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ORIGINAL ARTICLE

The Relative Importance of Global Agricultural Subsidies and Tariffs, Revisited*

Kym Anderson[1], Erwin Corong[2], Anna Strutt[3], and Ernesto Valenzuela[4]

[1]University of Adelaide, Adelaide and Australian National University, Canberra, Australia, [2]Center for Global Trade Analysis, Purdue University, West Lafayette, IN, USA, [3]Waikato Management School, University of Waikato, Hamilton, New Zealand and [4]Federation University, Berwick, Victoria, Australia
Corresponding author: Kym Anderson, Email: kym.anderson@adelaide.edu.au

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Abstract
Over the past three decades, tariff protection to farmers has fallen and partly been replaced by domestic support, whilst support for farmers in some emerging economies has grown. Against that backdrop, this paper provides new estimates of national economic impacts of global agricultural tariffs and domestic supports. Using the latest global economy-wide GTAP (Global Trade Analysis Project) model calibrated to 2017, we simulate (a) the removal of food and agricultural domestic supports and agri-food tariffs and (b) the removal also of tariffs on imports of non-agricultural goods. We find that agricultural support policies are still an important part of the global welfare cost of all goods' trade-restrictive policies (albeit only half as costly as in 2001), and tariffs still dominate the global welfare cost of all farm-support programs. That farm support could be re-instrumented to relieve natural resource and environmental stresses, boost food and nutrition security, and alleviate poverty and income inequality.

JEL Codes: F13; F14; O13; Q17; Q18

Keywords: Three pillars; distortions to agricultural incentives; domestic support; agricultural market access restrictions

1. Introduction

Agricultural price and trade policies were highly distortive of the world's food, feed, and fibre markets in the latter half of the twentieth century, but many trade reforms began in the 1980s and continued following the 1995–2004 implementation of the GATT/WTO Uruguay Round Agreement on Agriculture (Anderson, 2022). By 2001, agricultural policies were responsible for more than 60% of the global economic welfare cost of all protectionist merchandise trade-related policies, with import tariffs accounting for 93% of that part of global cost due to agricultural supports, the rest due to domestic subsidies (5%), and export subsidies (2%), according to economywide modelling by Anderson and Martin (2005) and Anderson et al. (2006).

Many import tariffs have since come down further, and export subsidies were outlawed by WTO members in 2015. However, domestic support measures have replaced some of the assistance previously provided to farmers by tariffs. At the start of the Uruguay Round, it was feared by some that this might happen, which led to demands for commitments also on domestic supports

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to limit such substitution. Snape (1987), by contrast, argued that this concern was unwarranted because the political cost of providing support in that way would be very transparent in annual budget papers. One purpose of this paper is to see to what extent domestic subsidies have grown in importance as farm trade protection measures have been lowered this century.

The WTO attempted to complete a comprehensive new round of multilateral trade reforms launched at the start of this century (the so-called Doha Development Agenda), but member interest has withered since the global financial crisis of 2008. More recently, agricultural negotiators have sought to focus attention on rising domestic subsidies, which has been further boosted with recent additions by populist governments. For example, subsidies rose from 8% to 14% of gross farm income in the United States between 2017 and 2019 (OECD, 2021).

Three empirical questions arise from these developments. First, how relatively important today are agricultural policies in the global cost of barriers to national goods markets. Second, within that, how relatively important are domestic supports (the key item on the current agenda of the WTO's agricultural committee) in that global contribution of agricultural policies? And third, to what extent are the global welfare costs due to high-income versus developing countries' policies?

The present study provides new estimates of those shares and related national economic impacts of global import restrictions and agricultural domestic supports. It builds on an earlier attempt that focused just on their adverse impacts on three food-exporting countries as of 2014 (Anderson and Valenzuela, 2021). It does so by first using the most-recent database of the global economy-wide GTAP (Global Trade Analysis Project) model, calibrated to 2017. It then simulates the removal of agricultural domestic supports with the removal of agricultural and food tariffs, and also the removal of import tariffs on non-agricultural goods.

We find agricultural policies to be a smaller but nonetheless still substantial contributor to the global welfare cost of trade-related policies than they were two decades ago and domestic supports to farmers to have grown in relative importance but only modestly. These together with recent estimates of the substantial contributions of agricultural production to greenhouse gas emissions and biodiversity losses (IPCC, 2020; Dasgupta, 2021), raises a further question addressed briefly at the end of the paper, which is: How could current agricultural supports be re-purposed to better serve society and the environment without harming farmer welfare?

The paper begins in Section 2 by summarizing trends in the extent of distortions to incentives in farm and non-farm goods markets. Section 3 outlines how the GTAP model and its latest (Version 11p4) database are employed to address the above empirical questions. Results are provided in Section 4, and are compared with those estimated early this century. The final section summarizes the findings and key policy implications that follow from them, pointing to ways in which farm support policies could be re-purposed to better serve society and the environment while still supporting farmer welfare.

2. Trends in the Extent of Distortions to Producer and Consumer Incentives

We draw primarily on OECD (2021) to consolidate its information on government budgetary transfers and other forms of assistance to farmers by policy instrument, plus consumer price distortions. The OECD provides estimates for 41 member countries and 13 major emerging economies of agricultural significance. Together those 54 countries account for two-thirds of global agricultural production. In addition to market price support estimates by product, the OECD also provides estimates of other product-specific and non-product-specific assistance both to farmers and to services assisting farmers. This allows us to rank countries by the extent (in current US$) of their domestic agricultural subsidies and by their market access restrictions as captured by their trade-weighted average tariff rates (taking into account the many tariff preferences and exemptions that stem from bilateral and regional free-trade agreements and custom unions). We also disaggregate assistance by policy instrument and, where product-specific, by each of the most important product groups. In the case of countries whose policies are not monitored

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empirically by the OECD, we rely on the applied tariff and subsidy estimates compiled in the GTAP database for them.

The OECD's indicators of the extent of domestic price distortions make it possible to attribute their aggregate impacts to those due to each of the three WTO pillars of farmer assistance (import market access, export subsidies, and domestic support). Key indicators at the commodity level are what the OECD calls single commodity transfers to producers and to consumers, both measured at the farm gate. As well, the OECD provides a producer support estimate (PSE) for each country's farm sector in US dollars and in percentage terms (including some measures that are not commodity specific, see OECD, 2016). It also compiles government expenditure on services for the farm sector, such as investments in rural infrastructure, in quarantine services, in public stockholding, and in marketing and promotion of farm products. Their aggregate, called the General Services Support Estimate (GSSE), added nearly one-quarter to the US$ value of the PSE over the first two decades of this century. That annual sum (PSE + GSSE) averaged $532 billion during 2018–2020, compared with $294 billion in 2000–2002 (both in current US$).

The single commodity transfers to producers and the sectoral PSE in percentage terms can also be expressed as a nominal rate of assistance (NRA) to parts or all of the agricultural sector. The NRA differs from, and is larger than, the PSE in that it reflects the percentage by which producer incentives are above what they would be without intervention, whereas the PSE reflects the percentage of the producers' actual gross earnings (including assistance) that are due to farm support measures and so is always smaller than the NRA and cannot be greater than 100% (OECD, 2016). That is, NRA = PSE/((100–PSE)/100).

Trade is also affected by the extent to which consumer prices of farm products are distorted by policies, as captured by a consumer tax equivalent (CTE). The CTE is generally positive and the opposite sign to the OECD's consumer support estimate (CSE). The most common instrument of such distortion is an import restriction such as a tariff or tariff rate quota and, in the past, export subsidies. However, a subset of countries directly subsidizes food prices for some groups of consumers, in which case the CTE could be negative (OECD, 2016).

Some other policy instruments that affect farmer incentives are called non-tariff measures (NTMs). They include regulatory policies behind national borders. In some cases, they may be bigger barriers to trade than are import tariffs, while in other cases they may even expand trade (Santeramo and Lamonaca, 2019; Beghin and Schweizer, 2021). It is challenging to estimate their extent and effects, and more progress is needed in this research area because they shift supply and demand curves rather than cause movements along those curves (Beghin et al., 2015; Francois and Hoekman, 2019), but recent work is improving NTM estimates and modelling mechanisms, including for global models such as GTAP (Walmsley and Strutt 2021; Kravchenko et al., 2022).

In most of the top-consuming countries, market demands can and mostly are met – or exceeded – by local production. Those countries for which self-sufficiency exceeds 100% are direct competitors to other agricultural-exporting countries. Assistance to their farmers obviously makes it more difficult for other countries' farmers to compete there and elsewhere. But supports to farmers in self-sufficient or net-food-importing countries also reduce opportunities for other countries' exporters. Hence, the need to examine producer and consumer assistance policies in all countries of consumption significance, regardless of whether they are currently net exporters, self-sufficient, or net importers of farm products.

2.1 Estimates of the Extent of Farmer Assistance

The rate of assistance to farmers is highest in the coolest European and East Asian countries. Apart from Japan, those countries are very small producers. To get a picture of where the assistance is greatest, Supplementary Figure S1 shows the aggregate annual value of agricultural

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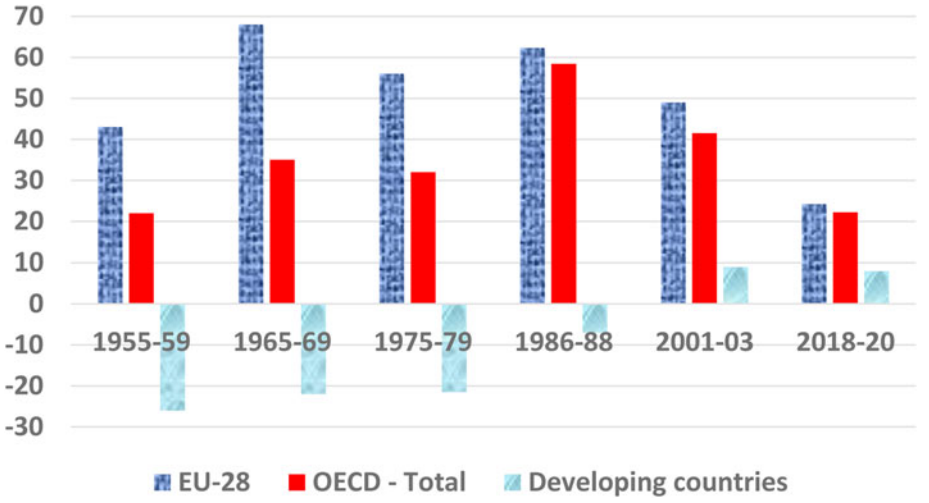

Figure 1. Agricultural NRAs for developing countries: the European Union and all OECD, 1955 to 2020 (%, weighted average using as weights the value of production without assistance).
Notes: The pre-1986 five-year average estimates are from Anderson (2009), as are the later developing country average rates, which are for 1985–1989, 2000–2004, and 2014 (the latter from www.ag-incentives.org). Prior to 1986, the rates are for Western Europe and all high-income countries rather than the EU and OECD, respectively.
Sources: Anderson (2009), OECD (2021), and www.ag-incentives.org.

assistance in US$ terms.[1] It reveals that assistance to farmers in 2019 amounted to US$184 billion for China (up from just $14b in 2000–2002) compared with US$243b for all OECD member countries. The US support (US$52b) is only half that of the EU's US$105b. Japan (US$38b), Indonesia (US25b), and Korea (US$20b) together provide barely four-fifths as much aggregate farmer assistance per year as the EU.

Once developing countries became independent from the 1950s, many effectively taxed their farmers rather than assisted them through to the 1980s, before gradually opening their economies and phasing out their export taxes and other farmer disincentives. Meanwhile, high-income countries increasingly assisted their farmers through to the mid-1980s (apart from a small dip in the mid-1970s when international food prices spiked), before reforms set in and rates of assistance progressively fell (Irwin, 2022). More recently, some middle-income countries have transitioned from taxing to subsidizing their farmers, including populous China, Indonesia, and the Philippines, so the average NRA for developing countries is converging on that for high-income countries (Figure 1). Hence, there is a need to examine current policies of both sets of countries in this study.

Table 1 shows the extent of these transitions in agricultural support/taxation since the mid-1980s for each of the countries monitored by the OECD. Only three countries in that 54-country sample still had negative agricultural NRAs in 2020: Argentina (−16%), India (−7%), and Viet Nam (−6%). A subset of that assistance is product-specific. In OECD countries, dairy (US$18 billion per year) and beef cattle (US$17b) were the largest recipients in 2016–2018, while in emerging economies it is rice (US$36b) that receives by far the most assistance followed by pigs (US$21b), maize (US$20b), and wheat (US$16b) (Supplementary Figure S2).

In addition to much change in the total support to farmers over the past three decades, there have also been substantial changes in the types of support. The key forms of assistance in the PSE include market price supports (such as import tariffs and quotas plus domestic price subsidies)

[1]Those figures and tables whose number begins with S are in the Supplementary Material that is available online.

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Table 1. Agricultural NRA by country, 1986–1988, 2001–2003, 2017–2019, and 2020 (%, weighted average using value of production without assistance as weights)

	1986–1988	2001–2003	2017–2019	2020
Switzerland	328	196	95	108
Norway	247	238	145	104
Korea	165	95	86	91
Japan	135	111	71	69
Philippines	na	23	37	37
United Kingdom	na	na	26	26
Indonesia	na	10	30	25
European Union	63	43	24	24
Turkey	29	33	22	24
Colombia	na	28	14	15
China	na	7	16	14
United States	26	21	13	12
Mexico	na	31	11	11
Canada	53	23	9	11
Costa Rica	na	8	6	8
Russia	na	12	12	7
Kazakhstan	na	3	5	3
South Africa	na	8	4	3
Chile	na	6	3	3
Australia	11	4	3	2
Ukraine	na	1	1	1
Brazil	na	8	2	1
New Zealand	12	1	1	1
Viet Nam	na	8	−6	−6
India	na	−5	−5	−7
Argentina	na	−13	−17	−16

Sources: Anderson (2009) and OECD (2021).

and payments based on outputs or input use, payments based on cropped area or livestock numbers where production is required, payments based on cropped area or livestock numbers where production is not required, payments to productive factors including whole farm income supports, and payments for environmental services. For the OECD as a group, the extent of assistance coming directly from support to output prices has declined substantially this century, from 63% to 41%, while the share of other budgetary payments has more than doubled. While for the EU it has plummeted from 95% to 33%, it is still nearly 90% in Japan (Figure 2). For most other countries, the vast majority of farmer assistance still comes from those two direct forms of support (Table 2). Each WTO member has legally bound their maximum extent of both of those support measures, but for most countries their applied subsidies and tariffs are well below those bound rates, leaving plenty of scope for nations to raise them without becoming inconsistent with their legal obligations.

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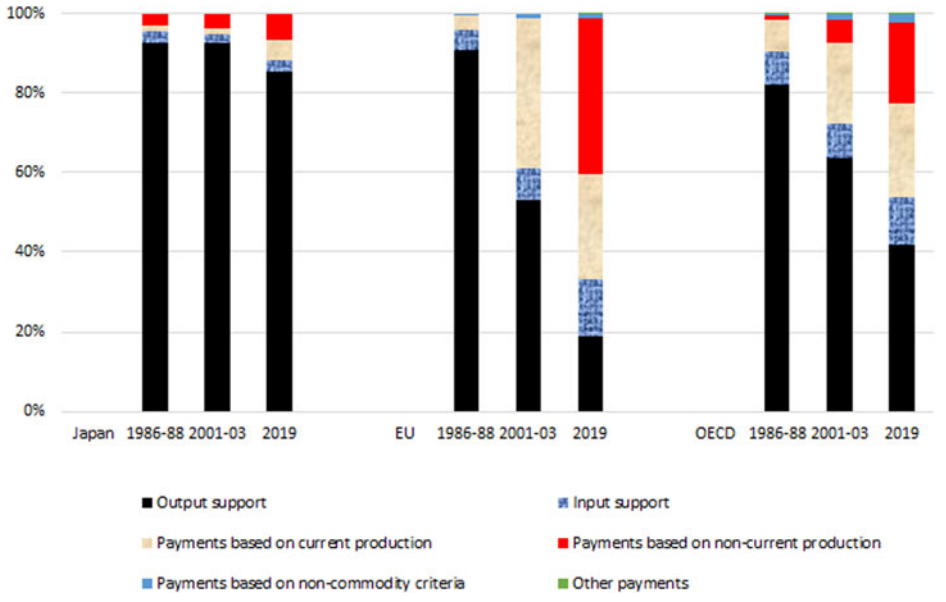

Figure 2. Component shares of agriculture's PSE, Japan, EU, and all OECD, 1986–1988, 2001–2003, and 2019 (%)
Source: OECD (2021).

2.2 Estimates of the Extent of Food Consumer Taxation

Data on the value of transfers from consumers are equally as important as the producer NRAs, because insofar as they discourage consumption of farm products they reduce net imports and hence export prospects for other countries' farmers. In most countries, these transfers are generated by import restrictions: a tariff (or quantitative import restriction) is the equivalent of a subsidy to the domestic producer of a like good and a tax at the same rate on domestic consumer price of that product.

Supplementary Figure S3 summarizes those CTE data. The estimated tax on Chinese consumers for 2019 (US$143b) is twice as large as that on all OECD consumers (US$78b) in aggregate terms, and in percentage terms at 10% it is above the OECD average at 8% and far above the EU's 4%. Particularly striking are the negative values for the US (US$27b or −9%) and India (US$76b or −14%). The US spends a lot on food stamps and the like for low-income families, while in India the rise in staple food consumer subsidies was enormous earlier this century: spending rose from US$12 billion in 2000 to $152 billion in 2013 before slipping back to $76 billion in 2019. Similarly, in the US, expenditure rose from less than $2 billion in 2000 to $40 billion at the peak of the price spike in 2011–2012, and was still $27 billion in 2019. For the full sample of 54 countries, though, the percentage CTE has more than doubled since the early 2000s, from 5% to 12%, as the negative impact on consumers of market access barriers far outweighs any positive effects of food consumer subsidies. Food-exporting countries nonetheless benefit from direct consumer subsidies insofar as they expand the global demand for farm products – although there is evidence for India that consumers simply switch from less-preferred coarse grains to now-subsidized rice and wheat rather than expand their overall food intake greatly (Jensen and Miller, 2011). In what follows, we incorporate only the negative effects on consumers from trade measures (which are by far the dominant ones), ignoring the direct subsidies to food consumers which still need to be estimated net of the effect of trade measures on consumer prices (and will be in a forthcoming paper by Anderson et al., 2023).

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Table 2. Component shares of agriculture's PSE, by country, 2019 (%)

	Output support (A)	Input support (B)	Payments based on current production (C)	Payments based on non-current production (D + E)	Payments for environment services and resource conservation (F)	Other payments (G)	TOTAL
Argentina	101	−1	0	0	0	0	100
Australia	0	55	23	21	1	0	100
Brazil	3	92	5	0	0	0	100
Canada	46	12	35	6	0	1	100
Chile	2	92	6	0	0	0	100
China	67	10	15	7	1	0	100
Colombia	90	10	0	0	0	0	100
Costa Rica	92	8	0	0	0	0	100
EU28	19	14	26	27[a]	14[a]	0	100
India	276	−145	0	−29	0	−2	100
Indonesia	89	11	0	0	0	0	100
Japan	85	3	5	7	0	0	100
Kazakhstan	−7	102	5	0	0	0	100
Korea	91	3	3	4	0	0	100
Mexico	56	22	1	9	12	0	100
New Zealand	86	14	0	0	0	0	100
Norway	51	6	31	11	0	0	100
Philippines	97	3	0	0	0	0	100
Russian Fed	50	33	10	0	0	8	100
South Africa	70	29	1	0	0	0	100
Switzerland	46	2	17	20	12	4	100
Turkey	77	9	13	0	0	0	100
United Kingdom	25	12	10	47	1	5	100
Ukraine	67	12	21	0	0	0	100
United States	21	17	46	12	4	0	100
Viet Nam	113	−11	−2	0	0	0	100

Source: OECD (2021).
[a]The EU's Greening Payments (PHNR12) in E have been shifted to F.

2.3 Estimates of Rates of Distortion to Trade in Non-Agricultural Goods

The other main sector that imposes import tariffs and quotas is manufacturing. The average tariff across all manufacturing is reported in WTO (2021). It shows that while those average tariffs have come down over the past 25 years, they are still higher for agriculture than manufacturing and the agricultural average for developing countries is well above that for high-income countries. Also, non-tariff measures altering both exports and imports are far more prevalent for farm products than for those from mining or manufacturing. Hence, it will not be surprising if agricultural policies are still responsible for a relatively large share of the estimated global economic welfare

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cost of all protectionist merchandise trade-related policies, bearing in mind that agriculture and food account for less than 10% of global GDP and exports.[2]

3. The Global Economy-Wide Model's Specifications

Our simulations to demonstrate the potential impact of removing price- and trade-distorting policies use an augmented version of the Global Trade Analysis Project (GTAP) model (Hertel, 1997; Corong et al., 2017). Use of this global computable general equilibrium (CGE) model enables us to capture inter-sectoral linkages within each country as well as between countries via international trade. The model's latest database (pre-release 4 of version 11) is calibrated to 2017. The model is solved using GEMPACK software (Harrison et al., 2014). It comprises 65 sectors in 160 countries and regions (Aguiar et al., 2022), which we aggregate to 56 countries/regions and 37 sectors in the current modelling to speed processing time and facilitate reporting. We further aggregate when reporting some of the results, including into high-income countries (HICs) as distinct from all other nations which self-classify themselves at the WTO as developing countries (DCs).

While the OECD does not separate the contributions of domestic price subsidies versus border restrictions in causing the domestic price to exceed the border price of a like product, contributors to the protection database of the GTAP model have made that distinction, by carefully drawing on detailed national and international databases. In this study, we focus on 2017 as our baseline.

The GTAP database includes domestic support payments based on output, intermediate input payments, and factor payments. Payments vary in the extent to which they are decoupled from current production, and some of them may even be welfare improving for society (such as rewards for providing ecosystem services), in which case they likely fall into the WTO's 'Green Box'. For subsidies not tied to specific sectoral output, integration in the GTAP database requires that assumptions be made to allocate these subsides across sectors (Boulanger et al., 2019; Huang and Aguiar, 2019). We adopt those same assumptions.[3]

As with all modelling, numerous other assumptions necessarily have to be made for the exercise to be tractable, and the values of myriad parameters such as elasticities have to be best guesses when reliable econometric estimates are unavailable. The modelling assumes fixed aggregate employment, thereby overlooking national employment changes that could be associated with simulated policy reforms in each country.

In addition, two caveats in particular are worth mentioning. One has to do with the extent to which the various forms of domestic support to farm households are decoupled from current production requirements. The most decoupled are often direct income payments, for example. In the GTAP database, it is assumed all budgetary payments to farmers' outputs, inputs, and primary factors are linked to output. This assumption means the agricultural subsidy results may be overstated to some extent.[4] The second caveat has the opposite bias and so offsets the first. It has to do with the price, income, and Armington elasticities in the model. In the current study, we use the standard GTAP parameters (Aguiar et al., 2022). However, there is an argument that these may be too low for simulating permanent policy shocks. In this sense, our results may be regarded as conservative.

[2]Markets for services also are subject to both border restrictions and behind-the-border regulations that impede trade. The OECD generates estimates of what they call a services trade restrictiveness index (OECD, 2022). However, the GTAP model does not include services trade barriers because that requires far more information, most notably an indicator for each bilateral trading partner for each type of service. Distortions to services markets are thus not able to be considered in this study.

[3]However, we modify the standard GTAP mechanism for allocating OECD intermediate input subsidies across sectors to avoid problems such as a significant overstatement of EU wool subsidies. We also modify the GTAP model code to separate primary factor subsidies from primary factor taxes, which enables us to directly target removal of primary factor subsidies rather than subsidies net of any taxes on primary factors (Anderson et al., 2022).

[4]Boysen-Urban et al. (2020) provide an estimate of that for an earlier period (2007) for the European Union. See also Urban et al. (2016).

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Table 3. Domestic subsidies and import tariffs on agricultural and food products and on non-agricultural goods in the updated GTAP database, 2017 (%)

	Domestic subsidies to agric + food producers[a]	Import tariffs on agric + food products[b,c]	Import tariffs on non-agric + food goods[b]
High-income countries	3.3(10.7)	5.1	1.3
Developing countries	2.0 (3.7)	7.5	3.6
WORLD	2.5 (5.3)	6.6	2.6

Notes: [a]Average subsidy to production (including total subsidy payments on outputs, intermediate inputs, and primary factor inputs), weighted by the value of output at market prices. Rates of subsidy to just primary agriculture (i.e., farmers) are shown in parentheses. The few remaining subsidies on agri-food exports are also removed, but have a negligible impact.
[b]Average tariff, weighted by imports at cif prices, excluding services and intra-EU trade.
[c]In 2001, those agri-food tariffs averages were nearly three times higher: 14% for HICs, 21% for DCs, and 17% for the world (see Table 2 of Anderson and Martin 2005). By contrast, the global average tariff on non-agricultural goods in 2001 averaged less than twice that in 2017.

4. Model Results

The extent of domestic support to farmers and the average applied import tariff equivalents at the border as a percent of imports in the GTAP database are shown in Table 3. It reveals that global agri-food tariffs are more than twice those of other goods, and subsidies are a considerable addition to distortions to agricultural and food production. Note, though, that in 2001 those agri-food tariff averages were nearly three times higher: 14% for high-income countries, 21% for developing countries, and 17% for the world (Table 2 of Anderson and Martin, 2005).[5]

Full global liberalization of just the agri-food sector in 2017 would have led to an increase in annual welfare[6] of US$48 billion globally. Of this, all but $3 billion is due to tariff removal, with removal of domestic producer subsidies contributing only 6% of that impact. That is only marginally more than the 5% contribution of domestic supports estimated in 2001 by Anderson et al. (2006), so market access barriers are still the dominant form of agricultural assistance in terms of global economic gains. The real welfare gains *per capita* from global agri-food reform in 2017 amount to US$23 in high-income countries and $4 in developing countries (Table 4).

In Supplementary Table S1, the estimated gains from the removal of subsidies are sub-divided into the types of subsidies from which they come and they are presented separately for the two country groups. The overall contribution to welfare from removal of domestic subsidies is non-trivial in high-income countries (whereas their removal leads to a slight reduction in aggregate welfare in developing countries). Even so, as Snape (1987) anticipated, domestic subsidies have been no more than a very partial substitute for export subsidies and import restrictions as the latter have been gradually lowered or dismantled.

Just over 40% of the gains to developing countries would come from their own country-group's agri-food policy reforms. That begs the question as to why do developing countries put so much negotiating energy into efforts at the WTO to lower agricultural supports of high-income countries? Part of the answer can be seen from the pattern of net farm income gains (losses) from liberalizing agricultural policies globally: they occur mostly in the lightly (heavily) assisting countries. The wide spread in those effects helps to explain why attempts at the WTO to reform agricultural support policies is so contentious: while per capita gains

[5]The results reported in Anderson and Martin (2005) draw from a variant of the GTAP model called GTAP-AGR, those from Anderson et al. (2006) draw from the World Bank's LINKAGE model, and – as in the present study – both report equivalent variations in income as a measure of welfare gain from reform in 2001. All three models have slightly different aggregations of sectors and countries too but all are based on the latest GTAP database at the time and all use the same aggregated 'agri-food sector' and the same categorization of developing countries (the WTO definition). Hence, for present purposes the three sets of results are very comparable.

[6]As measured by an equivalent variation in income.

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Table 4. Gains in welfare from regional and global elimination of domestic subsidies and import tariffs on all agricultural and food products, 2001 (in italics) and 2017 (current US$ billion and %)

	Welfare (US$ billion) due to:			Due to lib'n by:		Gain per capita (US $/yr)	% due to just subsidies	% due to DC reform
Gain to:	Subsidies	Tariffs	TOTAL	HICs	DCs			
HICs	4.3	19.5	23.7	6	18	23	18	75
DCs	−1.5	25.2	23.7	14	10	4	−6	41
WORLD, 2017	**2.7**	**44.8**	**47.5**	**20**	**28**	**6**	**6**	**58**
WORLD, 2001	*13*	*169*	*182*	*128*	*54*	*29*	*5*	*26*

Sources: Authors' GTAP model results and Anderson and Martin (2005).

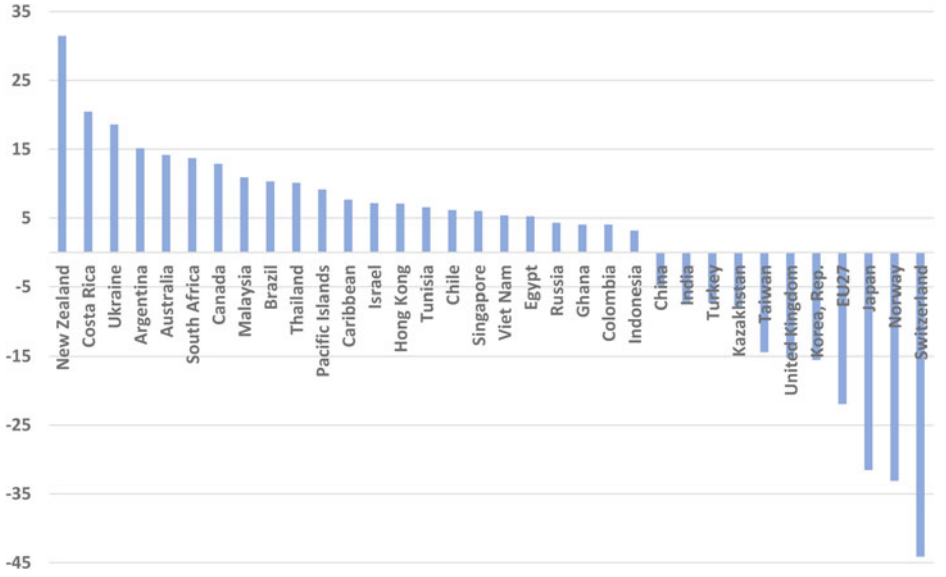

Figure 3. Impact on net farm incomes[a] of removing all of the world's agri-food tariffs and domestic producer subsidies, 2017 (%, omitting those whose change is in the ±3% range).
Note: [a]Change in value of total factor returns to farm sectors (excluding processed agricultural products).
Source: Authors' GTAP model results.

would be small, the gains in net farm income would amount to more than 10% in ten countries and the losses would amount to more than 15% in five countries plus the EU27 (Figure 3).

If tariffs on non-agricultural goods were to be removed globally, that would lower slightly the estimated gains from agricultural policy reform shown in Table 4 because of general equilibrium interactions. In that event, the world would be better off by $136 billion in 2017 (Table 5). That is well below the estimate for 2001 ($287 billion), thanks to the substantial lowering of many import tariffs this century. Agri-food policies are responsible for a still-sizable 32% of that total, but that is considerably less than its 63% share in 2001 reported in Anderson et al. (2006). The halving of that share is due to two changes: a big rise in the relative importance of the non-agricultural tariffs and of trade of developing countries, and the huge drop in agri-food tariffs. As noted in Table 3, the global average of the latter was three times higher in 2001 than in 2017, while the global average tariff on non-agricultural goods had less than halved between 2001 and 2017.

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Table 5. Gains in welfare from regional and global elimination of domestic subsidies and import tariffs on all goods, 2001 (in italics) and 2017 (current US$ billion and %)

	US$ billion, 2017 (& 2001 in italics)			% due to DC policies	
Gain to:	HICs	DCs	World	2017	*2001*
Gain from removing:					
Ag + food subsidies	3	−2	1	205	*0*
Ag + food tariffs	17	25	42	55	*17*
Non-agric tariffs	3	90	92	80	*28*
TOTAL, 2017 (US$b)	**23**	**113**	**136**	**73**	***45***
TOTAL, 2001 (US$b)	*201*	*86*	*287*		
	HICs	DCs	World		
% due to ag + food policies: 2017	15	17	32		
% due to ag + food policies: 2001	*46*	*17*	*63*		
Gain per capita (US$/yr): 2017	19	18	18		
Gain per capita (US$/yr): 2001	*181*	*17*	*46*		

Source: Authors' GTAP model results and (for results in italics for 2001) Anderson, Martin, and van der Mensbrugghe (2006).

Those absolute and relative changes in average tariff rates were the result of many things, including the completion in 2004 of the implementation of the GATT's Uruguay Round Agreements, the addition of another dozen countries to the European Union, the signing or further liberalizing of numerous other preferential economic integration agreements, plus unilateral trade policy reforms including the 22 countries that have joined the WTO since end-2001 such as China, Kazakhstan, Russia, Saudi Arabia, Ukraine, and Viet Nam.

What has also changed substantially is the share of the global cost of policies due to developing countries. In 2001, their share in the case of agricultural policies was just over one-quarter but in 2017 it was more than half (26% vs 58%, see Table 4), and for the policies of all trade-related goods the developing country share was 45% in 2001 but 73% in 2017 (Table 5). Much of the economic welfare gain in each of the two country groups is due to reform of the policies within their own group. The annual per capita benefit of full global goods trade reform in 2017 would be $22 in high-income countries and $17 in developing countries (final row of Table 5). These are very much lower-bound estimates because they come from a comparative static model, which ignores the (possibly much greater) dynamic gains that could result from trade-related policy reforms (see, e.g., Irwin 2019).

5. Conclusions

Evidently agricultural policy reforms continue to be an important potential source of global welfare gains, both absolutely and relative to potential gains from removing tariffs on imports of non-agricultural goods; and import market access barriers rather than domestic subsidies continue to be the dominant contributor to the global welfare cost of farm price distortions. Efforts to encourage such reform continue to be needed, even though progress has proven to be politically difficult for well-known reasons (Anderson et al., 2013). Further reform is important especially because large gaps remain between applied farm subsidy and tariff rates and their legal binding commitments at the WTO, meaning many countries have ample policy space to raise their supports for farmers (Anderson, et al., 2016; Brink and Orden, 2022). Reducing those farm supports is also likely to reduce income and wealth inequality within countries even among farmers, since

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agri-food policies mostly assist by raising output prices and hence helping farmers in proportion to their marketed farm output. Insofar as chemical farm inputs and the cost of pumping water for irrigation also are subsidized, these supports are contributing not only to that inequality among farmers but also to natural resource depletion and environmental damage. And where trade measures are used to raise farmers' product prices, they also raise food consumer prices to the same extent, which harms the poorest net buyers of food most because they spend the largest share of their budget on staple foods.

A far more efficient way to assist today's farmers is to reduce any underinvestment in rural infrastructure (to lower transport and communication costs involved in getting farm products to market), in agricultural R&D (to lower farmers' costs of production or raise the quality and thus price of their product), and in basic education and health in rural areas (to boost the managerial skills of farmers and increase the off-farm earning prospects of those wishing to exit from agriculture). Such investments can benefit consumers (including through improved nutrition and health) as well as producers. If that were not enough support for the poorest households, both net sellers and net buyers of food, a generic social safety net/trampoline e-payment such as a conditional targeted income supplement could suffice. The widespread use of e-banking now makes fiscal transfers to individuals possible at little administrative cost, even for poor households in low-income countries (Demirgüç-Kunt et al., 2022).

More recently, farmers have been seeking payments for typically unpriced 'ecosystem services' they claim to provide (Wunder et al., 2020). Where a market can be developed such that the community can express its willingness to pay for such services, it would then be up to farmers to demonstrate that they are competitive suppliers of those services. That may well boost demand for targeted research on how best to design and implement institutions and policies in this space. One example is biodiversity corridors. Another has to do with carbon sequestration in soils, demand for which will be greater the higher the taxation of carbon emissions and the more developed are markets for tradable emission permits nationally and abroad. In short, there is substantial scope for re-purposing farm supports so as to relieve global natural resource and environmental stresses, food and nutrition insecurity, and poverty and inequalities in income, wealth and health (World Bank and IFPRI, 2022).

Supplementary Materials. To view supplementary material for this article, please visit https://doi.org/10.1017/S1474745623000101.

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