2008).

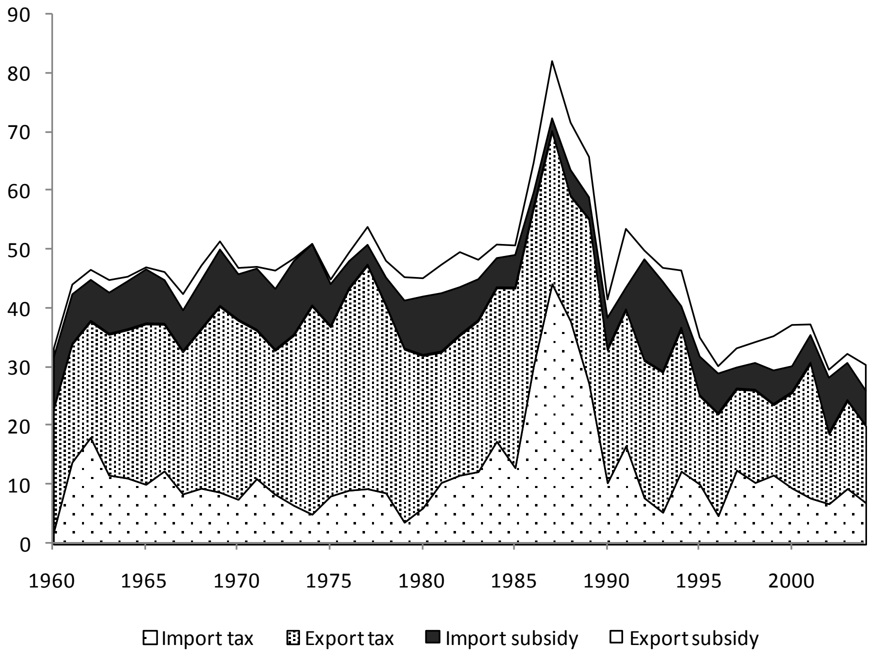
Figure 11: Annual time series of relative contributions of different border policy instruments to welfare reduction from agricultural policy, selected country groups, 1960 to 2004

(percent)

(a) All focus countries, border policy measures (IWRI)



(b) African focus countries, border policy measures (IWRI)

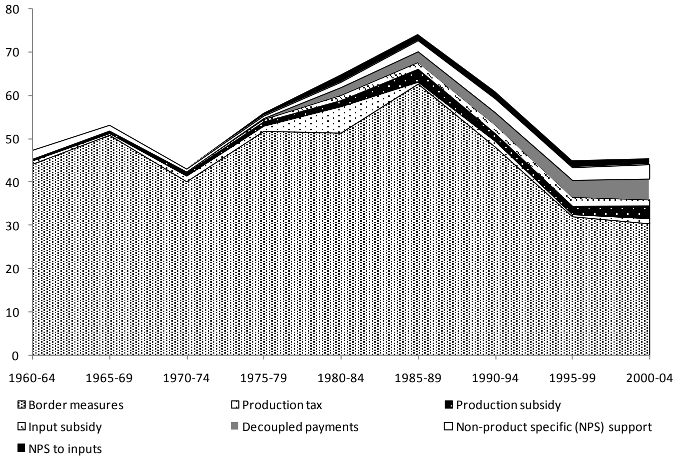


Source: Author‘s calculations using data in Anderson and Valenzuela (2008).

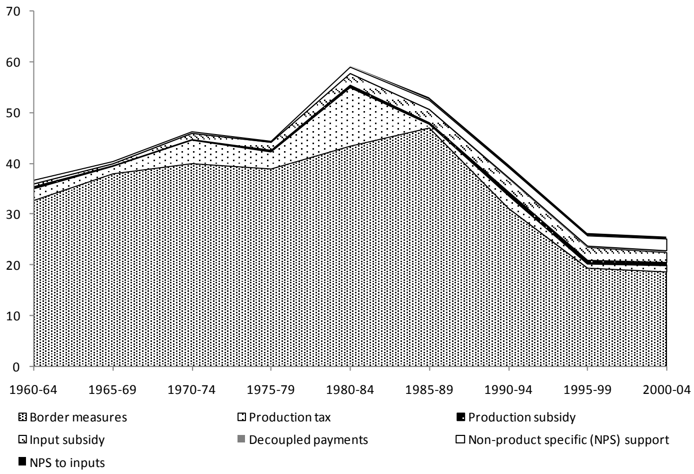
Figure 12: Relative contributions of different policy instruments to welfare reduction from agricultural policy, production side of the economy (IPDI), all measures (including non-product-specific assistance), 1960 to 2004

(percent)

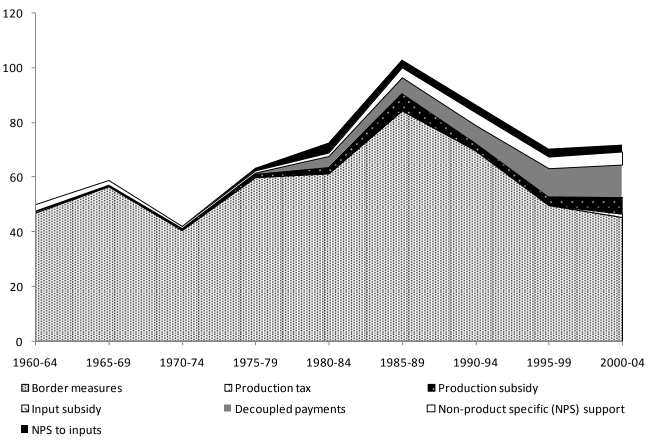
(a) All focus countries, all measures (IPDI)



(b) Developing countries, all measures (IPDI)



(c) High-income countries, all measures (IPDI)



Source: Author's calculations using data in Anderson and Valenzuela (2008)

Table 1: Composition of Distortions to Agricultural Incentives database, by policy instrument, developing and high-income counties and for the world
(number of observations)

	1960-69	1970-79	1980-89	1990-99	2000-04	Total	Share of total
World[a]							
Import taxes	1485	1663	2496	3249	1562	10455	29
Import subsidies	324	600	538	572	246	2280	6
Export taxes	682	1028	1173	1380	603	4866	13
Export subsidy	515	597	767	1259	659	3797	10
Production Tax	204	213	370	425	276	1488	4
Production Subsidy	191	264	1014	1796	885	4150	11
Consumption Tax	76	35	228	704	335	1378	4
Consumption Subsidy	32	31	658	2396	1291	4408	12
Input Subsidy	88	241	598	1625	830	3382	9
Developing countries							
Import taxes	392	506	843	960	494	3195	22
Import subsidies	240	393	427	417	167	1644	11
Export taxes	583	903	1079	1059	432	4056	27
Export subsidy	140	205	238	334	215	1132	8
Production Tax	202	208	291	300	139	1140	8
Production Subsidy	163	205	363	381	155	1267	9
Consumption Tax	16	30	78	174	107	405	3
Consumption Subsidy	15	27	87	105	29	263	2
Input Subsidy	88	241	558	557	273	1717	12
High-income countries (excluding Europe's transition economies)[b]							
Import taxes	1087	1142	1628	1834	750	6441	41
Import subsidies	72	193	87	7	4	363	2
Export taxes	68	72	32	8	3	183	1
Export subsidy	370	376	499	573	236	2054	13
Production Tax	2	5	75	106	92	280	2
Production Subsidy	28	59	648	1242	559	2536	16
Consumption Tax	60	5	150	265	47	527	3
Consumption Subsidy	17	4	571	1861	1043	3496	22

Source: Author's calculations using data from Anderson and Valenzuela (2008).
a. Including Europe's transition economies.
b. There are no input subsidies at the product level for high-income countries in the Distortions to Agricultural Incentives database.

Table 2: Nominal rates of assistance[a] for import-competing, exportable and all farm products, by region and globally, 1960 to 2004 (percent)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Covered import-competing products									
Africa	12	4	-7	8	8	65	2	7	3
Asia	4	34	26	31	21	45	28	28	35
Latin America	20	3	-4	2	10	4	17	9	19
All developing countries	11	26	17	23	17	39	22	22	28
Europe‘s transition economies	na	na	na	na	na	na	31	34	34
High-income countries	54	59	42	56	70	84	73	64	60
World	48	50	37	46	46	66	51	43	44
Covered exportables									
Africa	-31	-39	-44	-45	-36	-36	-39	-26	-28
Asia	-13	-26	-20	-25	-44	-39	-19	-4	0
Latin America	-23	-17	-30	-26	-27	-24	-9	-3	-4
All developing countries	-25	-29	-29	-30	-40	-37	-19	-5	-3
Europe‘s transition economies	na	na	na	na	na	na	-4	-1	0
High-income countries	4	10	8	7	8	17	13	6	5
World	-2	-4	-7	-11	-24	-21	-8	-1	0
All covered farm products[b]									
Africa	-13	-18	-22	-20	-12	1	-12	-7	-9
Asia	-3	3	0	0	-21	-15	-5	6	10
Latin America	-13	-13	-25	-20	-15	-14	1	1	3
All developing countries	-9	-5	-9	-8	-20	-13	-5	4	7
Europe‘s transition economies	na	na	na	na	na	na	7	15	15
High-income countries	32	39	29	36	43	58	49	36	32
World	24	24	15	18	6	16	18	16	16

Source: Anderson and Valenzuela (2008)

[a] Weighted using the value of production at undistorted prices.

[b] Includes nontradables.

[d] Estimates for China pre-1981 and India pre-1965 are based on the assumption that the nominal rates of assistance to agriculture in those years were the same as the average NRA estimates for those economies for 1981-84 and 1965-69, and that the gross value of production

in those missing years is that which gives the same average share of value of production in total world production in 1981-84 and 1965-69, respectively. This NRA assumption is conservative in the sense that for both countries the average NRA was probably even lower in earlier years.

Table 3: Consumer tax equivalents[a] for import-competing, exportable and all farm products, by region and globally, 1960 to 2004 (percent)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Import-competing products									
Africa	7	0	-8	7	3	76	5	9	5
Asia	1	14	8	24	24	44	32	27	35
Latin America	23	11	0	8	4	1	28	11	18
All developing countries	6	11	4	18	17	39	29	22	27
Europe‘s transition economies	na	na	na	na	na	na	12	21	31
High-income countries	53	56	41	54	65	66	57	55	50
World	46	44	32	43	43	55	41	38	39
Exportable products									
Africa	-29	-36	-42	-34	-28	-31	-38	-20	-24
Asia	-3	-38	-29	-32	-42	-40	-20	-5	0
Latin America	-25	-14	-25	-24	-27	-21	-12	1	0
All developing countries	-23	-36	-33	-30	-38	-37	-20	-5	-1
Europe‘s transition economies	na	na	na	na	na	na	-6	-4	2
High-income countries	4	11	9	9	6	11	8	-2	-3
World	0	-8	-9	-11	-24	-24	-11	-4	-2
All covered farm products[b]									
Africa	-8	-12	-16	-9	-6	16	-8	0	-3
Asia	0	-12	-15	-2	-15	-14	-3	5	10
Latin America	-7	-7	-18	-13	-12	-10	13	6	8
All developing countries	-5	-12	-16	-5	-14	-10	0	5	8
Europe‘s transition economies	na	na	na	na	na	na	-2	9	17
High-income countries	35	42	30	40	45	49	41	32	27
World	28	23	14	21	10	15	16	15	16

Source: Anderson and Valenzuela (2008)

[a] Weighted using the value of consumption at undistorted prices. [b] Includes nontradables.

Table 4: Contributions to total agricultural NRA from different policy instruments,[a] by region, 1981–84 and 2000–04 (percent)

Border measures	1981-84 All developing countries	1981-84 High-income countries	1981-84 All focus countries	2000-04 All developing countries	2000-04 High-income countries	2000-04 All focus countries
Import tax equivalent	6	34	18	8	24	14
Export subsidies	1	2	2	1	1	2
Export tax equivalent	-20	0	-13	-3	0	-2
Import subsidy equivalent	-2	0	-2	-1	0	-1
ALL BORDER MEASURES	**-15**	**36**	**5**	**5**	**25**	**13**
Domestic measures						
Production subsidies	1	2	1	1	1	1
Production taxes	-5	0	-3	-1	0	-1
Farm input net subsidies	1	3	2	2	2	2
Non-product-specific (NPS) assistance except to inputs	1	1	1	2	5	3
ALL DOMESTIC PRODUCTION MEASURES	**-2**	**6**	**1**	**4**	**8**	**5**
Decoupled payments to farm households	0	6	2	0	11	4
TOTAL NRA (including NPS and decoupled payments)	**-17**	**48**	**8**	**9**	**44**	**22**
Producer subsidy equivalent, in real 2000 US$ billion	***-113***	***223***	***99***	***58***	***173***	***250***

Source: Author‘s compilation based on data in Anderson and Valenzuela (2008).

[a] In the absence of data, it is assumed the share of input tax/subsidy, domestic production tax/subsidy and border tax/subsidy payments for non-covered farm products are the same as that for covered farm products. The first period begins in 1981 because that was the first year for which estimates for China are available.

[b] All entries have been generated by dividing the producer subsidy equivalent of all (including NPS and ‗decoupled‘) measures by the total agricultural sector‘s gross value of production at undistorted prices.

Table 5: Contributions to CTE on covered agricultural products from different policy instruments, by region, 1981-84[a] and 2000–04 (percent)

	1981-84			2000-04		
	All developing countries	High-income countries	All focus countries	All developing countries	High-income countries	All focus countries
Border measures						
Import tax equivalent	10	46	24	10	32	19
Export subsidies	1	2	1	1	1	2
Export tax equivalent	-22	0	-13	-2	0	-2
Import subsidy equivalent	-3	0	-2	-1	0	-1
ALL BORDER MEASURES	**-14**	**48**	**10**	**8**	**33**	**18**
Domestic measures						
Consumption subsidies	-1	0	-1	-1	-6	-3
Consumption taxes	0	0	0	1	0	1
ALL DOMESTIC CONSUMPTION MEASURES	**-1**	**0**	**-1**	**0**	**-6**	**-2**
TOTAL CTE (covered farm products only)	**-15**	**48**	**9**	**8**	**27**	**16**
Consumer tax equivalent, in real 2000 US$ billion	***-67***	***146***	***73***	***34***	***79***	***125***

Source: Author's compilation based on data in Anderson and Valenzuela (2008).

[a] This period begins in 1981 because that was the first year for which estimates for China are available.

[b] All entries have been generated by dividing the producer subsidy equivalent of all (including NPS and ‗decoupled') measures by the total agricultural sector's gross value of production at undistorted prices.

Table 6: Contributions to Trade Reduction Index for covered products by different policy instruments,[a] by region,[b] 1980-84 and 2000–04 (percent)

(a) Production side of economy

	1980-84						2000-04					
	Africa	**Asia**	**LAC**	**DCs**	**HIC**	**World**	**Africa**	**Asia**	**LAC**	**DCs**	**HIC**	**World**
All measures	**24**	**37**	**21**	**33**	**35**	**33**	**16**	**10**	**7**	**10**	**27**	**17**
Border measures	**22**	**33**	**20**	**30**	**35**	**32**	**13**	**9**	**7**	**9**	**28**	**17**
Export Tax	24	27	21	26	0	14	15	2	6	3	0	2
Export subsidy	-4	-1	-1	-1	-3	-2	-3	-1	-3	-2	-1	-2
Import tax	10	9	6	8	38	22	7	10	5	9	29	17
Import Subsidy	-8	-2	-5	-3	-1	-2	-6	-1	-2	-1	0	-1
Domestic taxes & subsidies	**2**	**4**	**1**	**3**	**0**	**1**	**3**	**1**	**0**	**1**	**-1**	**0**
Production Tax	2	3	0	2	0	1	3	1	0	1	0	0
Production Subsidy	0	0	0	0	0	0	0	0	0	0	-1	0
Net subsidies to farm inputs	0	0	1	1	0	0	0	0	0	0	0	0

(b) Consumption side of economy

	Africa	**Asia**	**LAC**	**DCs**	**HIC**	**World**	**Africa**	**Asia**	**LAC**	**DCs**	**HIC**	**World**
All measures	**12**	**35**	**16**	**29**	**41**	**34**	**12**	**11**	**11**	**11**	**30**	**19**
Border measures	**12**	**34**	**16**	**29**	**41**	**34**	**11**	**11**	**10**	**11**	**31**	**20**
Export Tax	14	26	15	23	0	12	11	1	4	3	0	2
Export subsidy	-3	-1	-1	-1	-2	-1	-2	-1	-2	-1	-1	-2
Import tax	13	11	8	11	43	25	9	12	11	11	33	21
Import Subsidy	-12	-3	-7	-4	-1	-3	-6	-1	-2	-1	0	-1
Domestic taxes & subsidies	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**-1**	**-1**
Consumption Tax	0	0	0	0	0	0	0	0	2	0	0	0
Consumption Subsidy	0	0	0	0	0	0	0	0	-2	0	-1	-1

Source: Author‘s compilation based on data in Anderson and Valenzuela (2008).

a. Each instrument share is computed in the following two steps: (1) ITRI indices are converted to constant 2000 $US by multiplying the index by the value of production or consumption for that instrument group at the country level; (2) each instrument dollar amount index is divided by the country value of production or consumption. The measures in the table — which are like a weighted average of an overall regional TRI — therefore reflect both the absolute size of the index for each policy instrument and the relative importance of that policy instrument in the region.

b. Asia excludes Japan; LAC = Latin America and the Caribbean; DCs = developing countries; HIC = high-income countries; and World includes Europe‘s transition economies (not shown separately).

Table 7: Contributions to Welfare Reduction Index for covered products by different policy instruments,[a] by region, [b] 1980-84 and 2000–04 (percent)

(a) Production side of economy

	1980-84						2000-04					
	Africa	**Asia**	**LAC**	**DCs**	**HIC**	**World**	**Africa**	**Asia**	**LAC**	**DCs**	**HIC**	**World**
All measures	**54**	**61**	**46**	**58**	**64**	**60**	**38**	**20**	**25**	**23**	**53**	**36**
Border measures	**48**	**44**	**38**	**43**	**61**	**51**	**33**	**17**	**18**	**19**	**45**	**31**
Export Tax	25	29	23	28	0	15	16	2	7	4	0	3
Export subsidy	4	1	1	1	4	2	3	3	3	3	4	4
Import tax	11	12	7	11	57	31	8	12	7	11	41	23
Import Subsidy	8	2	6	4	1	3	6	1	2	1	0	1
Domestic taxes & subsidies	**6**	**17**	**8**	**14**	**2**	**9**	**5**	**3**	**7**	**4**	**7**	**5**
Production Tax	5	15	1	12	0	6	4	1	2	1	1	1
Production Subsidy	1	0	1	0	2	1	0	0	2	1	6	3
Net subsidies to farm inputs	0	1	7	2	0	1	0	2	3	2	0	1

(b) Consumption side of economy

	Africa	**Asia**	**LAC**	**DCs**	**HIC**	**World**	**Africa**	**Asia**	**LAC**	**DCs**	**HIC**	**World**
All measures	**47**	**47**	**39**	**45**	**69**	**55**	**33**	**21**	**22**	**22**	**55**	**37**
Border measures	**46**	**41**	**37**	**40**	**69**	**53**	**32**	**20**	**22**	**21**	**53**	**36**
Export Tax	14	25	17	23	0	13	12	2	4	3	0	2
Export subsidy	3	1	1	1	3	2	2	3	3	3	3	3
Import tax	15	13	11	13	65	35	11	15	13	14	50	29
Import Subsidy	13	2	8	4	1	3	7	1	2	1	0	1
Domestic taxes & subsidies	**1**	**6**	**2**	**5**	**0**	**3**	**1**	**2**	**0**	**1**	**1**	**1**
Consumption Tax	1	6	2	5	0	3	1	2	0	1	1	1
Consumption Subsidy	0	0	0	0	0	0	0	0	0	0	0	0

Source: Author‘s compilation based on data in Anderson and Valenzuela (2008).
a. Each instrument share is computed in the following two steps: (1) IWRI indices are converted to constant 2000 $US billions by multiplying the index by the value of production or consumption for that instrument group at the country level; (2) each instrument dollar amount index is divided by the country value of production or consumption. The measures in the table — which are like a weighted average of an overall regional WRI — therefore reflect both the absolute size of the index for each policy instrument and the relative importance of that policy instrument in the region.
b. Asia excludes Japan; LAC = Latin America and the Caribbean; DCs = developing countries; HIC = high-income countries; and World includes Europe‘s transition economies (not shown separately).

Table 8: Contributions of different policy instruments to the decline in the border component of the agricultural Welfare Reduction Index[a], by region, between 1985-89 and 2000–04

(percent)

	Africa	Asia	LAC	**DCs**	HICs	**World**
Export Tax	21	94	93	**86**	0	**42**
Export subsidy	8	-4	-10	**-3**	10	**2**
Import tax	79	9	-17	**15**	88	**54**
Import Subsidy	-8	1	34	**2**	1	**2**
All border measures	100	100	100	**100**	100	**100**

Source: Author‘s compilation based on data in Anderson and Valenzuela (2008).
a. Contributions are computed using the value of the IWRI in constant 2000 $US billions.

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Table 9: Contributions to Producer Distortion Index for covered products by different policy instruments,[a] by region, [b] 1980-84 and 2000–04

(percent)

	1980-84						2000-04					
	Africa	**Asia**	**LAC**	**DCs**	**HIC**	**World**	**Africa**	**Asia**	**LAC**	**DCs**	**HIC**	**World**
Border measures	**48**	**44**	**38**	**43**	**61**	**51**	**33**	**17**	**18**	**19**	**45**	**31**
Export Tax	25	29	23	28	0	15	16	2	7	4	0	3
Export subsidy	4	1	1	1	4	2	3	3	3	3	4	4
Import tax	11	12	7	11	57	31	8	12	7	11	41	23
Import Subsidy	8	2	6	4	1	3	6	1	2	1	0	1
All domestic measures	**7**	**20**	**16**	**18**	**11**	**15**	**5**	**8**	**16**	**9**	**27**	**15**
Production Tax	5	15	1	12	0	6	4	1	2	1	1	1
Production Subsidy	1	0	1	0	2	1	0	0	2	1	6	3
Net subsidies to farm inputs	**0**	**1**	**7**	**2**	**0**	**1**	**0**	**2**	**3**	**2**	**0**	**1**
Decoupled payments	0	0	0	0	4	2	0	0	1	0	12	5
NPS[c] support	1	1	1	1	1	1	0	3	2	2	5	3
NPS[c] to inputs	0	0	0	0	4	2	0	0	2	0	3	1

Source: Author's compilation based on data in Anderson and Valenzuela (2008).

a. Each instrument share is computed in the following two steps: (1) IPDI indices are converted to constant 2000 $US billions by multiplying the index by the value of production for that instrument group at the country level; (2) each instrument dollar amount index is divided by the country value of production. The measures in the table — which are like a weighted average of an overall regional PDI — therefore reflect both the absolute size of the index for each policy instrument and the relative importance of that policy instrument in the region.

b. Asia excludes Japan; LAC = Latin America and the Caribbean; DCs = developing countries; HIC = high-income countries; and World includes Europe's transition economies (not shown separately).

c. NPS = non-product-specific

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Manuscript 4:

Agricultural Distortions in Sub-Saharan Africa: Trade and Welfare Indicators, 1961 to 2004

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Agricultural Distortions in Sub-Saharan Africa: Trade and Welfare Indicators, 1961 to 2004

Abstract

For decades, agricultural price and trade policies in Sub-Saharan Africa hampered farmers‘ contributions to economic growth and poverty reduction. While there has been much policy reform over the past two decades, the injections of agricultural development funding, together with on-going regional and global trade negotiations, have brought distortionary policies under the spotlight once again. A key question asked of those policies is: how much are they still reducing national economic welfare and trade? Economy-wide models are able to address that question, but they are not available for many poor countries. Even where they are, typically they apply to just one particular previous year and so are unable to provide trends in effects over time. This paper provides a partial-equilibrium alternative to economy-wide modelling, by drawing on a modification of so-called trade restrictiveness indexes to provide theoretically precise indicators of the trade and welfare effects of agricultural policy distortions to producer and consumer prices over the past half-century. We generate time series of country level indices, as well as Africa-wide aggregates. We also provide annual commodity market indices for the region, and we provide a sense of the relative importance of the key policy instruments used.

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Agricultural Distortions in Sub-Saharan Africa: Trade and Welfare Indicators, 1961 to 2004

In the 1960s and 1970s, governments of many Sub-Saharan African countries adopted macroeconomic, sectoral, trade and exchange rate policies that directly or indirectly taxed farm households seeking to export their way out of poverty. This anti-agricultural, anti-trade, welfare-reducing policy stance, which was also prevalent in numerous other developing country regions up to the early 1980s (Krueger, Schiff and Valdes 1988), has since begun to be reformed. How far has that reform effort gone in altering the trade- and welfare-reducing characteristics of farm and food policies in Sub-Saharan Africa? This matters greatly for economic development and poverty alleviation, because 60 percent of Sub-Saharan Africa‘s workforce is still employed in agriculture, nearly 40 percent of the population is earning less than $1/day, and more than 80 percent of the region‘s poorest households depend directly or indirectly on farming for their livelihoods (World Bank 2007, Chen and Ravallion 2008).

There are important questions to be addressed about future agricultural policy reform in Africa because African agriculture is currently the subject of several new agricultural development assistance programs, as well as being important in on-going multilateral and preferential trade negotiations. A first step in considering possible future policies is to examine the impacts of past policy choices, and in particular to ask by how much are the policies still reducing national economic welfare and trade?

Economy-wide models are able to address that question, but such models are not available for many of Africa‘s poorer countries. Even where they are, typically they depend on myriad assumptions about parameter (for lack of econometric estimates) and they apply to just one particular previous year and so are unable to provide trends in effects over time.

This paper provides a partial-equilibrium alternative to economy-wide modelling, by drawing on a modification of so-called trade restrictiveness indexes to provide theoretically precise indicators of the trade and welfare effects of agricultural policy distortions to producer and consumer prices. By drawing on a recent comprehensive database covering most of Sub-Saharan African agriculture, we generate annual country level indices for the past half-century, as well as region-wide aggregates including for individual commodities and a sense of the relative importance of the key policy instruments used. In doing so we make a methodological advance by incorporating a number of key nontradable products in our estimates of the indices, which turns out to be important in the African agricultural policy context.

Data for construction of the indices come from the World Bank‘s Distortions to Agricultural Incentives database (Anderson and Valenzuela 2008). The database gives consistent measures of price-distorting policies for 75 countries for the period 1955 to 2007. The data for the 21 African countries in that database is discussed comprehensively in Anderson and Masters (2009). In this paper we focus on 19 of those African countries, leaving aside Egypt and South

Africa because they are both large and very different from the others. That sample comprises five countries of eastern Africa (Ethiopia, Kenya, Sudan, Tanzania, and Uganda), four in southern Africa (Madagascar, Mozambique, Zambia, and Zimbabwe), five large economies in Africa‘s western coast (Cameroon, Côte d‘Ivoire, Ghana, Nigeria, and Senegal), and five smaller economies of West and Central Africa for which cotton is a crucial export (Benin, Burkina Faso, Chad, Mali, and Togo). We concentrate on the period 1961 to 2004, since those are the years for which the African data are most complete.

This paper is structured as follows: the next section presents the methodology we use. This is followed by a discussion of the data in the World Bank‘s Agricultural Distortions database. We then report our estimates of the series of indices before presenting our conclusions and listing some caveats and areas for further research.

Methodology

There is a growing literature that identifies ways to measure the trade- and welfare-reducing effects of international trade-related policies in scalar index numbers. This literature serves a key purpose: it overcomes aggregation problems (across different intervention measures and across industries) by using a theoretically sound aggregation procedure to answer precise questions regarding the trade or welfare reductions imposed by each country‘s trade policies.

These measures represent a substantial improvement on commonly used measures. The usual tools for summarizing price-distorting policy trends in a country or region (see, e.g., Anderson and Masters 2009) are measures of the unweighted or weighted mean nominal rate of assistance (NRA) and consumer tax equivalent (CTE), the standard deviation of NRAs, and in a few instances the weighted mean NRA for exportable versus import-competing covered products.[51] Authors often need to report more than one measure to gain an appreciation of the nature of the policy regime. For example, indicators of dispersion of NRAs give some idea of the additional welfare losses that come from greater variation of NRAs across industries within the sector (Lloyd 1974). Further, if import-competing and exportable sub-sectors have NRAs of opposite sign, they need to be reported separately because those policies would offset each other in calculating the aggregate sectoral NRA.

While those various indicators are useful as a set, it is often helpful to have a single indicator to capture the overall trade or welfare effect of an individual country‘s regime of agricultural price distortions in place at any time, and to trace its path over time and make cross-country comparisons. To that end, the scalar index literature is very useful. The pioneering theoretical work is by Anderson and Neary (summarized in their 2005 book), with an important partial equilibrium contribution by Feenstra (1995). The theory defines an ad valorem trade tax rate which, if applied uniformly across all tradable agricultural commodities in a

[51] The OECD (2009) measures similar indicators to the NRA and CTE, called producer and consumer support estimates (PSEs and CSEs). The main difference, apart from the CSE having the opposite sign to the CTE, is that the NRA and CTE are expressed as a percentage divergence from undistorted (e.g., border) prices whereas the PSEs/CSEs relate to the divergence from actual (distorted) prices.

country will generate the same reduction in trade, or in welfare, as the actual cross-product structure of distortions.[52]

In recent years, several empirical papers have provided series of estimates of scalar index numbers for individual countries. Irwin (2010) uses detailed tariff data to calculate the Anderson–Neary Trade Restrictiveness Index for the United States in 1859 and annually from 1867 to 1961. Kee, Nicita and Olarreaga (2009) estimate partial-equilibrium indexes for 78 developing and developed countries for a single point in time (mid-2000s). Lloyd, Croser and Anderson (2010) estimate indexes for 75 developed and developing countries in the World Bank's recently released Distortions to Agricultural Incentives database (Anderson and Valenzuela 2008) over the period 1960 to 2007.

In addition to being useful to summarize the agricultural and food policy regime in an individual country, the Anderson-Neary scalar index measures can be usefully adapted to summarize two other aspects of agricultural policy: they can be computed for individual policy instruments, to show the relative contributions of different policy instruments to reductions in trade and welfare (Croser and Anderson 2010); and they can be computed to measure the trade- and welfare-reducing effects of policy in a single global or regional commodity market (Croser, Lloyd and Anderson 2009). In this paper we utilise the methodology to estimate all three types of indexes. In doing so, we extend the theory and analysis to include nontradables, which have not been addressed in previous studies.

[52] Other indices define an ad valorem trade tax rate which, if applied uniformly across all tradable products, will generate the same government revenue (Bach and Martin 2001), or the same real national income and general equilibrium structure of the economy (Anderson 2009a), as the actual cross-product structure of distortions.

Country level trade- and welfare-reduction indexes

To capture distortions imposed by each country's border and domestic policies on its economic welfare and its trade volume, we adopt the methodology from Lloyd, Croser and Anderson (2010). Those authors define a Welfare Reduction Index (WRI) and a Trade Reduction Index (TRI) and estimate them by considering separately the distortions to the producer and consumer sides of the agricultural sector (which can differ when there are domestic measures in place in addition to or instead of trade measures). As their names suggest, the two indexes respectively capture in a single indicator the (partial equilibrium) welfare- or trade-reducing effects of all distortions to consumer and producer prices of farm products from all agricultural and food policy measures in place. The WRI and TRI thus go somewhat closer to what a computable general equilibrium (CGE) can provide in the way of estimates of the trade and welfare (and other) effects of price distortions, while having the advantage of providing an annual time series. Fortuitously, estimates of the actual price distortions are available in the NRAs and CTEs of the World Bank's Distortions to Agricultural Incentives database.

The derivation of the two indexes for *n* import-competing industries leads to the expressions for the TRI and WRI for the import-competing sector of a country shown in Box 1.

Box 1: Expressions for the TRI and WRI

TRI	**WRI**
$T = \{Ra + Sb\}$, with $R = \left[\sum_{i=1}^{n} r_i u_i\right]$ and $S = \left[\sum_{i=1}^{n} s_i v_i\right]$	$W = \{R'^2 a + S'^2 b\}^{1/2}$, with $R' = [\sum_{i=1}^{n} r_i^2 u_i]^{\frac{1}{2}}$ and $S' = [\sum_{i=1}^{n} s_i^2 v_i]^{\frac{1}{2}}$
where $u_i = p_i^{*2} dx_i / dp_i^C / \sum_i p_i^{*2} dx_i / dp_i^C = \rho_i (p_i^* x_i) / \sum_i \rho_i (p_i^* x_i)$ $v_i = p_i^{*2} dy_i / dp_i^P / \sum_i p_i^{*2} dy_i / dp_i^P = \sigma_i (p_i^* y_i) / \sum_i \sigma_i (p_i^* y_i)$, $a = \sum_i p_i^{*2} \mathrm{dx}_i / \mathrm{d}p_i^C / \sum_i p_i^{*2} \mathrm{d}m_i / \mathrm{d}p_i$, and $b = -\sum_i p_i^{*2} \mathrm{dy}_i / \mathrm{d}p_i^P / \sum_i p_i^{*2} \mathrm{d}m_i / \mathrm{d}p_i$.	
Variable definitions: T — Trade Reduction Index; W — Welfare Reduction Index; R — index of average consumer price distortions; S —index of average producer price distortions; R' — Consumer Distortion Index; S' — Producer Distortion Index; s_i — the rate of distortion of the producer price in proportional terms; r_i — rate of distortion of the consumer price in proportional terms; u_i — weight for each commodity in R and R', which is proportional to the marginal response of domestic consumption to changes in international free-trade prices and can be written as a function of the domestic price elasticity (at the protected trade situation) of demand (ρ_i); v_i — weight for each commodity in S and S', which is proportional to the marginal response of domestic production to changes in international free-trade prices and can be written as a function of the domestic price elasticity (at the protected trade situation) of supply, (σ_i); p_i^* — border price; $p_i^P = p_i^*(1 + s_i)$ — distorted domestic price; $p_i^C = p_i^*(1 + r_i)$ — distorted domestic consumer price; $x_i = x_i(p_i^C)$— quantity of good i demanded (as a function of own domestic price); $y_i = y_i(p_i^P)$ — quantity of good i supplied (as a function of own domestic price); a (b) — weight of consumption (production) in the WRI or TRI, which is proportional to the ratio of the marginal response of domestic demand (supply) to a price change relative to the marginal response of imports to a price change.	

Essentially the import-competing TRI and WRI are constructed from appropriately weighted averages of the level of distortions of consumer and producer prices. The TRI is a mean of order one, and the WRI a mean of order two, but they use the same weights. Because the WRI is a mean of order two, it better reflects the welfare cost of agricultural price-distorting policies because it recognizes that the welfare cost of a government-imposed price distortion is related to the square of the price wedge. It thus captures the disproportionately higher welfare costs of peak levels of assistance or taxation, and is positive regardless of whether the government's agricultural policy is favouring or hurting farmers.

The TRI and WRI can each be extended so as to add the exportable and nontradable sub-sectors of agriculture (see Appendix J to this thesis). Distortions to exportable industries are inputted into the TRI as negative values because a positive (negative) price distortion in an exporting industry has a trade-expanding (-reducing) effect, and thus decreases (increases) the TRI. Distortions to nontradable industries are inputted into the TRI as zero values because a domestic price distortion in a nontradable industry by definition has neither a trade-expanding nor trade-reducing effect because of assumed prohibitively high trade costs. This extension of the TRI and WRI to include nontradables is a methodological contribution of this paper,[53] and is of practical significance in the case of Sub-Saharan Africa where nontradables account for a non-trivial share of the gross value of agricultural production (discussed below).

The expressions for the TRI and WRI weights above show that estimates of price elasticities are required to compute the indexes. In line with Lloyd, Croser and Anderson (2010), in the absence of elasticities we adopt some simplifying assumptions in this paper. We assume that domestic price elasticities of supply (demand) are equal across commodities within a sub-sector. This powerful simplifying assumption allows us (in the empirical section below) to find appropriately weighted aggregates of distortions on the production and consumption sides simply by aggregating the change in consumer (producer)

[53] Anderson and Neary (2005), chapter 12 discusses the possibility of extending indices to nontradable sub-sectors and including domestic distortions in their general equilibrium framework.

prices across commodities and using as weights the sectoral share of each commodity‘s domestic value of consumption (production) at undistorted prices. We expect this simplifying elasticity assumption to have a very small impact on the reported indices. This is because elasticities appear in both the numerator and denominator of the weight expressions, and therefore cancel each other out to some extent. Further, Kee, Nicita and Olarreaga (2009) show that the TRI and WRI can be decomposed into three components and the elasticity only enters into one of the three components, which in practice is a very small component relative to the other two. This transparent assumption also makes sense in the context of computing time series of indices for Africa, where there is a dearth of reliable and consistent elasticity estimates across time for all our focus countries and their covered agricultural products.

Policy instrument trade and welfare reduction indexes

The above country-level TRI and WRI measures are the aggregate of the trade- and welfare-reducing effects of all the policy measures in place. The variables s_i and r_i, as domestic-to-border price ratios, can theoretically encompass distortions provided by all trade tax/subsidy and trade non-tax/subsidy measures, plus domestic price support measures (positive or negative), plus direct interventions affecting farm input prices. Furthermore, where multiple exchange rates operate, the measures can encompass an estimate of the import or export tax equivalent of that distortionary regime too.

Whilst it is desirable to have such an aggregated country level indicator that is so encompassing, agricultural policy analysts are sometimes interested in the relative contribution of different policy instruments to reductions in trade and welfare. To provide this insight, it is possible to use the Anderson-Neary framework to construct indicators of policy distortions at the instrument level to facilitate this comparison.[54]

To capture distortions imposed by each African country's different policy instruments on its economic welfare and its trade volume, we adopt the methodology from Croser and Anderson (2010). These authors define an Instrument Welfare Reduction Index (IWRI) and an Instrument Trade Reduction Index (ITRI), which can be estimated by considering the distortion from a single policy instrument to the producer and consumer sides of the economy.

The methodology in Croser and Anderson (2010) identifies four types of border distortions (import taxes and subsidies, and export taxes and subsidies), for which individual ITRI and IWRI series can be estimated. In addition to the border measures, the series for domestic distortions in the form of production, consumption and input taxes and subsidies can be estimated. To estimate the trade-reducing effect of an individual instrument, those authors derive expressions for the change in import volume from the individual policy measures, which are used as the basis for deriving ITRIs. To estimate the welfare-reducing effect of individual instruments, the authors make an assumption about the allocation of the

[54] We note that most of the series of TRI and WRI indicators in the literature are for single instruments anyway. For example, Irwin (2010) uses only import tariffs; and Kee, Nicita and Olarreaga (2009) report two series of indices — one based on tariffs only; and the other on tariffs plus NTBs. However, we are unaware of other studies that use the Anderson-Neary framework to directly compare the distortionary effects of different instruments on trade and welfare.

total welfare loss from the combination of individual policy instruments. The authors assume that border measures are applied first, and that this may be supplemented by additional domestic distortions. Thus the welfare reduction in the domestic distortion is the residual from subtracting the effects of the border measures from the total welfare reduction of all policy measures. This allocation assumption provides a lower-bound on welfare losses from border measures and an upper-bound on welfare losses from domestic measures.

The derivation of the ITRI and IWRI follows essentially the same steps as those for the country-level indices which encompass all forms of distortion. The difference in the algebraic methodology is to specify separate indices for the nine different types of policy instrument. Simplifying price elasticity assumptions can be made in the absence of reliable estimates, and again these assumptions have a minimal effect on the estimates.

Commodity market trade and welfare reduction indices

In addition to constructing country-level and instrument-specific indices, this paper makes use of another methodology within the Anderson-Neary framework to analyse a different aspect of agricultural policy in Africa's poorest nations. We construct indices that show the extent to which African markets for individual farm commodities are distorted relative to others. We employ the methodology in Croser, Lloyd and Anderson (2010) for this purpose. This methodology is novel because whereas all previous work within the trade restrictiveness indices literature has focused on constructing index numbers of distortions from the perspective of a single country, this methodology instead takes a regional view of individual commodity markets.

The commodity TRI (WRI) is equal to the uniform trade tax that has the same effect on regional trade volume (welfare) as the existing set of distortions in the region's national commodity markets. The measures are constructed in the same way as those for individual country indices, except that instead of summing across distortions in different industries for a single country, the measures are constructed by summing across distortions in different countries for a single commodity.

The indices are computed using data on the domestic production and consumption sides of the region's national commodity markets, and the measures account for all forms of border and domestic price distortion in each country for the commodity market of interest, as well as incorporating import-competing and exportable countries into the measure. In the absence of elasticity estimates, we make simplifying assumptions analogous to those made for national indexes. Croser, Lloyd and Anderson (2010) demonstrate that these assumptions have a minimal impact on the estimated series when constructing indices for global markets.

Distortions to Agricultural Incentives database

This study makes use of the World Bank's Distortions to Agricultural Incentives database (Anderson and Valenzuela 2008). The database came out of a global research project seeking to improve the understanding of agricultural policy interventions and reforms in Asia, Europe‘s transition economies, Latin America and the Caribbean as well as Africa. The database contains annual estimates of nominal rates of assistance (NRA) (positive or negative) for key farm products in 75 countries that together account for between 90 and 96 percent of the world‘s population, farmers, agricultural GDP, and total GDP. There are 21 African countries in the database.

We concentrate on the sample of 19 Sub-Saharan African countries listed in the introduction, but exclude relatively affluent Egypt and South Africa which together account for between one-third and one-fifth of Africa gross value of production at undistorted prices over the period under analysis. For the 19 African focus countries, the database contains around 6000 consistent estimates of annual NRAs to the agricultural sector and the same number of CTEs between 1955 and 2005. Country coverage up to 1960 is much less than from 1961, so the series of estimates presented in this paper begins in that latter year.

The estimates of NRA and CTE in the database are at the commodity level and cover a subset of 41 agricultural products in Africa. These so-called covered products account for around 70 percent of total agricultural production over the period studied. The data identifies each year the extent to which each commodity in each country is considered an importable, exportable or nontradable, a status that may change over time. In the 19 African focus countries, nontradable products account over time for between 40 and 55 percent of the gross value of production of all covered agricultural products (last column of Table 1).

The range of policy measures included in the NRA estimates in the Distortions to Agricultural Incentives database is wide. By calculating domestic-to-border price ratios, the estimates include assistance provided by all tariff and nontariff trade measures, plus any domestic price support measures (positive or negative), plus an adjustment for the output-price equivalent of direct interventions on inputs. Where multiple exchange rates operate, an estimate of the import or export tax equivalents of that distortion are included as well. The range of measures included in the CTE estimates include both domestic consumer taxes and subsidies and trade and exchange rate policies, all of which drive a wedge between the price that consumers pay for each commodity and the international price at the border.

Anderson and Masters (2009) note several patterns that emerge in the distortions to agricultural incentives in the 21 focus countries. In the 1960s and 1970s, many African governments had macroeconomic, sectoral and trade policies that increasingly favoured the urban sector at the expense of farm households and favoured production of import-competing farm goods at the expense of exportables. The policy regime was characterized as pro-urban (anti-agricultural) and pro-self-sufficiency (anti-agricultural trade). Since the 1980s, Africa has reduced its anti-agricultural and anti-trade biases, but many distortions still remain.

For the 19 countries in this study, Table 1 and Figure 1 illustrate those patterns. The weighted average NRA for the 19 countries is almost always below zero, indicating that together agricultural price, trade and exchange rate policies have reduced the earnings of farmers in these countries. The average rate of direct taxation (negative NRA) of African farmers rose until the late 1970s before declining by more than half over the next 25 years. Meanwhile, assistance to non-agricultural sectors rose (thereby making farming less attractive in relative terms) and then declined slower than for agriculture, as reflected in the Relative Rate of Assistance (RRA) estimates in Table 1.

Table 2 reports the country-level NRAs for covered products for each of the 19 countries in this sample. It reveals the considerable diversity within the sample. In some countries — such as Cameroon, Ghana, Senegal, Uganda, Tanzania, and Madagascar — there was a reduction in taxing farmers since the regional peak in 1975–79, while in other countries — such as and Cote d'Ivoire, Zambia, and Zimbabwe — high levels of agricultural taxation persist.

The country level aggregate measures hide the degree of variation in NRA estimates within countries. Anderson and Masters (2009) report the standard deviations around the weighted mean NRA for covered products in each country, showing that the variation is significant. An indication of the extent of variation between groups of products is seen when comparing the average NRAs for import-competing and exportable product groups, which reflects the antitrade bias (Figure 1).

Notwithstanding the valuable contribution of the measures reported in Anderson and Masters (2009), sectoral averages of NRAs and RRAs can be misleading as indicators of the aggregate extent of price distortion within the sector. They can also be misleading when compared across countries that have varying degrees of dispersion in their NRAs (and CTEs) for farm products. We therefore now turn to consideration of the TRI and WRI series estimated for this paper, and the additional insights these measures can provide.

Trade and welfare reduction index estimates

The regional aggregate TRI for the 19 African focus countries for all covered products is positive and of a significant magnitude over the period under analysis (Figure 2). The positive TRI indicates that overall agricultural policy in African countries resulted in reduced trade. The extent of that has decreased over time, however, with the five-year TRI averages of between 20 and 25 percent in the first two decades of data falling to around 10 percent in the most recent decade. The TRI has the opposite sign to the NRA because the TRI correctly aggregates policies that reduce trade volume, regardless of whether the NRA is positive or negative. The importance of the difference in these aggregations of the trade-reducing effect of policies can be seen in the early-1960s, for example, when the average NRA was around zero but the TRI was quite high (capturing the trade-reducing effect of both import taxes and export taxes, which offset one another in the NRA estimate). Similarly in the late 1980s, the NRA trends from around -15 to -10 percent at a time when the TRI increases from 20 to 30 percent. The aggregate NRA gives the impression that policies are becoming less distorted in this period but, because the upward trend in the NRA is caused by an increase in import taxes, the TRI correctly reveals that agricultural policies are in fact becoming more restrictive in this time period.

The WRI series for all covered products is necessarily positive and everywhere lies above the TRI series (Figure 2). The WRI series correctly demonstrates the negative welfare consequences that flow from both negative and positive price distortions. Furthermore, the WRI series provides a better indicator of the welfare cost of distortions than the average level of assistance or taxation, due to the inclusion in the WRI of the ‗power of two'. A weighted arithmetic mean does not fully reflect the welfare effects of agricultural distortions because the dispersion of that support or taxation across products has been ignored. By contrast, the WRI captures the higher welfare costs of high and peak levels of assistance or taxation. That is, the WRI reflects the disparity issue discussed in Lloyd (1974): the larger the variance in assistance levels, the greater the potential for resources to be used in activities which do not maximize economic welfare.

The aggregate African results mask country-level diversity in the TRI and WRI series. Some countries — such as Cote d'Ivoire, Ethiopia, Sudan, Tanzania and Zimbabwe — persistently restrict trade (in aggregate) throughout the period under analysis (Table 3). Other countries — such as Kenya, Zambia and Mozambique — have had periods in which policies in aggregate have expanded agricultural trade slightly. In terms of the WRI, there is less diversity across countries, since WRI measures are all necessarily positive (Table 4). The extent to which agricultural policy reduced aggregate welfare does differ across countries, however. Some countries have low reductions in welfare, including Uganda and most cotton-exporting countries. Figure 3 provides a snapshot for 2000–04 of the diversity in the WRI and TRI for each of the 19 countries, with the weighted African average in the middle.

A useful way of understanding the overall welfare reduction for Africa from agricultural policy is to compute the country contributions to the WRI for the 19 African focus countries as a whole. Contributions can be found by computing dollar values of the welfare reduction for each country (by multiplying the WRI percent by the average of the gross value of production and consumption at undistorted prices). Such contributions will therefore take account of the magnitude of national WRIs as well as the significance of each country in terms of its share of the gross value of production and consumption at undistorted prices. Table 5 shows that Nigeria and Sudan are the two countries that dominate the region‘s contributions, with Sudan becoming more important over time (as its WRI series trends upwards). Ethiopia accounts for up to 10 percent of the focus region‘s welfare reduction. The last column of Table 5 reports country contributions to the decline in the regional WRI from its value of 44 percent in 1975–79 to its value of 27 percent in 2000–04. Once again, Nigeria and Sudan dominate the overall reduction, together accounting for around 80 percent of the fall in the WRI. However, Uganda, Cameroon, Senegal and Madagascar have a slightly offsetting effect on the regional fall in the WRI over that period.

Figure 4(a) shows commodity contributions to the regional WRI. In line with the significance of nontradables in the focus countries, the products cassava, and yam dominate the contribution to the overall WRI. Cassava and yam both have average NRAs close to zero in all time periods (five year averages between -4 and 0 percent over the period studied) and are nontraded for most countries. The next contributor is maize, which on average has high levels of assistance in several import-competing focus countries – and significant negative levels of protection in exporting countries. None of the livestock products in the focus countries contribute significantly to the WRI for all covered products, because their share in regional gross value of production of covered products is low.

It is useful to compare the TRI and WRI series reported above for all covered products, with those for just covered tradables in Africa.[55] In Table 6, it can be seen that the TRI and WRI for all covered products is significantly lower than that for covered tradables. This is because, as noted above, nontradables account for a large share of the gross value of production and consumption. The TRI estimates for all covered products are roughly half, and WRI estimates are roughly two-thirds, what there were with nontradables included. Figure 4(b) shows that commodity contributions to the regional WRI are substantially different when considering only tradables. Beef and groundnut make the largest contributions to the reduction in regional welfare when considering only tradables.

Another point to note from Table 6 is that the country sample matters for the reporting of TRI and WRI results. For comparison, we report the results from Lloyd, Croser and Anderson (2010), which computed TRI and WRI series for an alternative sample of African countries in the Distortions to Agricultural Incentives database. Their sample is the same 19 countries in this paper, with the addition of Egypt and South Africa, and excluding the five cotton countries of Benin, Burkina Faso, Chad, Mali and Togo, because these countries only have one covered tradable product (cotton). In general, the 19 focus countries in this study have higher TRI and WRI 5-year averages. This is driven by the exclusion of

[55] Note that Lloyd, Croser and Anderson (2010) report measures for covered tradables only.

Egypt and South Africa, which had low country-level TRI and WRI estimates. The exception to the general pattern is the time period 1985–89, where the Lloyd, Croser and Anderson (2010) estimates are higher, owing to very high protection in Egypt in that five-year average period (when international food prices collapsed just as Egypt raised its previously very low domestic food prices).

It is also useful to compare the TRI and WRI results for the 19 focus countries to the TRI and WRI estimates for other developing country regions, which are reported in Lloyd, Croser and Anderson (2010). The 19 African focus countries had the most welfare reducing policies over time, and generally the most trade-distorting. The three developing country regions of Africa, Asia and Latin America have shown a trend towards less trade and welfare reducing agricultural policies in recent years, however (Figure 5).

Policy instrument results

We now turn to the national decompositions of the TRI and WRI to the policy instrument level. Figure 6 provides a summary of the estimates of the contribution to the weighted average WRI series for the 19 African focus countries of four different border measures: taxes and subsidies on both imports and exports. The figure demonstrates the very substantial role that export taxes have played in the reduction of welfare in the region. On average, more than half the welfare reductions have come from anti-agricultural export taxing policies over the period studied. Notwithstanding their significant distortionary contribution, export taxes have also been the area in which there has been most reform in recent decades.

The contribution of export taxes to the reduction in the WRI over the period 1985–89 to 2000–04 is 93 percent. Import taxes reduced the overall WRI by 34 percent; while there were offsetting increases in the contribution of export subsidies (13 percent) and import subsidies (15 percent) to the WRI. The contributions to TRI and WRI estimates for the 19 African countries from domestic distortions are small, never accounting for more than 2 percent of the overall regional TRI or WRI.

Commodity TRI and WRI results

The TRI and WRI estimates for individual regional commodity markets provide a different perspective on the level of distortion in the 19 focus countries over the period under analysis. Table 7 reports the five-year average WRI estimates for the focus region for individual commodity markets. The table reveals considerable diversity in the distortions in different commodity markets. Fruit and vegetable commodity markets, which tend to have a high share of nontradable production, have low WRI estimates on average, whereas traded commodities such as tropical crops, oilseeds and livestock tend to have more welfare-reducing policies in place. Grains, which comprise a mixture of tradable and nontradable products, had highly-distortionary policies in place in the 1960s on average, but these have been reduced over time.

Figure 7 gives a snapshot of the diversity across commodity markets in the regional TRI and WRI for 2000–04. Sugar and cotton markets continue to have highly distorted policies in terms of both the trade and welfare effects of policies.

Soybean, by contrast, has trade-expanding policies in aggregate, but the policies are nevertheless welfare reducing.

Conclusions, caveats and areas for further research

Reform of agricultural policy in Africa is topical at present. Recently announced international investment programs, domestic policy reforms, and the negotiation of international and regional trade agreements are on the agenda. To assess each of these policy initiatives, measurement of intervention levels is required. Certainly, economy-wide models can measure the welfare and trade (and other) effects of policy in a particular country or market. But such models require reliable data on the structure of the economy, and econometric estimates of myriad parameters, neither of which can be easily found for the poorer countries of Africa. Even where economy-wide models are available, they may be calibrated to a particular year and so incapable of providing a long time-series of estimates of the regional effect of distortional policies over time.

Scalar index measures, by contrast, can meaningfully summarize the welfare and trade effects of policy intervention in agriculture in poorer countries. These indices can be estimated using already available price, quantity and distortions data, and so are relatively inexpensive to generate. We demonstrate this for a subset of 19 African countries from the World Bank‘s recently released Distortions to Agricultural Incentives database.

The estimates in the paper reveal several important findings. The national level TRIs and WRIs indicate that although there has been policy reform in

African agriculture over the past 50 years, the overall trade- and welfare-reducing effects of current policies remain significant. Export taxes in particular continue to reduce African welfare and trade. Some individual commodity markets in Africa are more distorted than others, sugar and cotton being two of the most distorted.

The scalar index numbers reported in this paper provide a better measure of policy intervention than widely-used NRA-type measures because they correctly aggregate offsetting policies and the WRI captures the higher welfare costs of more disparate policies across industries. These scalar measures have the advantage of making policies more transparent, which can facilitate further reforms.

Notwithstanding their contribution, there are a number of limitations to the indices. Some are empirical. First, the estimates can only take account of agricultural products which have commodity level data in the World Bank‘s database. The database has product level data for approximately 70 percent of the 19 African focus countries‘ farm production value, and somewhat less of their consumption value. We, therefore, necessarily miss some information about distortions to production and consumption and therefore trade and welfare in Africa. Furthermore, the data in the World Bank‘s database are not highly disaggregated, which is not ideal for capturing the full extent of welfare and trade distortions from African policies. Finally, in the absence of reliable, consistently estimated time-series of elasticities of demand and supply, we make simplifying assumptions about those elasticities to compute the scalar index number series. The estimates would be more precise if we had access to reliable elasticity estimates, although probably not a lot different, according to sensitivity analysis conducted by Croser, Lloyd and Anderson (2010).

There are also some methodological caveats worth noting. The methodology in the paper adopts the standard approach still presented in most textbooks on trade policy or welfare economics, based on the benchmark of competitive markets. The methodology ignores the existence of divergences and governance problems, including administrative costs. Thus the trade and welfare reduction indexes reported above may be over- or under-stated to the extent that such problems exist. For example, in some cases where there is market failure, we know from second-best theory that policies that increase assistance to a lightly protected industry may increase rather than decrease national economic welfare. These neoclassical assumptions we make are unlikely to be realistic for many of the poorest nations in Africa. In particular, the RRA measure reported in Table 1 suggest that distortions to non-farm tradables sectors in Africa exist. Even so, the series reported in this paper are useful aggregations of data and almost certainly give a better indication of trade and welfare effects of policy than average NRA-type measures.

References

Anderson, J.E. (2009a), ―Consistent Trade Policy Aggregation", *International Economic Review* 50(3): 903–27.

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

Anderson, K. (2009b), ‗Five Decades of Distortions to Agricultural Incentives', chapter 1 in K. Anderson (ed.), *Distortions to Agricultural Incentives: A Global Perspective, 1955-2007,* London: Palgrave Macmillan and Washington DC: World Bank.

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

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

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

Bach, C. and W. Martin, (2001), ‗Would the Right Tariff Aggregator for Policy Analysis Please Stand Up?' *Journal of Policy Modeling* 23: 62–35.

Chen, S, and M. Ravallion (2008), ‗The Developing World is Poorer Than We Thought, But No Less Successful in the Fight Against Poverty', Policy Research Working Paper 4703, World Bank, Washington DC, August.

Croser, J. and K. Anderson (2010), ‗Contributions of Different Policy Instruments to Trade and Welfare Effects of Price Distorting Policies', Contributed Paper for the Annual Conference of the Australian Agricultural and Resource Economics Society, Adelaide, 10-12 February.

Croser, J.L., P.J. Lloyd and K. Anderson (2010), ‗How Do Agricultural Policy Restrictions on Global Trade and Welfare Differ Across Commodities?' *American Journal of Agricultural Economics* 92(3) pp. 698–712.

Feenstra, R. (1995). ‗Estimating the Effects of Trade Policy', in G. Grossman and K. Rogoff (eds.), *Handbook of International Economics, Vol. 3*, Amsterdam: Elsevier.

Irwin, D. (2010), ―Trade Restrictiveness and Deadweight Losses from U.S. Tariffs, 1859-1961", *American Economic Journal: Economic Policy* 2(3): 111–133, August.

Kee, H.L., A. Nicita and M. Olerreaga (2009), ‗Estimating Trade Restrictiveness Indexes', *Economic Journal* 119(534): 172–99.

Lloyd, P.J. (1974), ‗A More General Theory of Price Distortions in an Open Economy', *Journal of International Economics* 4(4): 365-86, November.

Lloyd, P.J., J.L. Croser and K. Anderson (2009), ‗Welfare-Based and Trade-Based Indicators of National Agricultural Distortions', Ch. 11 in K. Anderson (ed.), *Distortions to Agricultural Incentives: A Global Perspective, 1955-2007*, London: Palgrave Macmillan and Washington DC: World Bank.

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) pp. 141–160.

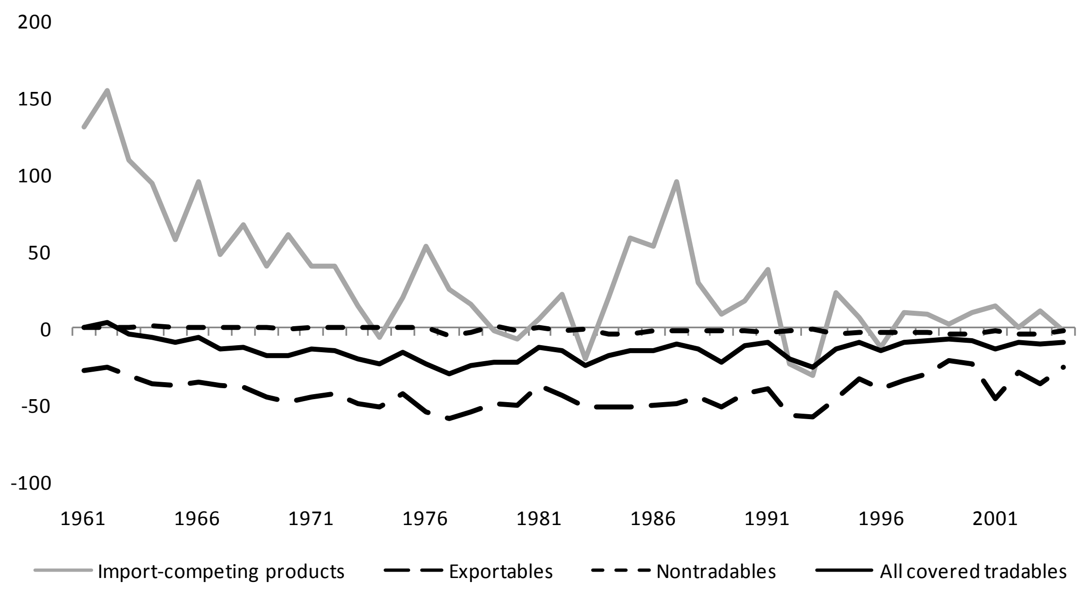
OECD (2009), *Agricultural Policies in OECD Countries: Monitoring and Evaluation 2009*, Paris: Organization for Economic Cooperation and Development.

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

Figures and Tables

Figure 1: Nominal Rates of Assistance for import-competing, exportable and all covered products, 19 African countries, 1961 to 2004

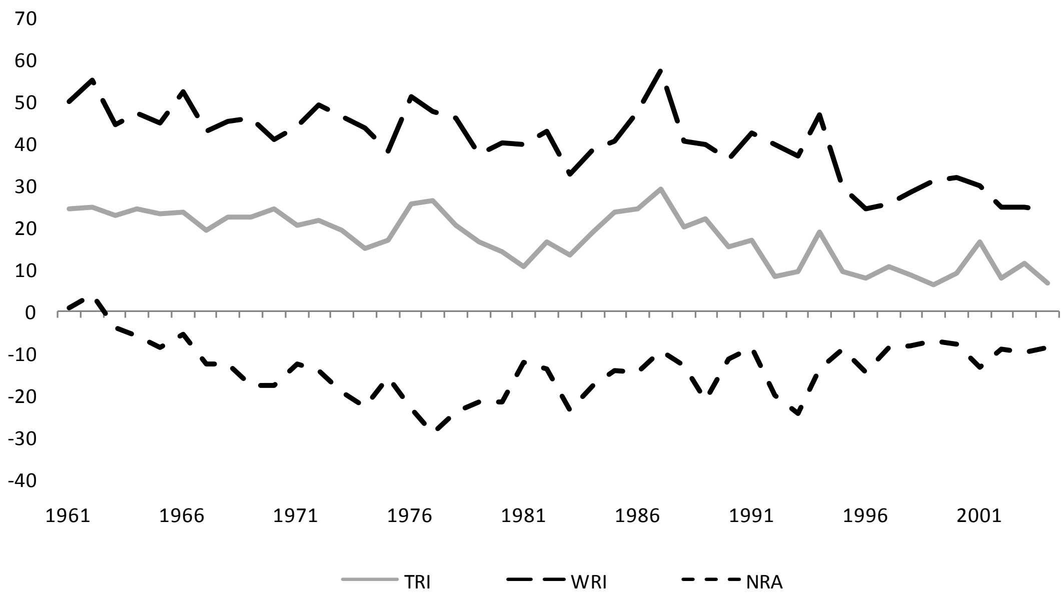
(percent)



Source: Anderson and Valenzuela (2008)

Figure 2: Trade and Welfare Reduction Indices, and Nominal Rate of Assistance for all covered products, 19 African countries, 1961 to 2004

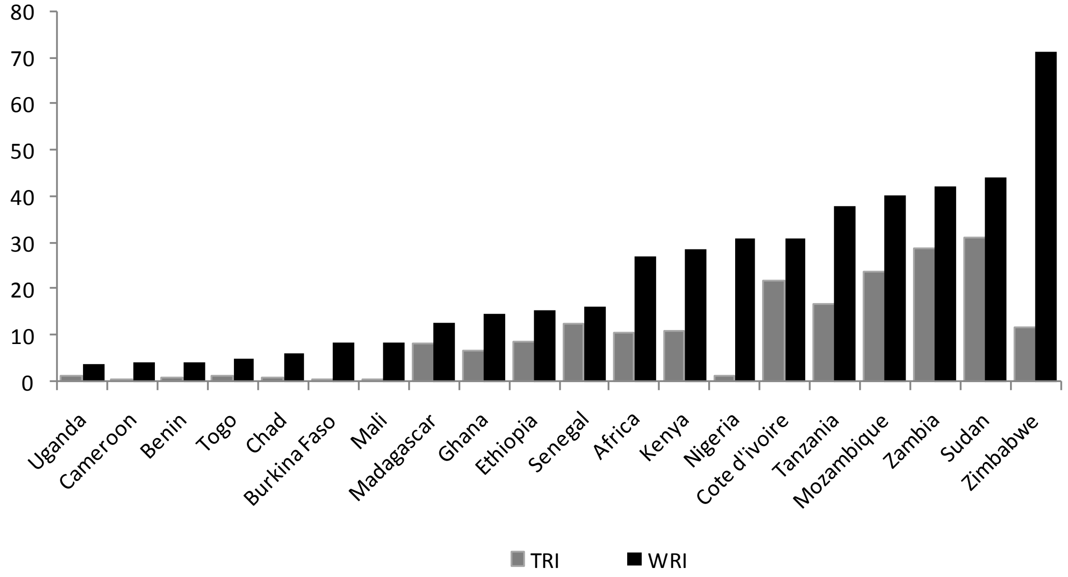
(percent)



Sources: Anderson and Croser (2009) based on NRA and CTE data in Anderson and Valenzuela (2008)

Figure 3: Trade and Welfare Reduction Indices, all covered products, 19 African countries and regional average[a], 2000–04

(percent)



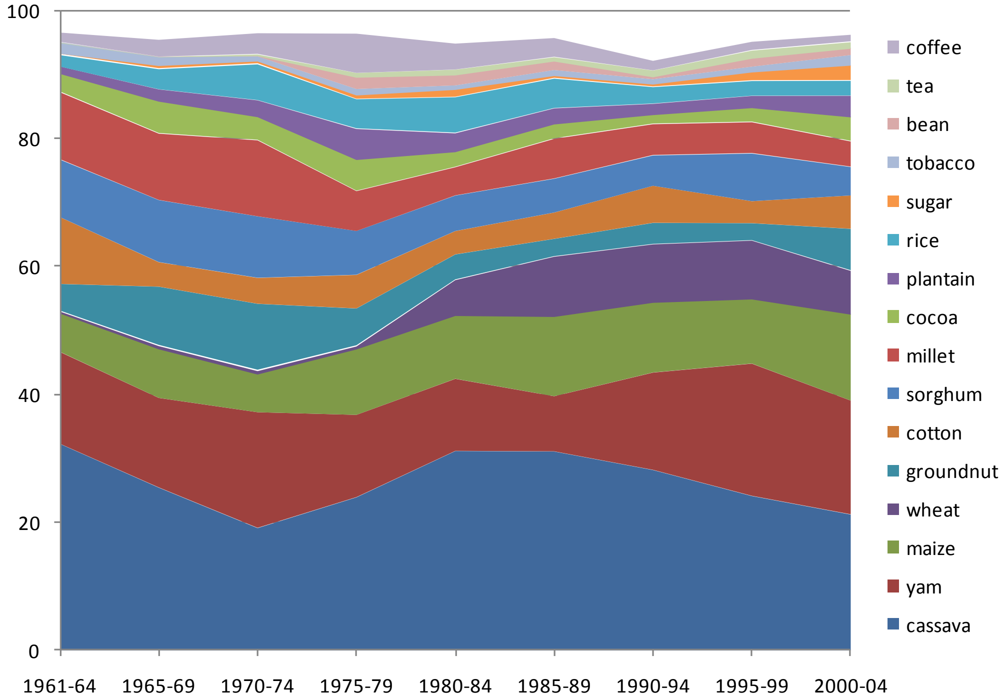
Source: Anderson and Croser (2009) based on NRA and CTE data in Anderson and Valenzuela (2008)

a. To get the regional average the national indexes are weighted by the average of the gross value of production and consumption at undistorted prices.

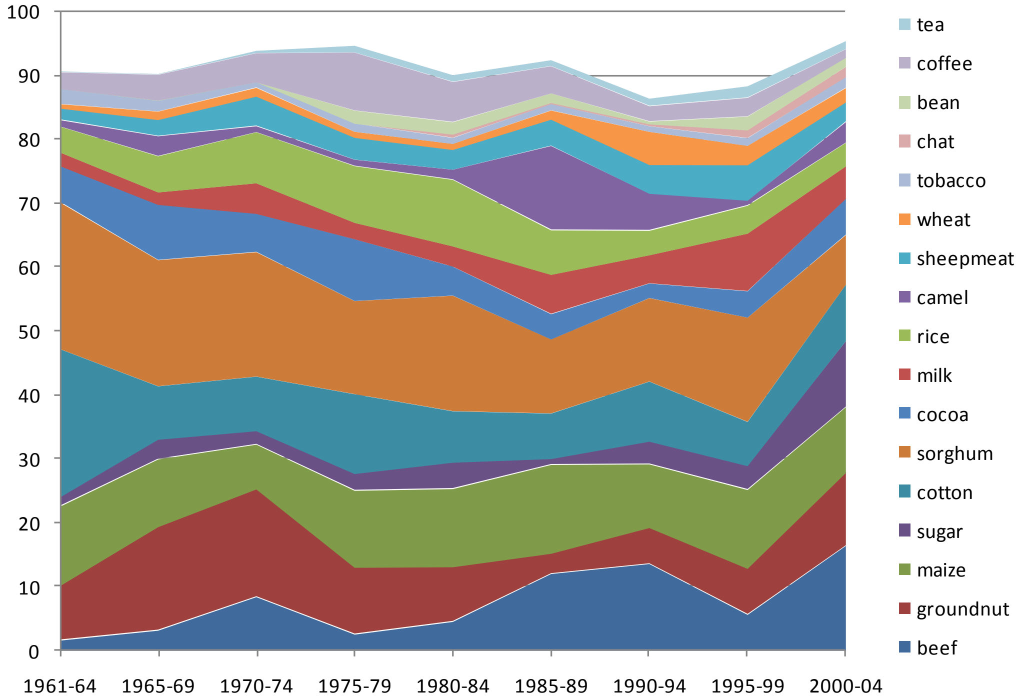
Figure 4: Product contributions[a] to the regional Welfare Reduction Index for 19 African countries, 1961–64 to 2000–04

(percent)

(a) Contributions to WRI, all covered products



(b) Contributions to WRI, all covered tradables (excludes nontradables)

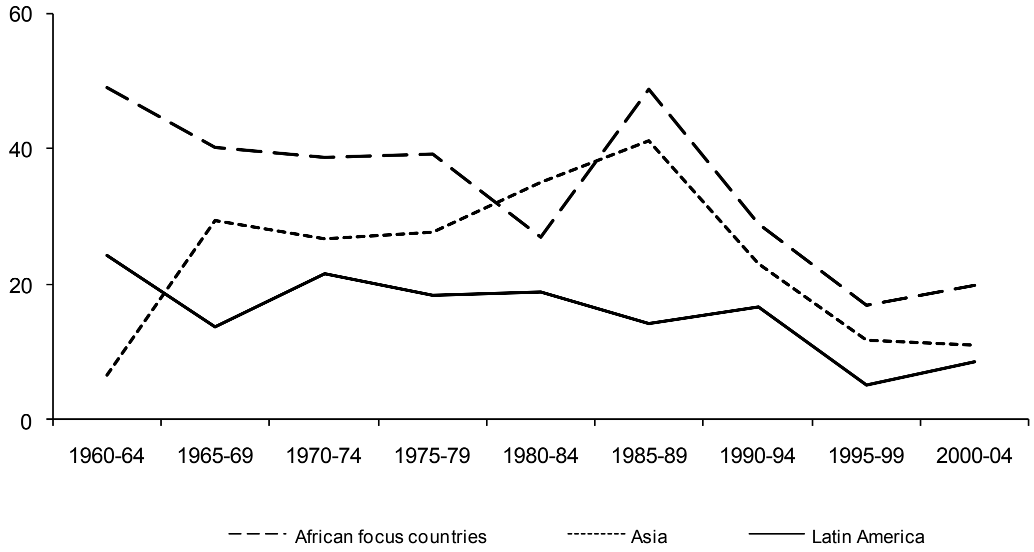


Source: Anderson and Croser (2009) based on NRA and CTE data in Anderson and Valenzuela (2008)
a. Products which contribute less than 1 percent to the WRI dollar amount in 2000–04 are omitted from the charts.

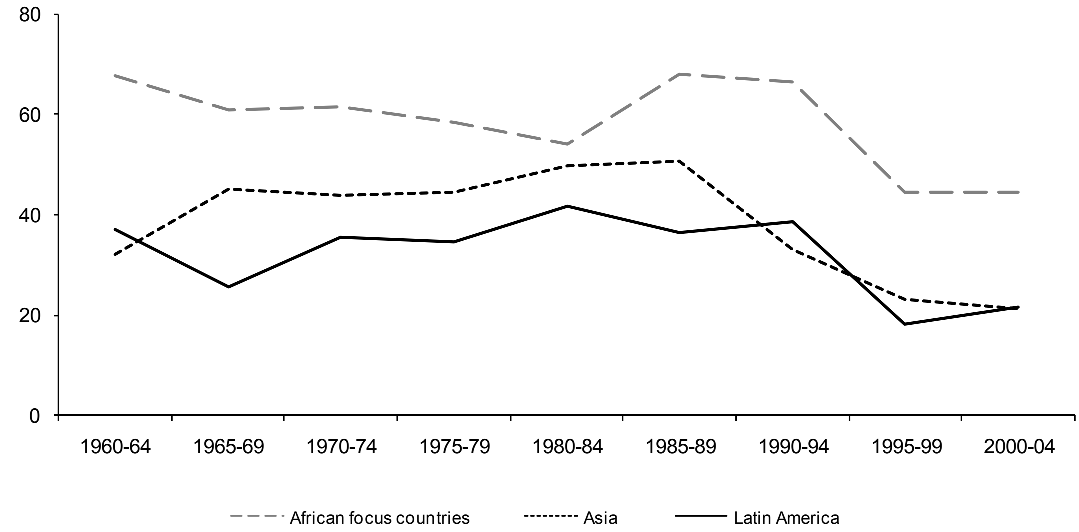
Figure 5: Trade- and Welfare-Reduction Indices, 19 African focus countries, Asia and Latin America, covered tradables, 1960–64 to 2000–04[a]

(percent)

(a) TRI



(b) WRI

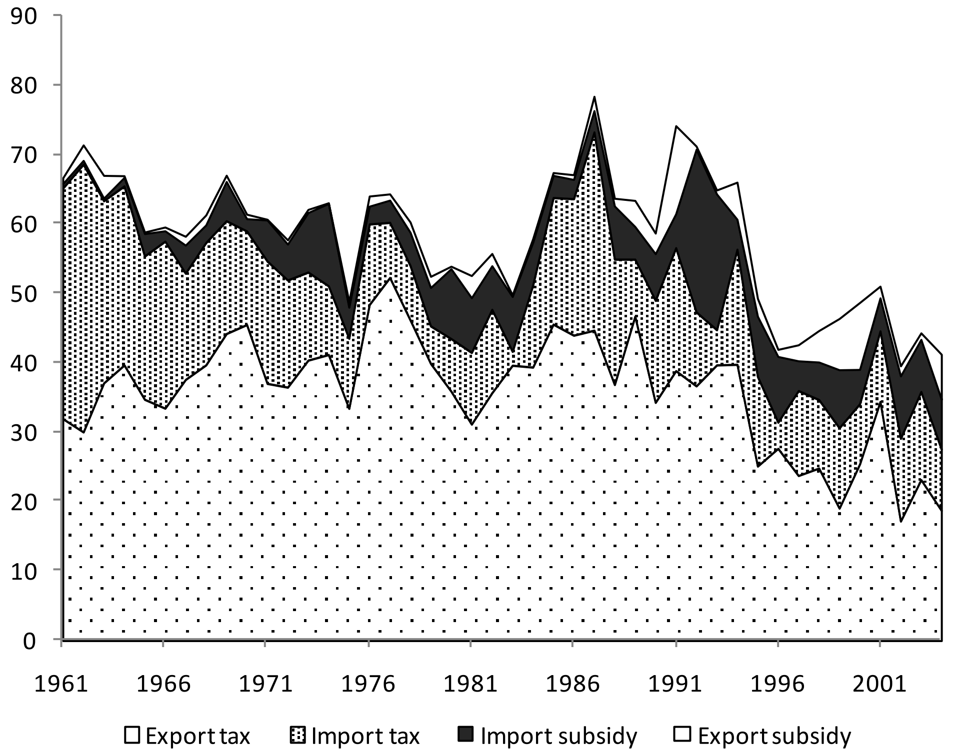


Source: Modified from Lloyd, Croser and Anderson (2009) using Anderson and Croser (2009), which is based on NRA and CTE data in Anderson and Valenzuela (2008)

a. 1960–64 is 1961–64 for Sub-Saharan African countries.

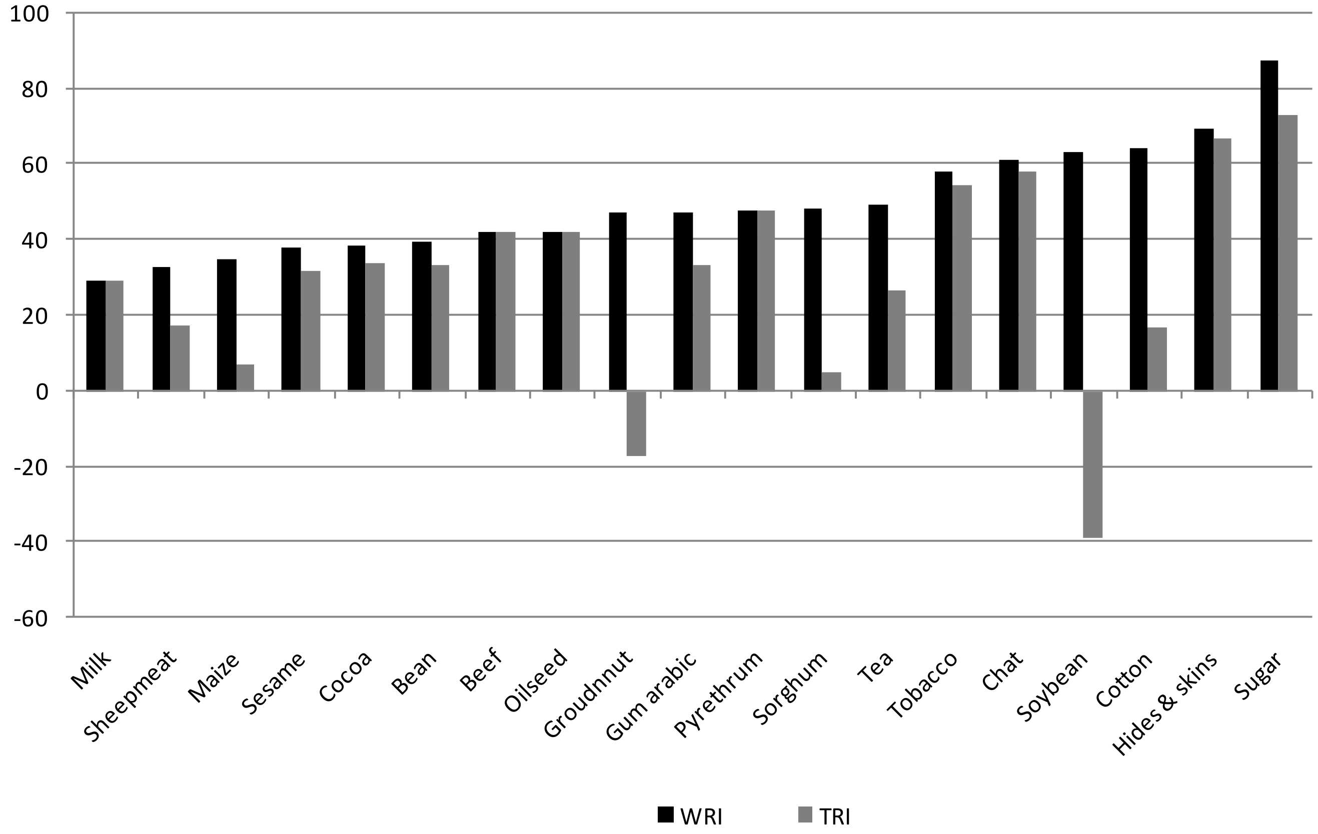
Figure 6: Decomposition of the Welfare Reduction Index[a] due to border measures, by policy instrument, 19 focus African countries, 1961 to 2004

(percent)



Source: Croser and Anderson (2010) based on NRA and CTE data in Anderson and Valenzuela (2008)

Figure 7: Commodity Trade and Welfare Reduction Indexes, markets of 19 African focus countries, all covered products[a], 2000–04 (percent)



Source: Anderson and Croser (2009) based on NRA and CTE data in Anderson and Valenzuela (2008)
a. Products with a WRI of less than 30 percent in 2000–04 are omitted from the chart; and camel — which has the highest WRI in 2000–04 — is also omitted.

Table 1: Summary of Nominal Rates of Assistance for import-competing, exportable, nontradable, and all covered agricultural products, Relative Rate of Assistance and Trade Bias Index, 19 African focus countries, 1961–64 to 2000–04

(percent)

	NRA, agricultural products[a]							Tradables share (%) of value of all covered agric. production
	Covered exportables	Covered importables	All covered tradables[b]	Covered nontradables	All covered products	Standard deviation of NRAs[b]	RRA[c]	
1961-64	-30	123	3	0	-1	34	5	49
1965-69	-39	62	-15	0	-11	33	-12	55
1970-74	-47	30	-27	0	-17	31	-19	55
1975-79	-52	22	-30	-1	-23	37	-27	54
1980-84	-47	4	-28	-1	-18	35	-17	46
1985-89	-50	49	-26	-2	-15	33	-22	46
1990-94	-49	5	-27	-2	-16	31	-19	41
1995-99	-32	3	-15	-3	-10	25	-11	39
2000-04	-32	7	-16	-3	-10	26	-18	43

Source: Anderson and Valenzuela (2008)

a. Nominal rates of assistance for the 19 African focus countries are weighted by the gross value of production at undistorted prices for the relevant sub-sector.
b. The simple average of the 19 focus countries‘ standard deviation of NRA around its weighted mean.
c. 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. The regional RRA is a weighted average of national RRAs, with weights being the gross value of production at undistorted prices for all agriculture.

Table 2: Nominal rates of assistance, all covered products, 19 African focus countries, 1961–64 to 2000–04

(percent)

	1961–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04
Africa	**-1**	**-11**	**-17**	**-23**	**-18**	**-15**	**-16**	**-10**	**-10**
Benin	na	na	-3	-1	-1	-1	-4	-4	-1
Burkina Faso	na	na	-2	-3	-4	-1	-3	-3	0
Cameroon	-4	-8	-12	-25	-19	-5	-4	-4	-1
Chad	na	na	-12	-11	-8	-1	-3	-3	-1
Côte d'Ivoire	-29	-35	-33	-40	-40	-28	-22	-22	-28
Ethiopia	na	na	na	na	-12	-15	-17	-10	-7
Ghana	-15	-28	-23	-41	-32	-8	-3	-5	-2
Kenya	13	-2	-24	-15	-30	-8	-30	-4	4
Madagascar	-19	-23	-20	-38	-51	-26	-7	-4	2
Mali	na	na	-6	-8	-7	-3	-5	-7	0
Mozambique	na	na	na	-56	-42	-51	-4	5	14
Nigeria	21	12	7	5	8	15	4	0	-5
Senegal	-15	-12	-33	-34	-30	5	7	-10	-12
Sudan	-26	-37	-48	-28	-33	-39	-54	-29	-15
Tanzania	na	na	na	-50	-60	-52	-30	-29	-17
Togo	na	na	-1	-1	-2	-2	-4	-3	-1
Uganda	-3	-5	-12	-24	-12	-14	-1	1	1
Zambia	-24	-32	-42	-57	-26	-68	-53	-34	-36
Zimbabwe	-36	-36	-44	-54	-47	-43	-45	-38	-73

Source: Anderson and Valenzuela (2008)

Table 3: Trade Reduction Index, all covered products[a], 19 African focus countries, 1961–64 to 2000–04

(percent)

	1961–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04
Africa	**24**	**22**	**20**	**21**	**15**	**24**	**14**	**9**	**10**
Benin	na	na	2	1	1	0	2	3	1
Burkina Faso	na	na	2	3	4	1	3	3	0
Cameroon	2	5	6	14	12	3	2	2	1
Chad	na	na	12	11	8	1	3	3	1
Côte d'Ivoire	13	13	24	27	19	17	12	15	22
Ethiopia	na	na	na	na	14	16	19	11	9
Ghana	6	11	10	22	20	15	7	3	7
Kenya	-16	-19	-4	12	21	19	-7	9	11
Madagascar	20	15	-13	6	-1	17	3	3	8
Mali	na	na	4	7	6	3	5	7	0
Mozambique	na	na	na	27	-6	-14	1	6	24
Nigeria	39	38	31	18	11	19	7	8	1
Senegal	14	10	30	36	28	25	26	7	12
Sudan	29	28	29	29	22	56	40	17	31
Tanzania	na	na	na	16	18	34	30	16	17
Togo	na	na	0	1	2	1	4	3	1
Uganda	2	4	8	14	9	10	2	2	1
Zambia	21	1	1	36	-11	-45	-27	-7	29
Zimbabwe	33	38	43	51	29	37	19	10	12

Source: Anderson and Croser (2009) based on NRA and CTE data in Anderson and Valenzuela (2008).

a. Includes all import-competing, exportable and nontradable products; with nontradable sectors assumed to have a zero level of distortion on the volume of trade.

Table 4: Welfare Reduction Index, all covered products, 19 African focus countries, 1961–64 to 2000–04

(percent)

	1961–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04
Africa	**49**	**46**	**45**	**44**	**39**	**45**	**40**	**28**	**27**
Benin	na	na	9	6	7	4	8	7	4
Burkina Faso	na	na	9	13	14	5	9	9	9
Cameroon	9	14	17	29	22	12	11	10	4
Chad	na	na	24	23	20	5	9	8	6
Côte d'Ivoire	28	36	36	40	38	30	25	25	31
Ethiopia	na	na	na	na	22	24	27	20	16
Ghana	17	30	28	44	49	36	17	11	15
Kenya	35	39	29	34	38	28	35	26	29
Madagascar	23	27	26	43	55	37	21	11	13
Mali	na	na	16	20	18	8	13	14	9
Mozambique	na	na	na	63	52	63	18	18	41
Nigeria	87	78	68	54	45	63	48	36	31
Senegal	17	15	38	41	36	50	55	11	16
Sudan	36	40	51	40	40	65	79	42	44
Tanzania	na	na	na	58	65	62	53	46	38
Togo	na	na	4	5	9	5	10	8	5
Uganda	6	9	20	35	24	24	4	4	4
Zambia	26	41	47	57	31	69	58	39	42
Zimbabwe	39	45	50	56	46	42	46	40	72

Source: Anderson and Croser (2009) based on NRA and CTE data in Anderson and Valenzuela (2008).

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Table 5: Country contributions to the regional Welfare Reduction Index for 19 African focus countries, all covered products, 1961–64 to 2000–04 and country contributions to the fall in the Welfare Reduction Index for all 19 countries from 1975–79 to 2000–04

(percent)

	1961-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	Contribution to fall in WRI 1975–79 to 2000–04[c]
Africa WRI	**49**	**46**	**45**	**44**	**39**	**45**	**40**	**28**	**27**	
Benin	-	-	0	0	0	0	0	0	0	0
Burkina Faso	-	-	0	0	0	0	0	0	0	0
Cameroon	2	3	3	4	2	1	1	1	0	-4
Chad	-	-	0	0	0	0	0	0	0	0
Cote d'Ivoire	3	5	5	8	6	4	4	4	5	1
Ethiopia	-	-	-	-	10	11	10	11	9	na
Ghana	2	4	3	4	4	3	2	2	3	1
Kenya	2	2	2	3	3	2	3	2	2	1
Madagascar	1	2	3	3	4	2	1	1	1	-2
Mali	-	-	0	0	0	0	0	0	0	0
Mozambique	-	-	-	2	2	1	1	1	2	2
Nigeria	74	60	51	36	37	37	38	45	35	34
Senegal	1	1	2	3	2	2	2	0	1	-3
Sudan	10	15	21	15	18	27	30	19	27	44
Tanzania	-	-	-	9	7	4	3	6	6	1
Togo	-	-	0	0	0	0	0	0	0	0
Uganda	1	2	4	7	4	2	0	1	1	-8
Zambia	1	2	2	2	1	1	1	2	2	1
Zimbabwe	3	4	4	4	3	2	3	3	5	7
Africa[b]	100	100	100	102	103	100	100	100	100	100

Source: Authors' calculations from data in Anderson and Croser (2009) based on NRA and CTE data in Anderson and Valenzuela (2008).

a. Country contributions are computed by converting national percentage WRIs to dollar values by multiplying by the average of the gross value of production and consumption at undistorted prices. The country contributions therefore capture both the magnitude of the WRI and the share of a country's gross value of production and consumption in the regional value of production and consumption.
b. The total for all countries does not necessarily sum to 100 for five-year averages, but it does sum to 100 for individual years.
c. This column gives the country contribution to the fall in the WRI from 1975–79 to 2000–04.

Table 6: Trade and Welfare Reduction Indexes, all covered products and all tradables, 19 African focus countries and 16 African focus countries, 1961–64 to 2000–04

(percent)

	1961-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
19 Africa focus countries									
Trade Reduction Indexes									
Covered tradables	49	40	39	39	27	49	29	17	20
All covered products	24	22	20	21	15	24	14	9	10
Welfare Reduction Indexes									
Covered tradables	68	61	61	58	54	68	67	45	45
All covered products	49	46	45	44	39	45	40	28	27
16 African focus countries[a]									
TRI, Covered tradables	21	22	21	26	18	50	18	14	14
WRI, Covered tradables	51	51	52	49	50	80	52	37	36

Source: Lloyd, Croser and Anderson (2010) and Anderson and Croser (2009) based on NRA and CTE data in Anderson and Valenzuela (2008).

a. 1961–64 results are for 1960–64 for 16 African focus countries. The 16 African focus country results are those reported in Lloyd, Croser and Anderson (2010). The 16 countries are those in this study including Egypt and South Africa, and excluding the five cotton countries — Benin, Burkina Faso, Chad, Mali and Togo.

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Table 7: Commodity Welfare Reduction Index, African regional market of 19 focus countries, 33 covered products, 1961–64 to 2000–04
(percent)

	1961-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Grains	**59**	**50**	**44**	**34**	**28**	**33**	**26**	**20**	**18**
Cassava	0	0	1	1	3	1	1	4	3
Maize	114	73	63	71	54	67	40	38	35
Millet	18	18	11	5	10	13	16	18	8
Rice	31	30	40	36	48	60	38	16	18
Sorghum	153	144	118	95	83	95	80	52	49
Wheat	17	37	40	30	14	16	35	16	16
Oilseeds	**28**	**42**	**54**	**49**	**47**	**40**	**72**	**43**	**36**
Cashew	na	na	na	80	80	85	61	13	11
Groundnut	27	43	54	51	50	35	60	41	47
Oilseed	na	na	na	na	47	52	61	56	42
Palmoil	25	31	45	26	28	44	132	50	13
Sesame	50	60	62	65	56	44	47	45	38
Soybean	na	14	34	44	45	44	56	52	64
Sunflower	0	0	0	0	0	0	0	0	0
Tropical crops	**36**	**41**	**45**	**61**	**54**	**49**	**53**	**44**	**51**
Cocoa	31	51	46	62	54	41	37	37	38
Coffee	39	41	46	64	56	48	47	35	21
Cotton	42	35	44	57	59	59	71	59	64
Sugar	22	35	47	49	43	38	45	45	87
Tea	12	8	24	56	52	47	51	50	49
Tobacco	39	38	48	56	50	50	40	39	58
Fruit & vegetables	**0**	**0**	**0**	**4**	**5**	**5**	**2**	**5**	**5**
Banana	2	4	0	2	2	1	5	5	2
Bean	7	10	3	48	62	73	35	42	40
Fruit & vegetable	0	3	7	2	6	3	5	1	0
Roots & tubers	0	0	0	0	0	0	0	0	0
Pepper	na	42	9	39	47	80	30	62	27
Plantain	0	0	0	0	0	0	0	0	0
Potato	na	na	na	0	0	0	0	0	0
Sweet potato	0	0	0	0	0	0	0	0	0
Yam	0	0	0	1	2	1	1	4	4
Livestock	**30**	**36**	**52**	**35**	**33**	**68**	**66**	**40**	**38**
Beef	34	42	58	29	29	60	73	43	42

(Continued over)

	1961-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Camel	38	60	34	38	34	68	84	49	99
Hides & skins	na	na	na	na	67	71	73	71	70
Milk	19	16	41	36	29	79	40	30	29
Sheepmeat	42	48	61	46	38	59	70	54	33
Other	**37**	**37**	**43**	**61**	**43**	**46**	**39**	**27**	**24**
Chat	na	na	na	na	71	66	70	67	61
Clove	na	45	39	81	92	85	63	49	20
Gum arabic	22	30	41	33	43	47	41	42	47
Pulse	na	na	na	na	37	63	58	39	24
Pyrethrum	na	na	na	82	71	73	37	68	48
Sisal	na	na	na	39	41	31	17	1	0
Teff	na	na	na	na	5	8	8	4	7
Vanilla	61	53	39	57	76	85	78	32	17

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

Manuscript 5:

Agricultural 'Protection for Sale' at different stages of development

Johanna L Croser

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Agricultural 'Protection for Sale'

at different stages of development

Abstract

This manuscript applies a new test of the Grossman and Helpman (1994) Protection for Sale (PFS) model to agriculture for countries at different stages of development. Using the new method and data from the World Bank's recently released Agricultural Distortions database (Anderson and Valenzuela 2008), the paper finds some support for the PFS model. This is most notably between import-competing industries and in high-income countries, but less so for exporting industries and in developing countries. The results suggest that institutions matter — democracies and non-presidential governance institutional arrangements on average have higher sectoral protection levels in agriculture.

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Agricultural 'Protection for Sale' at different stages of development

Political economy analysts have long been interested in questions about why agriculture is protected in some sectors and disprotected in others. Perhaps the most influential model of the political economy of distortions in the last 15 years is the Grossman and Helpman (1994) ‗Protection for Sale' (PFS) model. With its strong microfoundations and empirical support in several US contexts, this model quickly became a dominant model in the literature. Remarkably for such a seminal model, there is little empirical support for the model outside the US, and even less for developing countries. A key question therefore remains about whether protection is for sale in countries outside the US, and related questions about whether protection is for sale at different levels of development. There are reasons for supposing that agricultural protection at different stages of development is motivated by different factors. A good starting point in understanding these differences is to test whether the seminal PFS model holds in countries at different levels of development.

The reason that the PFS model has not been tested across countries at different levels of development is that the model has traditionally been thought only to be estimable with data on lobbying. However, Imai, Katayama and Krishna (2008) have developed a way to test the PFS that does not require data on lobbying. The method is an application of the recently developed instrumental variables quantile regression (IVQR) technique (Chernozhukov and Hansen 2005, 2006, 2008). The quantile regression approach provides a truer test of the PFS model based more closely on the theory of the model, and it does away with the need for arbitrary classification of sectors as politically organized or not in the absence of lobbying data.

Using the IVQR approach, this paper tests the PFS model in a cross-country setting to determine if there is support for the model in agriculture and whether the model holds at different levels of development. Agriculture is a good example for this test, because it traditionally has both protection and disprotection,[56] and there are reasons to believe that the PFS model might hold only at advanced stages of development (i.e. in high-income countries), but not in developing countries where other political objectives operate.

In addition to the new IVQR methodology, three other recent developments make this paper possible. The first development is the release of the World Bank's Agricultural Distortions database (Anderson and Valenzuela 2008). The database contains consistent estimates of agricultural protection and disprotection for 75 agricultural products across 75 countries. It also provides estimates of import and export penetration ratios, which are key regressors in the PFS model. The database contains data for five decades of agricultural distortion and therefore allows for the model to be tested over time to see if there is more support for the model under different policy regimes.[57] The data includes not just import tariffs/protection but all forms of policy instruments that cause nominal rates of assistance (NRAs) and consumer tax equivalents (CTEs) to be above or

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[56] See Anderson (2009) for a recent overview of patterns of agricultural protection in 75 countries over the past five decades.
[57] For example, many developing countries taxed agriculture up to the mid-1980s, before switching to positive levels of protection.

below zero (positive or negative). The data identifies the extent to which a country is import or export dependent for each product each year (which may change over time). The sample contains the full spectrum of countries at different stages of development and with a variety of government institutional arrangements. The Agricultural Distortions database has been used for political economy work (see Anderson 2010), but this is the first study that exploits the product level data in the database to examine the seminal PFS model.

The second additional development that makes this paper possible is the recently released estimates of import demand elasticities across countries and commodities by Kee, Nicita and Olarreaga (2008). Import demand elasticities are a key input into the PFS model. The Kee, Nicita and Olarreaga series includes import demand elasticities for agricultural products.

The third development is the recent release of two databases: a joint FAO and IFPRI database called Agro-MAPS (Mapping of Agricultural Production Systems), which provides sub-national data on the concentration of crops production; and the GLiPHA (Global Livestock Production and Health Atlas) database which provides sub-national data on the concentration of livestock production. These two databases allow for the construction of an important instrumental variable for the analysis: a Herfindahl index of the geographical concentration of production within a sector. In short, several areas of research have coalesced to make this paper possible at this time.

In addition to examining whether there is support for the PFS model in agriculture at different stages of economic development, this paper also considers support in the PFS context for other political economy of agriculture theories which have developed in recent years. This is done by way of the inclusion of a series of control variables in the econometric estimation. The variables capture emerging ideas that institutions matter in the formation of trade policy. As this is a cross-country study, it exploits the available data on different political institutions to see if the PFS model holds under different political institutional settings.

Applying the new quantile-based test of the PFS model to the agricultural commodities in the Agricultural Distortions database, this paper finds some support for the PFS model. The support is strongest for import-competing sectors alone. One interpretation of this finding is that government's make decisions about agricultural trade policy within the import-competing sector; but other government objectives might drive policy decisions in exportable industries. The global results are found to be driven mostly by high-income countries. Trade policy distortions in developing countries as a pooled sample do not accord as well with the theoretical predications of the PFS model.

The paper is structured as follows: Section I gives a brief overview of the conceptual framework and existing empirical literature. Section II presents the econometric specification and methodology employed in the paper. Section III details the data. Results are presented in section IV. Section V concludes, notes caveats on the results and discusses areas for further research.

Conceptual framework and previous evidence

Within the literature on the political economy of trade policy, one strand of theoretical models, called lobbying models, posit that governments use trade policy as an indirect tool to redistribute income to organized special-interest groups.[58] Of this group, the Grossman and Helpman (1994) Protection for Sale (PFS) model has been the most influential, redirecting the analysis of the political economy of trade policy for the last 15 years. The PFS has been influential because it provides strong micro-foundations about the behaviour of different actors in the economy and it is easy to work with and understand. Further, the two main predictions of the model are intuitive. The model is a general equilibrium model of a small open economy with a government that values the population's welfare and money contributions. The government has available trade policy tools that it can use to redistribute profits among producers and consumers. Because producers know this, they can organise into lobbying groups who offer the government money contributions to set government policy in a way that raises their profits. The predictions of the model are that: first, all else equal, sectors that have high import demand or export supply elasticity (in absolute value) will have smaller ad valorem deviations from free trade. Governments prefer to raise lobbying contributions from sectors where the cost is small, and because owners of specific factors in different sectors (who share in the deadweight loss from trade policy) will bid more to avoid protection in sectors that have a greater social cost of protection. Second, all else equal, specific factor owners in sectors with high domestic output (relative to imports or exports) have more to gain from an

[58] There are numerous comprehensive survey articles of political economy of trade policy. See Swinnen (2010) for a good overview in context of agriculture. Within the lobbying model group, there are 4 broad sub-groups of models: (1) the tariff-formation approach; (2) the political support function approach; (3) the political contributions approach; and (4) the campaign contributions approach (Rodrik 1995). See Dutt and Mitra (2010) for an overview of the key theoretical papers in each of these groups.

increase in domestic price due to trade policy, while the costs of protection are lower when the volume of imports or exports is low.

In this paper, I empirically test whether there is support for the main predictions of the PFS model in a cross-country setting. An abridged version of the PFS model is presented next for expositional purposes.

Protection for Sale model

The PFS model assumes a small, open economy producing *n* non-numeraire goods, each requiring a different kind of factor of production specific to that good, and labour. There is a numeraire good which is produced under constant returns to scale using only labour.

Consumption: There is a continuum of individuals, each of infinitesimal size. Each individual possesses labour and at most one kind of specific factor of production. Individuals have identical preferences and each maximise a utility function, and corresponding indirect utility function, as follows:[59]

$$u = c_0 + \sum_{i=1}^{n} u_i[c_i] \qquad \text{and} \qquad v = E + \sum_{i=1}^{n} s_i[p_i]$$

where $u_i[c_i]$ are the sub-utility functions for each non-numeraire good, E is expenditure, and $s_i[p_i]$ are the sector-specific consumer surplus functions, c_0 is the consumption of the numeraire good, c_i is the consumption of the typical good

[59] The quasi-linear utility function that is linear in numeraire good consumption, concave in the consumption of each non-numeraire good, and additively separable across all goods eliminates general equilibrium considerations from income effects; and ensures preferences are separable across sectors to eliminate the cross-price effects of demand.

i and p_i is the price of good i. One of the appealing features of the specification is that consumer surplus perfectly captures the welfare impacts of price changes.

Production: There is perfect competition in a specific factor setting. Each non-numeraire good is produced under constant returns to scale by a factor specific to the sector and labour. Labour's price is pinned down by productivity in the numeraire sector. Each specific factor is paid the Ricardian rent which depends on the price of the good using the specific factor. Producers have an incentive to influence government to increase the price of their good, since that increases their rent. For a typical consumer (owner of specific factor), E is therefore the labour income, wL, plus a payment to whatever specific-factor is owned, plus a share of tariff revenue, r (see below).

Lobby groups: In some sectors, owners of specific factors form lobbying groups to influence government, who make or amend trade policy. Being organized or not is exogenous to the model. In sectors that are politically organized, the specific factor owners are able to lobby the government for preferential treatment in the form of higher trade protection for their own sectors and lower protection for other sectors. They do this by making contributions to the government to influence policy if it will raise their total welfare.

Government: The government maximises an objective function, Ω, with two distinct components: political contributions by lobbies and aggregate social welfare, W (which is the sum of indirect utility across consumers):

$$\Omega = aW + \sum_{j \in \Lambda} C_i \qquad (1)$$

where Λ is the set of sectors that are politically organized (and thus make political contributions) and C_i is the contribution of sector *i* which depends on the vector of domestic prices of the non-numeraire goods. The parameter *a* is the weight the government attaches to aggregate social welfare relative to political contributions from lobbies. Government redistributes revenue uniformly across all its citizens. The only policy instruments available to politicians are trade taxes and subsidies on the N non-numeraire goods.

Trade policy game: The interaction between the government and the lobbies takes the form of a two-stage ‗menu-auction‘ game (Bernheim and Whinston 1986). In stage 1, each lobby simultaneously provides the government with their ‗contribution schedule‘ taking into account the government‘s objective function. Each lobby takes the contribution schedules of other lobbies as given. The contribution schedule of each lobby maximises its aggregate utility given by factor income plus consumer surplus less contributions by its members. In stage 2: taking into account the contribution of offer schedules from the previous stage, the government sets trade policy to maximise the weighted sum of political contributions and overall social welfare. In order to obtain a unique equilibrium, lobbyists‘ contributions are restricted to those that are ‗truthful‘. In essence, the PFS model is applied contract theory. The lobbies present the government with incentive contracts called contribution schedules to induce the government to do what the lobbies want it to do.

Equilibrium outcome: The outcome of the two-stage game is a set of trade taxes and subsidies that satisfy the Grossman-Helpman modified ‗Ramsey Rule‘:

$$\frac{b_i}{1+b_i} = \frac{I_i - \alpha_L}{a + \alpha_L} \cdot \frac{z_i}{e_i} \qquad (2)$$

where $b_i = (p_i - p_i^*)/p_i^*$ (and p_i^* is the free trade price in sector *i*), I_i is an indicator variable taking a value of 1 if sector *i* is politically organized, and zero otherwise, z_i is the equilibrium ratio of domestic output to trade (positive for imports, negative for exports), e_i is the elasticity of import demand or of export supply (the former defined to be positive, the latter negative), and α_L is the fraction of voters who are represented by a lobby.

The interpretation of the Ramsey Rule is as follows. First, all else equal, sectors that have high import demand or export supply elasticity (in absolute value) will have smaller ad valorem deviations from free trade. Governments prefer to raise lobbying contributions from sectors where the cost is small, and because owners of specific factors in different sectors (who share in the deadweight loss from trade policy) will bid more to avoid protection in sectors that have a greater social cost of protection. Second, all else equal, specific factor owners in import sectors with high domestic output (relative to imports) have more to gain from a given increase in domestic price due to trade policy. Further, the lower imports or exports in a sector (i.e. the denominator in z_i), the lower the social cost that a tariff or subsidy imposes on the population, making the government more amenable to distorting prices in those sectors. Third, the smaller the weight that the government places on a dollar of aggregate welfare compared with a dollar of campaign financing, *a*, the larger in absolute value are all trade taxes and subsidies. Fourth, as the share of voters who are members of an interest group increases, equilibrium rates of protection for the organized sectors decline.

At the extreme, when all voters belong to an interest group and all sectors are organized, free trade prevails in all markets.

The Ramsey Rule in (2) can be converted into a testable hypotheses along the same lines as Gawande and Bandyopadhyay (2000):

$$\frac{b_i}{1+b_i} = \beta_0 + \beta_1 \cdot I_i \cdot \frac{z_i}{e_i} + \beta_2 \cdot \frac{z_i}{e_i} + \varepsilon_i \qquad (3)$$

where ε_i is an error term.[60]

Previous Empirical Support for Protection for Sale

Empirical work on PFS has tended to confirm the predictions of the model. Goldberg and Maggi (1999) and Gawande and Bandyopadhyay (2000) provided the first empirical tests of the PFS model for US manufacturing industry data using different econometric specifications. Both studies used NTB coverage ratios in the US as the measure of trade protection, and both used data on corporate political contributions to determine the political organization indicator variable (I_i) for each sector. Goldberg and Maggi (1999) used various threshold levels of campaign contributions to determine whether a sector is classified as organized.

[60] To be explicit for import-competing and exportable sectors separately, we have from Gawande and Hoekman (2006): If *i*'s producers compete with imports:

$$\frac{t_i}{1+t_i} = \beta_0 + \beta_1 \cdot I_i \cdot \frac{z_i^M}{e_i^M} + \beta_2 \cdot \frac{z_i^M}{e_i^M} + \varepsilon_i$$

where t_i is the ad valorem distortion (positive or negative) on imports of good *i*, $z_i^M = y_i / m_i$ is the equilibrium ratio of domestic output to imports and e_i^M is the absolute elasticity of import demand. If *i*'s producers are exporters:

$$\frac{s_i}{1+s_i} = \beta_0 + \beta_1 \cdot I_i \cdot \frac{z_i^X}{e_i^X} + \beta_2 \cdot \frac{z_i^X}{e_i^X} + \varepsilon_i$$

where s_i is the ad valorem distortion (positive or negative) on exports of good *i*, $z_i^X = y_i / x_i$ is the equilibrium ratio of domestic output to exports, e_i^X is the elasticity of export supply.

Gawande and Bandyopadhyay (2000) regressed campaign contributions on a set of variables including import penetration. Those sectors with positive predicted campaign contributions were considered organized. Both studies adopted methodologies that account for the possible endogeneity of I, z and e in equation (3). In large part, the two studies verified the theory, although not without some unexplainable results, most notably an implausibly high estimate of the weight on welfare relative to lobbying contributions in the government‘s objective function.

Extensions to the basic framework examine more specifically PFS in agriculture (Gawande and Hoekman 2006) and food industries (Lopez 2008), and Bombardini (2008) incorporates firm size into the PFS model. Kee, Olarreaga and Silva (2007) examine the extent to which foreign lobbying determines preferential market access to the US. They find access to the US market is up for sale and foreign lobbies are buying it. These empirical extensions all take place within a US context.

The base PFS model has found support in a few contexts outside the US. Single country studies have been done for Australia (for the periods 1968/69 and 1991/92) (McCalman 2004) and for Turkey (for four different years between 1983 and 1990) (Mitra, Thomakos and Ulubasoglu 2002). There are two regional papers that attempt to test PFS in a cross-country setting. Belloc and Guerrieri (2008) modify the PFS model to better fit the EU institutional environment and find support for that modified version of the model. Gawande, Singuinetti and Bohara (2005) test an extension of the PFS model for Mercosur countries and find support for PFS.[61] Both of these ambitious regional studies have drawbacks, however, in terms of their classification of sectors as politically organized (discussed further below).

The reason that the PFS model has only been tested for a handful of countries outside the US is that the model has traditionally been thought only to be estimable with data on lobbying (either foreign or domestic, as an indicator of whether a sector is politically organized or not). In the US, detailed cross-sectoral data on Political Action Committee (PAC) campaign contributions and foreign lobby contributions is available, which has been used as the basis of classifying different sectors as organized. The Australian and Turkish studies used creative approaches to construct instruments for political organization. For Australia, McCalman (2004) classifies a sector as politically organized if a Tariff Board report was prepared on it between 1960 and 1969. The rationale is that sectors had to be organized to request a Tariff Board report. For Turkey, Mitra Thomakos and Ulubasoglu (2002) use primarily membership of the Turkish Industrialists and Businessmen Association (TUSIAD) as the basis of constructing an indicator of whether an sector is politically organized or not. Other studies outside the US have used more arbitrary means of classifying sectors as organized, including a classification based on whether imports or exports surpass the sample mean (Gawande, Singuinetti and Bohara 2005); a classification of all agriculture sectors as politically organized on the basis that agriculture traditionally enjoys a ‗privileged position' with regard to protection in the EU (Belloc and Guerrieri

[61] The extension tested is the Grossman and Helpman (1995) model of the politics of free trade agreements (FTAs). The model makes predictions about which industries are most likely to be excluded from an FTA, in order for an FTA to come into existence.

2008); and a classification of all sectors as organized (Gawande, Krishna and Olarreaga 2009), albeit when the PFS model is being estimated for a different purpose (namely to investigate the parameter *a* from equation (2)).[62]

In addition to the limited empirical testing of the PFS model across countries at different levels of development, recently Imai, Katayama and Krishna (2009b) have questioned the empirical approaches taken to estimating the PFS model. Their key concerns in the US studies are: the use of estimated import demand elasticities as regressors where these estimates often have the wrong sign and/or are insignificant; the methods of classifying sectors as politically organized or not, and in particular whether the methods are consistent with the PFS model theory; the lack of a well-specified alternative hypothesis; and the estimation of an implausibly high weight on welfare relative to contributions, *a*.[63] To overcome some of these issues, Imai, Katayama and Krishna (2008) propose a way to test the key predictions of the PFS model without using data on political organization. Their method is based on quantile regression analysis. The approach provides an opportunity to test the PFS model across a broader group of countries than the US, and importantly to answer the question of whether support for the PFS model can

[62] Gawande, Krishna and Olarreaga (2009) estimate a version of the PFS model given by:

$$\frac{b_i}{1+b_i}.\frac{e_i}{z_i} = \rho + \zeta_i$$

and they recover from the ρ parameter the weight the government puts on aggregate welfare relative to contributions in its objective function, *a*. They rank countries on the basis of *a* and look at correlations with political variables from the World Bank's database of Political Institutions (Beck et al. 2001) such as constraints on the executive and party concentration. Their methodology to obtain cross-country estimates of *a* is based on two strong assumptions: all sectors are politically organized; and a negligible proportion of the population are organized in lobbies.

[63] On this last point, several papers adjust the theory and empirical predictions of the PFS model to aim to obtain a more plausible estimate of the domestic welfare weight. Most studies are broadly within the same framework, however, and would be subject to the same criticisms from Imai, Katayama and Krishna (2009b). See Swinnen (2010) for an overview of adjustments to the PFS model to obtain a more plausible estimate of the domestic welfare weight.

be found for countries at different stages of development and for different governmental arrangements. This paper adopts their empirical approach and applies it in a cross-country setting.

Understanding whether PFS holds in different countries at different levels of development is important for a number of reasons. First the PFS model is pervasive and so it is important to know how much empirical support there is for the model on a global scale. Gawande and Bandyopadhyay (2000), in motivating their empirical work, suggest that the PFS model has the potential to be a theoretical paradigm in the political economy literature. Knowing whether or not there is support for the PFS model also helps to answer questions about whether there are certain fundamental variables that, on average, help determine policy in different countries. It is also of interest to know if there is more support for PFS in developed, as opposed to developing, countries. It could be that the PFS model is more well suited to agriculture in developed countries, where organised farming lobbies almost certainly play a role in agricultural policy; while in developing countries, other policy objectives such as price stability and food security, are more important.[64]

It is of interest to know whether the PFS model holds within the agricultural sector. If support can be found for the PFS model in the agricultural sector of a country, it might suggest that governments make policy decisions across agricultural sectors — choosing to protect some agricultural commodities

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[64] Of course, in all countries, agricultural lobbies may be very effective without any financial transfers. In small countries, it is probably that the lobby group can ‗bend the political ear' of a friend in government over lunch or on the golf course in order to achieve the desired result. However, this paper is looking for whether there are systematic influences in both developed and developing countries which increase a lobby's effectiveness or not.

at the expense of others. Such a finding could be a possible explanator of the diversity in levels of distortion across agricultural products within countries, whether developed or developing. Anderson, Croser, Sandri and Valenzuela (2010) document the great diversity in agricultural NRAs and CTEs across products within 75 countries over the past 50 years.

Two papers in the US context look specifically at agricultural protection in the political economy lobbying model framework. Gawande and Hoekman (2006) find direct support for the PFS model within agriculture in the US for 94 agricultural sectors (41 import-competing and 53 exportables). Gardner (1987) finds support for the notion that governments allocate protection across agricultural sectors to minimize welfare efficiency losses in a sample with 17 commodities. Gardner‘s theoretical framework — which predates the PFS model — accords with the intuition from the PFS model, albeit with less solid microfoundations. The model assumes a government that maximises an objective function that is the weighted sum of buyer‘s surplus (*B*) and producer rents (*R*): $W = B + \theta R$. Each sector has a sector-specific parameter θ that can be thought of as a measure of lobbying effectiveness (whereby producers seek to have the government place a higher weight on their share of economic welfare). Gardner finds that, among other things, price elasticities of demand and supply of commodities and the stakes of redistribution (output per farm) matter in determining the θ weight.

One issue to be mindful of in estimating the PFS model for agriculture across developed and developing countries is that the PFS might not fit well with some of the stylized facts observed in patterns of agricultural protection. Two stylized facts include a positive correlation between agricultural protection and average country incomes (i.e. rich countries tend to protect agriculture, while developing countries tend to tax agriculture — in absolute terms, and also relative to non-agriculture); and an anti-comparative advantage pattern of agricultural protection (i.e. protection tends to be lower (or taxation higher) in countries with a comparative advantage in agriculture).[65] With respect to both of these stylized facts, however, it is important to note that the facts are observed for agriculture as a whole. There remains a great deal of diversity in the levels of protection (both positive and negative) across agricultural sectors within countries, which needs to be explained. Why do rice, milk and sugar sectors persistently receive high levels of protection in developed as well as developing countries (see Anderson, Croser, Nelgen and Valenzuela 2009, for example)? Why do some products get taxed in developing countries, but protected in high-income countries (such as cotton)? Why do some goods (such as poultry, pigmeat, soybean) receive relatively low levels of assistance in both developed and developing countries? To answer these questions, it is plausible to test whether the PFS model can explain as a starting point the cross-sectoral variation in agricultural protection.

Econometric specification and methodology

65 Several papers in the political economy literature for agriculture seek to explain these and other stylized factors. Anderson (1995) explains some of the stylized factors using an influence-driven approach of political economy. Cadot, de Melo and Olarreaga (2004) bring together Anderson (1995) and the PFS model to make the PFS model more consistent with the empirical observations. They apply a theoretical twist to the PFS model (factor-market rivalry and input-output linkages) and are able to derive, among other things, the result that rich countries protect agriculture more than the manufacturing sector whereas poor countries do the reverse.

Equation (3) above provides an estimating equation that has as key regressors *z/e* and a dummy variable for whether the sector is politically organized or not. As noted earlier, however, in cross-country and cross-sectoral study, it is virtually impossible to find consistent data on which sectors are politically organized, which is why the PFS model has only been empirically tested for a handful of countries, and for the more ambitious regional studies, it has been tested in an unsatisfactory way with arbitrary classification of sectors as politically organized or not.

This paper overcomes the problems of limited data on political organization by employing a quantile regression approach to test the PFS model proposed by Imai, Katayama and Krishna (2008). Rather than using data on whether a sector is politically organized or not, the estimation procedure relies only on the relationship between observables implied by the PFS model — that is, on the relationship between the protection measure, the import (or export) penetration ratio and the import demand (or export supply) elasticity.

The quantile regression approach to test the PFS model predicts that given high *z/e*, high protection sectors (that is, those sectors whose protection measures are at high quantiles) are more likely to be politically organized. Thus, the effect of an increase in *z/e* on protection for high *z/e* sectors would tend to be that of politically organized sectors. The approach predicts that the coefficient estimate for *z/e* converges to $(B_1 + B_2) > 0$ as the conditional quantile given *z/e* approaches its maximum level of unity from below.

The reasoning behind this prediction can be seen most clearly in Figure 1, which plots distributions of *b/(1+b)* for given *z/e*. As Imai, Katayama and Krishna (2008) explain: the variation of *b/(1+b)* given *z/e* occurs for two reasons. First *b/(1+b)* varies because some industries are organized while others are not. The two dashed diagonal lines trace out this component of variation. The lines are the conditional expectations of *b/(1+b)* for organized and unorganized sectors as a function of *z/e*. The two lines start at the same vertical intercept, as predicted by the theory of the PFS model. Second, *b/(1+b)* varies because of the error tem, which in Figure 1 gives the distributions around *b/(1+b)* for any given *z/e* value. For each *z/e*, sectors with high *b/(1+b)* tend to be the politically organized sectors, i.e. these sectors *b/(1+b)* should be increasing in *z/e* as depicted by the solid line labelled the 75 percent quantile in Figure 1. The main proposition of the methodology is therefore that in the quantile regression of *b/(1+b)* on *z/e*, the coefficient on *z/e* should be close to $B_1 + B_2 > 0$ at the quantiles close to $\tau = 1$, where τ denotes quantile, $T = b/(1+b)$, $Z = z/e$. An estimating equation analogous to equation (3) for the PFS model can therefore be given by:

$$Q_T(\tau|Z) = \alpha(\tau) + \beta(\tau)Z$$

where $Q_T(\tau|Z)$ is the conditional τ^{th} quantile function of τ. If the PFS model is correct, it is expected that $\beta(\tau)$ converges to $B_1 + B_2 > 0$ as τ approaches its maximum level of unity from below.

In the quantile regression equation specified above, *Z* needs to be exogenous for the estimates of $\beta(\tau)$ to be consistent. However, this is unlikely to be the case because the variables underlying *Z* are likely to be correlated with the error term.[66] There is possibly measurement error of *e* also since it is an estimated regressor. Fortunately, a new instrumental variables quantile regression (IVQR) estimator has recently been developed (Chernozhukov and Hansen 2005, 2006, 2008). Using this estimator, the structural PFS model can be tested as follows:

$$P\left(T \leq \alpha(\tau) + \beta(\tau)Z \middle| W\right) = \tau$$

where *W* is a set of instrument variables.[67] The IVQR estimation procedure allows for a testing procedure which is robust to the presence of weak instruments.[68] The estimation can be computed in MATLAB using the code provided by Christian Hansen.[69] Because this paper deals with different countries over time, I include country fixed effects in some regressions.

There are several advantages to using the Imai, Katayama and Krishna (2008) quantile approach. First, and most importantly, nowhere in the estimating equation is data on political organization needed in order to test the PFS model. This overcomes the problems of classification in earlier studies, including the ad hoc classifications adopted in regional studies. Second, the Imai, Katayama and Krisha methodology does not suffer from a corner solution problem (that is, zero protection in a number of sectors) as the focus is mainly on higher quantiles where the effect of a corner solution is minimal. Imai, Katayama and Krishna (2008) show that estimates based on the linear models in other studies are likely to be

[66] See Goldberg and Maggi (1999), Mitra (1999) and Gawande and Bandyopadhyay (2000) for a discussion of the endogeneity problem in the non-quantile regression methodology, where *z*, *e* and *I* are all potentially endogenous. See Trefler (1993) for discussion of endogeneity in a related context.

[67] Imai, Katayama and Krishna (2008) show that in the presence of endogeneity the main prediction of the PFS model in the quantile approach does not change.

[68] The importance of dealing with weak instruments in the Protection for Sale model has recently been examined by Gawande and Li (2009).

[69] Code available at http://faculty.chicagogsb.edu/christian.hansen/research.

subject to bias due to the existence of such corners. Third, Imai, Katayama and Krishna (2008) show that linear model results can be driven by parametric assumptions on the error term, but that is not the case with a quantile regression approach. One drawback of the current approach, however, is that it is not possible to separately identify the equation (3) coefficients B_1 and B_2 from the econometric results. Nonetheless, the methodology provides a test of the PFS model that is solidly based on the theory of the model.

Control Variables

A series of political control variables are included in the analysis in this study. The justification for the inclusion of the various measures is derived from the political economy literature on assistance to agriculture. Because I have a cross-country panel, I include political control variables which are only available at the country-level.

Mitra, Thomakos and Ulubasoglu (2002) provided one of the early papers on the role of democracy in the PFS framework. They find support for PFS in Turkey under both dictatorial and democratic regimes (with similar average levels of protection), however, they estimate the weight on welfare, relative to lobby contributions, to be higher under democratic governance. They attribute the findings to an ‗exit effect', whereby some lobby groups disorganize once the country moves to democracy, thereby reducing the lobbying competition among remaining organised lobbies.

In this paper, the role of democracy in the PFS model is addressed in a cross-country setting, where because there is a variation of political systems across countries, I test whether different government regimes matter through the inclusion of control variables. Various measures of democracy are used to capture different aspects of the degree of democracy in a country. Olper and Raimondi (2010) suggest that it is not just democracy that matters in the determination of trade policy, but also the type of democracy. They find evidence of differences in parliamentary, as opposed to presidential, democracies; and when there is plurality (majoritarian) rule as opposed to proportional rule. Findings about the role of institutional factors in agricultural protection have also been made in the comparative politics lecture. Park and Jensen (2007), for example, find that electoral systems designed to represent diverse interests in society (such as majoritarian rule systems) tend to protect agricultural interests at the expense of the broad economic interests of consumers and taxpayers. A related finding in their study is that more electoral competition is a determinant of the level of agricultural subsidies in OECD countries. More electoral competition (that is, a higher number of competitors), captured through a Cox threshold index, has a significant positive effect on the level of government spending on subsidies.

Several studies include measures of constraints on the executive as a control variable in cross-country regressions (see, for example, Dutt and Mitra 2010; and Masters and Garcia 2010). Generally there is a negative relationship between constraints and the level of protection, indicating that lobbying mechanisms are less effective when there are higher checks and balances on the chief executive.

Dutt and Mitra (2010) posit that government ideology matters: more left-wing governments (that is, governments that attach a higher weight to the welfare of workers) are more protectionist in the case of capital-abundant economies but less protectionist in the case of capital-scare economies. Dutt and Mitra (2010) also find that ruling rural parties are more likely to be responsive to agricultural lobby groups, and that constraints on the executive or legislature might be important in determining the extent to which organized groups are successful in influencing government policy. I include various country-level regressors to capture the ideas highlighted here.

Addressing Endogeneity

As noted, the key empirical approach in this paper uses an instrumental variables (IV) methodology. An IV methodology isolates the exogenous source of cross-sector variation in an endogenous regressor that influences the dependent variable. Potential instruments need to satisfy two requirements: they must be correlated with the right-hand side variables *z* and *e* themselves, but not with the regression error. That is, the instruments should affect the level of distortion in a sector only through the variables *z* and *e*, and not through some other independent means. In the PFS framework, because the endogenous regressor is a non-linear transformation of two endogenous variables, methodologically it is necessary to use the Kelejian method to instrument the composite regressor (Kelejian 1971). The Kelejian method suggests using not only the instruments linearly but their higher order terms, which means including the squared and cross-product terms of instruments.

In the PFS empirical literature, the instruments selected draw from the empirical literature on sector level determinants of imports and exports. The instruments need to be variables that shift and/or rotate the import demand (or export supply) curve, since these affect the import demand (or export supply) elasticity and the import (or export) penetration ratio at any given rate of distortion. Mitra, Thomakos and Ulubasoglu (2002) use different forms of domestic (nontrade) government concessions, sector-specific minimum wages, incentives to freight, unionization and import growth as instruments for z, e and I. Mitra, Thomakos and Ulubasoglu (2004) use hourly wage, unionization and the level of intra-industry trade. Gawande and Bandyopadhyay (2000) estimate an import quantity equation with variables capital to labour ratio interacted by sector group dummies, comparative advantage variables and own and cross-price elasticises. Belloc and Guerrieri (2008) use output subsidies, taxes on primary factors (labour and capital), consumption taxes and a dummy for manufacturing and agriculture. Gawande and Hoekman (2006), in their empirical paper for US manufacturing use as instruments the variables geographic concentration and acres of farmland.

In this study, finding instruments for agricultural data is a nontrivial task due to the scarcity of truly exogenous variables across countries, time and sectors. For instruments at the industry level, I adopt a similar approach to that in Gawande and Hoekman (2006) and use as instruments geographic concentration and lagged output. Ideally, I would use acres of farmland (instead of lagged output) as an instrument because acres of farmland is more likely to satisfy the exclusion restriction required for instrumental variables estimation. However, acres of farmland data are only available for crops, which results in a loss of around one-third of all industry observations. I therefore use the highly correlated measure of lagged output. Because I have a cross-country panel, I also include a measure of the capital to labour ratio for agriculture for a country as a whole, and a measure of comparative advantage in agriculture — arable land per worker — since these exogenous variables impact on export and import penetration ratios. The squared and interaction terms of instruments are also included (Kelejian 1971).

These instruments are plausible since geographic concentration, lagged output, capital to labour ratio and comparative advantage should affect import and export penetration ratios and the elasticities of export supply and import demand, but not the level of protection directly. Some papers have found that geographic concentration (Gardner 1987; Gawande 1997) and comparative advantage (Anderson 1995) can directly impact on the level of protection in a sector. The assumption implicit in this paper is that the effect that these variables have on protection is through their impact on shifts or rotations of sector import demand or export supply curves. That is, the effect is through the costliness of protection in terms of aggregate welfare relative to the cost in other sectors.

With only one endogenous variable and multiple instruments, the econometric model is over-identified. Therefore, the hypothesis that the lagged output, concentration, capital to labour ratio and comparative advantage influence the level of protection only through shifts or rotations of sector import demand or export supply curves can be tested as an over-identifying restriction. In practice, the Sargan-Hansen over-identification test compares the estimates of the over-identified model with a just-identified model where the instrument variables enter the second stage regression one at a time.

I perform the Sargan-Hansen over-identification test using full pooled data sample and with the four key instruments. The joint null hypothesis is that the instruments are valid; i.e., they are uncorrelated with the error term and correctly excluded from the estimated equation. The Sargan statistic (over-identification test of all instruments) is 588.6, which means we cannot reject the hypothesis that the instrumental variables have no direct effect on the level of protection, once we control for *z/e*. The result gives some comfort against the risk of misspecification. As mentioned earlier, some econometricians include comparative advantage and measures of concentration as regressors in the second stage regression (Gardner 1987, for example). The inability to reject the over-identifying assumption suggests that diverging from this approach does not bias the results for inference.

Data

The data, its sources and the methods used to construct new variables are explained in this section. Table 1 provides summary statistics of the dependent variables and key regressors.

Data on trade policy distortions are taken from the World Bank's recently released Agricultural Distortions database (Anderson and Valenzuela 2008). This comprehensive database measures in a consistent manner across 75 countries and 75 products mainly government-imposed distortions (positive and negative) that create a gap between domestic prices and what they would be under free markets.[70] The Nominal Rate of Assistance (NRA) for each farm product in the database is computed as the percentage by which all government policies have raised gross returns to farmers above what they would be without the government's intervention (or lowered them in the case of NRA < 0). Each farm sector in each country is classified as either import-competing or a producer of exportables (with its status changing over the years). Table 1 reports the summary statistics for the dependent variable and the NRA. For the sample used in this paper, there are 5806 import-competing dependent variable observations with a mean of 0.20, derived from data with a mean NRA value of 66 percent.[71] There are 4529 exportable NRA observations with a mean of -0.27, derived from NRA data with a mean of -1 percent.

Data on the share of imports in consumption and the share of exports in output is contained in the Agricultural Distortions database for each country and product combination. The ratios reported in the database are the share of imports in consumption (*shrimp*) and the share of exports in production (*shrexp*). For this study, $z_i^X = y_i / x_i$ is computed as the inverse of *shrexp*. $z_i^M = y_i / m_i$ is computed by using *shrimp* to find a derived value of imports, and then dividing the value of production in the Agricultural Distortions database by the derived value of imports. Both measures are scaled by 10000, since very small values of *shrimp*

[70] Each country only has a subset of the products in the Agricultural Distortions database, depending on their production and consumption of various farm commodities. In addition, this paper uses less than the full set of 75 products because some products are not included where data for other variables are not available.

[71] The average NRA of 66 percent for import-competing sectors is higher than that reported in the Agricultural Distortions database. This is because I use only observations from the Agricultural Distortions database where all instruments are available. Instrument data are generally more available for high-income counties, which because they have a higher average NRA than developing countries for import-competing sectors, increases the overall average NRA for import-competing sectors used in this study. Nonetheless, there are significant observations from developing countries (almost 40 percent of observations).

and *shrexp* lead to large measures of import and export penetration ratio. Table 1 indicates that the z_i^M range is [0, 114]. The mean is 0.014, which says that on average over the 50 years and across 75 countries, import-competing sectors produce a ratio of domestic output to imports of 140. The z_i^X range is [0, 30] with a mean of 0.06. Exporting sectors on average produce 600 times the domestic production of what they export.[72] This mean FAO share of exports in output (*shrexp*) is 32 percent, indicating that exportable sectors in the sample, on average export one third of what they produce domestically.

Data on import-demand elasticities for the individual country and product combinations in this study are obtained from a recent study by Kee, Nicita and Olarrega (2008). These authors estimate import demand elasticities at the HS six-digit tariff line using a variation of the Kohli (1991) gross domestic production (GDP) function method for more than 4000 products in 117 countries. In this method, imports are treated as inputs into domestic production, given exogenous world prices, productivity and endowments. The estimates from this study represent a significant contribution to the literature. Although, only estimates for a snap-shot point in time (mostly 2006, but sometimes earlier depending on data availability), they are the first set of consistent elasticity estimates across commodities and thus make the kind of work in this study possible. In order to match the Kee, Nicita and Olarrega (2008) import-demand elasticities with the sector classifications in this study, I select the product description that most closely aligns with that in the Agricultural Distortions database (which is

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[72] These very high averages are driven by the long tail of the *z* variable. I deal with this issue below, by transforming the key regressor of interest to a log variable.

generally the unprocessed farm-gate product).[73] Because the elasticities of import-demand are estimated variables, a Fuller correction is applied before they are used as regressors (Fuller 1987 and Gawande 1997). This correction limits the influence of estimates that are large and also have large standard errors. Without the correction, large insignificant estimates would overstate the true elasticities. The mean elasticity of import demand for the main set of estimates used in this paper is -1.44, and the variance after the Fuller correction is applied is [-2.18, 0.00].

Corresponding estimates of export supply elasticities are unfortunately unavailable at this time. As such, I adopt the approach by Gawande and Hoekman (2006) and assume that because agricultural goods are relatively undifferentiated, it is reasonable to assume that their export supplies are elastic. The export supply elasticity is set to 2 for all goods. Chowdhury and Fetzer (2009) are replicating the Kee, Nicita and Olarreaga (2008) methodology to estimate export supply elasticities at the HS6 level for manufacturing and agricultural products. Once these estimates become available, they can be used in this manuscript to improve the accuracy of the estimation results.

From Table 1, it is possible to see that the key regressor (*z/e*) for import-competing and exportable industries is heavily skewed to the left. This distribution — caused by significant outliers in cases where *z* is very high — causes some problems with estimation of the PFS model in the IVQR framework.

[73] To match HS6 industries to the Agricultural Distortions database more precisely, one could use the industry concordance between HS6 and FAO product classifications (see Jon Haveman‘s website on Industry Concordances); and then use a concordance between FAO product classifications and the Agricultural Distortions database product classification. No published concordance of the latter type exists, but I am guided by the former concordance in the mapping from HS6 to Agricultural Distortions database.

I transform the key regressor to log(*z/e*) to shorten the tails of the *z/e* distribution. The interpretation on the reported coefficients is different, but in the results section I recover the structural PFS coefficients from the estimates.

Political control variables data comes from a variety of sources. Data on democracy are taken from the Polity2 index of PolityIV dataset. The PolityIV data source is used because it covers a longer time series than other available measures of political institutions. The Polity2 index assigns values -10 to +10 to each country and year. I use this measure directly, and, in the alternative, an indicator variable with value 1 (and 0 otherwise) if the Polity2 index is strictly positive.

To capture hypotheses about different types of democracy, I use variables from the Database on Political Institutions (DPI) of the World Bank (Beck et al. 2001).[74] I generate an indicator variable *majoritarian*, which equals 1 (and 0 otherwise) when elections to the lower house rely strictly on winner takes all/first past the post rule. The indicator variable *presidential* equals 1 (and zero otherwise) when the chief executive is not accountable to the legislature through a vote of confidence. This variable is generated from the *system* variable in the DPI.

In some specifications of the model I include a measure for ideology and rural party rule. Both variables are taken from the DPI. Rural party rule comes directly from the *execrurl* variable. Ideology is constructed from the *execrlc* variable such that an increasing value of ideology represents a more left-oriented government.

Data on constraints on the executive or legislature are from the *checks* variable in the DPI. This variable is intended to give a measure of politicians‘

[74] I use the most recent 2008 release of the data.

power. It has lower values where there are fewer checks on the government's power. I expect the coefficient to be negative, suggesting that controlling for *z/e*, governments that impose more checks and balances on their officials have less scope to put in place distortionary policies. In some specifications, I use an alternative measure of checks and balances (*Xconstraints*), which is derived from the *xconst* variable in the PolityIV database. This variable has a scale of 1 to 7 — where 1 means unlimited authority and 7 is executive party subordination. I expect in the PFS framework that a higher *xconst* variable would mean less protection.

I include two variables (*index_eec* and *index_lec*) to capture electoral competition from the index of legislative and executive index of electoral competition in the DPI (*eiec* and *liec*). Both of these variables are on a scale of 1 to 7, where a lower value represents less electoral competition. In line with findings in earlier studies, I expect a positive relationship between the degree of electoral competition and the level of agricultural protection.

The key instruments in this study are geographic concentration, lagged output and the country-level variables capital per worker in agriculture and arable land per worker. Geographic concentration for each sector in each country is measured by a Herfindahl index. To construct these for all crop and livestock sectors, I take data from the FAO AGRO-Maps and GLiPHA databases. These recently released sources give data on the crop production, and number of livestock per sub-national region, respectively. The data are available for different time periods in different countries and generally are not available for the period covered in the Agricultural Distortions database.[75] The Herfindahl index for a sector is the sum of squared shares of national acreage (for each crop) and numbers of livestock for each sub-region. Complete concentration in one region gives an index of 1, while lower indexes represent more dispersed production. One issue in a cross-country study is that the number of regions varies by country. AGRO-Maps provides two levels of regional disaggregation. The first level generally corresponds to the main sub-national breakdown (such as states the US). The second level gives much more disaggregated data (for the US, for example, there are over 1000 sub-regions). I use the first level of disaggregation in AGRO-Maps which is consistent with that in the GLiPHA database. The inclusion of country fixed effects in the estimation procedure can help account for variation in the indexes because of variation in the number of regions. Using data for the most recent years available, on a global level, bean (0.12) and palmoil (0.12) are the least geographically concentrated commodities, while sugar (0.53), millet (0.53), sunflower (0.50) and tobacco (0.46) are the most concentrated. For the second key instrument; data on lagged output is from FAOSTAT. It has a large variance for both import-competing and exportables sectors. Arable land per worker is constructed for a country from WDI and is in the range 0.1 to 8.2 hectares per person across all countries. The capital labour ratio for agriculture overall is constructed from WDI as agricultural machinery per worker. It has a range 0 to 0.13 across countries. Because the main regressor is a composite of *z* and *e*, for

[75] In some specifications where I use the full time-series available in the Agricultural Distortions database, I use a back-cast of the average of the earliest five-years of Herfindahl index data. This is not ideal as it is possible that changes in geographical concentration would have happen over the time period covered, but it is the best available instrument at this time.

identification I use a linear, quadratic and cross-product of the various variables as instruments (Kelejian 1971).

A simple OLS regression of log(*z/e*) on the full set of instruments suggests that the instruments are correlated with log(*z/e*), yielding mostly statistically significant coefficients and an adjusted R^2 and *F*-statistic of 0.14 and 114.3 respectively. Given some important determinants of import demand and export supply curves are likely missing from the specification and because the R^2 values are not especially high, I expect only weak identification. I use the IVQR inference procedure robust to weak instruments to ensure the estimates below do not suffer from weak identification problems.

Results

I start by presenting the results of pooled OLS and 2SLS estimation. These estimates serve as a benchmark for the quantile and instrumental quantile regression estimates presented later. They are also interesting in their own right, particularly in light of earlier reported PFS research in which all sectors are assumed to be organised such that pooled 2SLS is used to estimate the PFS model. Table 2 reports the results for all import-competing sectors in the sample. Columns (1) gives the basic specification of the model. Column (2) includes country fixed effects and Column (3) includes controls. The OLS estimate in Column (1) is positive and statistically significant at the 1% level. This suggests support for the PFS model under the assumption that all sectors are organised — which, as mentioned above, is an assumption adopted in other studies in the PFS literature in the absence of data on lobbying. Using the log regressor, the pooled coefficient has a magnitude of 0.015. This can be interpreted as a 1.5 percent increase in the dependent variable (the trade policy distortion) for a one unit increase in log(*z/e*) while all other variables in the model are held constant. In terms of the interpretation of the *z/e* regressor, this translates to a result that a 10 percent increase in *z/e* causes a 0.06 percent increase in the dependent variable. This coefficient, smaller than expected, is driven by the long tail on the distribution of *z/e* for the import-competing agricultural industries in the sample.

The pooled 2SLS estimate is also positive and statistically significant at the 1% level of significance. The estimate under 2SLS is higher than that under OLS. This accords with the intuition (for organised industries) that a higher level of trade policy distortion can have a dampening effect on domestic output and therefore might reduce the coefficient on log(*z/e*) if endogeneity is not taken into account. That is, the 2SLS estimate isolates the one-way causation of log(*z/e*) on *b/(1+b)* and results in a higher estimate. Converting the estimate to non-logs, the magnitude of the result is once again very small — a 10 percent increase in *z/e* causes an 0.1 percent increase in *b/(1+b)* — driven by the long tails of the *z/e* distribution.

The pooled and 2SLS results are robust to the use of different instruments, the inclusion of country fixed effects (Column (2)) and the inclusion of control variables (Column (3)). When country fixed effects are included, the magnitude on the pooled OLS coefficient is smaller than with no country fixed effects — the coefficient almost halves. This suggests that there could be country specific factors (omitted in the base OLS regression) such that countries with higher *z/e* values on average also tend to have higher levels of protection. With 2SLS, however, the magnitude is roughly the same so the relation between *b/(1/b)* and *z/e* is fairly robust.

I now turn to the QR and IVQR estimation results for the 0.1 to 0.9 quantiles for import-competing sectors. The computation of IVQR was conducted over the parameter space A = [-1, 1]. The IVQR methodology of Chernozhukov and Hansen (2008) allows for two procedures for the computation of standard errors in IVQR: the direct and dual inference procedures. The latter is appropriate when there is a weak correlation between the instrument and endogenous regressors (i.e. a possible weak instrument problem). As noted earlier, an inference procedure which is robust to the weak instrument problem is more appropriate in the current study.

Starting with ordinary QR, the results (without accounting for endogeneity concerns) suggest strong support for the PFS model using the Imai, Katayama and Krishna (2008) methodology. This can be seen most clearly in Figure 2(a), which plots the parameter estimates for different quantiles and the associated 95% confidence intervals. The null hypothesis that $\beta(\tau) \leq 0$ can be rejected at high quantiles in favour of the one-sided alternative that $\beta(\tau) > 0$. Estimates of the coefficient on log(*z/e*) are generally increasing as τ increases, which is as predicted by the PFS theory. The coefficients are also positive and statistically significant at middle quantiles, but recall that it is less easy to distinguish the two sources of variation in *b/(1+b)* given *z/e* at middle quantiles and so less weight should be placed on these estimates. Coefficient estimates are not statistically significant from zero at the lowest quantile. These are observations of *b/(1+b)* where the dependent variable is close to or slightly below zero. The insignificant result on the coefficient might be driven by the existence of a corner solution.

The IVQR results (presented graphically in Figure 2(b)) demonstrate support for the structural PFS model in import-competing agricultural sectors in the full sample of countries. Once again, at the highest quantiles the null hypothesis that $\beta(\tau) \leq 0$ can be rejected at high quantiles in favour of the one-sided alternative that $\beta(\tau) > 0$. The coefficients are increasing in magnitude as τ approaches 1. Like the pooled results, the magnitudes of the IVQR coefficients on log(*z/e*) are higher than the corresponding QR coefficients from the 0.3 quantile onwards, suggesting that the QR results understate the effect of log(*z/e*) on *b/(1+b)* due to endogeneity problems. The confidence intervals are wider for IVQR estimates because the inference procedure is robust to the presence of weak instruments.[76]

Column (2) in Table (2) shows that the QR results for import-competing industries at high quantiles are robust to the inclusion of country fixed effects. The null hypothesis can be rejected at high quantiles. A further test of the robustness of the results is provided in Column (3) of Table (2), where instead of including country fixed effects, a series of control variables is included, which seek to capture some of the underlying country fixed effects that might cause the relationship between *b/(1+b)* and *z/e* to be different in different countries. The base results at high quantiles are robust to the inclusion of these controls. I discuss the significance of different control variables later. Of note, however, is the

[76] Standard errors are estimated using heteroskedasticity-consistent standard errors from the Matlab Code provided by Christian Hansen; see the methods outlined in Chernozhukov and Hansen (2001).

observation that at lower quantiles when country fixed effects and controls are included, the estimated coefficients increase and are positive and statistically significant. One interpretation of this result is that after controlling for country specific factors (institutional or otherwise), all import-competing industries exhibit behaviour that tends to accord with the PFS model. This could be the case if indeed all import-competing sectors in the sample are considered politically organised. I return to a discussion of this point after presenting the results for exportable industries, and a stacked sample.

The pooled regression results (OLS and 2SLS) for exportable sectors suggest support for PFS under the assumption that all sectors are organised. The 2SLS coefficient is greater in magnitude in than the OLS estimate, which accords with the predictions earlier (Table 3, row 1). The baseline QR and IVQR estimates for exportables sectors at high quantiles also provide support for the PFS model (Table 3 and Figure 3). At high quantiles, it is possible to reject the null hypothesis that $\beta(\tau) \leq 0$ in favour of the one-sided alternative that $\beta(\tau) > 0$. That is, from quantile 0.5, the IVQR estimate of $\beta(\tau)$ approaches its highest level as τ approaches 1. It is noticeable, however, that in both the QR and IVQR results, the exportables industry estimates trace out a U-shaped path. The Imai, Katayama and Krishna (2008) test of the PFS model predicts negative coefficients on lower quantiles and positive coefficients on higher quantiles. The question therefore arises about what is driving high positive coefficients on *z/e* at low quantiles for exportables, and what interpretation these results have. It turns out that the answer appears to be driven by the omission of country specific factors (in the form of either country fixed effects or control variables); since columns (2) and (3) provide support for the Imai, Katayama and Krishna (2008) test. One possibility for the results is that at low quantiles of *z/e* the coefficient on *z/e* picks up country specific effects which are correlated with z/e and result in higher protection for these sectors. Another interpretation is that the baseline results cannot support the PFS model for exportable sectors.

In some exportable industry quantiles, the magnitude of the IVQR coefficients at high quantiles is higher for exportables than import-competing sectors. The estimate of 0.2274 on the 0.9 quantile (in column (1)) indicates that a 10 percent increase in *z/e* will result in an almost 1 percent increase in the level of trade policy distortion.

Combining the sample for import-competing and exportables sectors reveals some support for the PFS model overall for agriculture (Table 4). The null hypothesis that $\beta(\tau) \leq 0$ cannot be rejected at high quantiles. However, overall the stacked sample does not accord well with the Imai, Katayama and Krishna (2008) test that $\beta(\tau)$ approaches its highest level as $\beta(\tau)$ approaches 1. This can be seen by the sideways S-shaped pattern of the log(*z/e*) estimates as τ increases (Figure 4(b)). The sideways S-shape pattern of the IVQR estimates can perhaps be explained, however, by the dominance of exportables industries at low quantiles — resulting in coefficient estimates of higher magnitudes — and the dominance of import-competing industries at middle and higher quantiles (where the estimated IVQR coefficients are of a smaller magnitude (compare estimates in Tables 2 and 3). Figure 5 shows the distribution of the dependent variable for the different sectors, and for the sample overall, and higher values of *b/(1+b)* tend to be those of import-competing industries. One interpretation consistent with the results presented is that governments make decisions consistent with the PFS model theory within the import-competing part of agriculture, but to a lesser extent within the exportables part of agriculture. It is not clear that they trade-off aggregate welfare and contributions from lobby groups across the whole of agriculture, however.

The next issue I address is whether there is support for PFS in the high-income or developing country sub-samples of the data. The results in Table 5 and Figure 6 indicate support for the PFS model in high-income countries in terms of exportable and import-competing sectors. For exportables, positive and statistically significant coefficients at high quantiles and estimates reach their highest level as τ approaches 1. The support is less clear for import-competing sectors, but the coefficients at high quantiles are still positive and significantly different from zero. Developing countries exhibit a rather different story (Table 6 and Figure 7). While the coefficient estimates are statistically significant and positive for each of the three groups (exportables, import-competing and stacked samples), the relationship between the estimate on log(*z/e*) and τ does not appear to fit well with the predictions of the quantile-based test of the PFS model. One interpretation of the results is that the pattern of protection in developing countries does not comply with the theory of the model as depicted in Figure 1. Those industries on the upper dashed diagonal line are more likely to be politically unorganized than those on the bottom dashed diagonal line. Another interpretation of the results, however, is that support can be found in the upper most quantiles of the developing country results (since moving from the 0.8 to 0.9 quantile results in an increase in the $\beta(\tau)$ estimate) and there is too much noise in the developing country data at lower quantiles.

Another way of gauging the importance of the PFS model for high-income and developing countries is to estimate the model with separate $\beta(\tau)$ coefficients for each country. This takes account of the fact that it might not be realistic to expect each country to have the same $\beta(\tau)$ coefficient. The results at the 0.75 and 0.9 quantiles for selected countries in the sample are reported in Table 7.[77] The results demonstrate that there is a large variation of estimated $\beta(\tau)$ coefficients within each of the five regional groups. Of the 0.75 quantile results a little under half are positive and statistically significant coefficients at the 0.75 quantile, which suggests that in about 50 percent of individual countries, support can be found for the PFS model in agriculture.[78] Surprisingly, it is not necessarily the case that more support for the model is found in high-income countries. In Latin American countries, for example, support for PFS can be found for the highest share of countries in the region, and in most cases the findings are statistically significant. Overall, the results in Table 7 suggest there could be variation in the country-level $\beta(\tau)$ coefficients, so that whilst there is value in estimating the PFS model for a pooled sample of countries (to test the interaction of institutional factors with the PFS model, for example), there is also value in continuing to focus on single country studies when trying to understand the relationship

[77] Estimates are not obtained for some individual countries where there is not enough cross-sectoral data at the country level.
[78] This might seem like a low percentage of significance for individual countries; however, it is perhaps driven by the fact that for some countries there is not a great deal of industry variation in countries, such that it is not possible to detect significant relationship for the country alone.

between trade policy and factors which impact on the effectiveness of lobbying for protection.

Addressing Autocorrelation

It is possible that because the PFS model is being tested over time, persistence in the NRA over time could drive the results. Such a problem would not bias the coefficient estimates in the study; rather it would lead to underestimated standard errors. The ideal way to overcome the problem is to estimate clustered standard errors within each country, which are robust to both heteroskedasticity and autocorrelation problems. Unfortunately, such an inference procedure is not yet available in the IVQR methodology.

As such, I examine the sensitivity of the results to autocorrelated errors by including a lagged dependent variable as a regressor in the key estimating equations. The results of the sensitivity analysis are presented in Table 8. For import-competing sectors, the key coefficients remain statistically significant and the pattern is the same over the quantiles. The magnitudes of the key coefficients are slightly lower. Results for the exportable sub-sector and the full stacked sample are also not that different to those without the lagged regressor. The alternative specification of the model provides some confidence that the results are not being driven by the persistence of the NRA over time, and that where support for the PFS model is found in the panel dataset, it is genuine.

Protection for Sale and Institutional variables

This section considers the significance of selected institutional control variables on sector level protection, within the context of the PFS model. Results at the 0.25, 0.5 and 0.75 quantiles are presented in Table 9. The first result to emerge is that democratic governance is an important determinant of sectoral level protection of farm commodities. Table 9 reports the results of including a binary democracy indicator from the PolityIV series. Table 10 reports the estimates of using the democracy variable with the full range (of -10 to +10). In both cases, the coefficients are positive and statistically significant at higher quantiles, suggesting that on average there are higher levels of sectoral protection in countries with more democratic governments. This result holds, even after controlling for average incomes (Table 10), which suggests that the results are not driven by the stylized fact that protection is higher in higher income countries (which tend to have more democratic governance). This key finding complements the result in Olper and Raimondi (2010) that transition into democracy induces an increase in agricultural protection.[79]

The type of democracy also seems to matter, according to the results in Tables 9 and 10. A presidential system of government has a statistically significant negative effect on the level of agricultural protection, and this is more pronounced at higher quantiles.[80] As such, parliamentary democracies, on average, lead to higher farm-sector levels of protection after controlling for other

[79] Olper and Raimondi (2010) estimate the average effect of constitutions on policy outcomes using a difference-in-differences approach, hence the finding that transition into or out of democracy affects the level of trade policy distortion.

[80] It is noteworthy that this would not seem to be true for the US, the archetypal country for the PFS model. This is an area for further research.

variables. This finding accords with that in some of Dutt and Mitra's (2010) econometric specifications, where they control for presidential systems. Rural party rule has a statistically significant and positive effect on the level of farm-sector protection at high quantiles, as expected.

Turning to checks and balances on government power and legislative and executive competition, some results emerge in this area, although they are mostly not as expected. The index of legislative competition from DPI has a statistically significant and negative effect on the level of farm-sector protection. That is, more legislative competition results in less farm sector assistance. One possibility for this unexpected finding is that this variable alone is not able to capture the role that legislative competition plays in determining agricultural protection. A more complex econometric specification, which accounts for the interaction of the variable with other variables, such as checks and balances, for example, may be necessary. The index of executive competition, on the other hand, has the expected positive and statistically significant coefficient at lower quantiles, but not at higher quantiles where the attention is focussed. Checks and balances on power measured by *Xconstraints* from PolityIV or the *checks* variable from DPI do not appear to be important determinants of the level agricultural distortion. That is, lobbying mechanisms do not appear to be less effective when there are higher checks and balances on the chief executive.

In relation to government ideology, the results using sector level data support one set of findings in Dutt and Mitra (2010). The political ideology coefficient is negative and significant and the coefficient of the interaction between political ideology and the share of agriculture in employment is positive and significant. It appears to be the case that with a move from right wing to left wing governments, there is an increase in the level of agricultural protection the larger is the proportion of employment in the agricultural sector.

Conclusions, caveats and areas for further research

The PFS model is one of the most influential models in the political economy literature. Remarkably for such an influential theory, little empirical testing has been undertaken for countries other than the US.

In this paper, I apply a new test of the PFS model that does not require data on political organization to a cross-country panel of agricultural sectors over the period 1955 to 2007. To compare with other recent studies, I start by reporting the pooled OLS and 2SLS results under the assumption that all agricultural sectors are organised. I find support for the PFS model in all pooled specifications. The results of the new methodology (discussed below) show, however, that this support could be misplaced because the more robust test finds only limited support for the PFS model in the data. The first key finding to emerge from this study is therefore that researchers should be cautious about estimating PFS in the absence of lobbying data under the assumption that all sectors are organised.

Using the new IVQR approach, I find some support for the PFS model using the World Bank‘s Distortions to Agricultural Incentives data. In particular, there is support within import-competing sectors, and the results are reasonably robust to changes in instruments, controls and the inclusion of country fixed effects. Overall, it appears that there is more support within high-income countries, as opposed to developing countries, when estimating a pooled sample. However, estimation of the model at individual country level, suggests variation across countries in the ability of the model to explain cross-sectoral levels of trade policy distortion, even within the high-income country sub-sample.

The limited support that I find for the PFS model using the quantile-based approach can be contrasted to the lack of support for PFS in the first paper to use the quantile-based methodology: Imai, Katayama and Krishna (2008). In their empirical work, they cannot find support for the PFS model. Their quantile coefficients start from zero at low quantiles and decrease to negative values as the quantile increases. Imai, Katayama and Krishna (2008) therefore call into question the PFS model in explaining protection across manufacturing sectors in the US. However, the authors also note that their results could be driven by factors specific to their data. For example, they suggest one possibility is a form of heteroskedasticky — whereby the error term has a higher variance when the industry is politically unorganized — which could drive their coefficient results.[81] In contrast to the Imai, Katayama and Krishna (2008) results, I do find some support for the model. I use a very different dataset — focused on agriculture only, with fewer industry classifications and with cross-country observations — but I cannot rule out that a form of heteroskedasticity — whereby the error term has a higher variance when the industry is politically organized — is not driving my results too. Given that the quantile results tend to be positive at all quantiles,

[81] Imai, Katayama and Krishna (2008), p 19, provide a discussion of this possibility and mathematically show that if error term has a higher variance when the industry is politically unorganized, then the observations of politically unorganised industries would dominate in high quantiles as well as in low quantiles, while politically organised industries would be found mostly around the median.

this might in fact be what is happening. The results in the paper could be improved by finding a way to rule out this possibility (i.e. through a better understanding of the error structure).

The results in this paper could be improved in several other ways. One issue already noted in the manuscript would be to adopt an inference procedure robust to autocorrelated errors to ensure the results are not driven by the persistence of NRAs over time. It is possible that the very low standard errors obtained in the results of the analysis would be higher under such an alternative specification, even though the results with the inclusion of a lagged dependent variable give confidence that autocorrelation is not driving the statistical significance of the results.

Better results could be obtained by moving to a greater level of disaggregation in the distortions data. Imai, Katayma and Krishna (2009b) note that the testing of political economy models should be done at as disaggregated a level as possible. As such, data in this study — which is at a reasonably high aggregation level — might not adequately capture the model‘s predictions. The Kee, Nicita and Olarreaga (2008) elasticity data are available at the HS6 level. It is also possible to source tariff and NTB data and import and export penetration data at that level. The cross-country sample might be less comprehensive, but this is an avenue for further research.

Another way the results in this paper could be improved is by moving to a sample with both agriculture and non-agricultural sectors. In this paper, when looking for support for PFS in agriculture alone, I am making the implicit assumption that within agriculture governments make decisions about which sectors to protect at the expense of other agricultural sectors. This is perhaps an empirically reasonable assumption,[82] but it could also lead to misplaced support for the PFS model if governments in reality make trade policy decisions with regards to all sectors of the economy.

The elasticity data in the study could also be improved. There is a lack of data on export supply elasticities across countries and products, and as such the simplifying assumption is made that the export supply elasticity is 2 for all commodities in all countries. The variation in the key regressor for exportable sectors therefore comes from the inverse export penetration ratio alone. When looking at the results for export sectors, this could limit the test of the PFS model. When looking at import-competing and exportables sectors together, however, this is probably less of an issue because the relatively elastic supply of export sectors is compared to various import demand elasticities in import-competing sectors. A further limitation of the elasticity data in this study is that the import demand elasticities estimated in Kee, Nicita and Olarreaga (2008) are for one year only. This study implicitly assumes that elasticities of import demand are constant over that time.

The use of control variables in this study skims the surface of the vast potential to look at the interaction of lobbying models and government institutions. This is the first paper to use product level data and cross-country variation in institutional settings to examine the political economy of agriculture through the PFS model. There is scope to examine this area in greater detail. For example, further testing of the role of presidential versus parliamentary systems

[82] Supported, for example, by the findings in Gardner (1987) and Gawande and Hoekman (2006).

would be an area of interest. In Latin American countries, which often have presidential and proportional institutions, more support for the PFS model was found at the individual country level. Such findings warrant investigation in future research.

References

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

Anderson, K. (2009), ‗Five Decades of Distortions to Agricultural Incentives', Ch 1 in Anderson, K. (ed.) *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., J. Croser, D. Sandri and E. Valenzuela (2010), ―Agricultural Distortion Patterns Since the 1950s: What Needs Explaining", chapter 2 in *The Political Economy of Agricultural Price Distortions*, Cambridge and New York: Cambridge University Press.

Anderson, K., J. Croser, S. Nelgen and E. Valenzuela (2009), ―Global Distortions to Key Commodity Markets", Ch 12 in Anderson, K. (ed.) *Distortions to Agricultural Incentives: A Global Perspective, 1955–2007*, London: Palgrave Macmillan and Washington DC: World Bank.

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

Beck, T., G. Clarke, A. Groff and P. Keefer (2001), “New Tools in Comparative Political Economy: The Database of Political Institutions”, *World Bank Economic Review* 15(1): 165-76.

Belloc, M. and P. Guerrieri (2008), “Special Interest Groups and Trade Policy in the EU”, *Open Economies Review* 19(4): 457–78.

Bernheim, B. D. and M. D. Whinston (1986), “Menu Auctions, Resource Allocation, and Economic Influence”, *Quarterly Journal of Economics* 101(1): 1–31.

Bombardini, M. (2008), “Firm Heterogeneity and Lobby Participation”, *Journal of International Economics* 75(2): 329–348.

Cadot, O., J. de Melo and M. Olarreaga (2004), “Lobbying, Counterlobbying, and the Structure of Tariff Protection in Poor and Rich Countries”, *The World Bank Economic Review* 18(3): 345–366.

Chernozhukov, V. and C. Hansen, (2001) “An IV Model of Quantile Treatment Effects”, working paper, MIT Department of Economics.

Chernozhukov, V. and C. Hansen, (2005) “An Instrumental Variables Model of Quantile Treatment Effects”, *Econometrica* 73(1): 245–262.

Chernozhukov, V. and C. Hansen, (2006) “Instrumental Quantile Regression Inference for Structural and treatment Effect Models”, *Journal of Econometrics* 132(2): 491–525.

Chernozhukov, V. and C. Hansen, (2008) “Instrumental Variable Quantile Regression: A Robust Inference Approach”, *Journal of Econometrics* 142(1): 379–398.

Chowdhury, S. and J. Fetzer, (2009) “Estimating Export Supply Elasticities: Research Summary”, September, web.ics.purdue.edu/Sohini_Chowdhury_Estimating_Export_Supply_Elasticities_Research_Summary.pdf (accessed 11 November 2009).

Dutt, P. and D. Mitra (2010), “Political Economy of Agricultural Distortion Patterns: The Roles of Ideology, Lobbying and Public Finance”, chapter 11 in *The Political Economy of Agricultural Price Distortions*, K. Anderson (ed.), Cambridge and New York: Cambridge University Press.

Fuller, W.A. (1987), *Measurement Error Models*, New York: Wiley.

Gardner, B.L. (1987), “Causes of U.S. Farm Commodity Programs”, *Journal of Political Economy* 95(2): 290–310.

Gawande, K. (1997), “Generated Regressor in Linear and Nonlinear Models”, *Economics Letters* 54: 119–126.

Gawande, K. and B. Hoekman (2006), “Lobbying and Agricultural Trade Policy in the United States”, *International Organization* 60: 527–561.

Gawande, K. and C. Magee (2008), “Free-Riding on Protection for Sale”, unpublished manuscript.

Gawande, K. and H. Li (2009), “Dealing with Weak Instruments: An Application to the Protection for Sale Model”, *Political Analysis* 17(3): 236–260.

Gawande, K. and U. Bandyopadhyay (2000), “Is Protection for Sale? Evidence on the Grossman-Helpman Theory of Endogenous Protection”, *Review of Economics and Statistics* 82(1): 139–152.

Gawande, K., P. Krishna and M. Olarreaga (2009), “What Governments Maximise and Why: The View from Trade”, *International Organization* 63(3): 491–532.

Gawande, K., P. Sanguinetti and A.K. Bohara (2005), “Exclusions for Sale: Evidence on the Grossman-Helpman Model of Free Trade Agreements”, NAFTA-MERCOSUR Working Paper No. 4, University of New Mexico.

Goldberg, P. and G. Maggi (1999), “Protection for Sale: An Empirical Investigation”, *American Economic Review* 89: 1135–1155.

Grossman, G and E. Helpman (1995), “The Politics of Free-Trade Agreements”, *American Economic Review* 85(4): 667–690.

Grossman, G. and E. Helpman (1994), “Protection for Sale”, *American Economic Review* 84(4): 833–850.

Harding, M and C. Lamarche (2009), “A Quantile Regression Approach for Estimating Panel Data Models using Instrumental Variables”, *Economics Letters* 104(3): 133–135.

Imai, S., H. Katayama and K. Krishna (2008), “A Quantile-Based Test of Protection For Sale Model”, NBER Working Paper 13900, March.

Imai, S., H. Katayama and K. Krishna (2009a), “Protection for Sale or Surge Protection?”, *European Economic Review* 53(6): 675–688.

Imai, S., H. Katayama and K. Krishna (2009b), ―Is Protection Really For Sale? A Survey and Directions for Further Research”, *International Review of Economics and Finance* 18: 181–91.

Kee, H.L., A. Nicita and M. Olearraga (2008), ―Import Demand Elasticities and Trade Distortions”, *Review of Economics and Statistics* 90(4): 666-82.

Kee, H.L., M. Olarreaga and P.A. Silva (2007), ―Market Access for Sale”, *Journal of Development Economics* 82(1): 79–94.

Kelijian, H. H. (1971), ―Two Stage Least Squares and Econometric Systems Linear in Parameters but Non-Linear in Endogenous Variables”, *Journal of the American Statistical Association* 66: 373–74.

Kohli, U. (1991), *Technology, Duality and Foreign Trade: The GNP Function Approach to Modeling Imports and Exports*, Ann Arbor: University of Michigan Press.

Lopez, R.A. (2008), ―Does ‗Protection for Sale‘ Apply to the US Food Industries?”, *Journal of Agricultural Economics* 9(1): 25-40.

Masters, W. A. and A. F. Garcia (2010), ―Agricultural Price Distortion and Stabilization: Stylized facts and hypothesis Tests”, chapter 9 in *The Political Economy of Agricultural Price Distortions*, K. Anderson (ed.), Cambridge and New York: Cambridge University Press.

McCalman, P. (2004), ―Protection for Sale and Trade Liberalization: An Empirical Investigation”, *Review of International Economics* 12(1): 81–94.

Mitra, D. (1999), ―Endogenous Lobby Formation and Endogenous Protection: A Long-run Model of Trade Policy Determination", *American Economic Review* 89(5): 1116–1134.

Mitra, D., D.D. Thomaklos and M.A. Ulubasoglu (2002), ―‗Protection for Sale' in a Developing Country: Democracy vs. Dictatorship", *The Review of Economics and Statistics* 84(3): 497–508.

Mitra, D., D.D. Thomaklos and M.A. Ulubasoglu (2004), ―Protection verses Promotion: An Empirical Investigation", *Economics and Politics* 16(2): 147–162.

Mitra, D., D.D. Thomakos and M. Ulubasoglu, (2006), ―Can We Obtain Realistic Parameter Estimates for the ‗Protection for Sale' Model?", *Canadian Journal of Economics* 39(1): 187–210.

Olper, A. and V. Raimondi, (2010), ―Constitutional Rules and Agricultural Policy Outcomes", chapter 14 in *The Political Economy of Agricultural Price Distortions*, K. Anderson (ed.), Cambridge and New York: Cambridge University Press.

Park, J. H. and N. Jensen (2007), ―Electoral Competition and Agricultural Support in OECD Countries", *American Journal of Political Science* 51(2): 314–329.

Rodrik, D. (1995), ―Political Economy of Trade Policy" in G. Grossman and K. Rogoff (eds.) *Handbook of International Economics*, vol 3m Amsterdam: North-Holland.

Swinnen, J. (2010), ―Political Economy of Agricultural Distortions: The Literature to Date" chapter 3 in *The Political Economy of Agricultural*

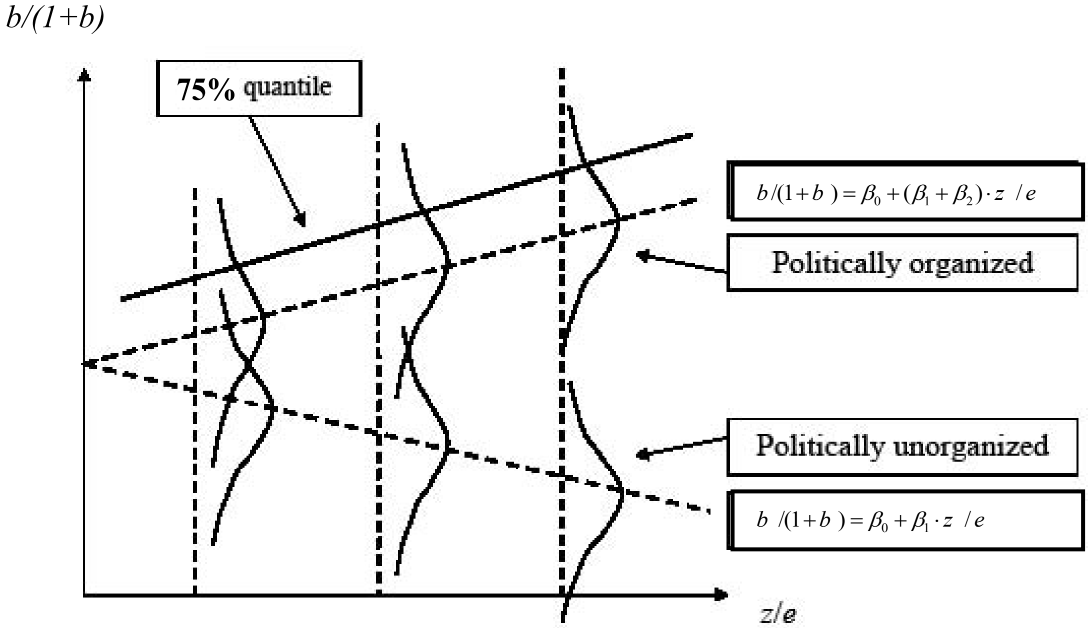
Price Distortions, K. Anderson (ed.), Cambridge and New York: Cambridge University Press.

Trefler, D. (1993), ―Trade Liberalization and the Theory of Endogenous Protection: An Econometric Study of U.S. Import Policy”, *Journal of Political Economy* 101(1): 138–60.

Tyers, R. (1991), ―Neglect of Dynamics, Rick and Market Insulation In the Analysis of Uruguay Round Food Trade Reform”, *Australian Journal of Agricultural Economics* 35(3).

Figures and Tables

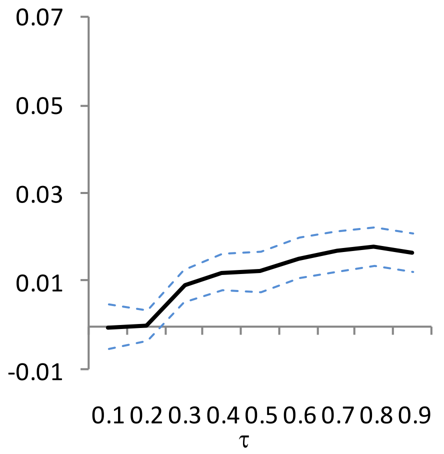
Figure 1: Graphical illustration of the prediction from the Protection for Sale model of the relationship between *b/(1+b)* and *z/e*



Source: Imai, Katayama and Krishna (2008), with minor modifications by the author.

Figure 2: Estimates of the effect of *z/e* on *b/(1+b)* from quantile regression and instrumental variables quantile regression, all countries in sample, import-competing sectors

(a) Quantile regression



(b) Instrumental variables quantile regression

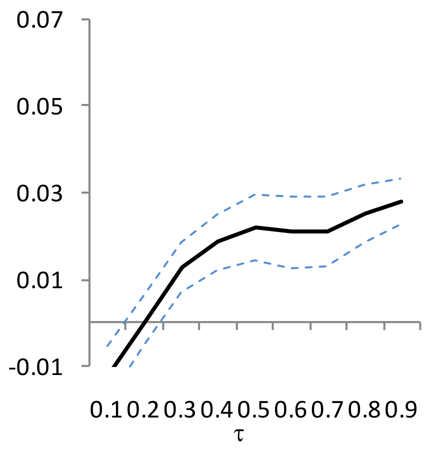
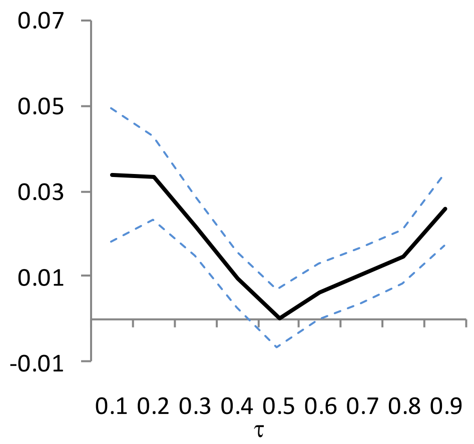


Figure 3: Estimates of the effect of *z/e* on *b/(1+b)* from quantile regression and instrumental variables quantile regression, all countries in sample, exportables sectors

(a) Quantile regression



(b) Instrumental variables quantile regression

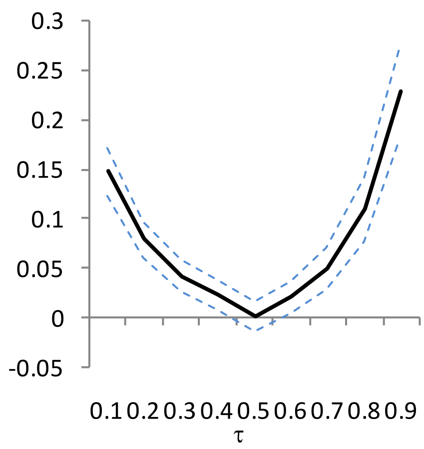
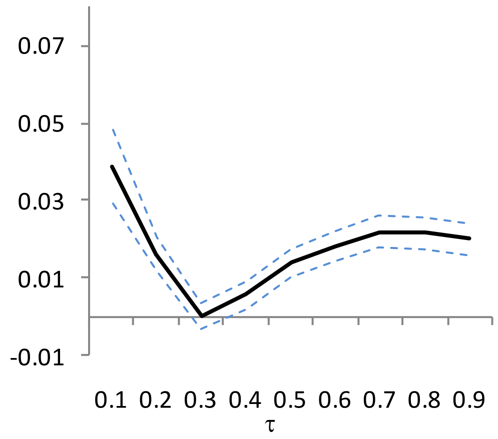


Figure 4: Estimates of the effect of *z/e* on *b/(1+b)* from quantile regression and instrumental variables quantile regression, all countries in sample, all import-competing and exportables sectors

(a) Quantile regression



(b) Instrumental variables quantile regression

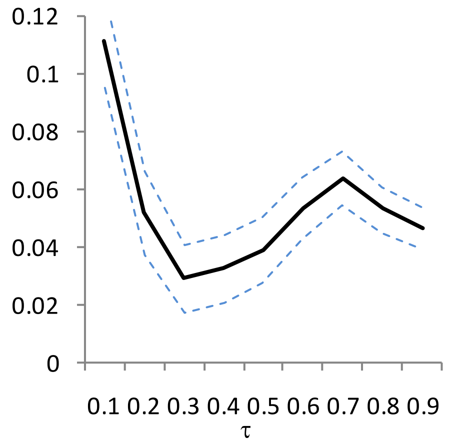
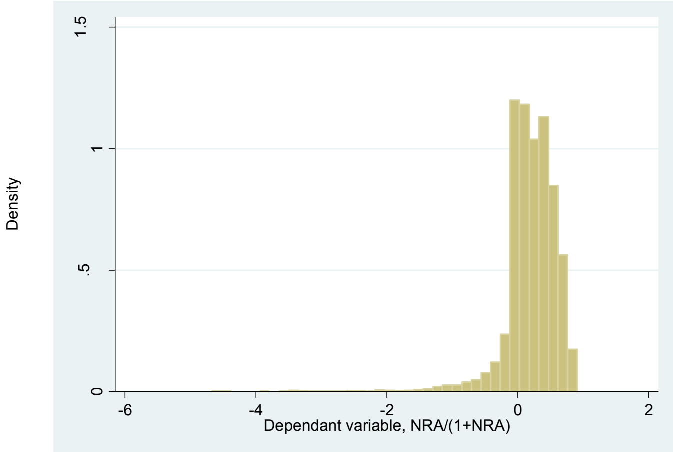
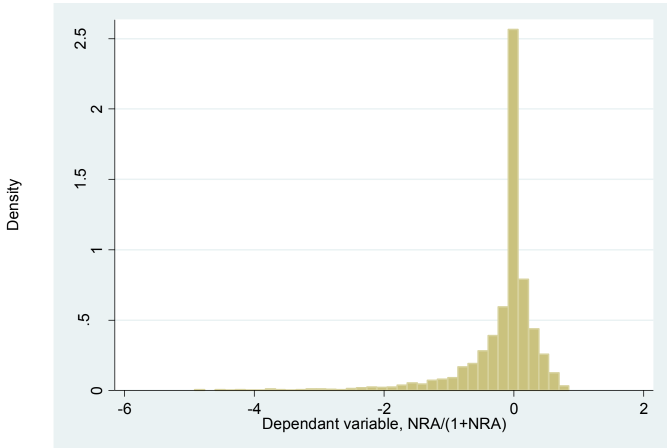


Figure 5: Distribution of the dependent variable for import-competing, exportables and all sectors, all countries in sample

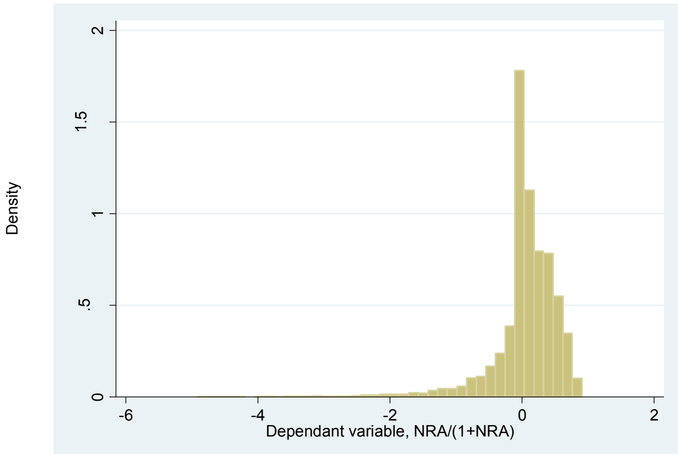
(a) Import-competing sectors



(b) Exportables sectors



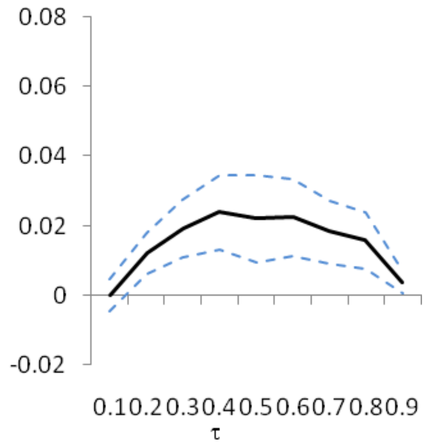
(c) Import-competing and exportables sectors



Source: Author‘s graphs based on Anderson and Valenzuela (2008)

Figure 6: Estimates of the effect of *z/e* on *b/(1+b)* from instrumental variables quantile regression, high-income countries sub-sample

(a) Import-competing sectors



(b) Exportables sectors

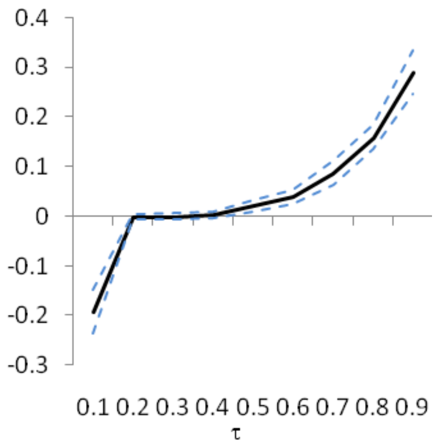
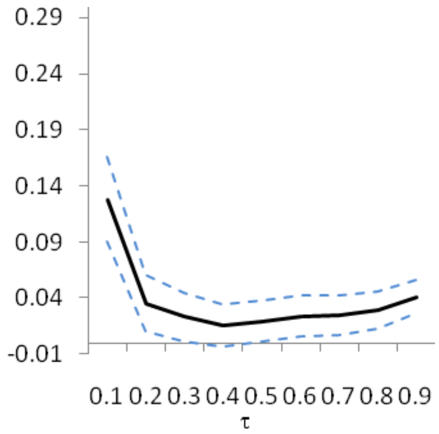


Figure 6: Estimates of the effect of *z/e* on *b/(1+b)* from instrumental variables quantile regression, developing countries sub-sample

(a) Import-competing sectors



(b) Exportables sectors

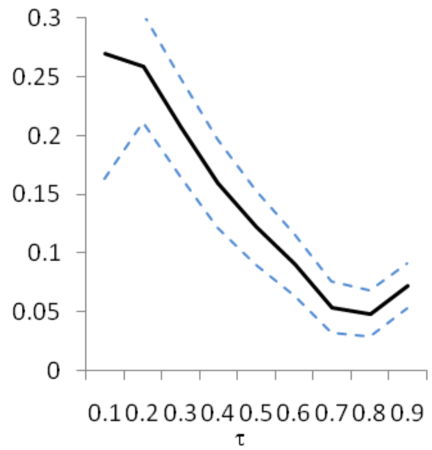


Table 1: Data summary statistics

(a) Import-competing sectors

Variables	Obs	Mean	Std. Dev.	Min	Max
Dependent variable and its component					
NRA/(1+NRA)	5806	0.20	0.48	-8.62	0.91
NRA	5806	0.66	1.00	-0.93	10.46
Key regressor and its components					
z/e	5806	0.10	1.42	0.00	61.34
z	5806	0.14	2.44	0.00	114.63
e	5806	1.44	0.44	0.00	2.18
shrimp	5806	0.27	0.34	0.00	10.48
Instruments					
HI	5806	0.29	0.22	0.01	1.00
Output (000s)	5806	4646	15000	0	299000
Capital per worker	5806	0.03	0.03	0.00	0.13
Arable land per worker	5806	0.79	1.01	0.06	8.23
Controls					
Democracy	5806	0.82	0.39	0	1
Polity2	5583	6.12	6.16	-9	10
Majoritarian	4398	0.53	0.50	0	1
Proportional	4410	0.66	0.47	0	1
Presidential	4458	0.36	0.48	0	1
Parliamentary	4458	0.64	0.48	0	1
Ideology	3765	2.13	0.93	1	3
Ideology*K/L	3765	0.08	0.08	0	0.34
Rural party rule	4425	0.01	0.09	0	1
Checks	4387	3.75	1.89	1	16
Constraints on executive	5530	1.63	0.55	0	1.95
Index EEC	4449	6.39	1.48	2	7
Index LEC	4449	6.47	1.39	1	7

(b) Exportables sectors

Variables	Obs	Mean	Std. Dev.	Min	Max
Dependent variable and its component					
NRA/(1+NRA)	4529	-0.27	1.19	-30.22	0.85
NRA	4529	-0.01	0.46	-0.97	5.81
Key regressor and its components					
z/e	4529	0.03	0.43	0.00	14.79
z	4529	0.06	0.87	0.00	29.58
e	4529	2.00	0.00	2.00	2.00
shrexp	4529	0.32	0.33	0.00	3.47
Instruments					
HI	4529	0.30	0.22	0.01	1.00
Output (000s)	4529	9170	30700	0	345000
Capital per worker	4529	0.03	0.03	0.00	0.12
Arable land per worker	4529	1.49	1.68	0.10	8.23
Controls					
Democracy	4529	0.72	0.45	0	1
Polity2	4466	4.56	6.85	-9	10
Majoritarian	3330	0.61	0.49	0	1
Proportional	3376	0.60	0.49	0	1
Presidential	3462	0.52	0.50	0	1
Parliamentary	3462	0.48	0.50	0	1
Ideology	2677	2.21	0.93	1	3
Ideology*K/L	2677	0.06	0.07	0	0.30
Rural party rule	3453	0.01	0.09	0	1
Checks	3390	3.38	1.75	1	18
Constraints on executive	4419	1.54	0.60	0	1.95
Index EEC	3459	6.14	1.69	2	7
Index LEC	3459	6.27	1.56	1	7

Table 2: Relationship between b(1+b) and log(*z/e*) for import-competing sectors

	(1)		(2)		(3)	
Pooled regression results						
	Pooled	2SLS[a]	Pooled	2SLS[a]	Pooled	2SLS[a]
	0.0152	0.0244	0.0073	0.0279	0.0126	0.0326
	(0.0023)	(0.0045)	(0.0021)	(0.0049)	(0.0020)	(0.0034)
Quantile regression results						
	QR	IVQR[a]	QR	IVQR[a]	QR	IVQR[a]
$\hat{\beta}$ (10)	-0.0004	-0.0121	0.0000	0.0000	0.005	0.0286
	(0.0025)	(0.0033)	(0.0018)	(0.0032)	(0.0021)	(0.0049)
$\hat{\beta}$ (20)	0.0000	0.0000	0.0012	0.0294	0.0140	0.0450
	(0.0017)	(0.003)	(0.0017)	(0.0034)	(0.0025)	(0.0052)
$\hat{\beta}$ (30)	0.0090	0.0125	0.0068	0.0347	0.0189	0.0444
	(0.0018)	(0.003)	(0.0016)	(0.0033)	(0.0022)	(0.0045)
$\hat{\beta}$ (40)	0.0121	0.0185	0.0092	0.0346	0.0218	0.0445
	(0.002)	(0.0034)	(0.0018)	(0.0032)	(0.0032)	(0.0038)
$\hat{\beta}$ (50)	0.0134	0.0217	0.0094	0.0336	0.0228	0.0398
	(0.0023)	(0.004)	(0.0019)	(0.0029)	(0.0029)	(0.0034)
$\hat{\beta}$ (60)	0.0153	0.0208	0.0096	0.0346	0.0196	0.0366
	(0.0023)	(0.0043)	(0.0019)	(0.0029)	(0.0027)	(0.0037)
$\hat{\beta}$ (70)	0.0168	0.0208	0.0120	0.0373	0.0136	0.0312
	(0.0023)	(0.0042)	(0.0019)	(0.0029)	(0.0025)	(0.0042)
$\hat{\beta}$ (80)	0.0179	0.0252	0.0155	0.0403	0.0106	0.0287
	(0.0022)	(0.0035)	(0.002)	(0.0027)	(0.0024)	(0.0047)
$\hat{\beta}$ (90)	0.0166	0.0278	0.0135	0.0320	0.0100	0.0252
	(0.0022)	(0.0028)	(0.0028)	(0.0031)	(0.022)	(0.0039)
No. Observations	5797	5797	5797	5797	2705	2705
Controls[b]	No	No	No	No	Yes	Yes
Country fixed effects	No	No	Yes	Yes	No	No

a Instruments are the Herfindahl index, lagged output, arable land per worker and the capital labour ratio; and their squared and cross-product terms.
b Controls are polityIV, checks, presidential, Index EEC, Index LEC, Ideology, Ideology*Share of agricultural employment, Share of Agricultural Employment and Rural Party.

Table 3: Relationship between b(1+b) and log(*z/e*) for exportables sectors

	(1)		(2)		(3)	
Pooled regression results						
	Pooled	2SLS[a]	Pooled	2SLS[a]	Pooled	2SLS[a]
	0.0122	0.1435	0.0295	0.0943	0.0168	0.0869
	(0.0093)	(0.0255)	(0.0099)	(0.0392)	(0.0048)	(0.0127)
Quantile regression results						
	QR	IVQR[a]	QR	IVQR[a]	QR	IVQR[a]
$\hat{\beta}$ (10)	0.0337	0.1461	0.0000	0.0000	0.0065	0.0312
	(0.0139)	(0.0120)	(0.0042)	(0.0125)	(0.0028)	(0.0052)
$\hat{\beta}$ (20)	0.0330	0.0780	0.0000	0.0000	0.0056	0.0315
	(0.005)	(0.0091)	(0.0042)	(0.0135)	(0.0029)	(0.0057)
$\hat{\beta}$ (30)	0.0212	0.0406	0.0000	0.0000	0.0065	0.0305
	(0.0036)	(0.0081)	(0.0041)	(0.0141)	(0.0026)	(0.0068)
$\hat{\beta}$ (40)	0.0093	0.0227	0.0000	0.002	0.0057	0.0421
	(0.0034)	(0.079)	(0.0041)	(0.0146)	(0.0025)	(0.0096)
$\hat{\beta}$ (50)	0.0000	0.0000	0.0000	0.0000	0.0076	0.0641
	(0.0035)	(0.0071)	(0.0041)	(0.0149)	(0.0025)	(0.0116)
$\hat{\beta}$ (60)	0.0063	0.0196	0.0000	0.0015	0.0111	0.0863
	(0.0034)	(0.0082)	(0.0041)	(0.0145)	(0.003)	(0.014)
$\hat{\beta}$ (70)	0.0101	0.0489	0.0000	0.0100	0.0130	0.1337
	(0.0033)	(0.0108)	(0.004)	(0.0136)	(0.0042)	(0.0195)
$\hat{\beta}$ (80)	0.0146	0.1084	0.0032	0.0239	0.0205	0.1797
	(0.0033)	(0.0165)	(0.0041)	(0.0124)	(0.0061)	(0.0231)
$\hat{\beta}$ (90)	0.0256	0.2274	0.0145	0.0228	0.0193	0.2489
	(0.0043)	(0.0234)	(0.0051)	(0.0097)	(0.0089)	(0.0225)
No. Observations	4528	4528	4528	4528	1954	1954
Controls[b]	No	No	No	No	Yes	Yes
Country fixed effects	No	No	Yes	Yes	No	No

a Instruments are the Herfindahl index, lagged output, arable land per worker and the capital labour ratio; and their squared and cross-product terms.
b Controls are polityIV, checks, presidential, Index EEC, Index LEC, Ideology, Ideology*Share of agricultural employment, Share of Agricultural Employment and Rural Party.

Table 4: Relationship between b(1+b) and log(*z/e*) for all import-competing and exportables sectors

	(1)		(2)		(3)	
Pooled regression results						
	Pooled	2SLS[a]	Pooled	2SLS[a]	Pooled	2SLS[a]
	0.0205	0.0796	0.0057	0.0506	0.0154	0.0591
	(0.0037)	(0.0103)	(0.0034)	(0.0092)	(0.0022)	(0.0056)
Quantile regression results						
	QR	IVQR[a]	QR	IVQR[a]	QR	IVQR[a]
$\hat{\beta}$ (10)	0.0386	0.1114	0.0000	0.0534	0.0041	0.1457
	(0.0048)	(0.0084)	(0.0016)	(0.0074)	(0.0019)	(0.0094)
$\hat{\beta}$ (20)	0.0161	0.0514	0.0000	0.0400	0.0078	0.0942
	(0.0022)	(0.00774)	(0.0016)	(0.006)	(0.0019)	(0.0081)
$\hat{\beta}$ (30)	0.0000	0.0288	0.0000	0.0474	0.0125	0.0781
	(0.0017)	(0.0060)	(0.0015)	(0.006)	(0.0021)	(0.0051)
$\hat{\beta}$ (40)	0.0055	0.0322	0.0008	0.0512	0.0177	0.0835
	(0.0018)	(0.0061)	(0.0016)	(0.0056)	(0.0023)	(0.0057)
$\hat{\beta}$ (50)	0.0137	0.0386	0.0040	0.0456	0.0218	0.0762
	(0.0019)	(0.0058)	(0.0017)	(0.0047)	(0.0026)	(0.0057)
$\hat{\beta}$ (60)	0.0181	0.0533	0.0046	0.0402	0.0250	0.0643
	(0.002)	(0.0054)	(0.0018)	(0.004)	(0.0027)	(0.006)
$\hat{\beta}$ (70)	0.0218	0.0634	0.0080	0.0365	0.0237	0.0535
	(0.0021)	(0.0048)	(0.0018)	(0.0039)	(0.0026)	(0.0047)
$\hat{\beta}$ (80)	0.0215	0.0528	0.00114	0.0295	0.0148	0.0407
	(0.0021)	(0.0041)	(0.0019)	(0.0039)	(0.0024)	(0.0049)
$\hat{\beta}$ (90)	0.0199	0.0462	0.00174	0.0254	0.0100	0.0269
	(0.0021)	(0.0037)	(0.002)	(0.0035)	(0.0021)	(0.0042)
No. Observations	10408	10408	10408	10408	4659	4659
Controls[b]	No	No	No	No	Yes	Yes
Country fixed effects	No	No	Yes	Yes	No	No

a Instruments are the Herfindahl index, lagged output, arable land per worker and the capital labour ratio; and their squared and cross-product terms.
b Controls are polityIV, checks, presidential, Index EEC, Index LEC, Ideology, Ideology*Share of agricultural employment, Share of Agricultural Employment and Rural Party.

Table 5: Relationship between b(1+b) and log(*z/e*) for all import-competing and exportables sectors, high-income countries

	(1)		(2)		(3)	
	Import-competing		Exportables		All sectors	
	QR	IVQR	QR	IVQR	QR	IVQR
$\hat{\beta}$ (10)	0.0000	0.0000	-0.0075	-0.1919	0.0000	0.0846
	(0.0012)	(0.0023)	(0.0087)	(0.0230)	(0.0008)	(0.0173)
$\hat{\beta}$ (20)	0.0125	0.0121	0.0000	0.0000	0.0000	0.0536
	(0.0018)	(0.0029)	(0.0013)	(0.0030)	(0.0011)	(0.0088)
$\hat{\beta}$ (30)	0.0176	0.0192	0.0000	0.0000	0.0066	0.0518
	(0.0021)	(0.0042)	(0.0015)	(0.0035)	(0.0013)	(0.0058)
$\hat{\beta}$ (40)	0.0232	0.0239	0.0012	0.0028	0.0150	0.0630
	(0.0024)	(0.0054)	(0.0016)	(0.0036)	(0.0019)	(0.0050)
$\hat{\beta}$ (50)	0.0210	0.0221	0.0032	0.0215	0.0205	0.0704
	(0.0029)	(0.0064)	(0.0017)	(0.0062)	(0.0024)	(0.0047)
$\hat{\beta}$ (60)	0.0218	0.0226	0.0027	0.0399	0.0253	0.0707
	(0.0028)	(0.0056)	(0.0020)	(0.0075)	(0.0025)	(0.0052)
$\hat{\beta}$ (70)	0.0211	0.0183	0.0022	0.0874	0.0236	0.0574
	(0.0026)	(0.0046)	(0.0039)	(0.0127)	(0.0027)	(0.0044)
$\hat{\beta}$ (80)	0.0228	0.0157	0.0164	0.1591	0.0220	0.0477
	(0.0022)	(0.0041)	(0.0075)	(0.0125)	(0.0025)	(0.0045)
$\hat{\beta}$ (90)	0.0210	0.0037	0.0151	0.2899	0.0242	0.0336
	(0.0020)	(0.0016)	(0.0091)	(0.0222)	(0.0018)	(0.0041)
No. Observations	6422	6422	6422	6422	6422	6422

Table 6: Relationship between b(1+b) and log(*z/e*) for all import-competing and exportables sectors, developing countries

	(1)		(2)		(3)	
	Import-competing		Exportables		All sectors	
	QR	IVQR	QR	IVQR	QR	IVQR
$\hat{\beta}$ (10)	0.0341	0.1281	0.0037	0.2697	0.0612	0.2657
	(0.0173)	(0.0194)	(0.0281)	(0.0055)	(0.0153)	(0.0223)
$\hat{\beta}$ (20)	0.0031	0.0358	0.0281	0.2586	0.0413	0.2018
	(0.0066)	(0.0129)	(0.0152)	(0.0240)	(0.0900)	(0.0187)
$\hat{\beta}$ (30)	-0.0036	0.0235	0.0235	0.2082	0.0254	0.1617
	(0.0051)	(0.0113)	(0.0108)	(0.0215)	(0.0050)	(0.0156)
$\hat{\beta}$ (40)	-0.0038	0.0158	0.0250	0.1602	0.0228	0.1283
	(0.0048)	(0.0098)	(0.0077)	(0.0193)	(0.0044)	(0.0151)
$\hat{\beta}$ (50)	-0.0027	0.0195	0.0228	0.1224	0.0170	0.0777
	(0.0047)	(0.0096)	(0.0064)	(0.0162)	(0.0039)	(0.0120)
$\hat{\beta}$ (60)	0.0045	0.0241	0.0241	0.0907	0.0149	0.0391
	(0.0047)	(0.0096)	(0.0060)	(0.0134)	(0.0038)	(0.0940)
$\hat{\beta}$ (70)	0.0083	0.0250	0.0230	0.0543	0.0194	0.0336
	(0.0047)	(0.0094)	(0.0058)	(0.0111)	(0.0037)	(0.0089)
$\hat{\beta}$ (80)	0.0173	0.0293	0.0262	0.0488	0.0212	0.0088
	(0.0046)	(0.0085)	(0.0055)	(0.0099)	(0.0038)	(0.0360)
$\hat{\beta}$ (90)	0.0228	0.0414	0.0348	0.0722	0.0280	0.0337
	(0.0045)	(0.0076)	(0.0053)	(0.0097)	(0.0040)	(0.0087)
No. Observations	4122	4122	4122	4122	4122	4122

Table 7: Relationship between b(1+b) and log(z/e) for all import-competing and exportables sectors, selected countries

	$\hat{\beta}$ (75)	se	$\hat{\beta}$ (90)	se
Asian countries				
Thailand	0.139	0.038	0.269	0.093
Sri Lanka	0.044	0.016	0.034	0.017
Korea	0.017	0.021	0.029	0.020
Indonesia	0.008	0.028	0.008	0.023
India	-0.001	0.004	0.002	0.003
China	-0.114	0.040	-0.194	0.045
African countries				
Kenya	0.170	0.050	0.366	0.133
Cameroon	0.093	0.037	0.120	0.043
Zambia	0.024	0.051	-0.047	0.041
Sudan	0.020	0.016	0.240	0.010
Madagascar	0.016	0.043	-0.019	0.033
Ghana	0.006	0.021	-0.019	0.020
Uganda	-0.040	0.040	-0.012	0.034
Senegal	-0.044	0.015	-0.066	0.017
Tanzania	-0.095	0.050	-0.063	0.039
Egypt	-0.210	0.042	-0.148	0.041
Zimbabwe	-0.392	0.151	-0.065	0.105
Latin American countries				
Ecuador	0.190	0.047	0.230	0.050
Argentina	0.085	0.026	0.029	0.017
Mexico	0.046	0.019	0.072	0.018
Chile	0.038	0.023	0.016	0.022
Colombia	0.003	0.010	0.021	0.009
Brazil	-0.049	0.017	-0.066	0.017
Nicaragua	-0.161	0.086	-0.129	0.066
Europe's transition economies				
Czech Republic	0.120	0.005	0.083	0.039
Slovakia	0.057	0.025	0.041	0.024
Turkey	0.001	0.000	0.002	0.000
Poland	-0.003	0.018	0.015	0.015
Slovenia	-0.040	0.134	-0.098	0.096
Bulgaria	-0.047	0.021	-0.060	0.017
Lithuania	-0.237	0.068	-0.213	0.055
High-income countries				
UK	0.274	0.054	0.000	0.000
France	0.101	0.010	0.089	0.009

Continued over

	$\hat{\beta}$ (75)	se	$\hat{\beta}$ (90)	se
Germany	0.061	0.013	0.206	0.032
Italy	0.048	0.007	0.035	0.012
Australia	0.031	0.010	-0.025	0.005
Netherlands	0.027	0.002	0.029	0.020
Canada	0.026	0.004	0.050	0.006
US	0.009	0.007	-0.011	0.008
Denmark	0.001	0.003	-0.032	0.053
New Zealand	-0.006	0.010	0.024	0.016
Portugal	-0.008	0.024	0.002	0.012
Sweden	-0.014	0.052	-0.065	0.070
Finland	-0.019	0.007	-0.001	0.010
Switzerland	-0.046	0.008	-0.040	0.007
Norway	-0.056	0.035	-0.026	0.026
Austria	-0.076	0.013	-0.012	0.018
Spain	-0.106	0.024	-0.075	0.023

Table 8: Relationship between b(1+b) and log(*z/e*) for all import-competing and exportables sectors, including a lagged dependent variable as a regressor

	(1)		(2)		(3)	
Pooled regression results						
	Pooled	2SLS[a]	Pooled	2SLS[a]	Pooled	2SLS[a]
	0.0078	0.0082	0.0084	0.1063	0.0124	0.0441
	(0.0022)	(0.0042)	(0.0090)	(0.0244)	(0.0035)	(0.0097)
Quantile regression results						
	QR	IVQR[a]	QR	IVQR[a]	QR	IVQR[a]
$\hat{\beta}$ (10)	-0.0016	-0.0022	0.0148	0.0657	0.0106	0.0287
	(0.0029)	(0.0071)	(0.0062)	(0.0089)	(0.0029)	(0.0102)
$\hat{\beta}$ (20)	-0.0011	-0.0032	0.0086	0.0272	0.0141	0.0062
	(0.0014)	(0.0024)	(0.0038)	(0.0087)	(0.0017)	(0.0058)
$\hat{\beta}$ (30)	0.0000	0.0000	0.0095	0.0151	0.0028	0.0093
	(0.0014)	(0.0024)	(0.0033)	(0.0080)	(0.0014)	(0.0047)
$\hat{\beta}$ (40)	0.0044	0.0064	0.0024	0.0088	0.0000	0.0097
	(0.0014)	(0.0025)	(0.0034)	(0.0078)	(0.0015)	(0.0046)
$\hat{\beta}$ (50)	0.0072	0.0089	0.0000	0.0000	0.0065	0.0222
	(0.0015)	(0.0027)	(0.0034)	(0.0076)	(0.0015)	(0.0049)
$\hat{\beta}$ (60)	0.0070	0.0089	0.0044	0.0200	0.0105	0.0286
	(0.0017)	(0.0023)	(0.0033)	(0.0082)	(0.0016)	(0.0043)
$\hat{\beta}$ (70)	0.0076	0.0076	0.0094	0.0349	0.0123	0.0267
	(0.0019)	(0.0035)	(0.0032)	(0.0170)	(0.0017)	(0.0041)
$\hat{\beta}$ (80)	0.0091	0.0132	0.0117	0.0800	0.0127	0.0360
	(0.0019)	(0.0034)	(0.0032)	(0.0136)	(0.0018)	(0.0038)
$\hat{\beta}$ (90)	0.0100	0.0161	0.0192	0.2182	0.0146	0.0314
	(0.0020)	(0.0028)	(0.0040)	(0.0238)	(0.0019)	(0.0035)
No. Observations	5797	5797	4528	4528	10408	10408
Controls[b]	No	No	No	No	Yes	Yes
Country fixed effects	No	No	Yes	Yes	No	No

a Instruments are the Herfindahl index, lagged output, arable land per worker and the capital labour ratio; and their squared and cross-product terms.
b Controls are polityIV, checks, presidential, Index EEC, Index LEC, Ideology, Ideology*Share of agricultural employment, Share of Agricultural Employment and Rural Party.

Table 9: Relationship between *b(1+b)* and selected control variables for all import-competing and exportables sectors, all countries, IVQR[a]

	0.25	0.5	0.75
Log(*z/e*)	0.0907***	0.0762***	0.0493***
	(0.0066)	(0.0057)	(0.0045)
Democracy (polity2)	0.0084	0.0094**	0.0128***
	(0.0066)	(0.0042)	(0.0043)
Checks on power	0.0017	0.0044	-0.0050
	(0.0050)	(0.0037)	(0.0042)
Presidential system of government	-0.1692***	-0.1429***	-0.24***
	(0.0189)	(0.0160)	(0.0231)
Index of executive competition	0.0813***	0.0593***	-0.0129
	(0.0233)	(0.0197)	(0.0212)
Index of legislative competition	-0.1498***	-0.1137***	-0.0654***
	(0.0193)	(0.0201)	(0.0224)
Ideology	-0.0025	-0.0085	-0.0396***
	(0.0072)	(0.0080)	(0.0107)
Ideology*share of employment in agriculture	0.0002	0.0009*	0.0021**
	(0.0007)	(0.0006)	(0.0008)
Share of employment in agriculture	-0.0083***	-0.0055***	-0.0069***
	(0.0016)	(0.0010)	(0.0015)
Rural party rule	0.1255*	0.2917***	0.2362***
	(0.0736)	(0.0507)	(0.0485)
Observations	4659	4659	4659

[a] Instruments are the Herfindahl index, lagged output, arable land per worker and the capital labour ratio; and their squared and cross-product terms.

Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; * significant at 1%.

Table 10: Relationship between *b(1+b)* and selected control variables for all import-competing and exportables sectors, all countries, IVQR[a]

	0.25	0.5	0.75
Log(*z/e*)	0.0844***	0.0737***	0.0458***
	(0.0061)	(0.0057)	(0.0045)
Democracy indicator	0.0078	0.0864**	0.0924**
	(0.1222)	(0.0421)	(0.0461)
Xconstraints	-0.0007	0.0005	0.0015*
	(0.0017)	(0.0011)	(0.0009)
Presidential system of government	-0.1532***	-0.1446***	-0.2091***
	(0.0182)	(0.0168)	(0.0257)
Index of executive competition	0.108***	0.0542**	-0.0035
	(0.0348)	(0.0207)	(0.0200)
Index of legislative competition	-0.1468***	-0.0998***	-0.0635***
	(0.0187)	(0.0189)	(0.0224)
Ideology	-0.0074	-0.0058	-0.038***
	(0.0066)	(0.0080)	(0.0113)
Ideology*share of employment in agriculture	0.0004	0.0007*	0.0017**
	(0.0007)	(0.0005)	(0.0008)
Share of employment in agriculture	-0.0047***	-0.0038***	-0.0054***
	(0.0016)	(0.0011)	(0.0016)
Rural party rule	0.1064	0.2774***	0.2278***
	(0.0732)	(0.0513)	(0.0483)
Real GPD per capita (constant $ 2000)	0.0604***	0.0307**	0.0341*
	(0.0137)	(0.0113)	(0.0169)
Observations	4659	4659	4659

[a] Instruments are the Herfindahl index, lagged output, arable land per worker and the capital labour ratio; and their squared and cross-product terms.
Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; * significant at 1%.

Conclusion

This thesis contributes to a better understanding of the effects and causes of five decades of distortions to global agricultural incentives. The thesis is part of, and builds on, a bigger project on five decades of Distortions to Global Agricultural Incentives, led by Kym Anderson.[83] The work in this thesis fits into that project by analysing the effects and causes of agricultural policy in ways different from those employed by other contributors to the project. The work also makes a contribution outside of the project, since the thesis establishes new methodologies and applications that have wider reach.

The contributions of the thesis fall into two parts. The first contribution is the development and estimation of several new series of indices within the so-called Anderson and Neary family of trade restrictiveness indices. These measures provide a better articulation of the trade- and welfare-reducing impacts of agricultural policies over the past half century than do traditional price-distorting measures (such as nominal rates of assistance, NRAs). The second contribution is to the literature on the political economy reasons behind distortions. The thesis finds that variations by commodity in producer protection or disprotection are to

[83] The main project focused on measuring distortions to agricultural incentives in the form of NRA and CTE estimates. The project comprised a series of national country studies in Africa, Asia, Latin America and Europe‘s transition economies, which culminated in a set of four regional books published in 2008–09. Those books were summarized and supplemented with overviews of policy trends since the 1950s in more-advanced economies in a global overview book, released in October 2009 (Anderson 2009b). The main project also had a second stage — the use of econometrics to estimate the political economy reasons behind distortions (Anderson 2010) and the inequality, poverty and other economic effects of current versus alternative policy regimes for individual countries (Anderson, Cockburn and Martin 2010).

some extent explained by the seminal Grossman and Helpman (1994) economic model of lobbying.

Turning to the first contribution, the thesis develops and estimates a series of new indices to measure the trade- and welfare-reducing impacts of agricultural policies. The new indices are superior to existing indicators used in the literature. While measures such as unweighted and weighted mean nominal rates of assistance (NRAs) and consumer tax equivalents (CTEs), standard deviations of NRAs and CTEs, trade bias indexes[84] and relative rates of assistance [85] can provide insights into agricultural policy distortions, it is useful to have a single indicator of the overall welfare or trade effect of each country‘s regime of agricultural price distortions in place at any time, and to trace its path over time, and to make cross-country comparisons. The indices developed in this thesis enable that to happen.

The measures have several benefits. From an empirical point of view, they tell us much about what has happened to agricultural policy over the past fifty years. This is summarized below. The measures have been made publicly available (Anderson and Croser 2009) for use by other researchers, as inputs into empirical work or for further analysis. The thesis also provides a methodology for others to use, both within and outside of agricultural policy research. Particularly

[84] The trade bias index is defined in the Anderson (2009) book as $TBI = (1+NRAag_x/100)/(1+NRAag_m/100) - 1$, where $NRAag_x$ and $NRAag_m$ are the weighted average percentage NRAs for the exportable and import-competing parts of the agricultural sector, with weights based on production valued at undistorted prices.

[85] The relative rate of assistance is defined in Anderson (2009) as $RRA = 100*[(100+NRAag^t)/(100+NRAnonag^t)-1]$, where $NRAag^t$ and $NRAnonag^t$ are the percentage NRAs for the tradables parts of the agricultural and non-agricultural sectors, respectively.

novel is the Manuscript 2 methodology which encourages researchers to take a global view of the distortions in a specific commodity market.

The indices provide an alternative for researchers who cannot access an appropriate national or sectoral computable general equilibrium (CGE) model for their work. This is common in many developing countries, especially smaller and poorer countries. The measures in this thesis are a substitute for detailed economic modelling because they provide a theoretically sound indicator of the welfare (or trade) effect in a single sectoral measure that is comparable across time and place. They thus go somewhat closer to what a sectoral or CGE can provide in the way of estimates of the trade and welfare (and other) effects of the price distortions captured by the product NRA and CTE estimates, while having the advantage of providing an annual time series.

Manuscript 1 introduces the first two new indices. These measures capture distortions imposed by each country‘s border and domestic policies on economic welfare and its trade volume. Manuscript 1 defines a Welfare Reduction Index (WRI) and a Trade Reduction Index (TRI) and estimates them for the project‘s focus countries since 1960, taking into account that for some products the NRA and CTE differ. As their names suggest, these two indexes respectively capture a single indicator of the (partial equilibrium) welfare- or trade-reducing effects of distortions to consumer and producer prices of farm products from all agricultural and food policies in place. The WRI measure reflects the welfare cost of agricultural price-distorting policies better than other aggregation measures because it recognises that the welfare cost of government-imposed price distortion is related to the square of the price wedge. It thus captures the disproportionately higher welfare costs of peak levels of assistance or taxation, and is larger than the mean and is positive regardless of whether the government‘s agricultural policy is favouring or hurting farmers.

The WRI five-year results reported in Manuscript 1 are much higher than the NRAs, especially for high-income countries. This comes from the fact that the measure picks up on the dispersion, and correctly aggregates positive and negative assistance levels. The results in Manuscript 1 also indicate a fairly constant tendency for covered products‘ policies to reduce welfare from the 1960s to the mid-1980s. This pattern is generated by different policy regimes in the different country groups though: in high-income countries, covered products were assisted throughout the period, although less so after the 1980s, whereas covered products in developing countries were disprotected until the most recent years.

For developing countries as a group, the trade restrictiveness of agricultural policy was roughly constant until the early 1990s and thereafter it declined, especially for Asia and Latin America, according to the TRI estimates. For high-income countries the TRI time path was similar but the decline began a few years later. The aggregate results for developing countries are being driven by the exportables sub-sector which is being taxed and the import-competing sub-sector which is being protected (albeit by less than in high-income countries). For high-income countries, policies have supported both exporting and import-competing agricultural products and, even though they favour the latter much more heavily, the assistance to exporters has offset somewhat the anti-trade bias from the protection of import-competing producers in terms of their impacts on those countries‘ aggregate volume of trade in farm products. Thus up to the early

1990s the TRI for high-income countries was below that for developing countries. To use the example of Africa, in 1985-89 when the NRA was closest to zero the TRI peaked, correctly identifying the trade-reducing effect of positive protection to the import-competing farmers and disprotection to producers of exportables.

Manuscript 2 differs from Manuscript 1 in that it focuses on commodities rather than countries, to show by what extent global markets for some farm commodities are distorted relative to each other. The manuscript reports new partial equilibrium estimates of global commodity TRIs and WRIs, to parallel the country-based ones reported in Manuscript 1. A summary of both indexes for 28 key farm commodities shows that the most distorted of all those commodities in 2000-04, in terms of both their global welfare cost and their trade restrictiveness, are rice, sugar, milk and beef — although cocoa trade is just as restricted as beef, because export restrictions are still prevalent in major supplying countries such as Cote d'Ivoire.

Manuscript 3 takes yet another different perspective. It approaches the trade restrictiveness index idea from the perspective of ascertaining the importance of the various policy instruments in contributing to global reductions in trade and welfare over the past half century. On the theory side, the paper develops a method of calculating and aggregating the trade and welfare reduction indexes for individual policy instruments from estimates of the rates of distortions of producer and consumer prices. These measures are estimated for 75 developed and developing countries over the past half century. The most significant result empirically in this manuscript is the importance of export taxes pre-1990s and their contribution to the fall in the global trade- and welfare-restrictiveness of agricultural policy over the past two decades. Previous studies that have measured the relative contributions of different policy instruments to global welfare reduction (and have ignored export taxes, import subsidies and production taxes), found that import taxes contribute as much as 90 percent of global welfare losses. By contrast, in Manuscript 3, I find that export taxes play a significant role in the aggregate reduction of global trade and welfare, contributing as much as one-third in some time periods. The contribution of export taxes to the almost halving of the global WRI (for border measures) from its peak in 1985–89 to 2000–04 is also significant. I find that globally import and export taxes each contribute roughly half to the decline in the WRI (for border measures). For developing countries, the fall is driven overwhelmingly by falls in export taxes, which account for 86 percent of the reduction.

Manuscript 4 provides a case study of the trade- and welfare-reducing impacts of agricultural policy for 19 Sub-Saharan African nations. The estimates reveal several important findings. The national level TRI and WRI indices indicate that although there has been policy reform in African agriculture over the past 50 years, the overall trade- and welfare-reducing effects of current policies are significant. This is especially so in countries such as Zimbabwe, Sudan, Mozambique and Zambia, which have the highest WRIs of the 19 focus countries. Export taxes, in particular, continue to reduce African welfare and trade. Some individual commodity markets in Africa are more distorted than others; sugar and cotton being two of the most distorted. The results of this manuscript provide a timely contribution to the literature given that agricultural policy in Africa will affect the payoff from the recent large increases in agricultural development assistance, and the negotiation of international and regional trade agreements are on the agenda.

In summary, the results of the first four manuscripts provide a considerable depth of information on the reform in country-level agricultural price and trade policies since the mid-1950s. But more than the provision of empirical data, they also provide a methodology that can be used as a substitute for sectoral or economy-wide modelling to generate a time-series that measures the state of policy in countries, regions and globally. The measures are applicable to broad sets of countries and products over time, providing long-run trends where no other estimates are available. The results also give insight into the efficiency and trade- and welfare-reducing effects of different policy instruments and different commodities‘ policies, which can be inputs into trade negotiations. The research paves the way for addressing more questions about the effects of agricultural trade policy on other economic outcomes — poverty, inequality and growth, for example.

To better understand what might happen in terms of continuing reform in agricultural policy, it is useful to understand something about the political economy of past behaviour. The Anderson and Valenzuela (2008) database provides the opportunity to consider the political economy of some of the government interventions reported in the preceding four papers. Anderson (2010) is devoted to an analysis of this subject. That book comprises a collection of theoretical and econometric analyses aimed at better understanding the political economy forces that generated the evolving pattern of inter- and intra-sectoral distortions to farmer and food consumer incentives over recent decades. The fifth manuscript in this thesis makes a further contribution in that area by looking at one aspect of the political economy of agricultural policy over the past century.

Specifically, Manuscript 5 uses product level data (as is done in the first four manuscripts of this thesis); and examines whether there is empirical support in the data for one of the seminal models of the political economy literature — the Grossman and Helpman (1994) Protection for Sale (PFS) model. That is, Manuscript 5 is an empirical application to agriculture of the PFS model that covers both developed and developing countries. The manuscript is enabled by the recent development of a new quantile-based methodology to test the PFS model (Imai, Katayama and Krishna 2008).

The results of the econometric analysis suggest that limited support for the basic propositions of PFS can be found in agricultural data. In particular, there is support for the model within the import-competing sector, which is reasonably robust to changes in instruments, controls and the inclusion of country fixed effects. Also, there is more support within high-income countries than in developing countries.

However, the results of the estimation of the model for exportable sectors, and at the individual country level, suggests there is some variation across countries in the ability of the model to explain cross-sectoral levels of trade policy distortion. One of the key findings of the paper is therefore that there is still work to be done in finding ways to apply the PFS model appropriately to different countries in the absence of lobbying data. In this context, the manuscript cautions against using (as has become common in several studies of late) ad hoc and arbitrary assumptions when estimating PFS in the absence of lobbying data.

Having an understanding of why governments choose certain trade policies is important. The first four manuscripts of the thesis establish that there is still much disarray in global agricultural markets, and that, while some progress has been made, there is a high degree of persistence in agricultural protection from import competition. Understanding political economy motives is important for governments as countries continue to work towards finalisation of the Doha round of multilateral trade negations. Perhaps the most important question is whether developing countries will follow the example of earlier industrializers and increase assistance to their farmers as their economies and polities develop.

Caveats

There are several ways in which the results in the thesis manuscripts can be improved. In terms of the WRI and TRI work, elasticity estimates would improve the results by enabling computation of more precise indicators of the trade- and welfare-reducing effects of policies. This extension of the results has obvious benefits. However, it is useful to recap here that it is expected that the price elasticity assumptions in the thesis have only a minimal effect on the estimates. As Anderson and Neary (2005, p. 293) observe, elasticities are ‗not very influential' in affecting trade restrictiveness indices because elasticities appear in both the numerator and denominator of the indices. Kee, Nicita and Olarreaga (2009) show that Anderson-Neary type indices can be decomposed into three elements —weighted average distortions, the weighted variance of distortions, and the covariance between each distortion and its relevant elasticity scaled by the weighted average relevant elasticity. In empirical work, Kee, Nicita and Olarreaga (2009) note that the contribution of the covariance term to their estimated trade restrictiveness indexes is small in practice. Irwin (2010) in his study for the US similarly shows that the covariance is a very small factor relative to the average tariff and variance of the tariff.

Nonetheless, it is useful to have some sense of the importance of the assumptions. In Manuscript 2 of the thesis, sensitivity analysis is carried out using available elasticity estimates for a subset of products. The two indexes for 8 key farm commodities were recomputed using country- and commodity-specific own-price elasticity of supply and demand estimates available from a widely cited source (Tyers and Anderson 1992). The inclusion of elasticity data made very little difference in the overall indications of distortions: the averages across the 8 products using the elasticity estimates were no more than 5 percentage points lower across the decade averages.

No sensitivity analysis is carried out in the thesis for the country-level estimates, because of the unavailability of elasticity estimates at the commodity level for our sample of developing and developed countries. However, Anderson and Croser (2010) provide an application of the work in this thesis just to high-income countries. The paper re-computes the two country-level indexes from Manuscript 1 for 22 high-income and transition economies using country- and commodity-specific own-price elasticity of supply and demand estimates available for 27 key farm products from two widely cited sources (Oley Roningen 2001; Tyers and Anderson 1992). In Anderson and Croser (2010), a comparison of the results with and without elasticity information reveals some differences.

The biggest divergence is for Korea and Japan, where the average WRI across countries using the elasticity data are between 6 and 46 percentage points lower than estimates without elasticity data. It should be noted that this is off a high base of WRI averages of well over 100 percent in those instances. The Western European countries also have differences in their TRI and WRI estimates. The elasticity data for this region reveals that livestock products tend to have a higher (absolute) elasticity of supply and demand, while grains and tropical crops have elasticities lower than the average. As a result, including the differentiated elasticity estimates causes livestock products to have a higher weighting in the EU than grains and sugar. There is little divergence in the results with and without the simplifying elasticity assumption for North America and Oceania, which have relatively low TRI and WRI estimates. Despite the differences reported, in all cases the index trends over time are much the same under either set of elasticity assumptions, suggesting they are a better indication of the trade reduction and welfare losses from agricultural policies than standard weighted aggregates of NRAs and CTEs. Nonetheless, when a global set of elasticities of supply and demand for agricultural commodities becomes available, the analysis in this thesis can be built upon and improved.

A second caveat on the TRI and WRI measures in this thesis is that they are partial equilibrium measures. The benefit of using partial-equilibrium measures is that they are simple yet powerful improvements on NRA and CTE aggregations and a low-cost substitute for formal models of markets. However, it is possible that the simplification biases the results. Lloyd and McLaren (2009) consider the bias in the partial equilibrium forms of the trade restrictiveness indexes due to the neglect of general equilibrium effects when these are not zero. They demonstrate that it is not possible to state, in general, the direction of bias in partial-equilibrium results.

A crude way to gauge the importance of partial equilibrium assumption is to compare the partial-equilibrium results in Manuscript 1 with those generated by a global general equilibrium model.[86] Even though there are numerous reasons for not expecting them to be the same, such a comparison can be a check on the orders of magnitude at least. Valenzuela, van der Mensburugghe and Anderson (2009) provides a set of global general equilibrium modelling results of the trade, welfare, and other effects of removing all distortions to goods markets globally as of 2004. The paper uses the economy-wide Linkage Model and the same NRAs and CTEs used in this thesis. According to that model, global trade in all primary and lightly processed agricultural products would be US$154 billion higher, and global welfare would be US$168 billion higher, or US$101 billion if just agricultural and food policies were liberalized (Valenzuela, van der Mensbrugghe, and Anderson 2009). This compares with the global TRI and WRI of US$138 billion and US$282 billion, respectively, for 2000–04 for just the 75 focus countries examined here and for just farm products. The welfare result from the Linkage Model is smaller than the WRI number, despite the broader coverage of the model of products and countries, because it takes into account the general equilibrium effects of other (including nonagricultural) distortions at home and also distortions abroad insofar as they affect international prices, whereas the global WRI is obtained simply by summing the WRIs of each country. A better

[86] This comparison draws on the work in Lloyd, Croser and Anderson (2009).

comparison would have been with a set of linkage model scenarios where only farm policies were liberalized in only one of the 75 countries at a time, but that would require 75 simulations; it remains an area for further research.

All manuscripts could be further enhanced by using data at a more disaggregated level, such as HS6 level data. In this thesis the World Bank's agricultural distortions database is used for several reasons: it enables cross-country comparison and it contains a breadth of measures that create price distortions across exportable, import-competing and nontradable sectors. Nonetheless, studies in both the trade restrictiveness index literature and the PFS literature tend to work with more disaggregated data, and it is possible that further insights into agricultural policy distortions over the past decades could be found with such data. In particular, the WRI is likely to be larger using more disaggregated data, in so far as there is more dispersion of NRAs and CTEs the more finely divided are the product sets.

There are several econometric caveats on the work in Manuscript 5, documented in that paper. One caveat is the use of the logs of the key regressor (*z/e*) because the distribution of the raw measure of *z/e* is such that it is not possible to estimate the econometric model. A measure of the coefficient on *z/e* can be recovered from the log results, but the estimation strategy means that the PFS model is not technically being estimated. To avoid this problem, the PFS model could be estimated within a single country where the variation of *z/e* is less dispersed; however, this would be at the loss of the cross-country analysis in the manuscript. The choice of instrumental variables in Manuscript 5 could be improved upon. Acres of farmland is a preferable instrument to output, but is not used in order to exploit the data in the Agricultural Distortions database on livestock products, for which protection levels are particularly high in many countries. The econometric specification could be improved by moving to a method which fully accounts for the possibility of autocorrelated errors, due to the persistence of NRA estimates over time. Sensitivity analysis reported in the Manuscript suggests that the results are robust to alternative specifications which account for autocorrelation. Nonetheless, improvement could be made by adopting an econometric specification within the IVQR framework that is fully robust to autocorrelation problems.

In summary, the econometric results in Manuscript 5 represent but an early attempt to shed light on the PFS determinants of agricultural policy at different stages of development, and the influence of several institutional frameworks on policy distortions in that context.

Future directions

The manuscripts in this thesis contribute to our understanding of the effects and causes of agricultural policy distortions over time. There are several directions for future research through which the work in the thesis could be built upon.

New indices of the impact of agricultural policy could be estimated using a similar framework to that in this thesis, but to summarize different economic variables. This thesis considers the trade and welfare effects of agricultural policy, but it is theoretically possible to derive indices which aggregate to hold constant other economic variables, such as tariff or government revenue (see Anderson

2009a, for example). All that is required is that the aggregation is based on a model that relates the index to a specified economic objective. Anderson (2009a) demonstrates the use of this approach for CGE modelling work. An example of a new index (in an endogenous prices setting) which could be useful in certain circumstances is a uniform tariff that would yield the same world price as existing tariffs (a Price-Equivalent Tariff).[87]

Aggregations could be based on alternative economic models to those used in this thesis, and in particular on models which relax some of the neoclassical assumptions inherent in the economic specification of the WRI and TRI in the thesis. The exposition in the thesis, drawing from Anderson and Neary, is based on neoclassical trade theory. It implicitly introduces some strong assumptions to simplify the calculations. For example, the economic model underlying the indices implicitly assumes full employment, functioning markets and no externalities. These assumptions may be nearly realistic for some countries, but certainly not for some developing and transitional countries. The exposition is also based on the notion that welfare losses can be computed by comparing the situation with and without protection. However, the economic model assumes that moving from one state to another is only a movement on given demand and supply curves, which is unlikely to be realistic in many countries. Other welfare impacts are likely to be present, for example, from technical change and capital flow changes. Further research could introduce an original and important idea to the trade restrictiveness index literature by looking at more sophisticated economic models of welfare changes, and then computing indexes based on these

[87] This index was suggested by an anonymous referee of Manuscript 2.

models. To date no other work proposes combining the TRI and WRI framework from Anderson and Neary with more sophisticated models from welfare economics.

Thinking more broadly, to achieve the goal of a better understanding of the trade- and welfare-effects of agricultural policy, it is possible to complement the index research in this thesis with research on the trade and welfare effects of policy using economy-wide modelling. An example of how CGE models can generate information on the trade- and welfare-effects of policy is referred to above (when comparing Manuscript 1 results to those in Valenzuela, van der Mensbrugghe, and Anderson 2009). In addition to capturing trade and welfare effects, such CGE models can estimate the impacts on agricultural markets and income distribution of alternative policies. The models can examine both past policy and proposed future reforms. CGE models are necessarily much more data and parameter intensive, but can provide greater insights into policy issues. Work in this area is already underway (see Anderson, Cockburn and Martin 2010, for example), but there is scope to do further work which seeks to answer similar questions to those posed in this thesis.

Empirical testing of the PFS model across countries makes but a small contribution to understanding the political economy of trade policy. There are at least three ways that the political economy work in this paper could be expanded to further understanding of trade policy decisions by governments. First, there is a greater story to tell in terms of the interaction between the seminal PFS model and institutions. Manuscript 5 skims the surface of the issue by examining briefly the role of democracy versus autocracy. One finding in Manuscript 5 is that Latin

American countries individually show strong support for the PFS model. One might ask, what is it about these countries that leads to support in that region? This research avenue could begin with theoretical expansions of the PFS model to introduce different political institutional frameworks which generate testable hypotheses.

A second area for further research in the political economy area is to use the WRI or TRI in econometric work. Several of the studies in Anderson (2010) use a single country statistic as the dependent variable. They use either the aggregate country-level NRA or RRA. As seen in the first four manuscripts of this thesis, weighted average measures can be misleading aggregates of the state of trade policy in a given country. For that reason, it would be useful to extend the analysis in the political economy area to use theoretically consistent aggregation measures.[88]

A third area for research is more detailed individual country studies. Overall, it is difficult to make generalizations about causes of agricultural policy across countries. The best that the papers in Anderson (2010) and Manuscript 5 can do is search for stylized findings that hold broadly across countries and sectors. However, within the area of political economy, there is much that is country specific, which provides scope for further research that delves more deeply into the detailed structure of individual economies and policies as they evolved over the past half century.

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[88] Aggregation issues are not present in the econometric work in Manuscript 5 because the analysis uses product level data.

References

Anderson, J. E. (2009a), ―Consistent Trade Policy Aggregation", *International Economic Review* 50(3): 903–927.

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

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., J. Cockburn and W. Martin (eds.) (2010), *Agricultural Price Distortions, Inequality and Poverty*, Washington DC: World Bank.

Anderson, K and J. L. Croser, (2009) *National and Global Agricultural Trade and Welfare Reduction Indexes, 1955 to 2007*, World Bank, Washington DC, available from April 2009 on the Database page at www.worldbank.org/agdistortions.

Anderson, K. and J.L. Croser (2010), ―Novel Indicators of the Trade and Welfare Effects of Agricultural Distortions in OECD Countries", discussion paper 7971, London: Centre for Economic Policy Research.

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

Grossman, G. and E. Helpman (1994), ―Protection for Sale", *American Economic Review* 84(4): 833–850.

Imai, S., H. Katayama and K. Krishna (2008) ―A Quantile-Based Test of Protection For Sale Model", NBER Working Paper 13900, March.

Irwin, D. (2010), ―Trade Restrictiveness and Deadweight Losses from U.S. Tariffs, 1859-1961", *American Economic Journal: Economic Policy* 2(3): 111–133, August.

Kee, H.L., A. Nicita and M. Olerreaga (2009), ―Estimating Trade Restrictiveness Indexes", *Economic Journal* 119(534): 172–199.

Lloyd, P.J., J. Croser and K. Anderson (2009), ―Welfare- and Trade-Based Indicators of National Distortions", Ch. 11 in Anderson, K. (ed.) (2009), *Distortions to Agricultural Incentives: A Global Perspective, 1955-2007,* London: Palgrave Macmillan and Washington DC: World Bank.

Lloyd, P.J. and D. MacLaren (2009), ―Partial and General Equilibrium Measures of Trade Restrictiveness", working paper, Parkville: University of Melbourne.

Oley Roningen, V, ‗VORSIM version 5', www.vorsim.com.

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

Valenzuela, E., D. van der Mensbrugghe and K. Anderson (2009), ‗General Equilibrium Effects of Price Distortions on Global Markets, Farm Incomes and Welfare', Ch. 13 in Anderson, K. (ed.) (2009), *Distortions to*

Agricultural Incentives: A Global Perspective, 1955-2007, London: Palgrave Macmillan and Washington DC: World Bank.

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Appendices

Appendix A: Elasticities[89]

This Appendix considers the impact of the simplifying assumption in several manuscripts that the domestic price elasticities of supply are equal across commodities within a country, and likewise for elasticities of demand.

Consider the standard form of the Producer Assistance Index (PAI) from equation (10c) in Manuscript 1:

$$S' = [\sum_{i=1}^{n} s_i^2 v_i]^{\frac{1}{2}} \qquad \text{with } v_i = p_i^{*2}\mathrm{dy}_i / \mathrm{d}p_i^P / \sum_i p_i^{*2}\mathrm{dy}_i / \mathrm{d}p_i^P$$

This partial equilibrium measure can be broken down into three parts:[90]

$$S' = [\bar{s}^2 + \Omega_s^2 + \rho_s]^{\frac{1}{2}}.$$

The three parts are:

- production-weighted average producer distortions, $\bar{s} = \sum_i s_i h_i$, where h_i is the production share of good *i*;
- production-weighted variance of producer distortions, $\Omega_s^2 = \sum_i (s_i - \bar{s})^2 h_i$; and
- the covariance between each producer distortion and its elasticity of output supply scaled by the production weighted average output supply elasticity, $\rho_s = \mathrm{cov}(\sigma_i / \bar{\sigma}, s^2)$, where σ_i is the elasticity of output supply as defined in Manuscript 1 and $\bar{\sigma} = \sum_i \sigma_i h_i$.

[89] This is a new Appendix by Croser.
[90] Kee, Nicita and Olarreaga (2009) show the decomposition for the usual Anderson and Neary index, which is based on import volumes, import demand elasticities and trade distortion measures.

The formula makes explicit that an increase in the dispersion of producer distortions increases the partial equilibrium index relative to production-weighted average producer distortion. In addition, the partial equilibrium distortion index will be larger than the production-weighted average producer distortion when the covariance between output supply elasticities and producer distortion measures is positive. An analogous decomposition can be derived for the Consumer Assistance Index (CAI).

In the absence of elasticity data across time and countries, Manuscript 1 shows that it is possible to estimate PAIs, CAIs, welfare reduction indexes (WRIs) and trade reduction indexes (TRIs) with the simplifying assumption that domestic price elasticities of supply are equal across commodities within a country, and likewise for elasticities of demand. The simplifying assumption equates to a computation of the PAI in which the third component of the decomposition shown above is zero.

It is expected that this simplifying assumption will have a small impact only on the estimates of PAI, CAI, WRI and TRI in Manuscript 1. Anderson and Neary (2005, p. 293) observe that elasticities are ‗not very influential' in affecting trade restrictiveness indices because elasticities appear in both the numerator and denominator of the indices. In the PAI expression in equation 10c, for example, elasticities appear in both the numerator and denominator of the v_i expression. In the third term of the PAI decomposition above, the elasticity for good *i* is scaled by the production weighted average elasticity for all goods.

In empirical work, Kee, Nicita and Olarreaga (2009) note that the contribution of the covariance term to their estimates trade restrictiveness indexes is very small in practice. Irwin (2010) in his study for the US similarly shows that the covariance is a very small factor relative to the average tariff and variance of the tariff. His estimated indices depend almost entirely upon the mean and variance of tariff rates, which are independent of elasticities.

In summary, it is reasonable to assume that even in the absence of widely-available elasticity data it is possible to derive good approximations of the PAI, CAI, WRI and TRI estimates.

References

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

Irwin, D. (2010), ―Trade Restrictiveness and Deadweight Losses from U.S. Tariffs, 1859-1961", *American Economic Journal: Economic Policy* 2(3): 111–133, August.

Kee, H.L., A. Nicita and M. Olearraga (2009), ―Estimating Trade Restrictiveness Indexes", *Economic Journal* 119(534): 172-99.

Appendix B: Alternative expressions for the TRI and the WRI using import-equivalent and welfare-equivalent tariff rates[91]

This Appendix derives alternative expressions for the TRI and the WRI which are simpler and can be related to other measures in the existing literature. First, we require the concepts of the import-equivalent tariff rate and the welfare-equivalent tariff rate.

When the market is distorted by a measure or measures other than a tariff, the usual practice is to take the producer price distortion as the equivalent rate (for example, Kee, Nicita and Olarreaga 2008, 2009). We can call this rate the *producer-price equivalent* rate. But this procedure is not, in general, correct because this producer-price equivalent rate does not replicate the effect on trade or welfare of the measure(s). The computation of the equivalent rates requires the rates of both the producer price and the consumer price distortions.[92]

Import-equivalent tariff rates

The import-equivalent tariff rate is the tariff rate that results in the same restriction of imports as the combination of measures applied to good *i*.

When the market is distorted by a combination of measures that distort the consumer and producer prices differentially, the change in imports (from equation 2 above) is:

[91] This Appendix is an Appendix to the Manuscript 1 journal article. It is joint work between Lloyd, Croser and Anderson.

[92] One must be careful in calculating these rates. In some cases, the effects of two (or more) measures on the distortions of producer and consumer prices are not additive. For example, suppose that the producers are assisted by a 10 per cent tariff and a quota that, if applied alone, would raise producer and consumer prices by 20 per cent. The combined effect of these two measures on producer and consumer prices is only 20 per cent. In other cases, one or a combination of measures may prohibit trade. In such a case, the relevant rate is the prohibitive tariff rate.

$$\Delta M_i = p_i^{*2} dx_i / d\,p_i^C r_i - p_i^{*2} dy_i / d\,p_i^P s_i \tag{A.1}$$

The import-equivalent tariff, t_i^I, is defined by the equality

$$p_i^{*2} dx_i / d\,p_i^C r_i - p_i^{*2} dy_i / d\,p_i^P s_i = p_i^{*2} dm_i / dp_i t_i^I$$

Hence,

$t_i^I = a_i r_i + b_i s_i$ where

$$a_i = (dx_i / dp_i^C)/(dm_i / dp_i) > 0\,,\ b_i = (dy_i / dp_i^P)/(dm_i / dp_i) > 0 \tag{A.2}$$

In general, $r_i \neq s_i$. The import-equivalent tariff rate is a weighted arithmetic mean of the rates of distortion of consumer and producer prices, the weights being their share of the import response to the change in price. If $r_i > 0$ and $s_i > 0$ then $t_i^I > 0$.

Welfare-equivalent tariff rates

The welfare-equivalent tariff rate, t_i^W, is the tariff rate that results in the same loss of welfare as the combination of measures applied to a good. As in the case of tariffs, we take the welfare triangles as the measure of welfare loss.

When the market for a good is distorted by a combination of measures that distort the consumer and a producer prices differentially, the welfare loss (from equation 7 above) is:

$$L_i = \tfrac{1}{2}\{(p_i^* s_i)^2 \mathrm{dy}_i / \mathrm{d}p_i^P - (p_i^* r_i)^2 \mathrm{dx}_i / \mathrm{d}p_i^C\} \tag{A.3}$$

This is the sum of two triangles. The two effects of the changes in consumer and producer prices capture all of the welfare effects when markets are competitive. The welfare-equivalent tariff is defined by the following equality:

$$\tfrac{1}{2}\{(p_i^* r_i)^2 \mathrm{dx}_i / \mathrm{d}p_i - (p_i^* s_i)^2 \mathrm{dy}_i / \mathrm{d}p_i\} = -\tfrac{1}{2}(p_i^* t_i^W)^2 \mathrm{dm}_i / \mathrm{d}p_i$$

Hence,

$t_i^W = \{a_i r_i^2 + b_i s_i^2\}^{1/2}$ where a_i and b_i are as defined in equation A.2.

The welfare-equivalent tariff rate is also a weighted average of the rates of distortion of consumer and producer prices, the weights again being their share of the import response to the change in price. However, the welfare-equivalent tariff rate is the mean of order 2, not the arithmetic mean (which is the mean of order 1). If $r_i > 0$ and $s_i > 0$ then $t_i^W > 0$.

Because both the import-equivalent and the welfare-equivalent tariff rates are means of the rates of producer and consumer distortions, they lie between these two rates, provided the weights are positive. For the same reason, both rates are different than the producer-price equivalent rate. They are greater or less than this rate depending on whether the producer price distortion rate is less than or greater than the consumer price distortion rate.

Importantly, the welfare-equivalent tariff rate is not equal to the import-equivalent tariff rate when the rate of distortion of the producer price is not equal to the rate of distortion of the consumer price. In fact, the welfare-equivalent tariff rate must be greater than the import-equivalent rate.[93] The difference between these two equivalent rates increases with the difference between the producer and the consumer distortion rate.

With some non-tariff measures, the rates of distortion of the producer price and the consumer price are equal. In these cases, the import-equivalent and the welfare-equivalent tariff rate are equal, and both are equal to the producer-price equivalent. This holds for variable levies. Quotas also fall into this category if the conditions required for equivalence are satisfied and if the quota is auctioned or one treats the

[93] From the Theorem of the Mean, the mean of order 2 is strictly greater than the mean of order 1 if $r_i \neq s_i$.

quota rents accruing to private quota-holders in the same way as revenues accruing to the government under a regime of tariffs only.

As one example, consider an industry that is assisted by an output-based subsidy alone. For the sake of illustration, we make the assumption that the slopes of the demand and supply functions are equal (ignoring signs). Then

$$(dm_i / dp_i) = (dx_i / d p_i^C) - (dy_i / d p_i^P) = -2(dy_i / d p_i^P) \quad \text{and} \quad t_i^I = ½s_i.$$

Hence, as required, the import-equivalent tariff rate is not equal to the producer-price equivalent tariff rate (s_i). In fact, it is exactly one half of this rate, because the import tariff affects both the domestic demand and the domestic supply whereas the subsidy affects on the supply side of the market. On the other hand, the welfare-equivalent tariff rate is 0.71 s_i (={0.5(s_i)^2}$^{1/2}$). This rate too is less than the producer-price equivalent tariff rate, and it is greater than the import-equivalent tariff rate.

As a second example, suppose a good is assisted by a combination of a 20 per cent tariff and a subsidy of 20 per cent in ad valorem terms. The consumer price increases by 20 per cent and the producer price by 40 per cent. If, again, the domestic demand and supply curves have the same slope, the import-equivalent rate is 30 (=0.5(0.2) +0.5(0.4)) per cent. The welfare-equivalent tariff rate for this combination is 31.2 (={0.5(0.2)^2+0.5(0.4)^2}$^{1/2}$) per cent. Again $t_i^W \neq s_i$ and $t_i^I \neq s_i$, and $t_i^W > t_i^I$.

Now define the TRI as:

$$T = \sum_{i=1}^{n} t_i^I w_i \quad \text{where} \quad w_i = \varepsilon_i (p_i^* m_i^*) / \sum_i^n \varepsilon_i (p_i^* m_i^*) \qquad \text{(A.5)}$$

and where ε_i (< 0) are the elasticities of the import demand function in the free-trade situation and $(p_i^* m_i^*)$ are the values of imports in the free-trade situation. If the definitions of t_i^I in equation A.2 are inserted into equation A.5, it is easily seen that the form in equation A.5 is identical with that in equation 4.

Similarly, define the WRI as:

$$W = [\sum_{i=n}^{n} (t_i^W)^2 w_i]^{1/2} \quad \text{where} \quad w_i \;=\; \varepsilon_i (p_i^* m_i^*) / \sum_i^n \varepsilon_i (p_i^* m_i^*) \qquad \text{(A.6)}$$

If the definitions of t_i^W in equation A.4 are inserted into equation A.6, it is easily seen that the form in equation A.6 is identical that in equation 12.

In effect, the indexes in equations A.5 and A.6 are calculated in two stages.[94] First, we calculate the import-equivalent (welfare- equivalent) tariff rate of distortions to both producer and consumer prices in each market and then we average these tariff rates across all goods. These forms of the indexes are particularly useful if we are interested in the contributions which the distortions in the market for each good make to the aggregate loss of trade or welfare for the country.

References

Kee, H.L., A. Nicita and M. Olearraga (2008), ―Import Demand Elasticities and Trade Distortions", *Review of Economics and Statistics* 90(4): 666-82.

Kee, H.L., A. Nicita and M. Olearraga (2009), ―Estimating Trade Restrictiveness Indexes", *Economic Journal* 119(534): 172-99.

[94] Kee, Nicita and Olarreaga (2009) use the expression in equation A.6 but again they wrongly use the producer price distortion in place of the welfare-equivalent tariff rate.

Appendix C: Additional Results and Analysis for Manuscript 1

This Appendix includes charts summarising the Agricultural Distortions data and additional results on the TRI and WRI that were not included in Manuscript 1 (the journal article version of the paper) due to space constraints. This material draws from Lloyd, Croser and Anderson (2009). The Appendix also presents a comparison of the results in Manuscript 1 with those in Kee, Nicita and Olarreaga (2008). The comparison analysis was the basis for Anderson and Croser (2010a).

Additional charts and results

Appendix Figures C1 to C4 present a graphical summary of aggregated regional NRAs and CTEs. Appendix Figures C5 and C6 present a graphical summary of regional TRIs and WRIs.

For completeness, the national WRI and TRI estimates (Appendix Tables C1 and C2) and PDI and CDI estimates (Appendix Tables C3 and C4) are included in this Appendix. The PDI and CDI estimates are not identical, but their similarity reflects the fact that most of the distortions to agricultural incentives, as compiled in Anderson and Valenzuela (2008), are due to price distortions at national borders rather than to domestic measures. Even so, it is important to keep the PDI and CDI separate because they can be very different for some countries. Likewise, the country detail in Appendix Tables C1 and C2 reveals that considerable differences within each region are concealed in the regional aggregates reported in tables and figures in the journal article. Those differences are illustrated clearly for 2000–04 in Appendix Figure C7, where individual country TRIs and WRIs are shown. That figure reveals the extremely high indexes for the most agricultural-protecting countries in the world, namely the three European Free Trade Area (EFTA) members (Iceland, Norway, and Switzerland) and the three advanced economies of Northeast Asia (Japan, Republic of Korea, and Taiwan, China). Notice also from Appendix Figure C7 that while the WRI is always positive, the TRI can be negative because of export or import subsidies.

A useful way of summarizing the regional estimates is provided in Appendix Figure C8, which shows their movement since the late 1980s, when most of the indexes peaked. The indexes suggest that agricultural policies were not reducing either the trade or welfare of a region if the region was located at the zero point of both axes—that is, in the bottom left corner of the diagram (the ―sweet spot"). While almost no region is near that point, virtually all regions have moved toward it since 1985–89, and substantially so for the outliers, namely Africa and EFTA + Japan, but also considerably for the largest developing country region, Asia, and the European Union.

Another result of interest is the countries which have contributed most to the global reduction in trade from farm policies. In Appendix Figure C9, the biggest contributors are (in order) Japan, Korea, India, France, and Germany, while the biggest contributors to the global reduction in welfare from farm policies are (again in order) Japan, the United States, Korea, China, and France. These country contributions have been computed so that each country‗s share reflects both the absolute size of the index for the country and the relative importance of that country in the world in terms of the average value of production and consumption at undistorted prices (see footnotes to Appendix Figure C9).

Over the entire period between 1961 and 2004, the WRI has tended to be higher the higher is a country‗s real GDP per capita (Appendix Figure C10). There has also been a negative correlation between the TRI and a trade specialization index defined as the ratio of net exports to the total value of exports plus imports of agriculture and food—and an even stronger negative correlation between the WRI and that trade specialization index. That is, agricultural-exporting countries tend to have both lower measures of the TRI and WRI, while import-competing countries tend to have more welfare- and trade-reducing policies in place.

Comparing the TRI results with an alternative TRI series

Drawing on the seminal theoretical work of Anderson and Neary (1994, 2005), Kee, Nicita and Olerreaga (2009) estimate, among other indices, a single trade reduction index (called an Overall Trade Restrictiveness Index or OTRI in their paper) for 78 developed and developing countries for a snapshot in time (a single year in the early or mid-2000s). Updates of these have been reported regularly in the World Bank‘s *Global Monitoring Report,* with estimates for circa 2007 reported in Chapter 5 of World Bank (2009), for example. The estimates are based on distortions to the import-competing sub-sectors of both the agricultural and manufacturing sectors due to each of these countries‘ import tariffs and non-tariff import-restricting measures (NTMs).

Manuscript 1 provides alternative annual estimates of a similar index (called a trade reduction index, TRI) for the agricultural sector of 75 developed and developing countries for the period 1961 to 2007. That TRI is available separately for the import-competing and export sub-sectors as well as for the overall sector. This alternative set is based on national estimates of the nominal rate of assistance to producers and the consumer tax equivalent (NRA and CTE) of domestic and border policy measures that affect each country‘s agricultural trade. Those NRAs and CTEs, provided by Anderson and Valenzuela (2008) and summarized in Anderson (2009), are derived by comparing domestic prices with prices at a country‘s border.

This note compares the trade reduction estimates in the two studies, and considers reasons why the two series could be – and are – different. With those insights it is possible to offer suggestions as to how estimation of the trade restrictiveness of agricultural policy can be improved in the future.

Comparison of estimates in different studies

This section briefly compares the Manuscript 1 (Lloyd, Croser and Anderson) estimates (LCA) to the Kee, Nicita and Olerreaga (2008) estimates available on the World Bank website (KNO).[95] Figure C11 shows the estimates used by KNO for the agricultural sector OTRI based on import tariffs and NTMs alongside the LCA estimates of the TRI for the import-competing agricultural subsector, with countries ranked according to the LCA estimates. For high-income and transition economies, there is a high degree of correlation between the estimated series in the two studies for many countries, especially the European Union (EU) countries and most of Central and Eastern Europe's transition economies. (Note that the common KNO estimate of the OTRI for EU member countries of the as a whole — 49 percent — is allocated to each member country in Figure C11.)

The differences between the two sets of estimates are most noticeable at the top and bottom of Figure C11(a), which includes the high-income and transition economies for which estimates are available in both sets. For the EFTA countries (Switzerland, Iceland and Norway) and Japan — countries with a strong comparative disadvantage in agricultural products — the LCA estimates are much higher than the KNO estimates; while for Australia, the United States and New Zealand — countries with a strong

[95] The Kee et al. (2008) estimates are slightly different to those in Kee et al. (2009), but we use the former because they include a disaggregation of the OTRI into manufacturing and agricultural sub-sectors of each national economy.

comparative advantage in agricultural products — the LCA estimates are much smaller than the KNO estimates.

Figure C11(b) presents a comparison of the estimates for developing countries in both data sets. The LCA estimates for developing countries are generally smaller than the estimates of KNO. This tendency holds across the three main developing country regions (Africa, Asia and Latin America). For a few developing countries, the TRI estimate by LCA is negative, indicating that their agricultural policies in aggregate were implicitly subsidizing imports slightly. There are only a few developing countries for which the KNO estimate is lower than the LCA estimate, most noticeably Ghana and Sri Lanka.

Why the estimates differ across studies

There are at least five reasons why the KNO and LCA estimates could differ. Some are empirical, others are methodological.

The most obvious reason for the series to differ is that the two studies take their distortions data are from different sources. In the KNO study, the main source of tariff data are the WTO Integrated Data Base and UNCTAD‘s TRAINS database. NTM data are mostly from TRAINS, supplemented by the WTO‘s national *Trade Policy Review* reports. Agricultural domestic support data (which are included in the KNO NTM estimate) are based on WTO members‘ notifications during the period 1995–98. By contrast, the data used in the LCA estimates are obtained from the World Bank‘s new Distortions to Agricultural Incentives database, which provides price-equivalent distortion estimates for the production and consumption sides of each commodity market based on direct price comparisons. By calculating domestic-to-border price ratios, the estimates include the price effects of all tariff and non-tariff trade measures plus any domestic price support measures (positive or negative), plus an adjustment for the output-price equivalent of direct interventions in farm input markets. Where multiple exchange rates operate, an estimate of the import or export tax equivalents of that distortion are included as well. The domestic-to-border price ratio is an appropriate measure for the TRI analysis since it captures agricultural price and trade policies by comparing like products at the same point in the value chain, namely, the farm-gate level.

The different sources of data (and their different years), and the way they are used, can potentially explain some of the difference in the estimates. For example, the KNO estimates of their OTRI are higher than the TRI estimates by LCA for agricultural-exporting countries potentially because of the methodology used by KNO to capture the effects of NTMs. The KNO method involves (1) estimating the restrictiveness of NTMs on import volumes by product and country, and (2) using import demand elasticities to transform the estimated import quantity to an ad-valorem tariff equivalent measure. The former step includes in the estimating equation a dummy variable for each quarantine measure (e.g. sanitary or phytosanitary regulation) regardless of the extent of restrictiveness of that measure. For countries such as Australia, the United States and New Zealand, almost half of the OTRI estimates by KNO are due to NTMs. The LCA method of domestic-to-border price comparisons for like products at the farmgate level of the value chain, by contrast, provides an ad valorem equivalent directly.

The second reason to expect differences between the two series is that the LCA estimates are computed with the simplifying assumption within each country that domestic price elasticities of supply are equal across commodities, and the same for domestic price elasticities of demand. That assumption allows the LCA estimates to be constructed by aggregating distortions using as weights just the sectoral share of each commodity's domestic value of consumption or production at undistorted prices. While this simplification means that the estimates do not fully capture the differential responses of various commodity trades to a given policy distortion, sensitivity analysis leads LCA to expect the assumption to have only a minor effect on their overall results.

The third reason to expect differences between the two series is that the KNO estimates are generated from a very disaggregated dataset (at the HS six-digit tariff line level, which has more than 4000 tariff lines) whereas the LCA estimates are based on a sample of around 15 farm products per country (so as to cover 70 percent of the gross value of each country's farm production). Assuming the level of disaggregation were the only difference between the two series (i.e. the product and instrument coverage (see below) were the same, and the series used the same distortions data), the greater level of disaggregation in the KNO study would result in more accurate TRI estimates. The KNO estimates correctly aggregate distortions from the more disaggregated base, and the estimates reflect the full diversity of distortions across industries within the agricultural sectors. The OTRI for industries distorted by import restrictions alone (the KNO approach) would give a higher estimate than a comparable TRI estimate by LCA because the former would be based on data that contains a fuller diversity of distortions across the import-competing sub-sector.[96]

The fourth reason why the two series could differ is the difference in the products included in the two studies. The KNO estimates are based on a methodology where distortions to import-competing products only are weighted by observed import values (multiplied by import demand elasticities, as per the Anderson and Neary formulation of the index). That is, the KNO estimates will only include products with some imports in the HS six-digit data, regardless of the importance of each industry to domestic production or consumption. By contrast, the LCA estimates are computed using a

[96] Another index reported in both the KNO paper and the AC database is a welfare reduction index, for which the variance of sectoral distortions is a component of the index. In this case, the more disaggregated dataset, which is likely to have a greater variance of distortions, would result in a higher welfare reduction index estimate than the estimates using the more aggregated dataset. This is in fact what Laborde, Martin and van der Mensbrugghe (2009) find when they aggregate HS six-digit tariff line data to the GTAP commodity level.

methodology where the weights are production and consumption based. From a practical point of view, the data in Anderson and Valenzuela (2008) is such that agricultural products are selected for inclusion in the database because they are important contributors to the gross value of national production at undistorted prices, thereby minimizing the number of products needed to achieve the target coverage of 70 percent of that total value. The LCA estimates are based on policy distortions to those 70 percent of products, which includes for both import-competing and exportable sub-sectors. The TRIs are computed for the sub-sectors of import-competing and exportable products separately as well as together; and they can be extended to include the nontradables sub-sector as well (see Manuscript 4 of this thesis). If the only difference between the two series was the product set, the LCA estimates would give a more accurate indication of distortions to the domestic agricultural markets of a country, because both import-competing and export sectors (and potentially nontradables) are included. However, the LCA estimates could be improved by including more coverage of production and consumption (currently about 70 percent coverage of production and somewhat less of consumption on average). The KNO methodology could be improved by including exportable products, since all agricultural products are excluded from the analysis where there is no import value at the HS six-digit level.

The fifth and related reason for the difference between the two series is differences in the policy instruments included in the analysis. The KNO estimates include only import-restricting policy distortions, whereas the LCA estimates are based on all distortions (positive and negative) to import-competing and exportable industries. That set includes import and export taxes and subsidies and ad valorem equivalents of non-price border measures such as quantitative trade restrictions or technical standards, and the implicit trade taxes associated with multiple exchange rates, as well as domestic production or consumption taxes and subsidies and the output subsidy equivalent of farm input subsidies net of input taxes.

Differences in the estimated TRI series due to differing extents of product disaggregation, product coverage and instrument coverage are evident from a comparison of the KNO estimates with two sets of LCA estimates in Figures C11 and C12. The first comparison is between the KNO estimates and the LCA TRI estimates for import-competing products in each country (Figure C11). Given the four differences between the two series analysed above, it is not possible to say a priori whether the TRI estimates by LCA will be larger or smaller than its KNO counterparts. For example, whilst the latter will include many more products — including ones involving little or no restriction because there is no local industry demanding protection from import competition, it will only include import restrictions and hence only a subset of distortions to agricultural trade (albeit probably the most distortive subset). For high-income and transitional economies, where most import distortions are protective, the LCA estimates (with fewer sectors) are higher than KNO estimates, most likely because the effect of including more products dominates. This could be partly why temperate-climate countries such as Japan, Switzerland, Norway and Iceland, despite having highly protected import-competing agricultural sectors, have low OTRIs: many of their imports from tropical countries would face few if any restrictions (Figure C11a). In African countries such as Zambia, where there have been import subsidies for staple foods, the lower TRI estimate by LCA is lower than the OTRI estimate by KNO, suggesting that the effect of including more policy instruments dominates (Figure C11b).

The second comparison is between the KNO estimates and LCA's TRI estimates for all covered tradables (both exportable and import-competing sectors). This comparison brings the two series closer together in terms of product coverage, but the LCA estimates also include distortions to exportable sectors. Once again it is not possible to say a priori whether the LCA estimates will be larger or smaller than the KNO estimates. The extent to which the increased product coverage in the LCA estimates brings them closer to the KNO estimates will depend on the type and extent of distortion to exportable versus import-competing sub-sectors. A comparison and Figures C11 and C12 reveals that when exportable sub-sectors are included to generate a TRI for all agricultural tradables, the TRI estimates generally are lower in 2000–04 than those involving just import-competing sub-sectors. This is because the exportable sub-sector tends to be less trade restricted than the import-competing sub-sector. For example, Switzerland and Iceland have large export subsidies in 2000–04 for several agricultural products (Josling 2009). These trade-expanding subsidies reduce the TRI estimate quite significantly when the exportable sub-sector is included. In contrast, Norway prides much lower assistance to its exportable sub-sector, so the inclusion of exporting industries has a less significant effect on that country‘s TRI estimate (compare the grey shaded bar for Norway in Figures C11 and C12). As for developing countries, Cote d‘Ivoire, Tanzania and Zambia each have trade-reducing policies in their exportable sub-sector, which leads to a higher TRI estimate for them in Figure C12 than in Figure C11.

As mentioned earlier, welfare reduction indexes (WRIs) are also included in the LCA database, and KNO estimate a comparable measure in their work (see, for example, Appendix Table A.3.a of World Bank 2007). In the LCA estimates, since both tariffs and export subsidies have welfare-reducing effects, one does not see the offsetting effects that are present above in their TRI. Instead there is a compounding effect when exportables are added to the product set. This can be seen in Figure C13, where Switzerland has one of the highest WRI estimates for all covered tradables. The WRI measure, however, fails to capture potential welfare benefits from some NTMs such as sanitary or phytosanitary measures that prevent the importation of disease, which could mean the WRIs are overstated.

Summary of comparison

Clearly, the level of disaggregation of the distortions data, the proportion of the sector included in the aggregation, and the types of policy instruments included in the analysis appear to be important determinants of indices of agricultural trade restrictiveness. The more prevalent are NTMs, the more difficult it will be to avoid domestic-to-border price comparisons to get an accurate measure. But such price comparison studies need to include not only products important in domestic production but also those important in domestic consumption but which may not be produced domestically (such as tropical products in temperate countries, and conversely). Such price comparison studies are of course laborious and therefore expensive, but they are being undertaken regularly by the OECD for gradually more and more countries, including for a large sample of African countries under a new joint project with the FAO and national governments funded by the Bill and Melinda Gates Foundation. Adding TRIs to the list of calculated indicators would enrich the policy analysis that will be possible with those estimates, and without requiring any more information that is currently needed to estimate NRAs/CTEs or PSE/CSEs.

One final point: the TRI, with its inclusion of export sub-sectors, will be especially useful when assessing the restrictiveness of policy responses to spikes in international food prices, as in 2008 when many developing countries placed restrictions on exports of food. Efforts are currently under way to update the Anderson and Valenzuela (2008) and Anderson and Croser (2009) databases to include that year.

References

Anderson, J.E. and J.P. Neary (1994), ―Measuring the Restrictiveness of Trade Policy”, *World Bank Economic Review* 8(2): 151–69.

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

Anderson, K. (2009), ‗Five Decades of Distortions to Agricultural Incentives‘, Ch. 1 in K. Anderson (ed.), *Distortions to Agricultural Incentives: A Global Perspective, 1955-2007*, London: Palgrave Macmillan and Washington DC: World Bank.

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

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

Anderson, K and J.L Croser (2010a), ―How Much Do Agricultural Policies Restrict Trade? Comparing Trade Restrictiveness Indexes”, *Economic Premise* 4, March.

Croser, J.L. and K. Anderson (2010b), ―Contributions of Different Policy Instruments to Trade and Welfare Effects of Price-Distorting Policies”, Contributed Paper for the Annual Conference of the Australian Agricultural and Resource Economics Society, Adelaide, 10-12 February.

Croser, J.L. and K. Anderson (2010c), ―Agricultural Distortions in Sub-Saharan Africa: Trade and Welfare Indicators, 1961 to 2004”, discussion paper 7747, London: Centre for Economic Policy Research.

Josling, T. (2009), ―Distortions to Agricultural Incentives in Western Europe”, Working Paper no. 61, Washington DC: World Bank.

Kee, H.L., A. Nicita and M. Olerreaga (2008), “Global Monitoring Report 2008 — Overall Trade Restrictiveness Indices” Washington DC: World Bank, available at http://go.worldbank.org/C5VQJIV3H0

Kee, H.L., A. Nicita and M. Olerreaga (2009), “Estimating Trade Restrictiveness Indexes”, *Economic Journal* 119(534): 172–99.

Laborde, D., W. Martin and D. van der Mensbrugghe (2009), “Measuring the Benefits of Global Liberalization with a Consistent Tariff Aggregator”, mimeo, Washington DC: World Bank.

Lloyd, P.J., J. Croser and K. Anderson (2009), “Welfare-Based and Trade-Based Indicators of National Agricultural Distortions”, chapter 11 in Anderson, K. (ed.) *Distortions to Agricultural Incentives: A Global Perspective, 1955–2007*, London: Palgrave Macmillan and Washington DC: World Bank.

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) pp. 141–160.

World Bank (2009), *Global Monitoring Report*, Washington DC: World Bank.

Appendix Table C1: Welfare Reduction Indexes by country and region[a], all covered tradable farm products, 1960 to 2007 (percent)

	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–07
Africa	**51**	**51**	**52**	**49**	**50**	**80**	**52**	**37**	**36**	**—**
Cameroon	29	37	42	54	38	23	20	18	11	—
Côte d'Ivoire	35	47	45	48	44	39	37	32	41	—
Egypt, Arab Rep. of	49	53	54	40	46	134	32	29	21	—
Ethiopia	—	—	—	—	44	56	58	52	47	—
Ghana	24	44	40	62	89	75	39	21	30	—
Kenya	39	39	29	19	31	27	36	22	26	—
Madagascar	26	28	26	45	58	46	30	16	15	—
Mozambique	—	—	—	72	65	75	33	31	56	—
Nigeria	148	129	121	105	102	127	94	75	58	—
Senegal	19	18	44	46	41	60	66	12	19	—
South Africa	20	18	25	34	48	39	31	22	20	—
Sudan	35	40	51	40	40	65	79	42	44	—
Tanzania	—	—	—	71	72	68	62	54	50	—
Uganda	11	16	44	83	58	60	11	10	10	—
Zambia	26	38	48	59	32	70	59	40	43	—
Zimbabwe	41	45	50	56	46	42	47	40	72	—
Asia	**32**	**45**	**44**	**45**	**50**	**51**	**33**	**23**	**21**	**—**
Bangladesh	—	—	30	41	29	49	29	25	31	—
China	—	—	—	—	55	48	25	12	8	—
India	37	46	49	61	54	87	31	22	27	—
Indonesia	—	—	18	22	31	21	24	28	27	—
Korea, Rep. of	45	43	69	86	130	176	211	194	228	—
Malaysia	14	12	10	31	57	95	71	31	34	—
Pakistan	44	71	75	37	39	46	31	24	29	—
Philippines	18	36	30	21	33	46	32	51	42	—
Sri Lanka	32	28	29	37	26	29	39	35	30	—
Taiwan, China	30	46	52	35	43	85	124	155	190	—
Thailand	—	—	30	24	22	18	16	19	12	—
Vietnam	—	—	—	—	—	22	30	24	37	—
Latin America	**37**	**26**	**36**	**35**	**42**	**37**	**39**	**18**	**22**	**—**
Argentina	32	30	28	27	24	19	10	8	17	—
Brazil	—	16	43	36	42	39	34	8	7	—
Chile	53	27	28	28	16	34	23	18	13	—
Colombia	28	23	22	26	40	25	25	35	58	—
Dominican Republic	78	42	44	46	50	55	89	48	59	—
Ecuador	—	37	48	59	71	44	20	24	32	—
Mexico	—	—	—	43	48	42	54	30	33	—
Nicaragua	—	—	—	—	—	—	29	31	26	—
All DCs	**41**	**43**	**44**	**43**	**48**	**51**	**36**	**23**	**22**	**na**

Continued over

Appendix Table C1 (continued)										
	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–07
European transition economies	**—**	**—**	**—**	**—**	**—**	**—**	**47**	**40**	**40**	**45**
Bulgaria	—	—	—	—	—	—	28	26	22	29
Czech Republic	—	—	—	—	—	—	39	30	39	33
Estonia	—	—	—	—	—	—	28	27	29	31
Hungary	—	—	—	—	—	—	35	34	51	31
Latvia	—	—	—	—	—	—	54	47	66	31
Lithuania	—	—	—	—	—	—	54	52	67	31
Poland	—	—	—	—	—	—	27	27	36	33
Romania	—	—	—	—	—	—	36	44	65	51
Russia	—	—	—	—	—	—	46	34	33	—
Slovak Republic	—	—	—	—	—	—	31	30	37	32
Slovenia	—	—	—	—	—	—	60	72	69	45
Turkey	21	36	35	41	38	38	50	58	50	59
Ukraine	—	—	—	—	—	—	39	33	25	—
High-income countries	**55**	**66**	**54**	**73**	**77**	**95**	**77**	**60**	**58**	**33**
Australia	20	31	28	18	13	21	21	9	4	2
Austria	92	93	39	43	39	82	106	60	56	33
Canada	16	15	15	50	81	90	59	37	42	35
Denmark	82	84	93	157	139	121	71	55	50	26
Finland	129	138	108	129	69	204	204	65	58	31
France	93	118	94	118	124	115	74	55	51	32
Germany	142	146	109	133	134	117	73	58	52	28
Iceland	—	—	—	188	193	365	299	201	180	194
Ireland	66	99	97	187	179	169	93	74	69	44
Italy	89	90	73	88	99	93	63	49	47	23
Japan	74	94	106	155	150	248	240	210	213	163
Netherlands	137	159	129	170	164	132	76	64	56	33
New Zealand	11	12	14	20	24	28	13	10	9	7
Norway	—	—	—	292	198	256	229	174	164	117
Portugal	22	29	31	57	30	70	56	43	42	30
Spain	35	53	29	38	40	80	59	44	41	27
Sweden	149	184	137	204	163	139	122	64	61	35
Switzerland	—	—	—	219	190	347	284	195	172	108
United Kingdom	147	142	115	140	135	128	81	62	58	37
United States	13	20	12	12	26	35	22	19	25	16

Source: Anderson and Croser (2009) based on product NRAs and CTEs in Anderson and Valenzuela (2008).

Note: — = not available.

a. Regional aggregates are weighted using the average of the value of production and the value of consumption at undistorted prices.

Appendix Table C2: TRIs, by Country and Region[a], All Covered Tradable Farm Products, 1960 to 2007 (percent)

	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–07
Africa	**21**	**22**	**21**	**26**	**18**	**50**	**18**	**14**	**14**	—
Cameroon	27	34	38	49	35	9	8	8	3	—
Côte d'Ivoire	17	16	37	50	28	31	27	27	39	—
Egypt, Arab Rep. of	-5	2	-2	15	8	95	12	17	6	—
Ethiopia	—	—	—	—	41	54	56	49	36	—
Ghana	3	13	18	42	59	66	32	11	25	—
Kenya	-27	-21	-6	-3	-7	25	-9	10	12	—
Madagascar	21	17	-15	7	-1	29	10	6	11	—
Mozambique	—	—	—	31	-6	-16	3	19	44	—
Nigeria	112	102	94	64	50	78	25	17	-7	—
Senegal	19	13	38	45	35	36	36	8	16	—
South Africa	1	4	9	2	4	-14	-9	-1	-2	—
Sudan	29	28	29	29	23	56	40	18	31	—
Tanzania	—	—	—	24	22	42	41	22	30	—
Uganda	8	14	38	85	59	61	10	7	6	—
Zambia	21	1	1	36	-12	-46	-28	-7	29	—
Zimbabwe	35	39	43	51	29	37	19	10	12	—
Asia	**7**	**29**	**27**	**28**	**35**	**41**	**23**	**12**	**11**	—
Bangladesh	—	—	-13	9	-1	24	1	-8	6	—
China	—	—	—	—	44	44	19	4	1	—
India	21	36	42	47	38	70	26	18	22	—
Indonesia	—	—	1	9	14	5	2	-1	19	—
Korea	5	16	44	69	119	158	189	164	184	—
Malaysia	12	4	8	19	18	21	14	5	5	—
Pakistan	7	42	19	3	4	12	-3	-2	4	—
Philippines	-4	2	1	0	3	16	18	39	27	—
Sri Lanka	26	17	20	20	13	5	23	17	4	—
Taiwan, China	-6	-3	-16	-8	-19	-25	37	67	96	—
Thailand	—	—	25	19	13	11	9	6	1	—
Vietnam	—	—	—	—	—	12	28	6	-11	—
										—
Latin America	**24**	**14**	**21**	**18**	**19**	**14**	**17**	**5**	**8**	—
Argentina	30	27	28	25	23	18	7	3	13	—
Brazil	—	12	28	19	20	13	11	0	0	—
Chile	9	-7	-15	4	8	24	17	14	8	—
Colombia	14	5	8	8	18	11	5	12	-13	—
Dominican Republic	60	25	21	27	37	34	57	30	37	—
Ecuador	—	12	15	34	45	26	3	7	16	—
Mexico	—	—	—	12	16	13	26	8	17	—
Nicaragua	—	—	—	—	—	—	11	22	18	—
All developing countries	**17**	**26**	**24**	**26**	**31**	**38**	**22**	**11**	**11**	—

Appendix Table C2 (continued)

	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–07
European transition econs.	—	—	—	—	—	—	**8**	**14**	**14**	**6**
Bulgaria	—	—	—	—	—	—	11	10	6	12
Czech Republic	—	—	—	—	—	—	-20	1	10	1
Estonia	—	—	—	—	—	—	2	16	4	6
Hungary	—	—	—	—	—	—	-6	-12	-20	-12
Latvia	—	—	—	—	—	—	32	22	21	11
Lithuania	—	—	—	—	—	—	36	14	-6	-3
Poland	—	—	—	—	—	—	15	7	-9	-17
Romania	—	—	—	—	—	—	8	20	41	31
Russia	—	—	—	—	—	—	-31	16	22	—
Slovak Republic	—	—	—	—	—	—	-2	7	5	0
Slovenia	—	—	—	—	—	—	-8	-17	-24	-12
Turkey	4	3	10	22	9	13	16	23	17	8
Ukraine	—	—	—	—	—	—	20	11	14	—
High-income countries	**30**	**33**	**23**	**32**	**40**	**45**	**39**	**33**	**29**	**15**
Australia	-7	-11	-6	-3	-4	-7	-7	-3	-1	0
Austria	69	66	19	24	23	-22	-11	41	38	17
Canada	8	6	6	15	22	25	22	13	14	14
Denmark	-35	-35	-3	61	70	75	51	37	32	12
Finland	39	17	-7	-10	18	-106	-153	50	41	16
France	58	73	44	47	69	72	51	32	29	13
Germany	98	112	66	64	81	73	52	39	33	14
Iceland	—	—	—	130	151	-33	10	35	38	45
Ireland	-4	-12	7	96	117	128	81	63	55	26
Italy	45	48	33	34	52	49	31	25	23	8
Japan	64	73	73	102	105	144	134	132	127	106
Netherlands	89	120	86	96	110	84	55	48	40	17
New Zealand	2	2	2	-8	-11	-1	2	2	1	0
Norway	—	—	—	31	-32	152	195	155	140	88
Portugal	10	15	13	32	20	33	24	21	21	12
Spain	21	18	-1	-2	3	42	30	23	21	11
Sweden	46	41	42	51	49	-71	-59	47	42	18
Switzerland	—	—	—	197	168	81	44	17	14	37
United Kingdom	70	49	36	64	82	89	65	44	39	22
United States	4	2	1	4	7	7	6	2	4	1

Source: Anderson and Croser (2009) based on product NRAs and CTEs in Anderson and Valenzuela (2008).

Note: — = not available.

a. Regional aggregates are weighted using the average of the value of production and the value of consumption at undistorted prices.

Appendix Table C3: Consumer Assistance Indexes by country and region[a], all covered tradable farm products, 1960 to 2007

	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–07
Africa	**64**	**62**	**63**	**60**	**62**	**88**	**58**	**46**	**41**	—
Cameroon	28	34	39	51	37	24	15	12	9	—
Côte d'Ivoire	30	44	42	45	34	36	29	26	37	—
Egypt, Arab Rep. of	49	51	53	38	45	139	33	30	20	—
Ethiopia	—	—	—	—	52	65	66	62	61	—
Ghana	24	31	31	37	85	79	35	16	32	—
Kenya	43	50	27	29	23	51	35	34	39	—
Madagascar	20	28	25	40	54	40	23	14	13	—
Mozambique	—	—	—	70	63	74	30	33	70	—
Nigeria	163	140	128	108	102	128	94	74	57	—
Senegal	20	17	25	34	47	38	30	21	20	—
South Africa	19	18	43	45	37	72	78	11	17	—
Sudan	32	37	48	37	37	64	80	40	43	—
Tanzania	—	—	—	70	70	65	60	54	50	—
Uganda	10	15	41	80	53	58	11	11	11	—
Zambia	27	46	50	57	31	69	60	38	40	—
Zimbabwe	40	47	49	56	43	40	45	40	68	—
Asia	**29**	**40**	**40**	**48**	**49**	**57**	**34**	**24**	**23**	—
Bangladesh	—	—	30	42	29	48	29	25	32	—
China	—	—	—	—	52	48	25	12	9	—
India	10	39	41	61	53	84	31	24	25	—
Indonesia	—	—	19	20	30	21	23	28	28	—
Korea	44	42	62	82	127	166	197	174	195	—
Malaysia	12	8	8	22	21	34	20	9	8	—
Pakistan	43	71	78	39	40	47	31	25	31	—
Philippines	18	32	30	21	32	46	32	51	42	—
Sri Lanka	28	23	25	34	23	29	40	41	36	—
Taiwan, China	30	46	50	36	45	86	123	153	185	—
Thailand	—	—	30	25	24	17	16	20	14	—
Vietnam	—	—	—	—	—	22	30	26	39	—
										—
Latin America	**38**	**26**	**34**	**35**	**40**	**34**	**40**	**18**	**19**	—
Argentina	33	30	28	27	25	18	9	4	15	—
Brazil	—	19	41	37	42	38	34	7	6	—
Chile	51	27	28	30	18	37	26	20	15	—
Colombia	33	24	21	26	44	28	27	36	57	—
Dominican Republic	104	45	43	42	49	53	95	52	61	—
Ecuador	—	39	49	60	76	45	20	24	33	—
Mexico	—	—	—	39	41	32	49	29	23	—
Nicaragua	—	—	—	—	—	—	30	29	27	—
All developing countries	**48**	**43**	**44**	**48**	**49**	**58**	**38**	**26**	**24**	—

Appendix Table C3 (continued)

	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–07
European transition econs.	—	—	—	—	—	—	**48**	**37**	**39**	**48**
Bulgaria	—	—	—	—	—	—	30	26	23	32
Czech Republic	—	—	—	—	—	—	41	28	39	29
Estonia	—	—	—	—	—	—	27	25	28	26
Hungary	—	—	—	—	—	—	35	33	54	25
Latvia	—	—	—	—	—	—	58	49	69	32
Lithuania	—	—	—	—	—	—	54	52	65	32
Poland	—	—	—	—	—	—	28	25	38	32
Romania	—	—	—	—	—	—	33	42	59	51
Russia	—	—	—	—	—	—	54	28	32	—
Slovak Republic	—	—	—	—	—	—	27	27	34	26
Slovenia	—	—	—	—	—	—	54	65	57	34
Turkey	19	36	36	42	38	36	48	54	50	62
Ukraine	—	—	—	—	—	—	34	30	22	—
High-income countries	**57**	**68**	**54**	**75**	**77**	**91**	**74**	**62**	**58**	**36**
Australia	23	37	35	24	16	26	27	10	6	2
Austria	104	99	40	42	37	88	111	57	53	30
Canada	17	15	15	52	85	97	59	38	45	38
Denmark	84	83	94	166	140	116	66	55	50	24
Finland	133	141	108	129	68	225	225	62	57	29
France	93	119	97	120	128	106	65	52	50	30
Germany	137	141	106	128	130	102	61	53	48	26
Iceland	—	—	—	56	86	323	257	146	124	141
Ireland	61	98	94	206	184	160	86	67	58	30
Italy	88	89	72	88	101	86	56	49	48	23
Japan	72	86	98	142	135	230	216	189	188	141
Netherlands	137	158	126	172	166	131	75	62	55	28
New Zealand	14	14	16	21	23	33	18	13	12	9
Norway	—	—	—	73	57	124	141	131	135	107
Portugal	24	32	33	59	31	67	53	44	44	29
Spain	36	56	29	38	39	68	51	42	40	25
Sweden	139	183	130	210	165	149	124	62	62	34
Switzerland	—	—	—	119	109	275	239	164	162	108
United Kingdom	139	139	111	136	136	117	73	60	58	39
United States	14	22	12	12	26	34	20	20	24	17

Source: Anderson and Croser (2009) based on product NRAs and CTEs in Anderson and Valenzuela (2008).
Note: — = not available.
a. Regional aggregates are weighted using the value of consumption at undistorted prices.

Appendix Table C4: Producer Assistance Indexes by country and region[a], all covered tradable farm products, 1960 to 2007

	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–07
Africa	**56**	**58**	**59**	**61**	**62**	**75**	**56**	**43**	**37**	—
Cameroon	29	40	44	57	40	22	23	22	11	—
Côte d'Ivoire	45	50	48	59	59	45	46	38	45	—
Egypt, Arab Rep. of	50	55	56	40	45	127	31	29	23	—
Ethiopia	—	—	—	—	35	47	49	41	25	—
Ghana	25	54	47	76	87	67	38	25	27	—
Kenya	30	29	28	14	27	20	34	18	16	—
Madagascar	28	29	28	51	63	52	38	18	17	—
Mozambique	—	—	—	75	69	77	37	30	46	—
Nigeria	133	118	112	100	101	125	93	74	58	—
Senegal	20	19	25	33	49	40	32	21	21	—
South Africa	20	17	44	47	44	45	50	14	20	—
Sudan	40	44	53	44	43	66	78	44	45	—
Tanzania	—	—	—	73	74	71	64	55	51	—
Uganda	11	18	47	90	66	65	12	8	9	—
Zambia	25	37	46	59	32	70	59	41	45	—
Zimbabwe	42	42	50	56	49	45	47	40	75	—
Asia	**33**	**48**	**48**	**47**	**51**	**56**	**32**	**22**	**20**	—
Bangladesh	—	—	30	41	29	49	29	25	30	—
China	—	—	—	—	58	48	25	11	7	—
India	51	50	55	61	54	89	30	19	28	—
Indonesia	—	—	18	23	31	21	23	28	27	—
Korea	46	45	75	90	133	185	224	212	257	—
Malaysia	13	11	14	25	29	34	32	15	16	—
Pakistan	46	71	73	36	38	45	30	24	29	—
Philippines	19	41	30	21	35	46	32	50	41	—
Sri Lanka	38	36	34	42	29	29	37	30	24	—
Taiwan, China	30	47	53	35	42	85	124	157	195	—
Thailand	—	—	29	24	21	18	17	18	11	—
Vietnam	—	—	—	—	—	22	30	22	35	—
										—
Latin America	**32**	**25**	**37**	**34**	**42**	**39**	**35**	**18**	**23**	—
Argentina	32	29	29	27	24	20	11	10	19	—
Brazil	—	12	46	36	42	40	34	8	7	—
Chile	54	26	27	26	13	31	21	17	12	—
Colombia	23	24	23	28	37	24	23	33	55	—
Dominican Republic	59	38	42	47	51	57	83	43	56	—
Ecuador	—	35	47	56	65	40	19	23	30	—
Mexico	—	—	—	46	54	49	56	31	38	—
Nicaragua	—	—	—	—	—	—	29	35	27	—
All developing countries	**45**	**48**	**49**	**48**	**51**	**55**	**36**	**24**	**23**	—

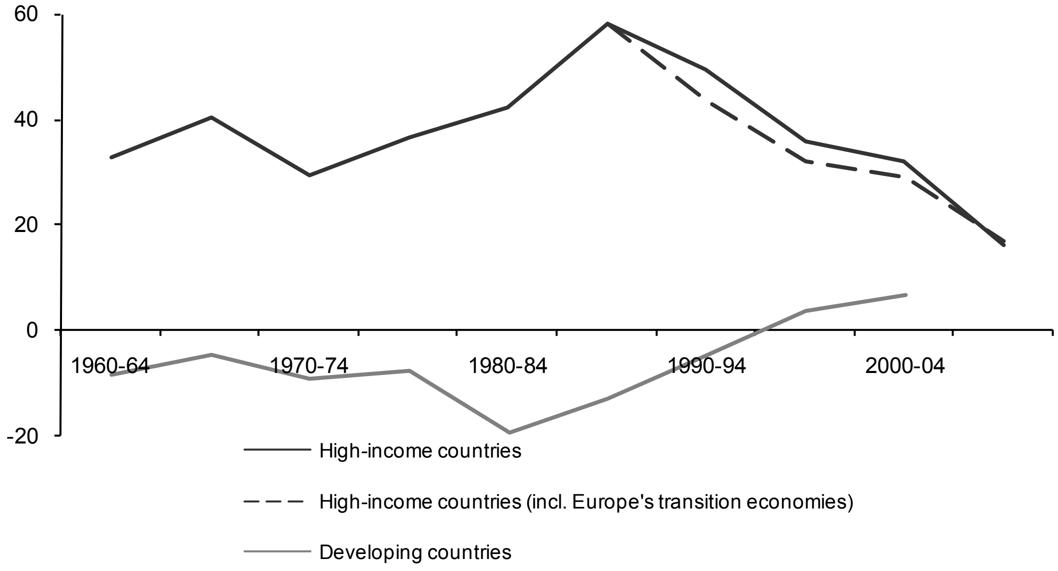
Appendix Table C4 (continued)

	1960–64	1965–69	1970–74	1975–79	1980–84	1985–89	1990–94	1995–99	2000–04	2005–07
European transition econs.	—	—	—	—	—	—	***46***	***43***	***40***	***40***
Bulgaria	—	—	—	—	—	—	25	26	22	28
Czech Republic	—	—	—	—	—	—	33	32	38	28
Estonia	—	—	—	—	—	—	28	27	30	24
Hungary	—	—	—	—	—	—	35	34	47	23
Latvia	—	—	—	—	—	—	52	45	63	24
Lithuania	—	—	—	—	—	—	54	52	69	29
Poland	—	—	—	—	—	—	26	30	33	29
Romania	—	—	—	—	—	—	37	45	70	52
Russia	—	—	—	—	—	—	38	38	34	—
Slovak Republic	—	—	—	—	—	—	34	33	40	25
Slovenia	—	—	—	—	—	—	68	80	79	38
Turkey	23	37	35	41	39	40	51	61	50	56
Ukraine	—	—	—	—	—	—	43	36	27	—
High-income countries	**52**	**62**	**51**	**69**	**73**	**95**	**76**	**56**	**54**	**31**
Australia	16	23	21	14	11	12	9	7	0	0
Austria	77	85	37	43	40	73	102	62	59	33
Canada	15	14	14	46	75	81	56	35	39	32
Denmark	72	81	86	139	131	124	75	55	48	23
Finland	126	134	107	129	70	170	175	68	58	28
France	92	117	92	116	120	124	83	57	53	29
Germany	147	150	112	137	139	131	83	63	57	29
Iceland	—	—	—	260	258	382	319	217	188	212
Ireland	75	106	102	164	172	178	99	81	79	49
Italy	89	90	73	88	97	98	66	49	46	21
Japan	77	101	113	164	161	263	261	228	236	181
Netherlands	136	161	131	168	162	133	76	65	58	31
New Zealand	9	10	12	19	25	24	10	8	7	5
Norway	—	—	—	407	274	339	291	207	188	127
Portugal	21	26	29	56	28	71	56	42	40	26
Spain	34	50	28	37	41	88	64	46	42	25
Sweden	173	185	150	196	160	126	116	66	60	30
Switzerland	—	—	—	286	245	405	325	223	183	108
United Kingdom	153	145	120	143	134	139	89	63	57	37
United States	12	19	12	11	25	36	24	17	26	17

Source: Anderson and Croser (2009) based on product NRAs and CTEs in Anderson and Valenzuela (2008).
Note: — = not available.
a. Regional aggregates are weighted using the value of production at undistorted prices.

Appendix Figure C1: Nominal rate of assistance to farmers in high-income and developing countries, for all covered farm products, 1960 to 2007

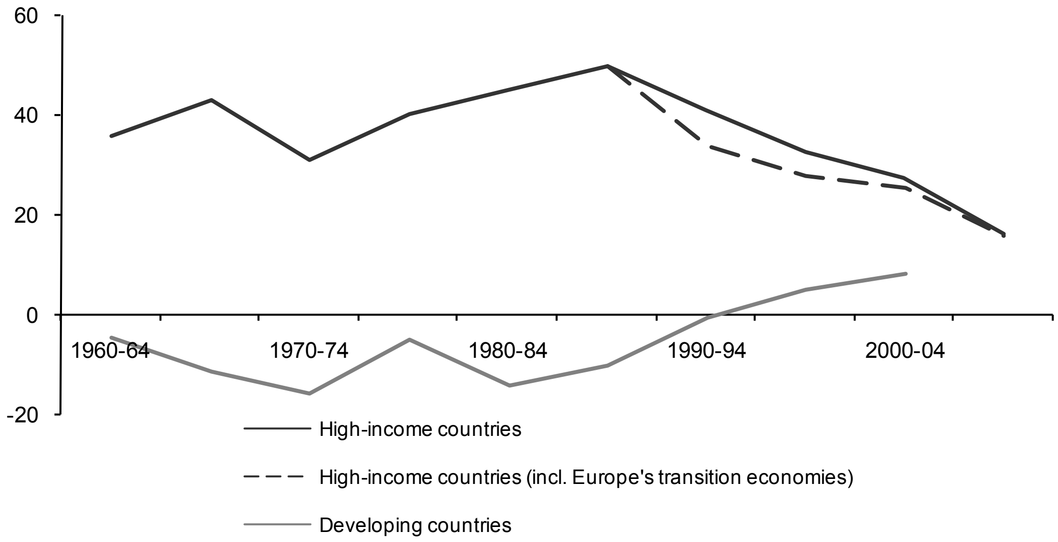
(percent, averaged using weights based on the gross value of agricultural production at undistorted prices)



Source: Anderson and Valenzuela (2008)

Appendix Figure C2: Consumer tax equivalents affecting covered farm products in high-income and developing countries, 1960 to 2007

(percent, averaged using weights based on the value of agricultural consumption at undistorted prices)



Source: Anderson and Valenzuela (2008)

Appendix Figure C3: Nominal rate of assistance to farmers in developing countries of Africa, Asia, Latin America and in Europe's transition economies (ECA) for covered farm products, 1960 to 2007

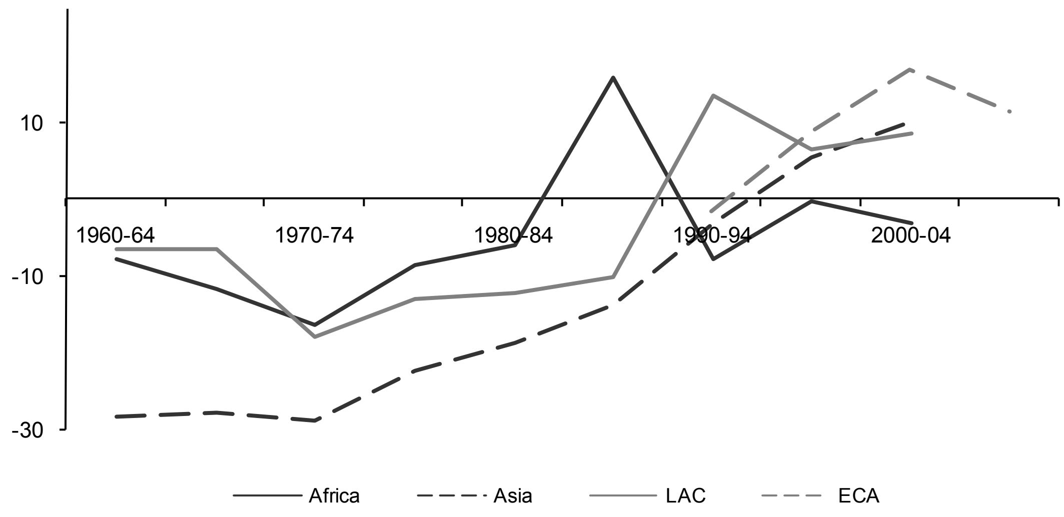
(percent, averaged using weights based on the gross value of agricultural production at undistorted prices)

NOTE:
This figure is included on page 356 of the print copy of the thesis held in the University of Adelaide Library.

Source: Anderson and Valenzuela (2008)

Appendix Figure C4: Consumer tax equivalents affecting covered farm products in developing countries of Africa, Asia, Latin America and in Europe‘s transition economies (ECA), 1960 to 2007

(percent, averaged using weights based on the gross value of agricultural consumption at undistorted prices)

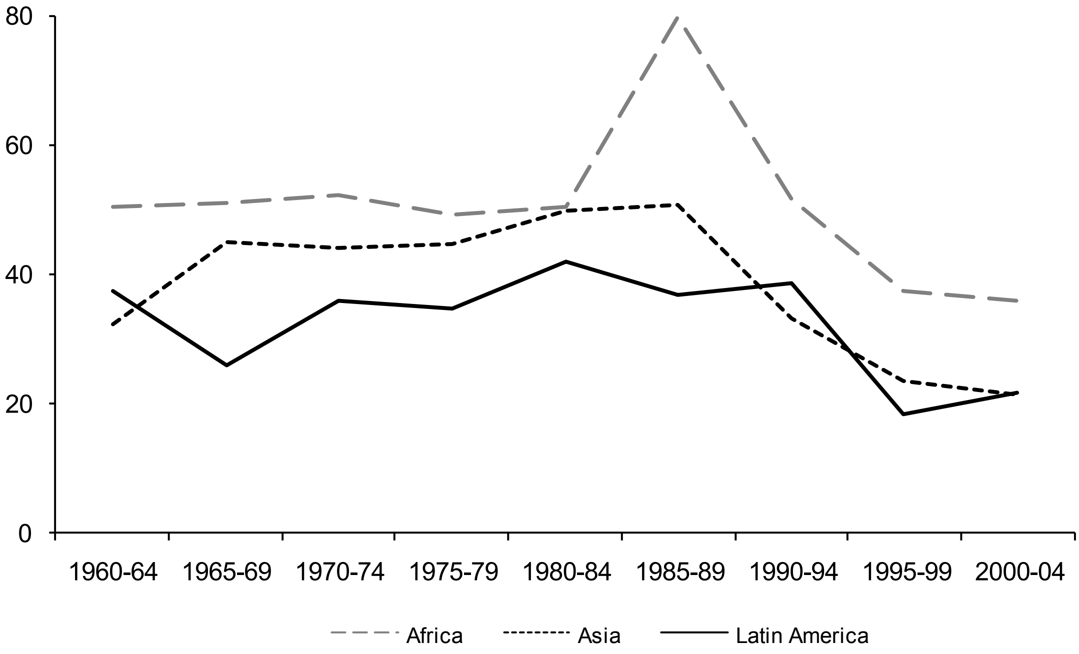


Source: Anderson and Valenzuela (2008)

Appendix Figure C5: Welfare Reduction Indexes for covered tradable farm products, by region, 1960 to 2007

(percent)

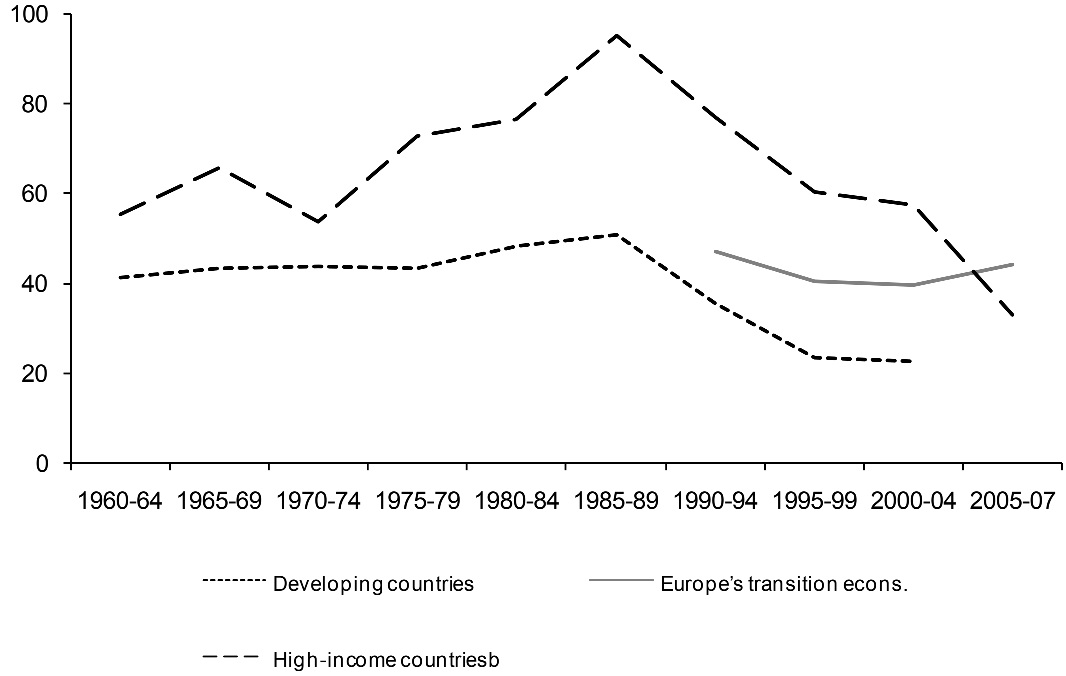
(a) Africa, Asia and Latin America



Appendix Figure C5 (continued): Welfare Reduction Indexes for covered tradable farm products, by region, 1960 to 2007

(percent)

(b) Developing countries, high-income countries and Europe‘s transition economies

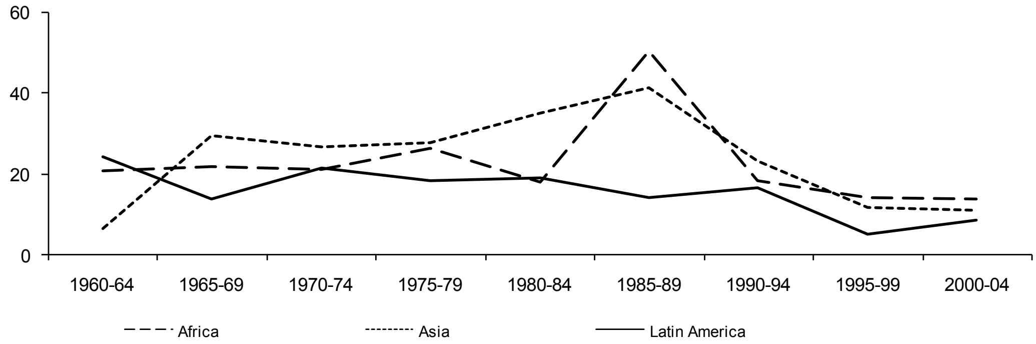


Source: Anderson and Croser (2009), based on NRAs and CTEs in Anderson and Valenzuela (2008).

Appendix Figure C6: Trade Reduction Indexes for covered tradable farm products, by region, 1960 to 2007

(percent)

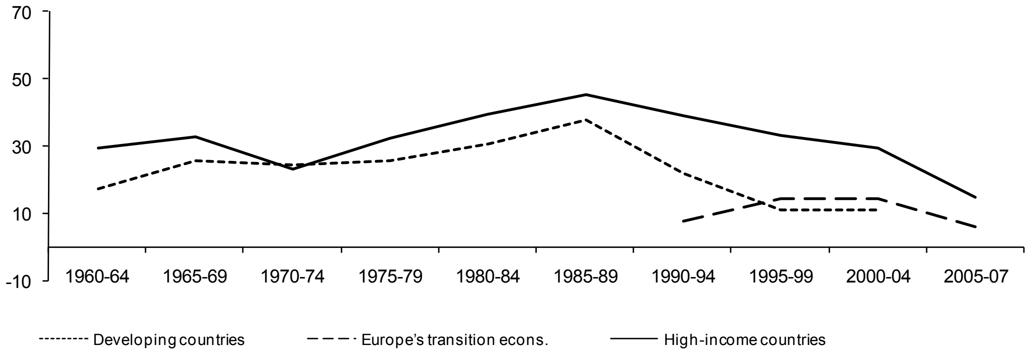
(a) Africa, Asia and Latin America



Appendix Figure C6 (continued): Trade Reduction Indexes for covered tradable farm products, by region, 1960 to 2007

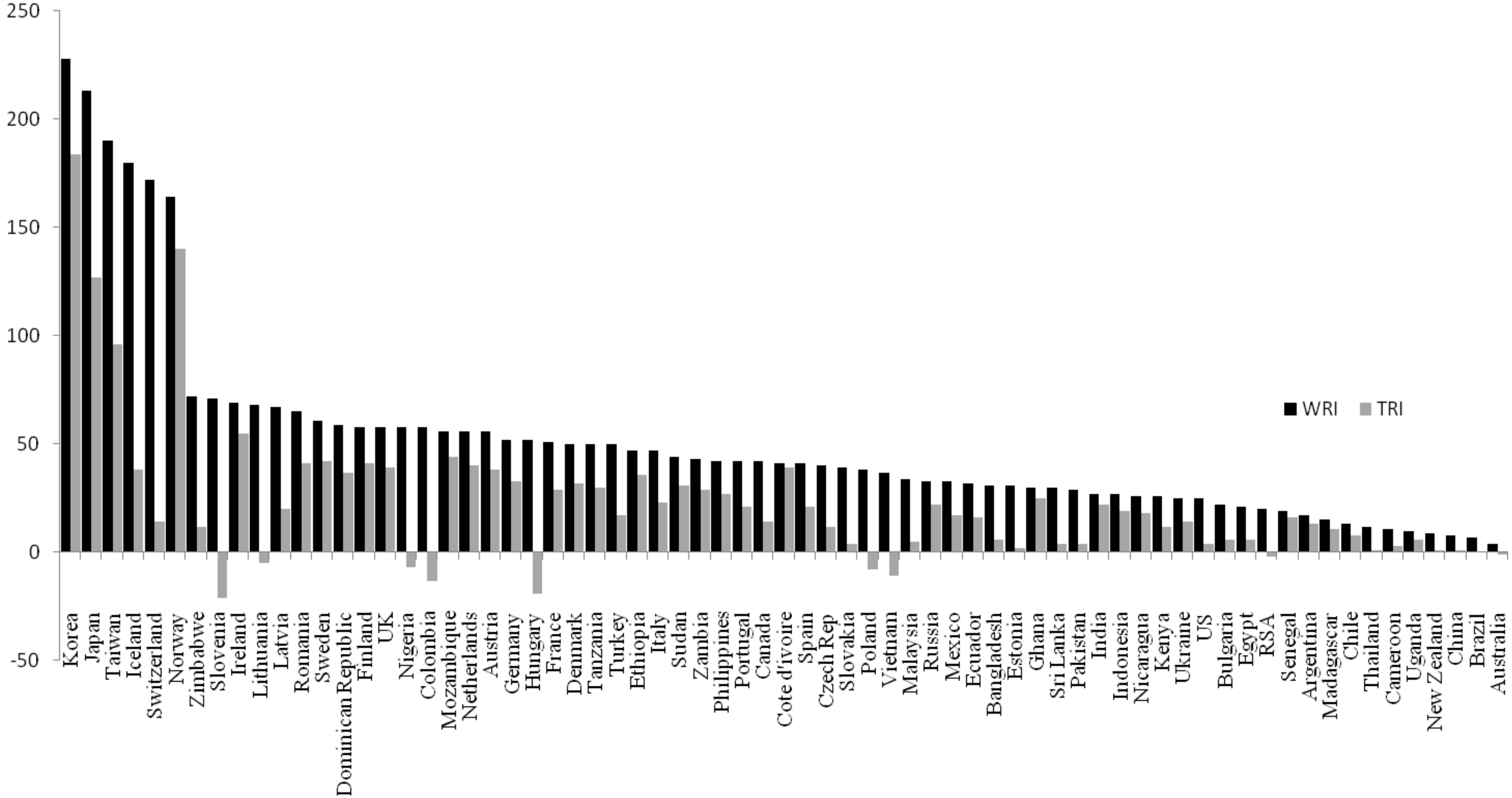
(percent)

(b) Developing countries, high-income countries and Europe's transition economies



Source: Anderson and Croser (2009), based on NRAs and CTEs in Anderson and Valenzuela (2008).

Appendix Figure C7: Welfare and Trade Reduction Indexes for covered tradable farm products, by country, 2000-04
(percent)



Source: Anderson and Croser (2009), based on NRAs and CTEs in Anderson and Valenzuela (2008).

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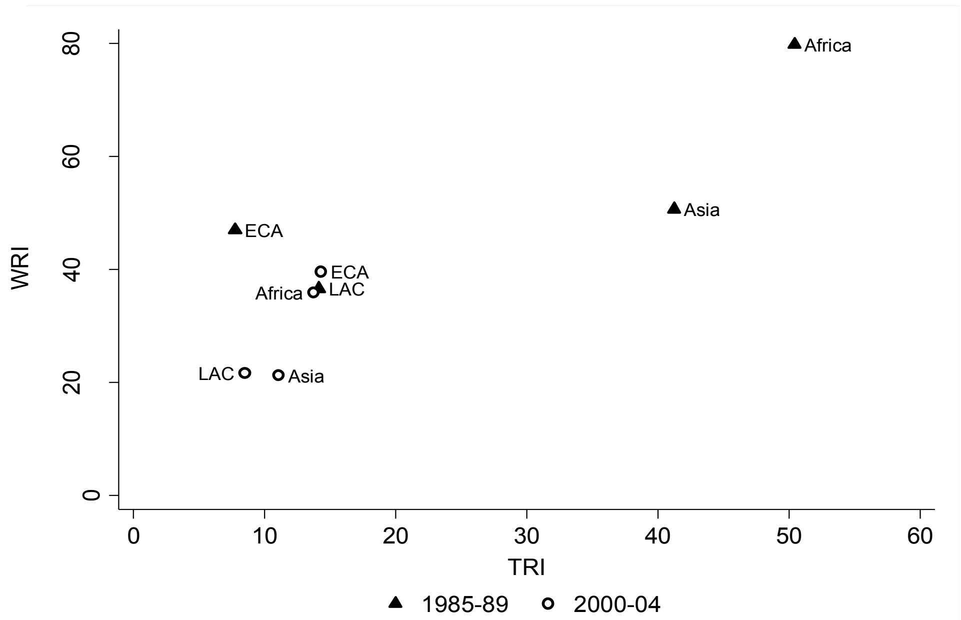
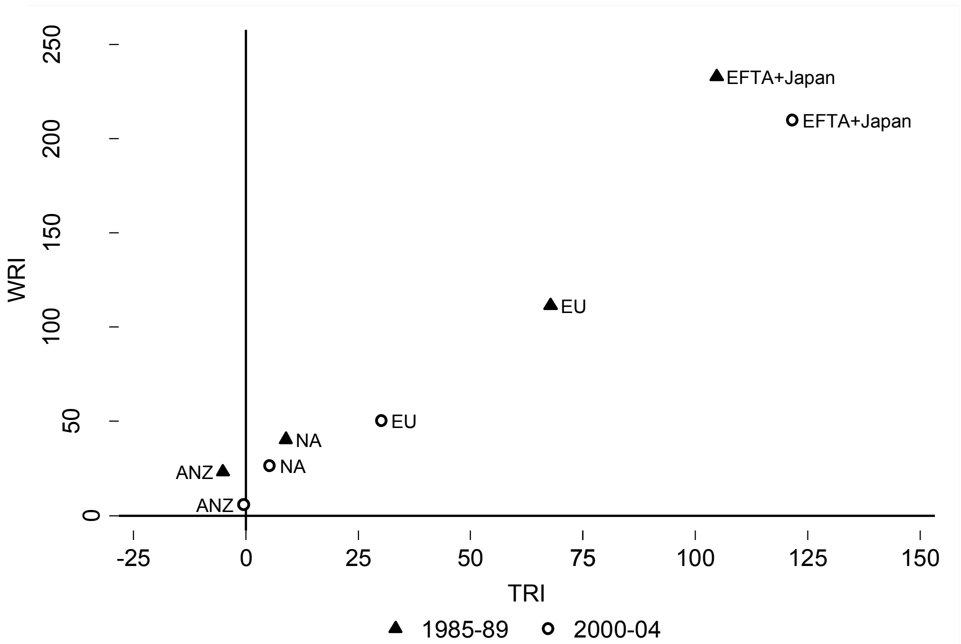
Appendix Figure C8: TRIs and WRIs for Covered Tradable Farm Products, by Region, 1985–89 and 2000–04

(percent)

a. Developing and transition countries



b. High-income countries



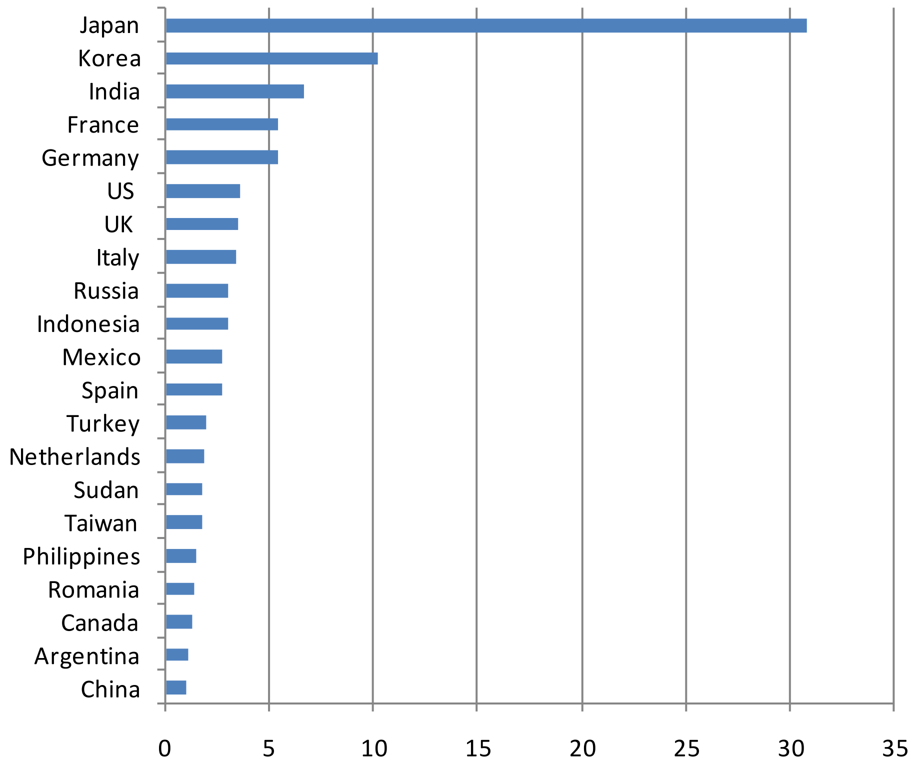
Source: Derived using data from Anderson and Croser (2009).

Note: For Europe and Central Asia in the top panel, data for 1985–89 is for 1992–94.

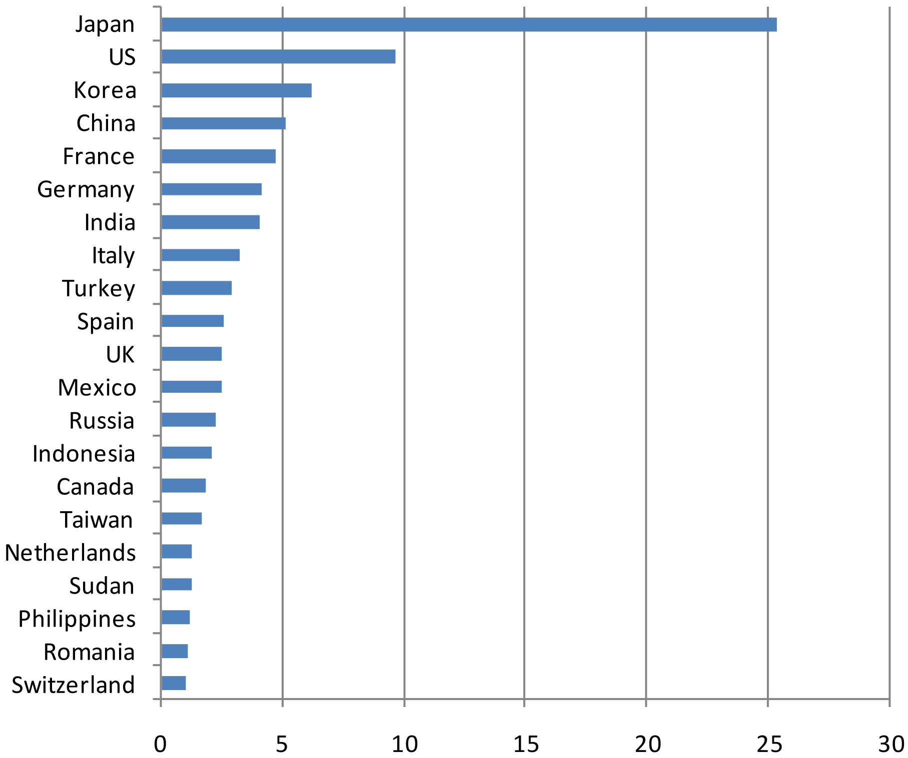
Appendix Figure C9: Country Contributions to the Global TRI and WRI, 2000–04

(percent shares, based on US dollar values at undistorted prices)[b]

a. TRI[a]



b. WRI[c]



Source: Derived from data in Anderson and Croser (2009).

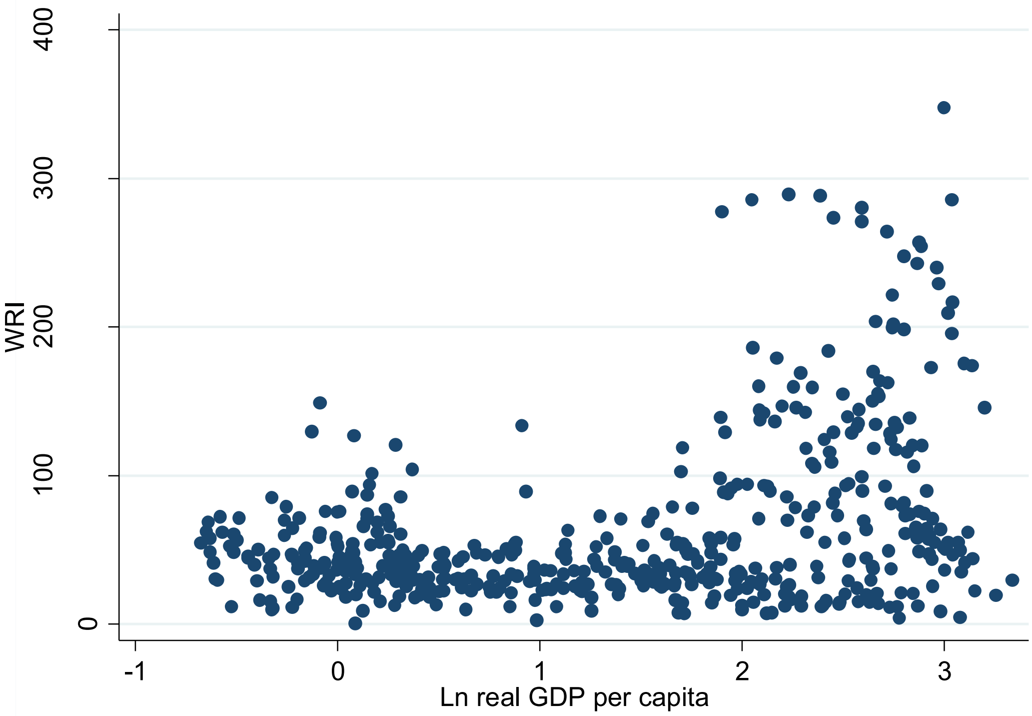
a. The global TRI in current U.S. dollars is computed by multiplying the TRI by the average of the value of global production and consumption at undistorted prices. Each country contribution is computed as the country-level TRI multiplied by the country-level value of production and consumption at undistorted prices, as a share of the global aggregate TRI multiplied by the global value of production and consumption at undistorted prices.

b. The sum of all country contributions (which are necessarily all positive for the WRI) is 100. Country contributions of less than 1 percent are omitted from the figures.

c. The global WRI in current U.S. dollars is computed by multiplying the WRI by the average of the value of global production and consumption at undistorted prices. Each country contribution is computed as the country-level WRI multiplied by the country-level average of the value of production and consumption at undistorted prices, as a share of the global aggregate WRI multiplied by the global average value of production and consumption at undistorted prices.

Appendix Figure C10: WRI and Real Per Capita GDP, All 75 Countries, 1961–2004

(WRI in percent, five-year averages)



Source: Derived from data in Anderson and Croser (2009).

Figure C11: Trade reduction indexes for the agricultural sector's import-competing sub-sector, selected focus countries, 2000–04

(percent)

(a) High-income and transition economies

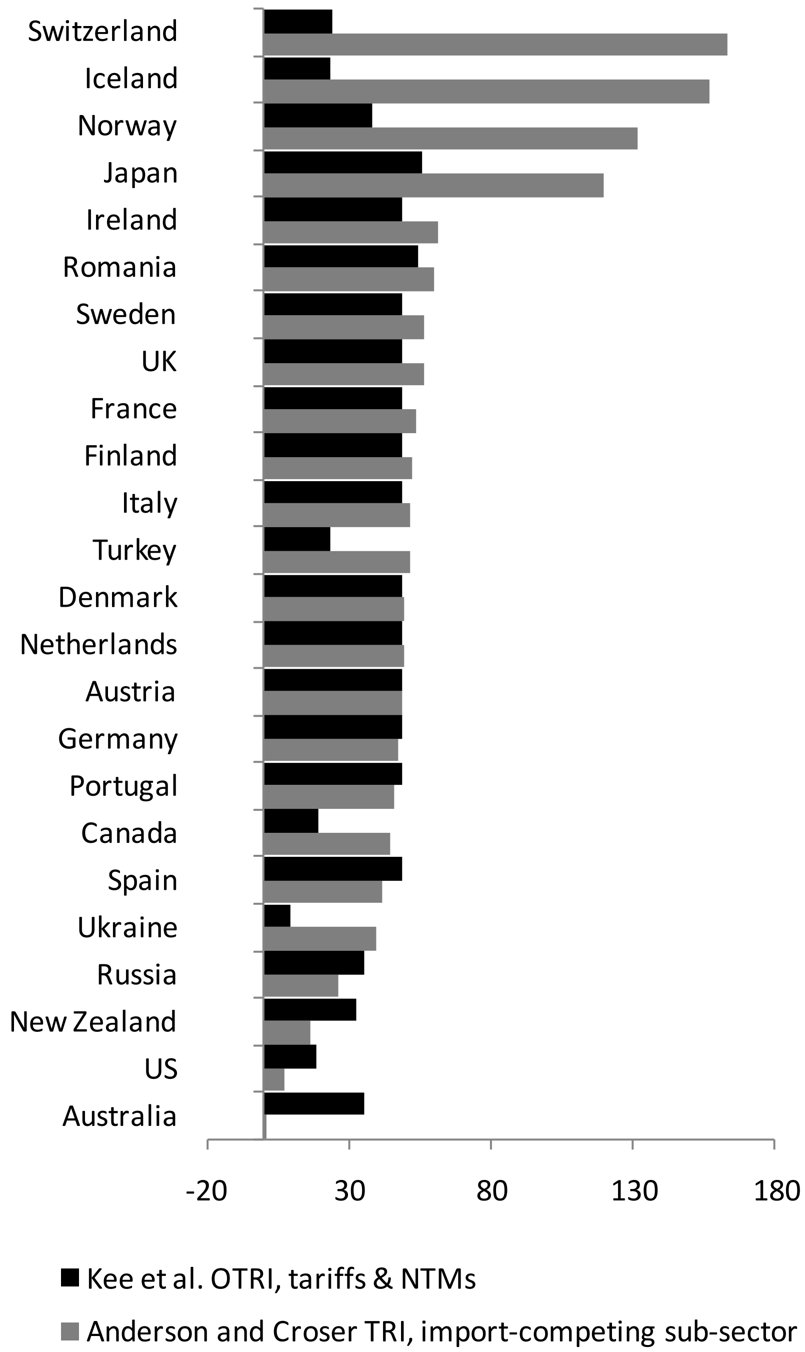
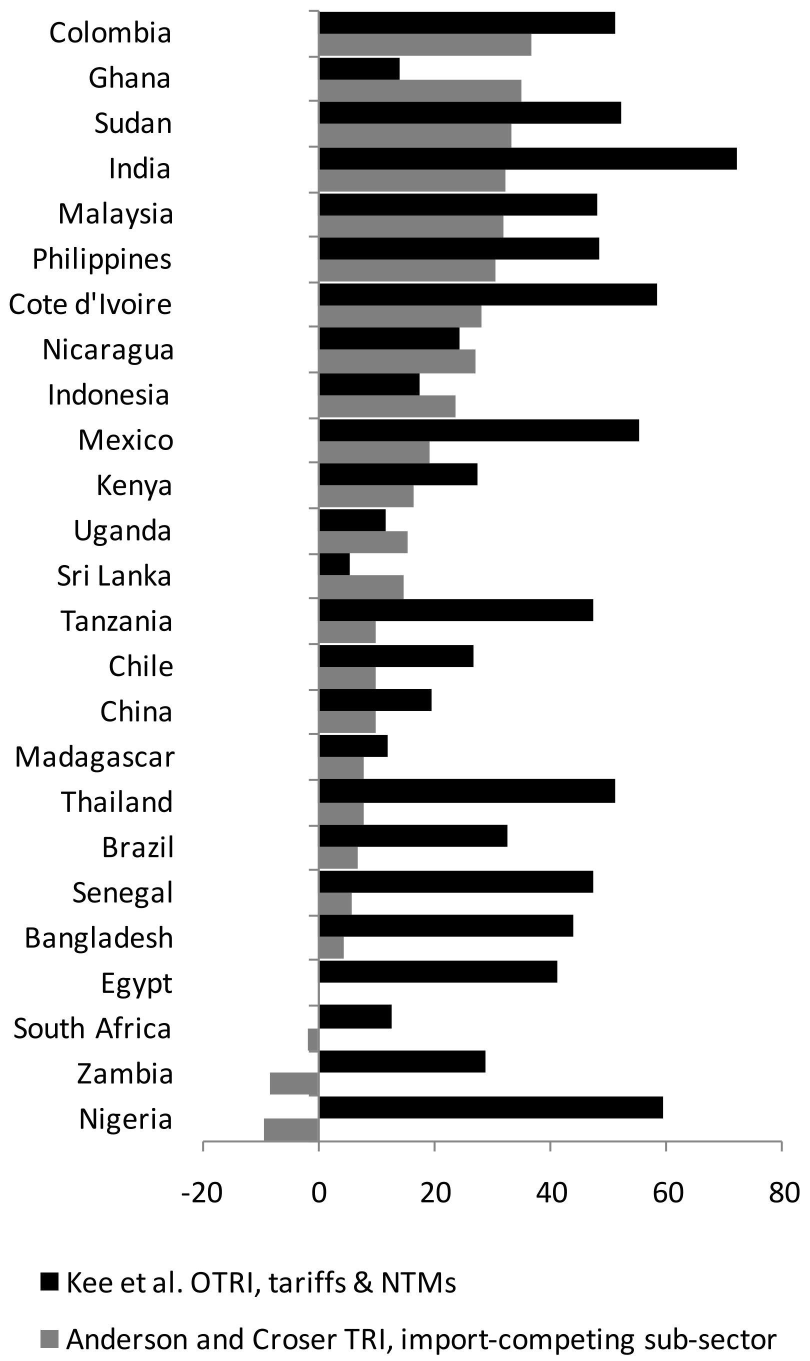


Figure C11 (continued): Trade reduction indexes for the agricultural sector's import-competing sub-sector, selected focus countries, 2000–04

(b) Developing countries



Sources: Anderson and Croser (2009) and Kee, Nicita and Olarreaga (2008).

Figure C12: Trade reduction indexes for the agricultural import-competing sub-sector and for all covered tradable farm products, selected focus countries, 2000-04

(percent)

(a) High-income and transition economies

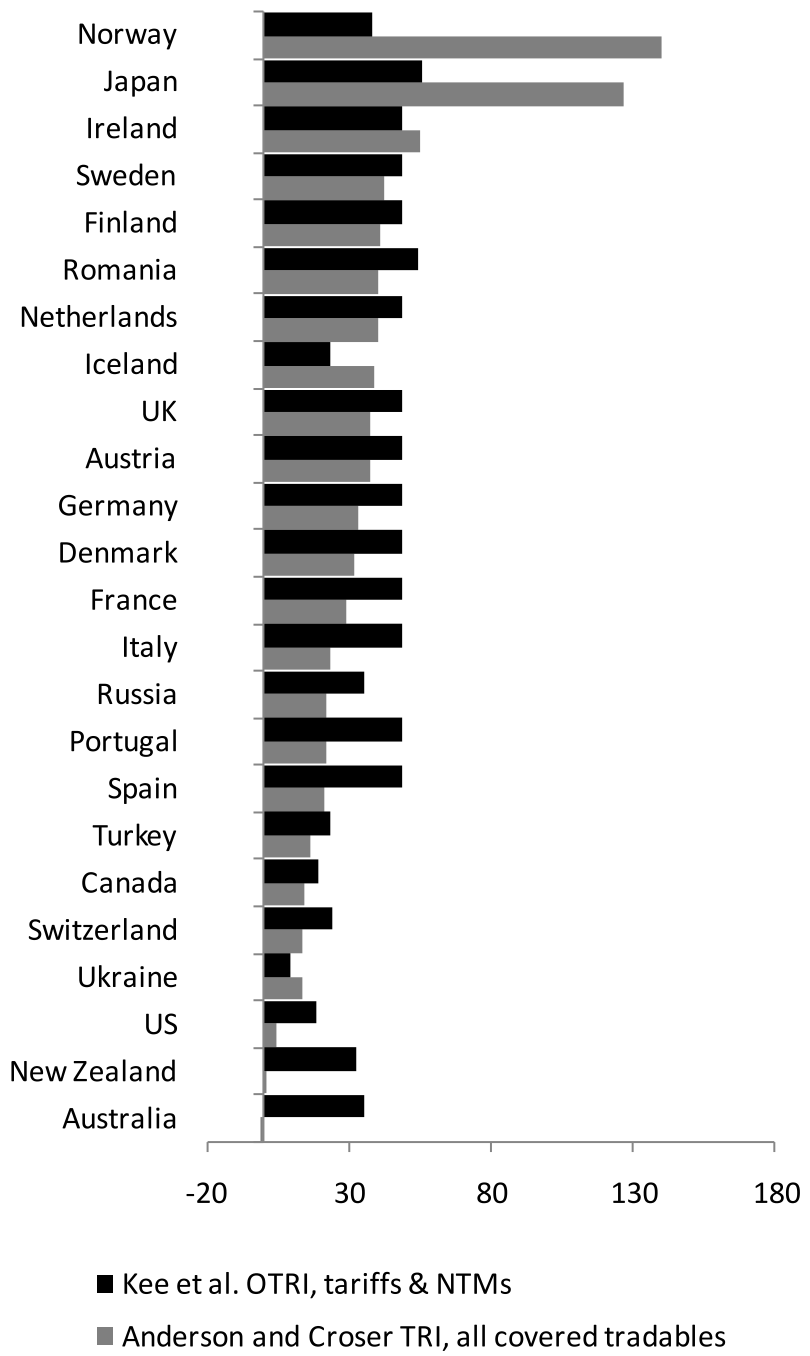
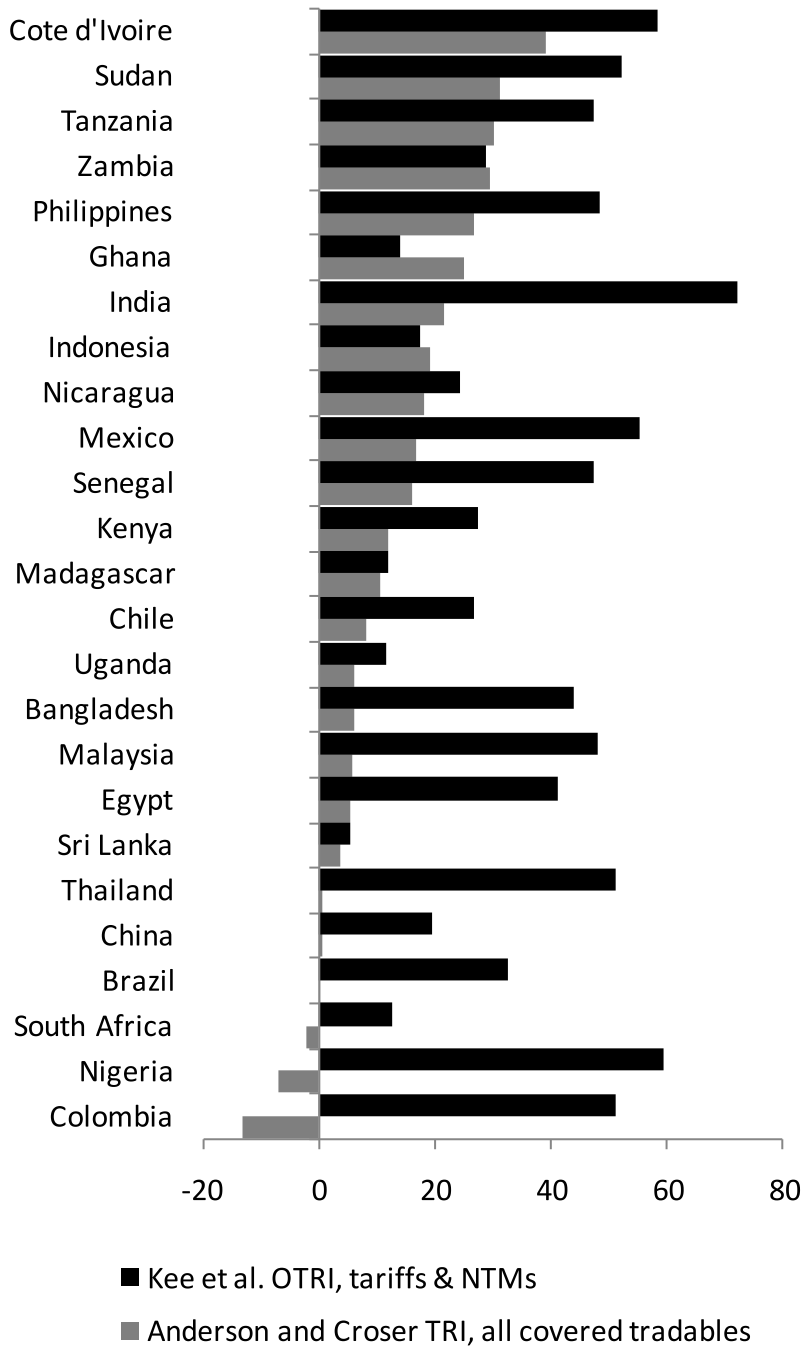


Figure C12 (continued): Trade reduction indexes for the agricultural import-competing sub-sector and for all covered tradable farm products, selected focus countries, 2000-04

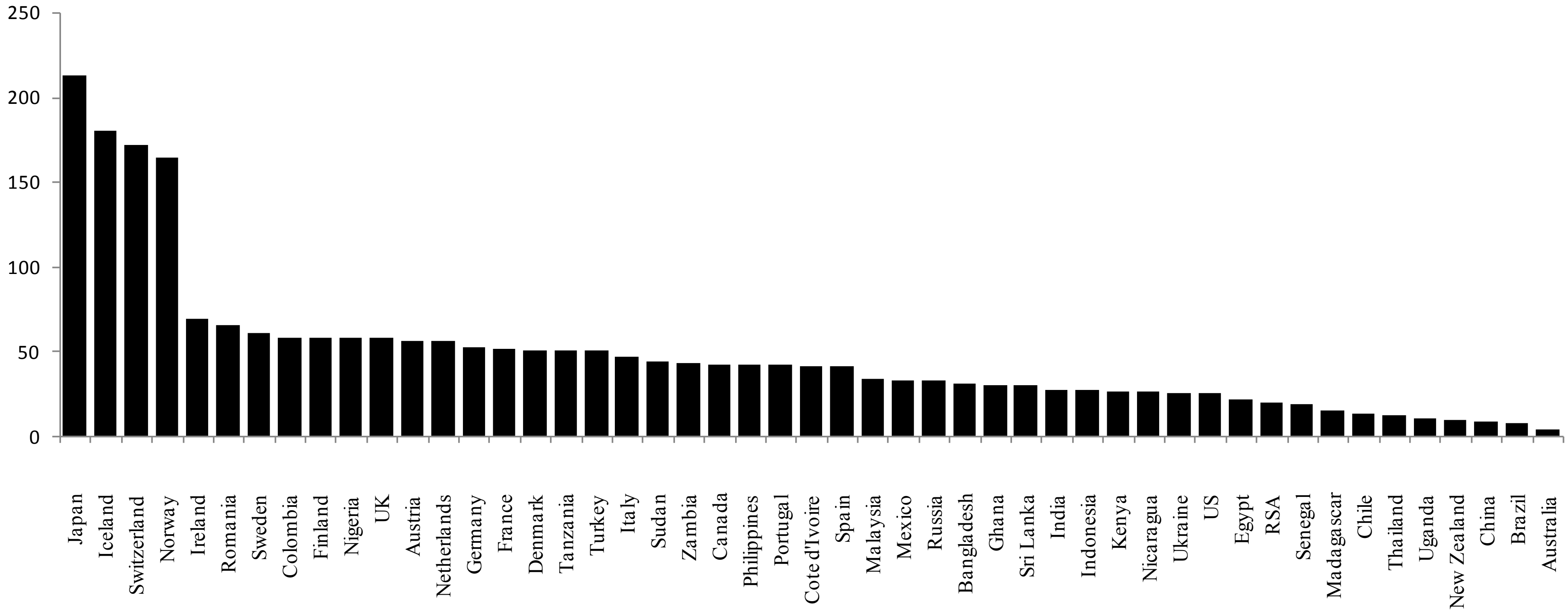
(b) Developing countries



Source: Anderson and Croser (2009).

Figure C13: Welfare reduction indexes for the all covered tradable farm products, selected high-income and transition economies and developing countries, 2000-04

(percent)



Source: Anderson and Croser (2009).

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Appendix D: Additional Results for Manuscript 2

This Appendix reports additional results for GWRI and GTRI which were not included in Manuscript 2 (the journal article version of the paper) due to space constraints. The Material in this Appendix draws from Anderson, Croser, Nelgen and Valenzuela (2009).

Appendix Tables D1 and D2 report the nominal rate of assistance (NRA) and consumer tax equivalent (CTE) data for each of the 28 products studied in Manuscript 2.

A useful way of summarizing the WRI and TRI estimates for particular products is provided in figure Appendix Figure D2, which shows their movement since many of the indexes peaked in the late 1980s. The indexes would suggest policies for a particular commodity market were not reducing either trade or welfare if the product were located at the zero point of both axes, that is, in the bottom left corner of the diagram (the ―sweet spot”). Nearly all of the farm commodities shown have moved toward that spot since 1985–89, and very substantially so for the outliers—namely milk and coffee—but also considerably so for wheat and maize.

References

Anderson, K., J. Croser, S. Nelgen and E. Valenzuela (2009), ―Global Distortions to Key Commodity Markets”, chapter 12 in Anderson, K. (ed.) *Distortions to Agricultural Incentives: A Global Perspective, 1955–2007*, London: Palgrave Macmillan and Washington DC: World Bank.

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

Appendix Table D1. Nominal Rates of Assistance of Policies Assisting Producers of 28 Covered Farm Products, All 75 Focus Countries, 1960 to 2004 (percent)

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Grains and	**20**	**15**	**9**	**9**	**-1**	**25**	**20**	**14**	**17**
Rice	39	6	11	12	-10	26	25	23	39
Wheat	15	22	7	2	9	30	23	12	6
Maize	4	8	5	2	-3	11	3	6	7
Cassava	0	0	-3	1	1	-1	-2	-4	-3
Barley	40	38	23	33	10	85	73	20	2
Sorghum	61	56	47	17	14	24	11	12	9
Millet	-19	-6	-4	-1	1	0	1	-3	-2
Oat	38	52	33	69	12	54	45	28	0
Oilseeds	**-3**	**2**	**-3**	**-7**	**-2**	**10**	**8**	**2**	**1**
Soybean	0	1	0	-2	-1	-2	1	7	4
Groundnut	-21	2	-14	-27	-1	34	3	-10	-14
Palmoil	-20	-24	-23	-15	-4	-5	8	-5	-3
Rapeseed	12	29	14	5	12	72	47	7	13
Sunflower	13	1	-9	-14	-23	46	19	-10	-12
Sesame	-53	-64	-65	-68	-60	-48	-46	-49	-39
Tropical crops	**1**	**22**	**-8**	**-13**	**-10**	**0**	**3**	**9**	**21**
Sugar	78	157	-4	9	15	38	28	39	60
Cotton	-10	0	9	-9	-12	-8	-10	-6	3
Coconut	-29	-24	-8	-3	-11	-19	-34	-22	-8
Coffee	-20	-31	-33	-43	-43	-31	-8	-10	0
Rubber	-16	-14	-8	-19	-19	-14	-16	5	4
Tea	-32	-31	-26	-26	-25	-24	-27	-19	-12
Cocoa	-27	-50	-45	-56	-47	-32	-32	-31	-35
Livestock	**38**	**41**	**36**	**48**	**29**	**39**	**33**	**28**	**25**
Pigmeat	33	47	36	31	-16	-12	4	10	10
Milk	96	97	91	140	138	152	85	62	53
Beef	15	14	12	13	25	42	29	31	23
Poultry	21	20	26	26	29	20	26	20	19
Egg	-8	-3	-6	12	11	17	15	19	6
Sheepmeat	41	48	61	99	64	51	30	13	11
Wool	0	0	6	4	7	4	5	1	1
All of the above 28 commodities	**26**	**27**	**17**	**19**	**9**	**27**	**23**	**19**	**20**

Source: Anderson and Valenzuela (2008), based on NRA estimates reported in national studies covering 75 focus countries.
Note: The countries for which there are NRA (and CTE) estimates of these commodities account on average for 77 percent of global production (85 percent for grains, 74 percent for oilseeds, 74 percent for tropical crops, and 72 percent for livestock products).

Appendix Table D2. Consumer Tax Equivalents of Policies Assisting Producers of 28 Covered Farm Products, All 75 Focus Countries, 1960 to 2004 (percent)

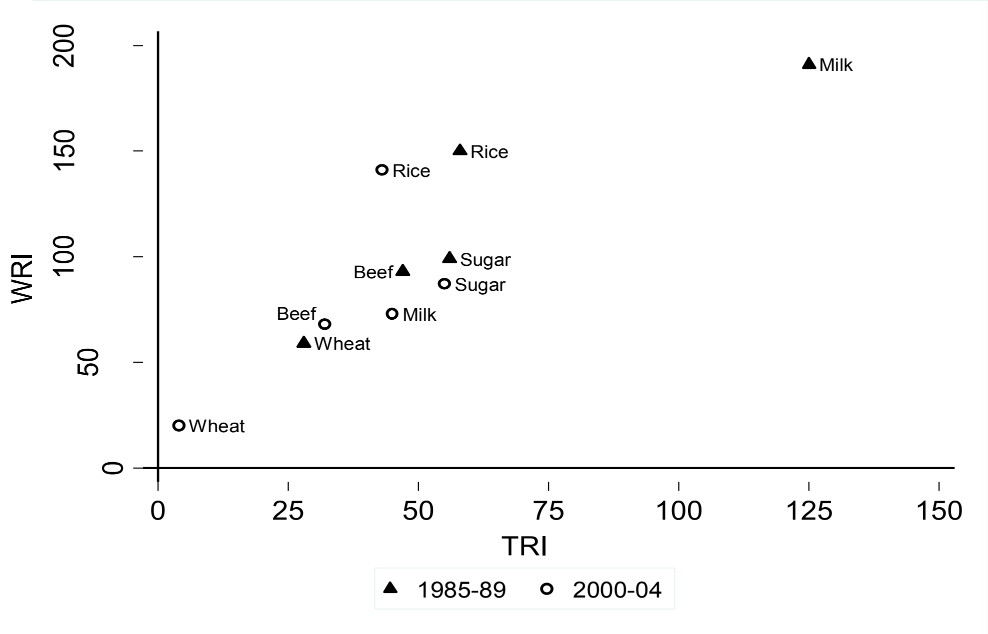
	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04
Grains and	**23**	**7**	**1**	**7**	**4**	**20**	**15**	**10**	**13**
Rice	42	-14	-11	4	1	24	25	22	38
Wheat	19	19	2	3	12	27	16	6	2
Maize	7	11	7	8	2	4	-3	-2	-2
Cassava	0	0	-1	-1	-2	-1	0	3	3
Barley	44	39	24	33	10	28	27	11	6
Sorghum	62	32	43	20	5	17	7	10	7
Millet	-15	-4	-2	0	2	3	4	6	6
Oat	39	54	33	68	11	24	17	4	-3
Oilseeds	**-4**	**-2**	**-8**	**-8**	**0**	**3**	**2**	**4**	**2**
Soybean	0	1	-3	-1	3	1	0	7	4
Groundnut	-21	-8	-20	-30	-7	26	-6	-12	-15
Palmoil	-19	-30	-35	-15	-7	-9	33	-2	-6
Rapeseed	3	13	7	5	9	13	15	5	11
Sunflower	10	1	-9	-17	-23	-2	-6	-5	-8
Sesame	-43	-56	-58	-61	-51	-38	-36	-40	-26
Tropical crops	**28**	**56**	**-2**	**-2**	**-1**	**11**	**19**	**15**	**27**
Sugar	116	175	1	13	19	38	42	44	63
Cotton	-8	0	3	-12	-15	-11	-18	-11	-6
Coconut	-29	-24	-9	-3	-12	-22	-36	-25	-10
Coffee	-16	-30	-30	-32	-49	-35	-18	-14	-4
Rubber	-43	-52	-6	-19	-23	-19	-11	2	1
Tea	-38	-41	-28	-26	-21	-21	-19	-21	-21
Cocoa	-28	-29	-33	-50	-43	-29	-19	-22	-31
Livestock	**41**	**43**	**37**	**49**	**31**	**39**	**28**	**26**	**24**
Pigmeat	34	47	35	30	-12	-11	0	7	8
Milk	96	98	89	137	130	139	69	54	46
Beef	19	16	14	16	25	46	30	36	31
Poultry	24	23	28	27	28	17	21	18	19
Egg	-6	-1	-6	11	8	17	15	17	8
Sheepmeat	64	77	107	161	94	70	39	19	19
Wool	0	0	6	4	6	2	4	1	0
All of the above 28 commodities	**32**	**26**	**15**	**23**	**15**	**26**	**21**	**18**	**19**

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

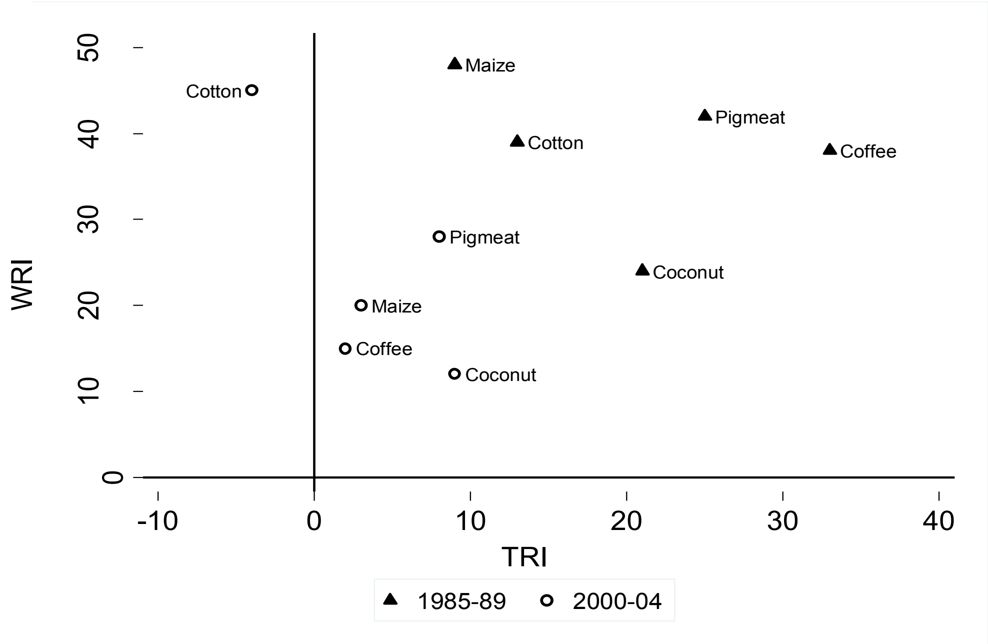
Appendix Figure D2: Global TRI and WRI for Covered Tradable Farm Products, by Commodity, 1985–89 and 2000–04

(percent)

a. Beef, milk, rice, sugar, and wheat



b. Coconut, coffee, cotton, maize, and pig meat



Source: Derived from estimates in Anderson and Croser (2009), based on NRA and CTE estimates in Anderson and Valenzuela (2008).

Appendix E: Elasticities for sensitivity analysis in Manuscript 2

Appendix Tables E1 and E2 report elasticities of supply and demand for 8 key commodities, taken from Tyers and Anderson (1992) and used for the elasticity sensitivity analysis reported in Manuscript 2.

Reference

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

Appendix E: Elasticities for sensitivity analysis in Manuscript 2

NOTE:
This appendix is included on pages 379-382 of the print copy of the thesis held in the University of Adelaide Library.

Appendix F: Derivation of Change in Imports from domestic measures alone

This Appendix to Manuscript 3 derives the changes in import value from domestic measures alone, when both domestic measures (s_{ij} and r_{ij}) and border measures (t_{ij}) are in place on the production and consumption sides of the economy, respectively.

$$\begin{aligned}
\Delta M_{Dij} &= p_i^* \Delta x_{ij} - p_i^* \Delta y_{ij} \\
&= p_i^* \cdot dx_{ij} / dp_{ij}^C \cdot \Delta p_{ij}^C - p_i^* \cdot dy_{ij} / dp_{ij}^P \cdot \Delta p_{ij}^P \\
&= p_i^* \cdot dx_{ij} / dp_{ij}^C \cdot (p_{ij}^C - p_{ij}) - p_i^* \cdot dy_{ij} / dp_{ij}^P \cdot (p_{ij}^C - p_{ij}) \\
&= p_i^{*2} \cdot dx_{ij} / dp_{ij}^C \cdot \frac{(p_{ij}^C - p_{ij})}{p_i^*} - p_i^{*2} \cdot dy_{ij} / dp_{ij}^P \cdot \frac{(p_{ij}^C - p_{ij})}{p_i^*} \\
&= p_i^{*2} \cdot dx_{ij} / dp_{ij}^C \cdot r_{ij} - p_i^{*2} \cdot dy_{ij} / dp_{ij}^P \cdot s_{ij}
\end{aligned}$$

Appendix G: Derivation of the IWRI for domestic measures alone

Equation (18)in Manuscript 3 gives the IWRI formula for domestic measures, which is comprised of four terms. In this Appendix the components of the four terms are elaborated upon and discussed. Simplifying assumptions to make the index more easily computed are discussed.

If equation (18) is relabelled (18a); the full expression for *WDj* is given by:

(18a) $$WD_j = \{(R'_{Dj1}a_{Dj1} - R'_{Di2}a_{Dj2}) + (S'_{Dj1}b_{Dj1} - S'_{Dj2}b_{Dj2})\}$$ where

(18b) $$R_{Dj1} = \left[\sum_{i=i}^{n}(t_{ij}+r_{ij})^2 u_{Dij1}\right]^{1/2} \text{ with } u_{Dij1} = p_i^{*2}dx_{ij}/dp_{ij}^C / \sum_i p_i^{*2}dx_{ij}/dp_{ij}^C$$

(18c) $$R_{Dj2} = \left[\sum_{i=i}^{n}t_{ij}{}^2 u_{Dij2}\right]^{1/2} \text{ with } u_{Dij2} = p_i^{*2}dx_{ij}/dp_{ij} / \sum_i p_i^{*2}dx_{ij}/dp_{ij}$$

(18d) $$S_{Dj1} = \left[\sum_{i=i}^{n}(t_{ij}+s_{ij})^2 v_{Dij1}\right]^{1/2} \text{ with } v_{Dij1} = p_i^{*2}dy_{ij}/dp_{ij}^P / \sum_i p_i^{*2}dy_{ij}/dp_{ij}^P$$

(18e) $$S_{Dj2} = \left[\sum_{i=i}^{n}t_{ij}{}^2 v_{Dij2}\right]^{1/2} \text{ with } v_{Dij2} = p_i^{*2}dy_{ij}/dp_{ij} / \sum_i p_i^{*2}dy_{ij}/dp_{ij}$$

(18f) $$a_{Dj1} = \sum_i p_i^{*2}dx_{ij}/dp_{ij}^C / \sum_i p_i^{*2}dm_{ij}/dp_{ij}^D$$

(18g) $$a_{Dj2} = \sum_i p_i^{*2}dx_{ij}/dp_{ij} / \sum_i p_i^{*2}dm_{ij}/dp_{ij}^D$$

(18h) $$b_{Dj1} = \sum_i p_i^{*2}dy_{ij}/dp_{ij}^P / \sum_i p_i^{*2}dm_{ij}/dp_{ij}^D$$

(18i) $$b_{Dj2} = \sum_i p_i^{*2}dy_{ij}/dp_{ij} / \sum_i p_i^{*2}dm_{ij}/dp_{ij}^D$$

The *WDj* index is computed by working on the production and consumption sides of the economy separately. The last step is to aggregate production and consumption. The weights for this are the familiar *a* and *b* values. The weight in equation 18f (equation 18h) is proportional to the ratio of the marginal response of domestic demand (supply) to a price change from border and domestic distortions relative to the marginal response of imports to a price change from domestic distortions. The weight in equation 18g (equation 18i) is different because it is proportional to the ratio of the marginal response of domestic demand (supply) to a price change from a border distortion only relative to the marginal response of imports to a price change from domestic distortions. (That is, the partial derivative in the numerator of equations 18f and 18h (equations 18g and 18i) differs with respect to the price at which the partial derivative is being taken).

Appendix H: Extension of the ITRI and IWRI to exporting products

In equation (19) of Manuscript 3 the sub-indices of the ITRI for border measures in exportable sectors are presented. The difference from the sub-indices in import-competing sectors is that distortions enter the expressions in equation (19) as negative values.

To compute the ITRI for domestic measures in exportable sectors, it is also necessary to enter the distortions into the sub-indices as negative values. That is, the ITRI for domestic measures in exportable sectors is given by equation (11), where R_{Dj} and S_{Dj} are replaced with the following expressions:

$$R_{DjX} = \left\lfloor \sum_{j=i+n}^{z} -r_{ij} \; u_{Dij} \right\rfloor ; \; S_{DjX} = \left[\sum_{j=i+n}^{z} -t_{ij} \; v_{Dij} \right]$$

The IWRI for border and domestic measures in exportable sectors is given by equations (17) and (18) respectively. No change is needed from the import-competing sector expressions because these measures are mean of order 2.

Appendix I: Elasticity assumptions for derivation of the IWRI for domestic measures alone

This appendix details the simplifying assumptions that can be applied to the IWRI in equation (18) in Manuscript 3 for domestic measures alone to make the computation of this index more tractable. If one is willing to assume that the marginal response of domestic demand to a final price change relative to the marginal response of imports to a change in domestic prices is equal to the marginal response of domestic demand to a price change from border distortion alone relative to the marginal response of imports to a change in domestic prices alone, then $a_{Dj1} = a_{Dj2} = a_{Dj}$. An analogous assumption on the supply side of the economy gives: $b_{Dj1} = b_{Dj2} = b_{Dj}$. In this case, the expression for WD_j reduces to:

(18j) $$WD_j = \{(R'_{Dj1} - R'_{Di2})a_{Dj} + (S'_{Dj1} - S'_{Dj2})b_{Dj}\}$$

With linear demand and supply curves, this relationship always holds. Even if the curves are not linear, when domestic distortions are small relative to border distortions this assumption will provide a good approximation.

In the step before that final aggregation of production and consumption, four individual IWRI indexes are computed. Equations 18c and 18e give the welfare loss from border measures only. These equations are equal to the expression in equation (17). That is, they are the means of order two equivalents of equations (9b) and (9c).

Equations 18b and 18d give the welfare loss from all measures (border and domestic). Each of the *u* and *v* weight expressions in equations 18b–18e can be written as function of domestic price elasticities. As with the ITRI, in the absence of estimates of domestic demand and supply elasticities, if one is willing to assume domestic price elasticities of supply are equal across commodities for a country, and domestic price elasticities of demand are equal across commodities for a country, the elasticities in the numerator and denominator will cancel. Thus the R and S terms above can be found by share weighting the distortions, where the shares are values of production and consumption at various price levels.

Appendix J: Extension of Trade- and Welfare-Reduction Indexes to the nontradable sectors

Manuscript 1 of this thesis reports how the WRI and TRI measures can each be extended to include the exportables sub-sector. This is facilitated by way of aggregating the import-competing and exportables sub-indices where the weights for each sub-sector are the share of the sub-sectors' value of production (consumption) in the total value of production (consumption). The resulting measure is the import tax/export subsidy which, if applied uniformly to all products in the sector, would give the same loss of welfare as the combination of measures distorting consumer and producer prices in the import-competing and exportable sub-sectors.

The main issue in the case of the TRI is to keep separate track of the subsets of import-competing and exportable goods because the sign of an NRA in exportable sector (positive or negative) has the opposite effect on the TRI. That is, while an export subsidy in the exportable sub-sector reduces welfare in the same way as an import tax in the import-competing sub-sector, the export subsidy will increase trade and the import tariff reduces trade.

For Manuscript 4, a further methodological extension is made to the theory to include nontradable products, as well as tradables. This is important for Africa, because in many countries the share of nontradables in the gross value of agricultural production is high. Because nontradables are generally free of distortions, an index that does not take into account these sectors will tend to overstate the trade- and welfare-reducing effect of agricultural policy.

To include nontradables, separate track is kept of three subsectors of the economy: import-competing, exportable and nontradable sub-sectors. A sector specific

TRI and WRI indices is generated for each sub-sector. The three sub-sector indices are aggregated using as weights each sub-sectors' share of value of production (consumption) in the total value of production (consumption).

For the WRI, because distortions in nontradable sectors cause welfare distortions, the s_i and r_i values in equations 7b and 7c(in Manuscript 4) are the actual level of distortion in the nontradable sectors.

For the TRI, however, an assumption is made that s_i and r_i values in equations 3b and 3b (in Manuscript 4) are zero. This assumption is such that distortions to nontradable products are assumed not to expand or reduce trade volume. The assumption recognises the high trade costs in these products, which is the case for the vast majority of nontradable products. It means that the contribution of nontradables to TRI is only through the share of nontradables in value of production (consumption) in the total value of production (consumption).

Bibliography

[Note: Each manuscript and appendix in the thesis has a self-contained reference list, which should be used as the reference list when reading individual manuscripts and appendices. This bibliography is a consolidated list of references to satisfy the University of Adelaide's thesis specification requirements.]

Anderson, J.E. (2009), “Consistent Trade Policy Aggregation”, *International Economic Review* 50(3): 903–927.

Anderson, J.E., G. Bannister and J.P. Neary (1995), “Domestic Distortions and International Trade”, *International Economics Review* 36(1): 139–57.

Anderson, J.E. and J.P. Neary (1994), “Measuring the Restrictiveness of Trade Policy”, *World Bank Economic Review* 8(2): 151–69.

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.

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

Anderson, K. (2009b), “Five Decades of Distortions to Agricultural Incentives”, Chapter 1 in K. Anderson (ed.), *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., J. Cockburn and W. Martin (eds.) (2010), *Agricultural Price Distortions, Inequality and Poverty*, Washington DC: World Bank.

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

Anderson, K. and J. Croser (2010a), ―Novel Indicators of the Trade and Welfare Effects of Agricultural Distortions in OECD Countries", Discussion Paper 7971, London: Centre for Economic Policy Research.

Anderson, K and J.L Croser (2010b), ―How Much Do Agricultural Policies Restrict Trade? Comparing Trade Restrictiveness Indexes", *Economic Premise* 4.

Anderson, K., J. Croser, D. Sandri and E. Valenzuela (2010), ―Agricultural Distortion Patterns since the 1950s: What Needs Explaining?", Ch. 2 in *The Political Economy of Agricultural Price Distortions*, K. Anderson (ed.), Cambridge and New York: Cambridge University Press.

Anderson, K., J. Croser, S. Nelgen and E. Valenzuela (2009), ―Global Distortions to Key Commodity Markets", Ch 12 in Anderson, K. (ed.) *Distortions to Agricultural Incentives: A Global Perspective, 1955–2007*, London: Palgrave Macmillan and Washington DC: World Bank.

Anderson, K, M. Kurzweil, W. Martin, D. Sandri and E. Valenzuela (2008), ―Measuring Distortions to Agricultural Incentives, Revisited", *World Trade Review* 7: 1-30.

Anderson, K. and W. Martin (2005), ―Agricultural Trade Reform and the Doha Development Agenda", *The World Economy* 28(9): 1301–1327.

Anderson, K., W. Martin and E. Valenzuela (2006), ―The Relative Importance of Global Agricultural Subsidies and Market Access", *World Trade Review* 5(3): 357–376.

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

Anderson, K, and W. Masters (2009b), ―Introduction and Summary”, chapter 1 in K. Anderson and W. Masters (eds.), *Distortions to Agricultural Incentives in Africa*, Washington DC: World Bank.

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

Bach, C. and W. Martin, (2001), ―Would the Right Tariff Aggregator for Policy Analysis Please Stand Up?”, *Journal of Policy Modeling* 23: 62–35.

Beck, T., G. Clarke, A. Groff and P. Keefer (2001), ―New Tools in Comparative Political Economy: The Database of Political Institutions”, *World Bank Economic Review* 15(1): 165-76.

Belloc, M. and P. Guerrieri (2008), ―Special Interest Groups and Trade Policy in the EU”, *Open Economies Review* 19(4): 457–78.

Bernheim, B. D. and M. D. Whinston (1986), ―Menu Auctions, Resource Allocation, and Economic Influence”, *Quarterly Journal of Economics* 101(1): 1–31.

Bombardini, M. (2008), ―Firm Heterogeneity and Lobby Participation”, *Journal of International Economics* 75(2): 329–348.

Cadot, O., J. de Melo and M. Olarreaga (2004), ―Lobbying, Counterlobbying, and the Structure of Tariff Protection in Poor and rich Countries”, *The World Bank Economic Review* 18(3), 345–366.

Chen, S, and M. Ravallion (2008), ―The Developing World is Poorer Than We Thought, But No Less Successful in the Fight Against Poverty”, Policy Research Working Paper 4703, Washington DC: World Bank.

Chernozhukov, V. and C. Hansen, (2001), ―An IV Model of Quantile Treatment Effects”, working paper, MIT Department of Economics.

Chernozhukov, V. and C. Hansen, (2005), ―An Instrumental Variables Model of Quantile Treatment Effects", *Econometrica* 73(1), 245–262.

Chernozhukov, V. and C. Hansen, (2006), ―Instrumental Quantile Regression Inference for Structural and treatment Effect Models", *Journal of Econometrics* 132(2), 491–525.

Chernozhukov, V. and C. Hansen, (2008), ―Instrumental Variable Quantile Regression: A Robust Inference Approach", *Journal of Econometrics* 142(1), 379–398.

Chowdhury, S. and J. Fetzer, (2009), ―Estimating Export Supply Elasticities, Research Summary", web.ics.purdue.edu/Sohini_Chowdhury_Estimating_Export_Supply_Elasticities_Research_Summary.pdf (accessed 11 November 2009).

Croser, J.L. and K. Anderson (2010a), ―Changing Contributions of Different Agricultural Policy Instruments to Global Reductions in Trade and Welfare", CIES Discussion Paper 1005.

Croser, J.L. and K. Anderson (2010b), ―Agricultural Distortions in Sub-Saharan Africa: Trade and Welfare Indicators, 1961 to 2004", discussion paper 7747, London: Centre for Economic Policy Research.

Croser, J.L., P.J. Lloyd and K. Anderson (2010), ―How Do Agricultural Policy Restrictions on Global Trade and Welfare Differ Across Commodities?", *American Journal of Agricultural Economics* 92(3), 698–712.

Diao, X, A. Somwaru and T. Roe (2001), ―A Global Analysis of Agricultural Policy Reform in WTO Member Countries" in M. Burfisher et al. (eds.), *Agricultural Policy Reform in the WTO: The Road Ahead*, Agricultural Economics Report No. 802, Economic Research Services, Washington, DC: United States Department of Agriculture.

Dollar, D and A. Kraay (2003), “Institutions, Trade and Growth”, *Journal of Monetary Economics* 50; 133–162.

Dupuit, J., (1844) “On the Measurement of Utility of Public Works”, *Annals des Ponts et Chaussees*, 2nd series: 8.

Dutt, P. and D. Mitra (2010), “Impacts of Ideology, Inequality and Democracy on Agricultural Distortion Patterns”, chapter 11 in K. Anderson (ed.) *The Political Economy of Agricultural Price Distortions*, Cambridge and New York: Cambridge University Press.

Feenstra, R.C. (1995), “Estimating the Effects of Trade Policy” in *Handbook of International Economics*, vol. 3, edited by G.N. Grossman and K. Rogoff, Amsterdam: Elsevier.

Frankel, J. and D. Romer (1999), “Does Trade Cause Growth?”, *American Economic Review* 89(3): 379–399.

Fuller, W.A. (1987), *Measurement Error Models*, Wiley, New York.

Gardner, B.L. (1987), “Causes of U.S. Farm Commodity Programs”, *Journal of Political Economy* 95(2): 290-310.

Gawande, K (1997), “Generated Regressor in Linear and Nonlinear Models”, *Economics Letters* 54: 119–126.

Gawande, K. and B. Hoekman (2006), “Lobbying and Agricultural Trade Policy in the United States”, *International Organization* 60: 527-561.

Gawande, K. and C. Magee (2008), “Free-Riding on Protection for Sale”, unpublished manuscript.

Gawande, K. and H. Li (2009), “Dealing with Weak Instruments: An Application to the Protection for Sale Model”, *Political Analysis* 17(3): 236–260.

Gawande, K. and U. Bandyopadhyay (2000), ―Is Protection for Sale? Evidence on the Grossman-Helpman Theory of Endogenous Protection”, *Review of Economics and Statistics* 82(1): 139–152.

Gawande, K., P. Krishna and M. Olarreaga (2009), ―What Governments Maximise and Why: The View from Trade”, *International Organization* 63(3): 491–532.

Gawande, K., P. Sanguinetti and A.K. Bohara (2005), ―Exclusions for Sale: Evidence on the Grossman-Helpman Model of Free Trade Agreements”, NAFTA-MERCOSUR Working Paper No. 4, University of New Mexico.

Goldberg, P. and G. Maggi (1999), ―Protection for Sale: An Empirical Investigation”, *American Economic Review* 89: 1135–1155.

Greenaway, D. and Nelson, D. (eds.) (2001) *Globalisation and Labour Markets*, Vols. I and II. London: Edward Elgar.

Grossman, G and E. Helpman (1995), ―The Politics of Free-Trade Agreements”, *American Economic Review* 85(4): 667–690.

Grossman, G. and E. Helpman (1994) ―Protection for Sale”, *American Economic Review*84(4): 833–850.

Harberger, A.C. 1959, ―Using the Resources at Hand More Effectively”, *American Economic Review* 49(2):134–46.

Harding, M and C. Lamarche (2009), ―A Quantile Regression Approach for Estimating Panel Data Models using Instrumental Variables”, *Economics Letters* 104(3): 133–135.

Hertel, T. W. and R. Keeney (2006), ‗What‘s at Stake: The Relative Importance of Import Barriers, Export Subsidies and Domestic Support‘, in K. Anderson and W. Martin (eds.) *Agriculture Trade Reform and the Doha Development Agenda*, London: Pelgrave Macmillian and Washington DC, World Bank, Ch 2.

Hertel, T.W. and L. A. Winters (eds.) (2006), *Poverty & the WTO: Impacts of the Doha Development Agenda*, Palgrave MacMillan and the World Bank, Houndmills, Basingstoke, Hampshire, UK.

Humphrey, T. M. (1992), ―Marshallian Cross Diagrams and Their Uses Before Alfred Marshall: the Origins of Demand and Supply Geometry", *Economic Review*, Richmond VA: Federal Reserve Bank of Richmond.

Imai, S., H. Katayama and K. Krishna (2008), ―A Quantile-Based Test of Protection For Sale Model", NBER Working Paper 13900.

Imai, S., H. Katayama and K. Krishna (2009a), ―Protection for Sale or Surge Protection?", *European Economic Review* 53(6), 675–688.

Imai, S., H. Katayama and K. Krishna (2009b) ―Is Protection Really For Sale? A Survey and Directions for Further Research", *International Review of Economics and Finance*, 18: 181–91.

Irwin, D. (2010), ―Trade Restrictiveness and Deadweight Losses from U.S. Tariffs, 1859-1961", *American Economic Journal: Economic Policy* 2(3): 111–133, August.

Josling, T. (2009), ―Distortions to Agricultural Incentives in Western Europe", Agricultural Distortions Working Paper no. 61, Washington DC: World Bank www.worldbank.org/agdistortions.

Kee, H. L. (2007), ―Measuring the Restrictiveness of International Trade Policy: Book Review", *Journal of International Economics* 73: 434–441.

Kee, H.L., A. Nicita and M. Olerreaga (2008), ―Global Monitoring Report 2008 — Overall Trade Restrictiveness Indices", Washington DC: World Bank, available at http://go.worldbank.org/C5VQJIV3H0

Kee, H.L., A. Nicita and M. Olerreaga (2008), ―Import Demand Elasticities and Trade Distortions", *Review of Economics and Statistics* 90(4): 666–82.

Kee, H.L., A. Nicita and M. Olerreaga (2009), ―Estimating Trade Restrictiveness Indexes", *Economic Journal* 119(534): 172–99.

Kee, H.L., M. Olarreaga and P.A. Silva (2007), ―Market Access for Sale", *Journal of Development Economics* 82(1): 79–94.

Kelijian, H. H. (1971), ―Two Stage Least Squares and Econometric Systems Linear in Parameters but Non-Linear in Endogenous Variables", *Journal of the American Statistical Association* 66: 373–74.

Kohli, U. (1991), *Technology*, *Duality and Foreign Trade: The GNP Function Approach to Modeling Imports and Exports*, Ann Arbor: University of Michigan Press.

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.

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

Laborde, D., W. Martin and D. van der Mensbrugghe (2009), ―Measuring the Benefits of Global Liberalization with a Consistent Tariff Aggregator", mimeo, Washington DC: World Bank.

Lloyd, P.J. (1974), ―A More General Theory of Price Distortions in an Open Economy", *Journal of International Economics* 4(4): 365-86.

Lloyd, P.J. and D. MacLaren (2009), ―Partial and General Equilibrium Measures of Trade Restrictiveness", working paper, Parkville: University of Melbourne.

Lloyd, P.J., J. Croser and K. Anderson (2009), ―Welfare-Based and Trade-Based Indicators of National Agricultural Distortions", chapter 11 in Anderson, K. (ed.) *Distortions to Agricultural Incentives: A Global Perspective, 1955–2007*, London: Palgrave Macmillan and Washington DC: World Bank.

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): 141–160.

Lloyd, P.J., J. Croser and K. Anderson (2009), ―Global Distortions to Agricultural Markets: New Indicators of Trade and Welfare Impacts, 1960 to 2007”, Working Paper 2009-13, School of Economics, Adelaide: University of Adelaide at http://webdev.economics.adelaide.edu.au/research/papers/

Lopez, R.A. (2008), ―Does ‗Protection for Sale' Apply to the US Food Industries?”, *Journal of Agricultural Economics* 9(1): 25-40.

Masters, W. A. and A. F. Garcia (2010), ―Agricultural Price Distortion and Stabilization: Stylized facts and hypothesis Tests”, chapter 9 in *The Political Economy of Agricultural Price Distortions*, K. Anderson (ed.), Cambridge and New York: Cambridge University Press.

McCalman, P. (2004), ―Protection for Sale and Trade Liberalization: An Empirical Investigation”, *Review of International Economics* 12(1): 81–94.

McCulloch, N., L. A. Winters, and X. Cirera (2001), *Trade Liberalization and Poverty: A Handbook*, London: Centre for Economic Policy Research.

Mitra, D. (1999), ―Endogenous Lobby Formation and Endogenous Protection: A Long-run Model of Trade Policy Determination”, *American Economic Review* 89(5): 1116–1134.

Mitra, D., D.D. Thomaklos and M.A. Ulubasoglu (2002), ―‗Protection for Sale' in a Developing Country: Democracy vs. Dictatorship”, *Review of Economics and Statistics* 84(3): 497–508.

Mitra, D., D.D. Thomaklos and M.A. Ulubasoglu (2004), ―Protection verses Promotion: An Empirical Investigation”, *Economics and Politics* 16(2): 147–162.

Mitra, D., D.D. Thomakos and M. Ulubasoglu, (2006), ―Can We Obtain Realistic Parameter Estimates for the ‗Protection for Sale' Model?", *Canadian Journal of Economics* 39(1): 187–210.

Ndlela, D. and P. Robinson (2009), ―Zambia", Ch 6 in Anderson, K. and W. Masters (eds.), *Distortions to Agricultural Incentives in Africa*, Washington DC: World Bank.

OECD (2004), *Agricultural Policies in OECD Countries: Monitoring and Evaluation*, Paris: Organization for Economic Cooperation and Development.

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

OECD (2009), *Agricultural Policies in OECD Countries: Monitoring and Evaluation 2009*, Paris: Organization for Economic Cooperation and Development.

OECD (2009), *Producer and Consumer Support Estimates* (online database accessed at www.oecd.org for 1986-2007 estimates; and OECD files for estimates using an earlier methodology for 1979-85).

OECD (2008), *PSE-CSE Database (Producer and Consumer Support Estimates, OECD Database 1986–2007*, Paris: Organisation for Economic Co-operation and Development at www.oecd.org/document/55/0,3343,en_2649_33727_36956855_1_1_1_1,00.html

Olper, A. and V. Raimondi, (2010), ―Constitutional Rules and Agricultural Policy Outcomes", chapter 14 in *The Political Economy of Agricultural Price Distortions*, K. Anderson (ed.), Cambridge and New York: Cambridge University Press.

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, Research Report 152, Washington DC: IFPRI.

Park, J. H. and N. Jensen (2007), —Electoral Competition and Agricultural Support in OECD Countries", *American Journal of Political Science* 51(2): 314–329.

Robinson, P. J. Govereh and D. Ndlela (2009), –Zimbabwe", Ch 7 in Anderson, K. and W. Masters (eds.), *Distortions to Agricultural Incentives in Africa*, Washington DC: World Bank.

Rodriguez, F. and D. Rodrik (2001), –Trade Policy and Economic Growth: a Skeptic‵s Guide to the Cross-National Evidence", *NBER Macroeconomics Annual 2000*, vol 15, Cambridge: MIT Press, pp. 261–325.

Rodrik, D. (1995), —Political Economy of Trade Policy," in G. Grossman and K. Rogoff (eds.), *Handbook of International Economics*, vol 3, Amsterdam: North-Holland.

Roningen, V.O, (2003) –VORSIM version 5", www.vorsim.com.

Serra, Zilberman, Goodwin and Featherstone (2006), –Effects of Decoupling on the Mean and Variability of Output", *European Review of Agricultural Economics* 33(3): 269-288.

Swinnen, J. (2010), —Political Economy of Agricultural Distortions: The Literature to Date", chapter 3 in *The Political Economy of Agricultural Price Distortions*, K. Anderson (ed.), Cambridge and New York: Cambridge University Press.

Trefler, D. (1993), –Trade Liberalization and the Theory of Endogenous Protection: An Econometric Study of U.S. Import Policy", *Journal of Political Economy* 101(1): 138–60.

Tyers, R. (1991), —Neglect of Dynamics, Risk and Market Insulation In the Analysis of Uruguay Round Food Trade Reform", *Australian Journal of Agricultural Economics* 35(3).