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The relative importance of global agricultural subsidies and market access

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Abstract: The claim by global trade modelers that the potential contribution to global economic welfare of removing agricultural subsidies is less than one-tenth of that from removing agricultural tariffs puzzles many observers. To help explain that result, this paper first compares the OECD and model-based estimates of the extent of the producer distortions (leaving aside consumer distortions), and shows that 75 % of total support is provided by market access barriers when account is taken of all forms of support to farmers and to agricultural processors globally, and only 19 % to domestic farm subsidies. We then provide a back-of-the-envelope (BOTE) calculation of the welfare cost of those distortions. Assuming unitary supply and demand elasticities, that BOTE analysis suggests 86 % of the welfare cost is due to tariffs and only 6 % to domestic farm subsidies. When the higher costs associated with the greater variability of trade measures relative to domestic support are accounted for, the BOTE estimate of the latter's share falls to 4 %. This is close to the 5 % generated by the most commonly used global model (GTAP) and reported in the paper's final section.

In the debate over the multilateral trade negotiations under the WTO's Doha Development Agenda (DDA), there has been much confusion over numbers. This is especially so when referring to farm subsidies. Measures of the size of those subsidies in developed countries are published each year by the OECD Secretariat as part of its regular monitoring and evaluation of agricultural policies of its member countries. Initially they were called producer subsidy equivalents, but since they are expressed as a percentage of the support-inclusive (rather than undistorted) value of production, they are now referred to as producer support estimates, their common acronym being PSEs.

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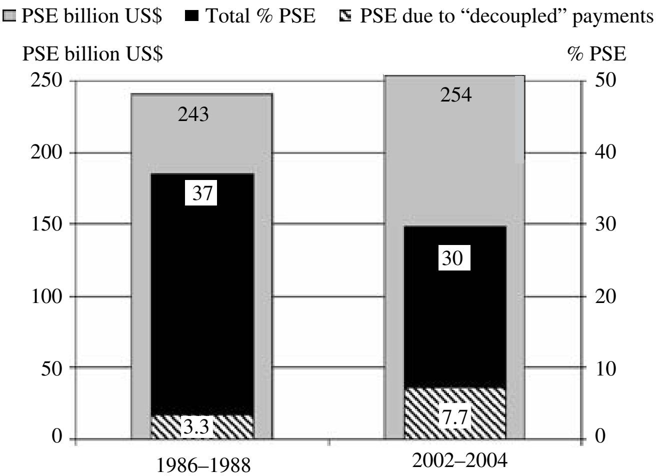

Figure 1. Agricultural producer support in high-income countries, by value, percent, and type of support, 1986 to 2004 ($ billion and percentage of total farm receipts from support policy measures)[a]

Notes: [a] The striped rectangle represents the portion of the PSE percentage that is due to payments to farmers based on area planted, animal numbers, historic entitlements, input constraints, or overall farming income. The residual black area above it represents the portion due to payments based on output or input use or otherwise not classified. In 1986–1988 the former was 9 % of the latter, and in 2002–2004 it was 25 %.
Source: OECD (2005).

Developing country governments and development NGOs (non-government organizations) frequently point to the fact that the dollar value of the average PSE for developed countries has not fallen since the Uruguay Round negotiations began in 1986, despite that round's Agreement on Agriculture which was expected to reduce government distortions to world food markets. While that is true, protective high-income country governments have countered by stressing that there has been some progress in two respects: in the PSE when expressed as a percentage of gross farm receipts (the latter rising over time with inflation and with the volume of output); and in the proportion of the PSE that affects output as distinct from that part which is at least somewhat decoupled from production (Figure 1).

The 2004 dollar value of the PSE, $280 billion, is the number that has received the most attention in recent debates over the Doha Round. And since the acronym is known to refer to producer subsidies or support, it is assumed by many that developing countries and other advocates of liberal agricultural markets should focus their attention on obtaining cuts in government subsidies paid to farmers in high-income countries. This focus has the rhetorical appeal of contrasting the ability of developed countries to pay such subsidies with the much more limited resources available to developing countries. Also jarring is the contrast between this wasteful largesse and the much smaller amount devoted to foreign aid by the same industrial country governments (less than $80 billion per year). Politically, this focus is potentially appealing to developing countries because it also implies large-scale farm policy changes are needed only in developed countries.

Why, then, have economists and organizations such as the World Bank argued that even more important than direct producer subsidies are barriers to agricultural imports and therefore that, from the viewpoint of economic welfare and trade, it is import barriers that need to be targeted in the DDA – and in developing countries as much as in high-income countries? This question has been asked by numerous trade negotiators and their advisors seeking an intuitive understanding of the modeling result that suggests 93 % of the global cost of agricultural tariff protection and subsidies is due to tariffs and only 2 % to export subsidies.[1] The purpose of the present paper is to provide such an explanation.

At the outset, it is helpful to recognize two things. The first is that the OECD estimates refer to the extent of support to farmers not only directly via producer subsidies from the treasury but also indirectly by propping up domestic prices via export subsidies and, far more importantly, import barriers. This is something the OECD has gone to great lengths to explain in its documentation (OECD, 2005 and earlier issues), but some misconceptions remain. Secondly, what matters is how those various elements of support affect production, consumption, and trade, and thereby national economic welfare. It is the net impact on economic welfare globally and in developing countries that the World Bank uses as its main criterion for determining the relative importance of the various measures. To estimate that requires a multi-country model of the global economy that takes into account the size of the sectors being distorted, the price responsiveness of supply and demand in different regions, the extent to which distortions vary across commodities and countries, and the fact that production subsidies distort only production responses, while border measures distort both production and consumption.

The paper first shows the relationship between the OECD's PSEs on the one hand, and on the other hand the representation of the various agricultural interventions in the database used by global modelers. It then provides a back-of-the-envelope assessment of the welfare implications of global trade liberalization, before reporting in Section 3 the results from the full-blown computable general equilibrium (CGE) model, building on earlier work by Hertel and Keeney (2006). Those CGE results show the estimated effects of policies not

1 See, for example, Anderson and Martin (2005), drawing on the chapter in their subsequent edited volume by Hertel and Keeney (2006), as well as the earlier partial equilibrium study by Hoekman, Ng, and Olarreaga (2004). Hertel and Keeney's finding that 93 % of the global welfare cost of agricultural support programs is due to import tariff barriers to market access (using a 2001 protection database) is very close also to the 89 % finding of Diao, Somwaru, and Roe (2001) who used a 1995 protection database.

only on developing country and global economic welfare but also on global agricultural trade and on agricultural incomes in both developed and developing countries.

1. OECD vs. GTAP measures of the extent of agricultural subsidies and trade distortions

The OECD's PSE is intended to provide a summary measure of the producer subsidy that would be equivalent to all the forms of support provided to farmers, including direct farm subsidies that may or may not encourage production domestically, as well as market price support provided by import tariffs and export subsidies. All three of those components of government assistance to farmers are disciplined under the Uruguay Round Agreement on Agriculture, and have become known as the 'three pillars'.

One element of the OECD's PSE is that provided by market price support (MPS) measures. It is calculated by comparing domestic and border prices of like products so as to capture the total domestic market price effect of all trade distortions, including tariff and non-tariff import barriers as well as export subsidies. The OECD also uses the price comparison method to calculate a CSE: the consumer subsidy equivalent of those measures. The CSE is negative in countries that raise domestic food prices via restricting imports and subsidizing exports, and would only be positive if a country had direct subsidies to food consumption significant enough to offset the effect of those trade measures in raising consumer prices.[2]

The OECD's PSE can be compared with the extent of the distortions inserted into global economic models used to calculate the economic welfare and other consequences of these (and non-agricultural) trade-distorting measures. For more than a decade now the Global Trade Analysis Project (GTAP) at Purdue University has coordinated the compilation of a global database of trade and agricultural subsidy interventions by governments. This GTAP database has become the standard and is used in dozens of different models by hundreds of modelers throughout the world. The most recent and by far the most comprehensive release, which relates to 2001 policies, is Version 6 (Dimaranan and McDougall, 2005). It incorporates all three components of support for agricultural production – producer subsidies, import tariffs, and export subsidies – and thereby also the effect of the latter two on raising food consumer prices.

How do the OECD's PSE numbers compare with those in the most recent version of the GTAP database (that is, for 2001)?[3] To allow easy comparison, we

2 In principle the PSE and CSE would also capture the effects of import subsidies and taxes or other restrictions on exports, but in practice these are not being used in OECD countries.

3 A side issue is how the OECD's PSE compares with the Aggregate Measure of Support (AMS) that members notify to the WTO as part of their commitments under the Uruguay Round Agreement on

present them in Table 1 on the same subsidy-equivalent basis as the OECD numbers. To do this, we estimate the domestic subsidy amounts in the GTAP database by adding the subsidies paid to output, inputs, land, and capital. We compare this with the subsidy equivalents of border measures, which are calculated by multiplying the rate of assistance assumed in the GTAP database by the value of agricultural output.[4]

For domestic support in OECD countries we find that the OECD and the GTAP numbers are within 1 % of each other (a total of $89 billion reported by the OECD compared with $90 billion in the GTAP database). This is not surprising because the OECD estimates are the source for that part of the GTAP protection database. To that needs to be added domestic support to primary agriculture in non-OECD countries, which is another $7 billion in 2001 according to the GTAP database (Dimaranan and McDougall, 2006: ch.16b). These estimates are shown in row 1 of Table 1.

For market price support provided through trade measures, the GTAP database relies on applied tariff rates including preferential rates where applicable, plus export subsidy notifications by members to the WTO Secretariat (Dimaranan and McDougall, 2005: chs.16d and 16e). By contrast, the OECD relies on domestic-to-border price comparisons to capture the combined effect of all trade measures, both tariffs and such non-tariff barriers as quarantine restrictions. In Table 1 the cost to producers of having to pay higher prices for intermediate inputs that are subject to tariffs or export subsidies has been netted out of the gross benefits to downstream producers of market price support measures in the GTAP database.[5]

For primary agriculture in OECD countries, the two market price support estimates differ substantially – $46 billion in the GTAP database compared with $139 billion in the OECD's PSE estimate for 2001 (see first two columns of row 3 of

Agriculture. The AMS refers only to the domestic support pillar, and it excludes measures that are not subject to reduction commitments (so-called blue box and green box measures). For a comparison of the PSE and AMS methodologies, see Diakosavvas (2002). In 1999 (the most recent year for which there has been full notification to the WTO) the AMS was $88 billion for high-income countries and $2 billion for developing countries. The $88 billion comprises $52 billion from market price support and $36 billion from direct domestic subsidies. By contrast, the PSE for just OECD countries was $273 billion in that year. Of that latter amount, $182 billion was from market price support measures and only the residual ($91 billion) was direct domestic subsidies. That residual is further reduced, to $43 billion, when measures that are somewhat decoupled from production are excluded. Since those decoupled measures are not counted as part of the AMS, that $43 billion is comparable with the $36 billion notified to the WTO as that component of the AMS.

4 For the purpose of this calculation, we assume in this section that domestic and imported farm products are homogeneous, so that a tariff equal to 20 % of the value of imports will raise the price of domestic production by 20 %.

5 This is a way of capturing the impact on net value added by primary factors of production instead of just on the gross value of output, paralleling the difference between the concepts of effective and nominal rates of protection (Corden, 1971).

Table 1. Estimates of the extent of support to agriculture and food sectors, by region and policy instrument, 2001 (US$ billion)

	OECD estimates of support to primary agriculture	GTAP database price-based distortions (excluding non-tariff barriers)						
		GTAP database estimates of support to primary agriculture			GTAP database estimates of support to food processing			GTAP database estimates of support to all countries' agriculture and food (% in brackets)
	OECD countries	OECD countries	Non-OECD countries	All countries	OECD countries	Non-OECD countries	All countries	
Direct domestic subsidies	89	90[b]	7	97	0	0	0	97 (19 %)
– *Fully coupled to prod'n*	*37*[a]							
Market price support (MPS)	139	46	76	122	198	82	280	402 (81 %)
– *Export subsidies*[c]	*na*	*3*	*1*	*4*	*26*	*0.1*	*26*	*30 (6 %)*
– *Import tariffs*[d]	*na*	*43*	*75*	*118*	*172*	*82*	*254*	*372 (75 %)*
All support measures[e]	**228**	**136**	**83**	**219**	**198**	**82**	**280**	**499 (100 %)**

Notes: [a] The portion somewhat decoupled from production refers to payments to farmers based on area planted, animal numbers, historic entitlements, input constraints, or overall farming income. The fully coupled portion refers to payments based on output or input use or otherwise not classified. Even if all non-OECD domestic subsidies were fully coupled, that would still mean less than half [(37 + 7)/97 = 45 %] of domestic farm subsidization is fully coupled globally.

[b] The domestic support is estimated from the value wedges between payments at agents' prices and market prices in the GTAP database. These payments are collected by commodity and region in payments to final output, payments to factors, payments to domestic intermediate inputs, and payments to imported intermediate inputs. The GTAP-AGR Model allows us to identify from the GTAP database payments to land based on historical entitlements of $8 billion (Keeney, 2005: 85).

[c] Export subsidy market price support is calculated as the sum over all goods of the value of output at undistorted prices of good i in region r times the corresponding export subsidy rate of good i in region r, minus the sum of the value of each intermediate inputs used in industry i in region r times its corresponding export subsidy rate.

[d] Import tariff market price support is calculated as the sum over all goods of the value of output i at undistorted prices in region r times the corresponding trade weighted tariff rate of good i in region r, minus the sum of the value of each intermediate input used in industry i in region r times its corresponding tariff rate. In deriving the import weights for making these calculations, intra-EU15 trade was excluded.

[e] The value of OECD production of primary agriculture at undistorted prices in the GTAP database is US$614 billion, so $136b represents an *ad valorem* subsidy equivalent of 22 %. The OECD Secretariat's estimated value of production at farm gate prices is $653b plus $77b worth of direct payments based on output, and $228b of that sum of $730b is subsidies. Hence at undistorted prices the production value is $502b, so $228b represents an *ad valorem* subsidy equivalent of 44 %.

Sources: Authors' calculations based on OECD (2004) and the GTAP database Version 6 (see www.gtap.org).

Table 1). This is mainly because the GTAP method does not capture the protective effect of non-tariff barriers (NTBs) such as Sanitary and Phyto-Sanitary (SPS) measures or other technical barriers to imports that may provide additional economic protection, in contrast to the OECD measure which does. Such NTBs are still a major trade restriction despite GATT and WTO attempts to convert all non-tariff barriers to tariffs.[6] When direct subsidies are added to market price support the total support is the equivalent of a 22 % *ad valorem* subsidy equivalent, whereas the comparable rate for the OECD Secretariat's estimate is 44 % (which is equal to its Producer Support Estimate (PSE) of 31 % of the support-inclusive value of production). That difference between the GTAP and OECD's rates is very consistent with a recent estimate of the trade-restrictiveness of NTBs in OECD agriculture in recent years, which suggests tariffs account for just 52 % of the total tariff equivalent of both tariffs and NTBs (Kee, Nicita, and Olarreaga, 2006).

It is necessary to go beyond primary agriculture, however, when evaluating the consequences of reforms under WTO. This is because the WTO negotiations on agriculture involve potential liberalization of a wide range of processed agricultural products as well. In OECD countries domestic subsidies are not paid to processed agricultural products, but the extent of border protection to processing activities is substantial – even after netting out the effect on processors' costs of having to pay higher than border prices for many primary agricultural product inputs.[7] According to the GTAP database, in 2001 that assistance amounted to $198 billion, which is greater than the estimated $136 billion in total support to primary agriculture for that year (final row of Table 1).[8]

The remaining important element to consider is the market price support provided to the agricultural and food sectors of non-OECD countries. At $76 billion for primary agriculture plus $82 billion for food processing, this support is a substantial addition to the support through import barriers of $46 billion provided to OECD agriculture and $198 billion to OECD processed food (row 2 of Table 1). But there are almost no export subsidies in non-OECD countries (row 3 of Table 1), further increasing the prominence of market access.

In summary, the OECD and GTAP databases are very similar in their estimates of the extent of direct support to farmers in OECD member countries and the differences in market price support are easily reconciled (columns 1 and 2 of

6 Such NTBs are appropriately left out of Doha modeling analyses, since those NTBs are not part of the WTO negotiations in this round.

7 Again this follows the effective protection concept mentioned above in footnote 5.

8 As well, any given nominal protection rate for agricultural processing activities delivers a higher rate of effective protection and hence a greater welfare cost than the same nominal protection to primary agriculture, other things equal. This is because of the difference in value added shares of output (VASO) in the two sets of activities. According to the GTAP Model, VASO is 32 % in processing and 45 % in primary agriculture in OECD countries, while in non-OECD countries the difference is even greater: 24 % compared with 54 %, making for global averages of 30 and 50 %, respectively.

Table 1); but the GTAP database also includes support via the food processing sector in those countries plus the support to both sets of activities in non-OECD countries. In total, the GTAP database suggests only 19 % of the dollar value of the transfers to those producers from taxpayers and consumers is in the form of domestic support and only 6 % comes via export subsidies (see final column of Table 1).[9]

That is not the end of the story, however. What matters is how those policy measures affect economic welfare, to which we now turn.

2. Relative importance of the three pillars in a back-of-the-envelope estimate of the global welfare cost of these distortions

To assess the importance of each type of distortion for the overall welfare costs of protection, we need to take into account not only of the magnitude of the support under each pillar, described above, but also the ways in which the support is provided and the variation in the rates of distortion across commodities and countries. In examining these aspects, we focus in this section on the simplest back-of-the-envelope calculation of the welfare effects of these distortions, in an attempt to provide further intuition behind the more-complex CGE model results reported in the following section.

The back-of-the-envelope model is depicted in Figure 2 in the case of a net agricultural importing region. As shown by Martin (1997), the welfare impacts generated by CGE models can be identified with the traditional partial equilibrium Harberger welfare triangles of waste in production and consumption.[10] Using the price wedges between border prices and producer prices induced by each of the three pillars of agricultural support, described above, we can obtain the relative contribution of each policy measure to the economic welfare cost of total intervention by assuming values for the price elasticities of aggregate supply and demand for agricultural products.

When changes in the level of one instrument affect the volumes passing over a related distortion – whether in the same market or in a related market – the allocation of the effects between measures needs to recognize that the measured impact of each policy instrument is path dependent. Allocation procedures such as in Huff and Hertel (2000) deal with this problem by changing each distortion incrementally along a path from the original distorted situation to an undistorted

9 The value of the transfer to producers via export subsidies, as reflected in the GTAP database, is estimated at $28 billion globally (row 3 of Table 1). This includes not just the budget cost of export subsidies ($4.4 billion in OECD and $0.5 billion in non-OECD countries) but also the transfer from domestic consumers to producers, because export subsidies raise consumer prices as well as producer prices.

10 For individual countries, terms-of-trade changes must also be taken into account, but these net out at the global level.

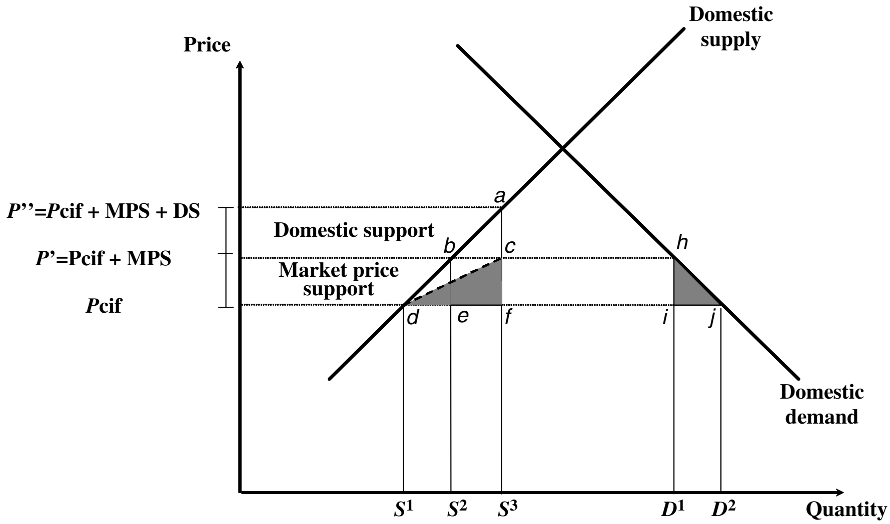

Figure 2. Welfare losses induced by domestic support and market price support

equilibrium. This approach allows us to fully allocate the total gain from reform into its individual components.

2.1 Trade measures are costly also to consumers

Figure 2 exposes the fact that domestic support measures only accrue to the producer side (triangle *adc*), while market price supports (induced by tariffs and export subsidies) distort the consumer and producer side of the market (triangles *cdf* and *hij*). If the elasticities of demand and supply were equal, that means the welfare cost of a given tariff or export subsidy would be twice as great as that from a domestic subsidy applied at the same rate.[11] Consistent with Huff and Hertel (2000), we specify the total distortion to production resulting from border measures and domestic subsidies as creating a welfare triangle of losses on the production side, and partition this total between the two on the assumption that the two policies are reduced (or increased) in parallel.

11 As well, as pointed out in note a of Table 1, over half of all domestic support globally is at least somewhat decoupled from production. Even though we believe that this decoupling reduces the extent to which domestic subsidies distort production, this is taken into account to only a limited degree in global CGE Models. (In the GTAP Model, decoupling is incorporated to the extent that payments to land distort output less than other factor payments given that land is specific to the agricultural sector in the model.) Thus, if anything, CGE models should overstate the contribution of domestic support measures to the total welfare cost of protection. Our BOTE analysis also ignores decoupling and similarly overstates the contribution of domestic support to the overall cost of protection.

For the OECD countries, the $90 billion in domestic support to producers represents 13.5 % of the value of their agricultural output at market prices. The rates of market price support are 17.0 % from OECD import tariffs and 3.3 % from export subsidies in agricultural and food production (Table 2). Using these rates and assuming unitary[12] elasticities of demand and supply, the total welfare cost of agriculture protection in OECD countries is calculated at $87 billion, from which 8 % is induced by domestic support, 11 % by export subsidies, and 81 % by import tariffs. Using the same process for non-OECD countries, we calculate the cost of protection to producers at $42 billion, from which barely 1 % is attributed to domestic support and export subsidies, so almost all is attributed to market access measures. These back-of-the-envelope calculations yield a world total cost of protection in agriculture of $129 billion, of which 6 % is attributed to domestic support, 8 % to export subsidies and 86 % to market price support (Table 3).

2.2 *Variations in rates of assistance add to welfare costs*

Another important factor that must be taken into account is the variation in agricultural assistance rates across commodities and across countries. The average numbers discussed above would be appropriate if protection and subsidy rates were the same across countries. However, the cost of protection rises with the square of the tariff, so a situation where one commodity has high protection and another has low protection is more costly than one where each commodity has the (appropriately weighted) average tariff rate.

We illustrate in Figure 3 the point using a diagram for the case of a tariff. The import demand curve is downward sloping, and a world price of 100 is given by the horizontal line at that price. We compare the welfare costs of two tariffs – a tariff of 50 and one of 150 – with the costs associated with their average, a tariff of 100. With the tariff of 50, the domestic price of the imported good is 150 and the economic cost of the tariff is shown by the area a. At the average tariff of 100, the economic cost is given by the area $a+b+c$; and with a tariff of 150, the domestic price of imported goods is 250 and the cost of the tariff is $a+b+c+d+e+f$. Examination of the figure shows that the average of the costs of the two tariffs is greater than cost of the average tariff by the area f. For this example, the quantitative difference is substantial, with the estimated average cost associated with the two tariffs being 25 % higher than the cost of the 100 % tariff.[13]

12 The choice of unit elasticities is quite arbitrary. For our interest in the relative importance of different barriers, it is only the relative magnitude of supply and demand elasticities that is relevant.

13 This is calculated by comparing the cost of the 100 % tariff ($1/2.s.t^2$, where s is the slope of the demand curve, so $C=1/2.s.1$) with the average cost of the two tariffs ($1/2.s.(0.5^2+1.5^2)$).

Table 2. Agricultural subsidies and applied tariffs, by region, 2001 (percent)

	Primary agriculture			Processed agriculture[d]	
	Domestic production subsidies[a]	Export subsidies[b]	Import tariffs[c]	Export subsidies[b]	Import tariffs[c]
OECD countries	**13.5**	**0.8**	**16.9**	**3.3**	**17.0**
Australia	2.9	0.0	1.0	0.0	9.1
New Zealand	0.3	0.0	0.4	0.0	2.7
United States	16.2	0.0	1.1	0.2	3.2
Canada	10.6	0.0	1.3	0.0	13.6
Mexico	8.8	0.0	10.7	0.0	12.2
European Union (EU15)	17.7	4.4	7.4	8.6	17.9
Switzerland-Iceland-Norway	39.8	4.2	29.5	3.9	31.4
Other European members	10.7	0.0	6.2	1.4	17.0
Turkey	3.1	0.2	15.9	1.6	18.0
Japan	6.0	0.0	27.8	0.0	31.4
Korea	3.6	3.3	146.4	0.0	26.1
Non-OECD countries	**0.7**	**0.0**	**14.9**	**0.0**	**17.5**
E. Europe & Central Asia	***0.5***	***0.0***	***8.9***	***0.2***	***18.0***
Russia	0.6	0.0	5.1	0.0	16.7
Other E. Europe & C. Asia	0.5	0.0	10.8	0.3	18.9
East Asia & Pacific	***0.0***	***0.0***	***32.9***	***0.0***	***19.8***
China	0.0	0.0	50.8	0.0	18.3
Indonesia	0.0	0.0	1.8	0.0	9.0
Other E. Asia & Pacific	0.0	0.0	16.8	0.0	22.9
South Asia	***3.0***	***0.0***	***17.8***	***0.0***	***50.9***
Bangladesh	0.1	0.0	6.3	0.0	19.7
India	3.4	0.0	25.5	0.0	76.4
Other South Asia	2.3	0.0	13.4	0.0	29.9
Middle East & North Africa	***0.0***	***0.6***	***10.3***	***0.0***	***16.4***
Sub-Saharan Africa	***0.2***	***0.0***	***9.3***	***0.0***	***21.3***
South Africa Custom Union	0.0	0.0	6.3	0.0	8.3
Other Southern Africa	0.4	0.0	11.0	27.2	0.4
Other Sub-Saharan Africa	0.1	0.0	10.4	0.0	24.5
Latin America & Caribbean	***0.4***	***0.0***	***6.7***	***0.0***	***11.1***
Argentina	0.0	0.0	4.7	0.0	7.6
Brazil	1.3	0.0	2.4	0.0	8.6
Other Latin America & Carib.	0.0	0.0	8.6	0.0	11.8

Notes: [a] Ratio of subsidies to the value of primary agriculture production at market prices (i.e. domestic support is estimated by measuring value wedges between payments at agents' prices and at market prices). These payments are by commodity and region to final output, factors of production, domestic intermediate inputs, and imported intermediate inputs.
[b] Export subsidy rates are the ratio of subsidy payments over the value of exported commodities. Trade weights are used for aggregation.
[c] Intra-EU15 trade is ignored in EU and world trade in calculating import weights.
[d] There are no domestic production subsidies on processed agricultural products.
Source: Authors' calculations from GTAP database 6.

Table 3. Back-of-the-envelope calculation of the impact of agricultural and food subsidies and tariffs on global economic welfare, by region and policy instrument, 2001 (US$ billion)

	OECD	Non-OECD	All countries
Direct domestic subsidies	7	0.5	8 (6 %)
Market price support	80	41	121 (94 %)
Export subsidies	*10*	*0.1*	*10* (8 %)
Import tariffs	*70*	*41*	*111* (86 %)
All support measures	**87**	**42**	**129 (100 %)**

Source: Authors' calculation assuming unitary elasticities of domestic demand and supply.

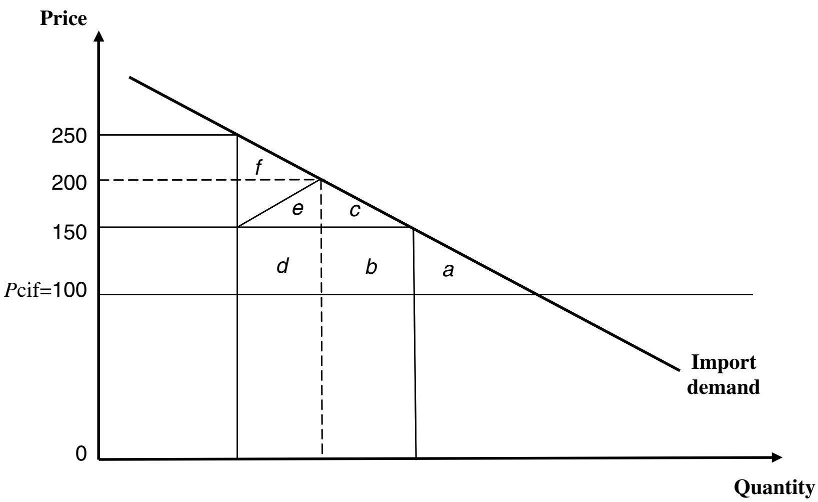

Figure 3. Implications of variability of protection rates for the cost of protection

To obtain an indication of the relative importance of the three pillars when the variability of each form of assistance is taken into account, we use a procedure based on analysis of variance. We first characterize the cost of protection using the standard relationship

$$C_i = \tfrac{1}{2}\eta_i w_i \cdot t^2$$

where C_i is the cost of the tariff, η_i is the elasticity of demand or supply (depending upon which is being distorted), w_i is the value of production or consumption at undistorted prices, and t_i is the tariff rate.[14] Since we are only interested in the extent to which the variability of tariffs affects the relative importance of the different forms of support, we ignore the purely proportional ½ term. To simplify further, we assume that the η_i terms are equal for all commodities so that this also becomes a purely proportional term that will not affect the ratio of the cost of protection with and without the variance terms. Under these assumptions, we can decompose the costs of protection into an element associated with the cost of protection at a uniform rate equal to the average observed rate of protection, and a component due to the variability of protection rates around this average. This total cost, C, is given as

$$C = \sum_i \sum_r w_{irs} \left[(\bar{\tau} - \tau_{irs})^2 + \bar{\tau}^2 \right] \tag{1}$$

where the summation is over commodity (i) and country/region (r).

From this analysis, we find that the cost of protection provided by agricultural tariffs is 8.1 times what it would be if all protection were provided through a tariff equal to the weighted average tariff rate. Using the same methodology, the cost of domestic subsidies must be raised by a factor of 5.4. The corresponding multiplier for export subsidies is 13.9. The greater variability of border measures relative to domestic support is a factor that increases the relative cost of these trade barriers.

If we were to adjust the estimated cost of tariff protection to account for this variability, we would find that the resulting total estimated cost would be eight times larger than if all protection were provided at the average observed rate. When we take the shares of each pillar in the resulting adjusted total we find them to be: 4 % for direct domestic support, 13 % for export subsidies, and 83 % for tariffs.[15]

2.3 *Second-best effects can alter the welfare contribution of export subsidies*

A feature of the above back-of-the-envelope results, compared with those in Section 3 obtained from CGE models, is the much greater importance of export subsidies relative to market access and domestic support barriers. This is due to the ability of CGE models to take into account second-best welfare interactions that we cannot easily include in back-of-the-envelope calculus. World trade is greatly reduced by a wide range of distortions, almost all of which diminish trade. Export subsidies, by contrast, increase trade. When, for instance, an importing country

14 This ignores the cross-product terms that may be important (see Martin, 1997), but can only be adequately accounted for in a complete model as in Section 3 below.

15 The welfare share contribution of each of these three pillars is remarkably consistent even when production or value added weights are applied to compute the variances of these policies, changing by less than one-twentieth.

with a tariff is induced to purchase more inputs by the provision of another country's export subsidy, each additional unit of imports inside the importing country costs less than it would in the absence of that export subsidy. This suggests we should expect a global CGE model's estimate of the contribution of import market access restrictions to the welfare cost of agricultural policies to be somewhat above 83 %, the lowest of the above back-of-the-envelope estimates.

3. Relative importance of the three pillars in the GTAP Model's estimate of their impact on global economic welfare, agricultural trade, and net farm incomes

How do those expectations compare with model-based estimates of the three pillars' relative contributions to the global welfare cost of current agricultural distortions? The Diao, Somwaru, and Roe (2001: 37) study provides estimates that imply an 89 % share of the total costs for import tariff market access, 10 % for domestic support, and 1 % for export subsidies, while the estimates from the World Bank's recent analysis reported in Anderson and Martin (2005), drawing on results in Hertel and Keeney (2006) using their GTAP-AGR Model, are 93, 5, and 2 %, respectively.[16] These results have been replicated and added to by Anderson and Valenzuela (2007), who also find that the cost to non-OECD country welfare is even more heavily dependent on market access barriers than is the global cost, because export subsidies are only prominent in OECD countries and contribute to the welfare of non-OECD countries by lowering the price of their food imports. These results are summarized in the first three rows of Table 4.

The middle row of Table 4 shows that import barriers have a far more important impact than do subsidies on global agricultural trade as well, accounting for 85 % of the trade-reducing impact of the three measures. Domestic support measures explain the rest, apart from a small contribution of the opposite sign by export subsidies. Freeing all merchandise trade would raise the share of agricultural production that is traded internationally by one-fifth globally (from 9.6 to 11.7 %), and by almost one-third for developing countries (from 7.7 to 10.2 %), according to the GTAP-AGR Model used here (Anderson and Valenzuela, 2007).

Finally, what impact do those distortions have on net farm incomes (agricultural value added) in OECD and developing countries? Again using the GTAP-AGR Model, Anderson and Valenzuela (2007) estimate that the contribution of tariffs still dominates subsidies, but only just (54 % – see bottom rows of Table 4). The reason that removal of domestic support would make so much

16 This 5 % relative contribution to global welfare corresponds to an upper bound estimate, as the GTAP database does not differentiate non-coupled to production payments, and the GTAP Model partially restricts the use of land in alternative agricultural uses (see Dimaranan and McDougall, 2006; Keeney and Hertel, 2005).

Table 4. GTAP-AGR Model calculations of the impact of agricultural and food subsidies and tariffs on global economic welfare, agricultural trade and net farm incomes, by region and policy instrument, 2001 (percent)

	Agricultural liberalization component									
	OECD countries' liberalization of			Non-OECD countries' liberalization of			All countries' liberalization of			
	Domestic support	Export subsidies	Import market access	Domestic support	Export subsidies	Import market access	Domestic support	Export subsidies	Import market access	All measures
Contribution to economic welfare (equivalent variation in income)										
OECD countries	6	5	78	0.2	−0.1	11	6	5	89	100
Non-OECD countries	2	−10	84	−0.8	0.2	25	1	−10	109	100
World	**5**	**2**	**79**	**−0.1**	**0.0**	**14**	**5**	**2**	**93**	**100**
Contribution to world agricultural trade (by value)	**15**	**−2**	55	**2**	**−0**	**30**	**17**	**−2**	**85**	**100**
Contribution to net farm incomes (agricultural value added)										
% loss OECD countries	45	3	55	−1	−0.1	−2	44	3	53	100
% gain Non-OECD countries	54	10	120	−16	−0.3	−68	38	10	52	100
(% loss)World[a]	**42**	**−0.3**	**31**	**4**	**0**	**23**	**46**	**−0.3**	**54**	**100**

Notes: [a] There is an estimated global decrease in net farm income (or agricultural value added) of 6% as a result of removing agricultural and food subsidies globally, comprising an average loss of 22% in OECD countries and an average gain of 4% in non-OECD countries.
Source: Authors' calculations drawing on Anderson and Valenzuela (2007).

more of a contribution to net farm income than to global welfare is because a non-trivial part of the effects of distortions on welfare and trade comes from the consumer side of the market, and that is absent in the case of domestic support measures.[17]

Given that it is farm and agri-business lobbying pressures that dominate agricultural trade negotiations, this greater importance of subsidies to non-OECD farmers helps explain the strong emphasis by developing countries on subsidy cuts even though, as a net food-importing group, they would lose from export subsidy removal. A further part of the explanation is that developing country governments, knowing that they are less capable of financing farm subsidies than are rich countries, are unwilling to suffer the political pain of being more disciplined in their countries' use of agricultural tariffs, unless rich countries also are more-strictly disciplined in their use of subsidies.

4. Conclusion

The above results on the relative importance of market access, domestic support, and export subsidies as sources of global economic costs of agricultural protection are important to understand, because they can influence the weight of effort trade negotiators put into liberalizing the three 'pillars'. The intuition behind the model results is straightforward. Agricultural market access barriers are much more important than domestic subsidies because: (i) the amounts of support provided through market access barriers – to agriculture and to processed food – in developed (and even more so in developing) countries are much greater than the supports provided through subsidies; (ii) trade barriers distort both production and consumption whereas domestic support only distorts production (and less so the more those measures are decoupled); and (iii) market access barriers vary much more across countries and commodities, and hence generate larger costs, than do domestic support measures.

These results point to the importance of ensuring that market access is high on the Doha Development Agenda's agricultural negotiations.[18] Recall, though, that the GTAP database does not include the tariff equivalent of non-tariff import restrictions such as technical barriers to trade. That means market access is even more important than the above model results imply, but it also means improving access requires not only tariff cuts but also stronger disciplines on non-tariff import

17 The relative impact of the three measures on net farm incomes differs across commodity and country groups, but Anderson and Valenzuela (2007) show that for each of the main farm product groups market access dominates. An important exception is the case of cotton, for which almost 90% of the global welfare cost of trade-distorting policies is due to domestic subsidies (Anderson and Valenzuela, 2006).

18 This echoes the more-general point made by Snape (1987, 1991) that if multilateral trade negotiators focus just on reducing border measures, domestic subsidies will generally be of minor significance to trade because of their dependence on explicit treasury outlays that are subject to annual budget scrutiny.

restrictions. If the DDA can at least result in a lowering of bound agricultural tariffs down to or below applied rates, that will provide a much stronger base from which to seek a lowering of non-tariff barriers in the future.

Finally, it should be stressed that none of this analysis suggests disciplining and reducing agricultural subsidies is unimportant. To the contrary, that discipline and reform are essential, for several reasons. First, export subsidies have been banned in the GATT for decades apart from the exception for farm products, so bringing agriculture into conformity with that rule is important for systemic reasons but also so as never to have a repeat of the farm export subsidy war that took place across the North Atlantic in the mid-1980s. Second, for some products – most notably cotton (Anderson and Valenzuela, 2006) – subsidies are indeed dominant and so it will be helpful (including through reducing demands on the WTO's Dispute Settlement system) if reform in such product markets is captured in the Doha negotiations. Third, there is always the risk that negotiated tariff cuts would be accompanied by policy re-instrumentation, which could include reverting to subsidies. While trade measures may be more trade-distorting than a similar rate of production subsidy (since they also have a consumption-tax component), if domestic supports were not disciplined there is the risk that a higher rate of subsidy could be used. And fourth, from a political economy viewpoint, in the Doha negotiations it has already been agreed that export subsidies should be phased out, so cuts to domestic subsidies would be necessary for the United States to share with the European Union the political and adjustment 'pain' of reducing agricultural distortions globally (since the EU has a much higher dependence on trade measures for supporting farm incomes than does the US).

References

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 D. van der Mensbrugghe (2006), 'Market and Welfare Implications of Doha Reform Scenarios', in K. Anderson and W. Martin (eds.), *Agricultural Trade Reform and the Doha Development Agenda*, London: Palgrave Macmillan and Washington, DC: World Bank, Chapter 12.

Anderson, K. and E. Valenzuela (2007), 'Do Global Trade Distortions Still Harm Developing Country Farmers?', *Review of World Economics*, **143** (forthcoming).

—— (2006), 'The WTO's Doha Cotton Initiative: A Tale of Two Issues', Policy Research Working Paper 3918, World Bank, Washington, DC, May.

Corden, W. M. (1971), *The Theory of Protection*, Oxford: Clarendon Press.

Diakosavvas, D. (2002), 'How to Measure the Level of Agricultural Support: Comparison of the Methodologies Applied by OECD and WTO', Paper presented at the Workshop on Agricultural Policy Adjustments in China after WTO Accession, Beijing, 30–31 May.

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

Dimaranan, B. V. and R. A. McDougall (eds.) (2006), 'Global Trade, Assistance, and Production: The GTAP 6 Data Base', Center for Global Trade Analysis, Purdue University. Downloadable at www.gtap.agecon.purdue.edu/databases/v6/v6_doco.asp

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.), *Agricultural Trade Reform and the Doha Development Agenda*, London: Palgrave Macmillan and Washington DC: World Bank, Chapter 2.

Hoekman, B., F. Ng, and M. Olarreaga (2004), 'Agricultural Tariffs versus Subsidies: What's More Important for Developing Countries?', *World Bank Economic Review*, **18**(2): 175–204.

Huff, K. and T. Hertel (2000), 'Decomposing Welfare Changes in the GTAP Model', GTAP Technical Paper No. 5, Center for Global Trade Analysis, Purdue University, West Lafayette.

Kee, H. L., A. Nicita, and M. Olarreaga (2006), 'Estimating Trade Restrictiveness Indices', Policy Research Working Paper No. 3840, World Bank, Washington, DC, February.

Keeney, R. (2005), 'Decoupling and the WTO: Farm Sector and Household Impacts in the United States', unpublished Ph.D. dissertation, Purdue University, West Lafayette.

Keeney, R. and T. Hertel (2005), 'GTAP-AGR: A Framework for Assessing the Implications of Multilateral Changes in Agricultural Policies', GTAP Technical Paper No. 24, Center for Global Trade Analysis, Purdue University, West Lafayette.

Martin, W. (1997), 'Measuring Welfare Changes with Distortions', in Francois and K. Reinert (eds.), *Applied Methods for Trade Policy Analysis*, Cambridge: Cambridge University Press.

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

—— (2005), *Agricultural Policies in OECD Countries: Monitoring and Evaluation*, Paris: OECD.

Snape, R. H. (1987), 'The Importance of Frontier Barriers', in H. Kierzkowski, *Protection and Competition in International Trade: Essays in Honour of W. M. Corden*, Oxford: Basil Blackwell, Chapter 15.

—— (1991), 'The International Regulation of Subsidies', *The World Economy*, **14**(2): 139–164.

World Bank (2005), *Global Monitoring Report 2005*, Washington DC: World Bank.

Appendix: Sensitivity analysis of results to choices of elasticities in the back-of-the-envelope and GTAP-AGR Models

All model results are dependent on the choices of model parameters, and this applies as much to the simplest of demand/supply models as to the most sophisticated CGE models. In this appendix we show how the key results on the relative importance of the '3 pillars' vary as we alter the domestic demand and supply elasticities in our back-of-the-envelope model and the supply and trade elasticities (and hence implicitly the domestic demand elasticities) in the GTAP-AGR Model.

The results in Table 3, based on unitary price elasticities of domestic demand and supply, are reproduced in the middle of Appendix Table A, alongside which are the results when those elasticities are 50 % higher or lower. While those large elasticity changes cause large differences to the welfare effects in dollar terms, they make almost no difference to the relative contribution of import market access barriers, which ranges from 84 to 89 %.

The results in Table 4, based on the medium-run elasticities in the GTAP-AGR Model developed by Keeney and Hertel (2005), are reproduced in row 1 of Appendix Table B, below which are the results when the trade elasticities are increased by one-third (bringing them roughly into line with those in the World Bank's LINKAGE Model – see Anderson, Martin, and van der Mensbrugghe, 2006, Appendix Table 12A.2) and/or when the implicit supply elasticities in the GTAP-AGR Model are doubled. Again these changes have very little impact on the relative contribution of import market access barriers, which ranges from 92 to 95 %.

Appendix Table A. Sensitivity analysis of the back-of-the-envelope results with respect to domestic demand and supply elasticities, 2001

		Supply elasticity		
		0.5	**1.0**	**1.5**
(a) Contribution to global economic welfare (in $US billion)				
Demand elasticity	**0.5**	65	101	137
	1.0	93	**129**	165
	1.5	122	158	194
(b) Share of global welfare due to import market access (%)				
Demand elasticity	**0.5**	86	85	84
	1.0	88	**86**	85
	1.5	89	87	86

Source: Authors' calculations.

Appendix Table B. Sensitivity analysis of CGE results using the GTAP-AGR Model with respect to trade and supply elasticities, 2001 (percent)

	Agricultural liberalization component									
	OECD countries' liberalization of:			Non-OECD countries' liberalization of:			All countries' liberalization of			
	Domestic support	Export subsidies	Import market access	Domestic support	Export subsidies	Import market access	Domestic support	Export subsidies	Import market access	All measures
Contribution to global economic welfare										
(equivalent variation in income) using:										
GTAP-AGR original parameters	5	2	79	0	0	14	5	2	93	100
Trade (Armington) elast. increased by 33 %	4	1	81	0	0	14	4	1	95	100
Supply elasticities increased by 100 %	6	2	78	0	0	14	6	2	92	100
Both trade and supply elasticities increased as above	5	1	80	0	0	14	5	1	94	100

Source: Authors' calculations drawing on Anderson and Valenzuela (2006a).