Formulas and Flexibility in Trade Negotiations: Sensitive Agricultural Products in the World Trade Organization's Doha Agenda

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Many trade negotiations involve large cuts in high tariffs, while allowing smaller cuts for an agreed share of politically sensitive products. The effects of these flexibilities on market access opportunities are difficult to predict, creating particular problems for developing countries in assessing whether to support a proposed trade agreement. Some widely used ad hoc approaches for identifying likely sensitive products—such as the highest-bound-tariff rule—suggest that the impact of a limited number of such exceptions on average tariffs and market access is likely to be minor. Applying a rigorous specification based on the apparent objectives of policymakers in setting the prenegotiation tariff enables more accurate assessment of the implications of sensitive-product provisions for average agricultural tariffs, economic welfare, and market access under the Doha negotiations. The analysis concludes that highest-tariff rules are likely to seriously underestimate the impacts on average tariffs and that treating even 2 percent of tariff lines as sensitive is likely to have a sharply adverse impact on economic welfare. The impacts on market access are also adverse, but much smaller, perhaps reflecting the mercantilist focus of the negotiating process. JEL codes: C8, F13, F17, Q17

In recent years, trade negotiations involving developing countries have commonly used a formula approach to tariff cutting, coupled with provisions for smaller, or zero, cuts for certain products. This approach follows that of earlier multilateral negotiations (Martin and Winters 1996) and regional agreements (Olarreaga and Soloaga 1998) that combined ambitious tariff reduction goals with discretion on some politically sensitive products. One difference is that the specific products to be subjected to smaller cuts were typically directly

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negotiated in earlier agreements. By contrast, the Doha agenda "modalities" for agriculture specify the share of products allowed smaller cuts, while leaving the choice of products to the importer's discretion.

The WTO agricultural negotiations use a "tiered" formula with larger proportional cuts in higher bound tariffs while allowing, as exceptions, smaller cuts for "sensitive" products selected by members (WTO 2004, 2008). Earlier work suggests that this approach may erode market access gains by allowing smaller cuts in a small number of products with high tariffs, particularly in industrial countries, where the variance of agricultural tariffs is very high (Jean, Laborde and Martin 2006).

While individual policymakers are able to reduce the political costs of the negotiated outcome through discretionary smaller cuts on sensitive products, this approach raises difficult questions for ex ante evaluations of proposed agreements, especially for policymakers in small developing countries. While large trading countries may have the resources to estimate reasonably well the direct impact of key partners' choices on their market access, small developing countries have difficulty doing so. And both groups are vulnerable to importers changing their choice of products at the last moment. Analysts attempting to provide policymakers with ex ante assessments of proposed global agreements face a difficult challenge—they need a consistent basis for assessing the use of these flexibilities in more than 150 WTO member countries.

One widely used approach is to assume that flexibility will be used to shelter the highest bound tariffs (Sharma 2006) or applied tariffs (WTO 2006) from cuts. This approach leads to the conclusion that flexibilities will have only small impacts on cuts in average tariffs. There are two broad reasons to question this conclusion. The first is that this approach ignores the importance of the product—high tariffs are frequently observed on products that are minor in consumption and trade. Would policymakers use their limited number of exceptions to shelter unimportant products? The second reason relates to the variable, and frequently large, gaps between bound and applied agricultural tariffs. Even large cuts in many high bound tariffs would require no cuts or only small cuts in applied rates if the binding overhang on these products is sufficiently large. Would products with high bound tariffs be selected if the bound rate remains above the applied rate even after the bound rate is cut?

To deal with these concerns, Jean, Laborde and Martin (2006) proposed an alternative approach to ex ante assessment of the implications of tariff reforms—a minimization-of-tariff-revenue-loss approach that takes into account the size of the cut in applied tariffs resulting from the formula for bound tariffs, the binding overhang on each product, and the initial value of imports. This approach leads to the strikingly different conclusion that flexibility for even a small number of sensitive products can dramatically reduce the cuts in average agricultural tariffs.

Estimating the effects of flexibilities requires forecasting the products likely to be chosen and then estimating the effects of these choices on efficiency and

market access. To do that, this article develops a simple model, well grounded in theory, for policymaker preferences and uses it to assess which agricultural products WTO members are likely to treat as sensitive. The approach focuses on policy choices within a single country, building on the framework developed by Grossman and Helpman (1994) and others in the political-economy literature. It provides a much needed ex ante assessment of the impact of policy choices on market access and welfare and a basis for ex post testing should the current negotiations be successfully completed.

An important question for negotiations is whether the combination of ambitious tariff-cutting formulas with flexibilities allowing small cuts on relatively high tariffs makes sense from economic or mercantilist perspectives. To shed light on this issue, an Anderson-Neary (2007) approach, applying the most disaggregated data available at the international level, is used to assess the implications of flexibility for welfare and market access.

The agricultural tariff prior to the negotiations is assumed to result from maximization of a government objective function along the lines of the Grossman-Helpman (1994) model. This approach seems appropriate for agricultural tariffs in the current negotiations because those tariffs have not been effectively disciplined by multilateral agreements (Hathaway and Ingco 1996). The analysis considers a liberalization agreement involving a tariff-reduction formula that includes flexibility for sensitive products; it focuses on how policymakers use this flexibility at any given level of world prices. The combined effect of the decisions by all members leads to changes in domestic and international prices that members must take into account in deciding whether to accept the agreement. It is at this point that changes in world prices are taken into account and countries decide whether the terms of trade gains accruing to them from the negotiations justify the political pain associated with lowering their own trade barriers.

The first step, in section I, is to develop an objective function for government policymaking and to use it to assess the implications of changes in tariffs on policymakers' welfare. Section II details the data and tariff-cutting formulas on which the analysis is based. Section III contains applications to real world data designed to assess the likely outcomes for average tariffs, provide comparisons with earlier approaches, and examine the sensitivity of outcomes to different rules for sensitive products. Section IV examines the implications of sensitive products for economic welfare in the country using the flexibility provisions and for the market access opportunities of partner countries.

I. Representing Policy Objectives and Identifying Sensitive Products

The first step is to specify an objective function for policymakers that takes into account the benefits to politicians from protecting particular sectors and the costs to consumers and taxpayers of providing this protection. Like

Grossman and Helpman (1994, equation 5), it is assumed that this political-economy objective function can be expressed as a weighted sum of lobbying "contributions" by interest groups and of a social welfare function reflecting the net economic costs imposed on producers and consumers. The analysis departs from their specification in two respects. First, for simplicity, contributions from interest groups are assumed to be at least locally linear in prices.[1] Second, an Anderson and Neary (1992) balance of trade function, with the effects of price changes on the cost of living represented through an expenditure function rather than through consumer surplus, is used to account for aggregate welfare.

The political-economy objective function is a short-run version of the political-economy welfare functions developed in Jean, Laborde, and Martin (2010b):

$$G(\mathbf{p}, u^0) = \mathbf{h}'\mathbf{p} - B(\mathbf{p}, u^0) = \mathbf{h}'\mathbf{p} - z(\mathbf{p}, u^0) + \mathbf{z_p}'(\mathbf{p} - \mathbf{p}^*) \tag{1}$$

where $z(\mathbf{p}, u^0) = e(\mathbf{p}, u^0) - g(\mathbf{p})$ is the trade expenditure function, defined as the difference between the consumer expenditure function $e(\mathbf{p}, u^0)$ defined over domestic prices $\mathbf{p}$ and the exogenously fixed utility level of the representative household u^0 and a net revenue function $g(\mathbf{p})$, defined over domestic prices for given factor endowments; $\mathbf{p}^*$ is the vector of world prices for traded goods; $(\mathbf{p}-\mathbf{p}^*)$ is a vector of specific tariffs; $\mathbf{z_p} = \mathbf{e_p} - \mathbf{g_p}$ is a vector of net imports; $\mathbf{z_p}(\mathbf{p}, u^0)'(\mathbf{p}-\mathbf{p}^*)$ is tariff revenues, assumed to be redistributed to the household; and the elements of $\mathbf{h}$ reflect the valuation by governments of changes in domestic prices, over and above their impact on general economic welfare. Changes in the negative of the balance of trade function, $-B(\mathbf{p}, u^0) = -z(\mathbf{p}, u^0) + \mathbf{z_p}'(\mathbf{p}-\mathbf{p}^*)$, represent the changes in income from production plus trade tax revenues plus consumer surplus measured by W in Grossman and Helpman's equation (5). Because u^0 is used in the current analysis, the initial value of B is zero for a country with a zero initial balance of trade, but its value changes as non-numeraire elements of $\mathbf{p}$ change relative to $\mathbf{p}^*$, altering the cost of economic distortions and hence the amount of compensation from the rest of the world needed to maintain the initial utility level.

Like Grossman and Helpman (1994, proposition 2) and virtually all subsequent applications based on this model, importers and governments are assumed to view import prices as fixed, so that changing tariffs from their initial level involves a reduction in the value of the government's objective function. This seems reasonable for individual governments choosing their own protection levels for relatively homogeneous agricultural products considering that estimated export supply elasticities are five times as high for homogeneous goods as for other products (Broda, Limão, and Weinstein 2008, p. 2033). It

1. A presentational difference with Grossman and Helpman's (1994) equation 5 is that the analysis here divides the objective function by their positive scalar a. As a consequence, economic welfare has a unitary weight in the political-economy objective function.

also seems consistent with the approach of agricultural policymakers dealing with product-specific issues, such as "tariffication" of nontariff barriers (Hathaway and Ingco 1996).

Following Grossman and Helpman's (1994) model, the first term on the right side of equation (1) reflects contributions from interest groups, assuming these contributions to be linear in prices. In moving beyond this model, the **h** weights may also reflect some political-economy features that influence how much protection a particular agricultural sector will receive, as identified by studies such as Anderson and Hayami (1986), Lindert (1991), Olarreaga and Soloaga (1998), Cadot, de Melo, and Olarreaga (2004), and Dutt and Mitra (2010). Among these features are how effectively the sector is organized, the impact of own-output prices on returns to specific factors in the sector, adverse impacts on the costs to other politically influential groups of protecting a particular sector, the ratio of imports to domestic consumption that determines the balance of benefits between tariff revenues and transfers to producers, and concentration in the sector.

Unlike those studies, this article does not seek to explain the premium policymakers place on higher prices for particular goods. Rather, it uses observed policy choices to infer the elements of **h** for highly disaggregated products. The first order conditions for maximization of policy makers' welfare are:

$$\mathbf{h} = -\mathbf{z}^0_{\mathbf{pp}}(\mathbf{p}^0 - \mathbf{p}^*) \tag{2}$$

where $-\mathbf{z}^0_{\mathbf{pp}}(\mathbf{p}^0-\mathbf{p}^*)$ is the marginal welfare cost of tariff changes around $(\mathbf{p}-\mathbf{p}^*)$, and the superscript 0 refers to values at the initial equilibrium (since world prices are assumed to be constant, $\mathbf{p}^{*0} = \mathbf{p}^*$). Since it is assumed that the political-economy objective function is being maximized in the initial equilibrium, equation (2) allows the value of **h** to be identified. The revealed value of **h** for product i clearly depends on the tariff for the sector. However, h_i also depends on the slope of the demand curve, z_{ii}, and on the cross-price effects with other goods subject to tariffs, z_{ij}. In addition, for any given import demand elasticities, the value of h_i increases with import volume. Note that h_i for a good with a zero tariff will be negative if there are positive tariffs on its substitutes and none on any complements. Sectors that are organized will likely have positive values of h_i, while unorganized sectors are expected to have negative values. Equations (1) and (2) together show the strong link between the approach here and the Grossman-Helpman (1994) formulation.[2]

2. With the model and notation of Grossman and Helpman (1994, equation 15), h_i is given by $\frac{\partial W}{\partial p_j} = (p_j - p_j^*)m_j'$, where W is economic welfare and m_j' is the slope of the import demand function. From their equation (5), h_j equals $\frac{1}{a}\frac{\partial \sum C_i(p_i)}{\partial p_j}$, where a is the value policymakers assign to general economic welfare relative to political contributions and C_j is the contribution schedule of sector i.

Equation (2) allows replacing the unknown **h** vector with potentially observable values, yielding:

$$G = -z(\mathbf{p}, u) + \mathbf{z_p}'(\mathbf{p} - \mathbf{p}^*) - (\mathbf{p}^0 - \mathbf{p}^*)'\mathbf{z}^0_{\mathbf{pp}}\mathbf{p}. \tag{3}$$

A second-order Taylor-Series expansion of equation (3) around the initial equilibrium provides insights into the implications of tariff adjustments that change **p** relative to **p***. Begin by taking the first and second derivatives of equation (3) with respect to prices:

$$\frac{\partial G}{\partial \mathbf{p}} = \mathbf{z_{pp}}(\mathbf{p} - \mathbf{p}^*) - \mathbf{z}^0_{\mathbf{pp}}(\mathbf{p}^0 - \mathbf{p}^*) \text{ and } \frac{\partial^2 G}{\partial \mathbf{p}^2} = \mathbf{z_{pp}} \tag{4}$$

where, following conventional practice, a possible term involving the third derivative of the trade expenditure function **z** has been omitted. This does not impose onerous restrictions on preferences or technology. It is consistent, for example, with fully flexible functional forms—such as the normalized quadratic introduced by Diewert and Ostensoe (1988) or the symmetric normalized quadratic used by Kohli (1993) to model import demand—that provide a second-order approximation at any point to any twice-differentiable functional form, such as the widely used, but much less flexible, constant elasticity of substitution (CES) function.[3] Given this assumption, the implications of deviations in tariffs from the domestic political-economy optimum can be analyzed using the Taylor-Series expansion:

$$\Delta G = \frac{\partial G}{\partial \mathbf{p}}\Delta \mathbf{p} + \frac{1}{2}\Delta \mathbf{p}'\frac{\partial^2 G}{\partial \mathbf{p}^2}\Delta \mathbf{p} = \frac{1}{2}\Delta \mathbf{p}'\mathbf{z_{pp}}\Delta \mathbf{p}. \tag{5}$$

Equation (5) is particularly simple because the initial equilibrium is an optimum from the point of view of the government, and so the first derivative term disappears from the analysis. Because of the concavity of expenditure functions and the convexity of revenue functions in prices, the first-order conditions are certain to correspond to a maximum for policymakers' welfare, and deviations from this point will reduce political-economy welfare. Note that equation (5) contains none of the interactions with existing distortions that complicate calculation of standard welfare effects (see Martin 1997).

The quadratic nature of equation (5) immediately reveals a problem with the tariff-revenue-loss rule of Jean, Laborde, and Martin (2006)—the impact of a reduction in the required tariff cut on the value of the government's objective function will depend nonlinearly not only on the size of the price increase allowed by sensitive product status, but also on the size of the initial cut

3. The quadratic system is flexible to the point that it requires an enormous number of parameters. While the CES has one independent parameter, the quadratic has around 12.5 million for a demand system with the 5,018 products in Revision 1 of the Harmonized System.

required by the formula. Further insights into the effects of particular tariff changes are given in the appendix to the Working Paper version of this article (Jean, Laborde, and Martin 2010a) by rearranging equation (5) into proportional-change form.

The results are presented using three different approaches for identifying sensitive products (developed in detail in the Working Paper). Each uses a second-order approximation based on equation (5) to ensure that G is globally concave in domestic prices. Unfortunately, there are no estimates of the full matrix of own-price and cross-price elasticities at the six-digit level of the harmonized system used for this analysis.[4] For simplicity, and to obtain observable measures of market access and welfare costs based on Anderson and Neary (2007), estimates of the coefficients of the quadratic trade expenditure function were initially generated at the six-digit level of the Harmonized System using a CES function.

The initial approach for identifying sensitive products solves equation (5) simultaneously for the set of sensitive products that minimizes the political-economy welfare loss associated with the permitted combinations of formula cuts and sensitive product exceptions using the Simple Branch and Bound (SBB) GAMS® solver for Mixed Integer Nonlinear Programming (GAMS 2010), with up to 2 percent of products allowed as sensitive. Because the simultaneous identification of sensitive products is likely too complex for policymakers operating in real time, results are also presented for a one–product-at-a-time approach (see the appendix of the Working Paper version; Jean, Laborde, and Martin 2010a). Careful examination of the structure of the problem leads to the conclusion that this approach is likely to yield similar results because of the nature of the weights used. Next, the study verified that the results are similar using the full matrix of elasticities for the CES function and using only the own-price elasticities. Finally, to continue the focus on own-price effects, the individual-product elasticities estimated by Kee, Nicita, and Olarreaga (2008) were used to consider information on differences in the estimated import demand elasticities for particular products.

II. Data and Tariff Formulas

The analysis uses the MAcMapHS6 v1.1 database on applied protection in 2001, the base year for the negotiations (Bouët and others 2008). The dataset includes key features such as the ad valorem equivalents of specific tariffs, an assessment of the impact of tariff-rate quotas on key commodities, tariff preferences, and import values. The analysis is carried out at the six-digit level of the

4. Alternative estimates of import elasticities of substitution provided by Hummels (2001) and Broda and Weinstein (2006) would enable taking cross-price effects into account, but these studies focus on substitution between products from different suppliers rather than on the responses of aggregate imports, the focus here. Kee, Nicita, and Olarreaga (2008) provide estimates of the own-price elasticities needed but not of the cross-price elasticities.

Harmonized System, the finest level at which country classifications are internationally compatible.[5] The protective effect of tariff-rate quotas is represented using the in-quota tariff when the quota is less than 90 percent filled, the out-of-quota tariff when the quota is filled, and their average in between. Adjustments were made for Korean corn and soybeans, because although imports over high out-of-quota tariffs appear to be very large, the tariff-rate quotas are, in fact, expanded to meet demand. A pre-experiment introduced reforms that will proceed irrespective of the Doha outcome, including expansion of the European Union, the phase-in of remaining agricultural commitments by developing countries,[6] and reforms agreed by WTO accession countries.

The negotiations specify cuts in WTO bound tariffs, which are frequently well above applied rates. This binding overhang means that reductions in bound tariffs will not always bring about corresponding reductions in applied rates or increases in market access. A detailed dataset on bound duties conformable with the MAcMapHS6 applied rate data was used to specify the cuts in bound rates (see Bchir and others 2006). Applied rates were reduced only to the extent that the new bound rate was below the initial applied rate.

The analysis uses the tariff cut proposal by the G-20 that has shaped the negotiations—a tiered formula with four bands and three inflexion points (G-20 2005). For industrial countries, this involves proportional cuts in bound tariffs rising through four tiers to reach a 75 percent cut on tariffs above 75 percent. For developing countries, the cuts rise to 40 percent on tariffs above 130 percent. Tariffs are capped at 100 percent for industrial countries and 150 percent for developing countries. Least developed countries are not required to commit to any reductions.

Bound tariffs on sensitive products can be cut by one-third or two-thirds of the formula cut, with increases in tariff-rate quotas to compensate trading partners for the resulting loss of market access (WTO 2008). As in Hufbauer, Schott, and Wong (2010), the combined effect of the tariff cut and tariff-rate quota expansion for a sensitive product with a tariff-rate quota is half the formula cut.

III. Experiments and Impacts on Average Tariffs

The scenario for assessing the impact of sensitive products applies the tiered formulas to all products (Formula column in table 1). First, these results are

5. In an earlier assessment of the impact of flexibilities, Martin and Wang (2004) found little difference between results obtained using tariff-line level data and those using six-digit data for the impacts on overall protection considered in this article. While policymakers undoubtedly view some products at finer levels as strongly differentiated, many countries have notified their tariffs to the WTO at the six-digit level, and few have notified beyond the eight-digit level.

6. Developing countries had 10 years from 1994 to implement their Uruguay Round commitments, as did developed countries for a few products.

TABLE 1. Implications of Sensitive Products for Reductions in Average Applied Agricultural Tariffs (percentage point reduction unless otherwise noted)

Country or group	Base[a] (%)	Formula	Sens 2	Sens 2-simple	Sens 2-elas	Sens 2-highest bound	Sens2-highest applied	Sens 2-tariff losses	Sens 2-sin	Sens 4	Sens 2-trade
Industrial countries	14.9	8.5	4.3	4.4	4.7	6.8	6.8	4.3	4.5	3.8	6.8
Australia	3.1	1.0	0.5	0.5	0.6	0.9	0.8	0.5	0.8	0.5	0.8
Canada	9.8	5.0	1.5	1.5	1.9	3.9	3.9	1.5	1.5	1.0	3.8
European Free Trade Association	28.9	14.2	7.6	7.5	8.9	11.9	11.9	7.5	7.8	6.1	11.0
European Union	13.4	7.5	4.4	4.4	4.4	5.8	5.8	4.4	4.4	4.0	6.3
Japan	35.6	22.4	11.2	11.3	12.2	18.7	18.7	11.0	11.2	9.9	18.0
United States	2.7	0.9	0.4	0.4	0.5	0.7	0.7	0.4	0.4	0.3	0.6
Developing countries	14.2	2.5	1.2	1.3	1.4	1.9	1.8	1.2	1.6	1.1	1.8
Association of Southeast Asian Nations	8.9	2.3	0.8	0.8	1.1	1.2	0.9	0.8	2.2	0.8	1.9
China	10.2	2.7	1.8	1.8	1.9	2.2	2.6	1.8	1.8	1.7	2.5
India	55.4	3.6	1.9	1.9	1.9	3.6	3.4	1.9	2.0	1.8	3.2
Korea	27.7	10.4	4.2	4.6	5.7	7.0	6.8	4.2	4.2	3.6	5.0
Maghreb	19.0	3.3	1.7	1.7	1.8	3.1	2.6	1.7	2.2	1.6	2.8
Mercosur	12.8	0.2	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1
Mexico	9.5	0.9	0.2	0.2	0.2	0.9	0.9	0.2	0.3	0.2	0.8
Other Sub-Saharan Africa	25.3	2.0	0.9	0.9	1.0	1.9	1.1	0.9	1.5	0.8	1.9
Pakistan	31.3	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
South African Customs Union	12.6	0.6	0.3	0.3	0.2	0.5	0.3	0.3	0.3	0.3	0.4
Turkey	14.1	1.1	0.5	0.4	0.6	1.1	1.1	0.4	0.5	0.4	0.6
Rest of world	10.3	1.8	1.0	1.0	1.0	1.2	1.2	1.0	1.4	0.9	1.5
WTO, non–least developed countries	14.6	6.0	3.1	3.1	3.3	4.8	4.7	3.0	3.2	2.7	4.8

a. Weighted average agricultural tariffs in 2001 for non–least developed country World Trade Organization (WTO) members, adjusted for agreed reductions.

Note: Base is 2001 applied tariffs; *Formula* applies the G-20′s tiered formula (TF), without sensitive products (SPs); *Sens 2* is TF with 2 percent SPs, selected simultaneously; *Sens 2-simple* is TF with 2 percent SPs, selected using only own-price effects; *Sens 2-elas* is TF with 2 percent SPs, selected using estimated own-price elasticities of demand; *Sens 2-highest bound* is TF with 2 percent SPs, selected by highest bound rates; *Sens 2-highest applied* is TF with 2 percent SPs, selected by highest applied rates; *Sens 2-tariff losses* is TF with 2 percent SPs, selected to minimize tariff loss; *Sens 2-sin* is Sens 2 TF, with "sin" products excluded from selection; *Sens 4* is 4 percent SPs, selected simultaneously; *Sens 2-trade* is TF with 2 percent SPs, by share of imports.

Source: Authors' analysis based on data from the MacMapHS6 v1.1 database (Bouët and others 2008).

compared with those obtained with 2 percent of products classified as sensitive using simultaneous selection, one-product-at-a-time selection with CES preferences, and one-product-at-a-time selection with estimated elasticities from Kee, Nicita, and Olarreaga (2008). Second, these results are compared with those for the three ad hoc approaches used in earlier studies—highest bound tariff, highest applied tariff, and tariff losses. Third, the results are examined for sensitivity to the inclusion of "sin" products among sensitive products, since these might have high tariffs to discourage consumption rather than to gain political-economy benefits. Fourth, the results are examined for sensitivity to the share of tariffs permitted sensitive treatment. Finally, the analysis considers the implications of an alternative approach of basing the share of sensitive products on the percentage of imports rather than of tariff lines.

Even though the formulas more than halve average bound tariffs worldwide, the reductions in applied rates are smaller because of binding overhang (Formula column in table 1). With no sensitive products, the average tariff for non–least developed country WTO members falls 6 percentage points (from 14.6 percent to 8.6 percent). Of the economies shown in table 1, only Canada, the European Union, the Republic of Korea, the European Free Trade Association (EFTA), and Japan have a 5 percentage point or larger cut in average applied rates. Indeed, liberalization appears to be overwhelmingly concentrated in Japan, EFTA, and Korea, with very limited liberalization elsewhere.[7] For many countries, applied duties hardly change: 8 of the 18 countries and groups shown in table 1 experience a decline in applied duties of less than 2 percentage points. The formula considered narrows the binding overhang in many cases, without substantially changing applied rates.

With 2 percent sensitive products, the cuts in countries' own weighted-average tariffs (Sens 2 column of table 1) lower the reduction in the worldwide average applied duty from 6 percentage points to 3.1. Table 2 displays the sensitive products most frequently selected when equation (A.3) is used to select sensitive products simultaneously. Meat products head the industrial country list, which also includes cheese, wheat, and raw sugar. While sugar and poultry meat are also among the most frequently selected products by developing countries, their list also includes a large number of alcohol and tobacco products (the robustness of the results to excluding these sin commodities is examined below).

Using the one-product-at-a-time approach based on equation (A.4) changes the aggregate results very little (Sens 2-simple). This is reassuring, given that policymakers are unlikely to have algorithms for simultaneous product selection. The results using the own-price elasticities of Kee, Nicita and Olarreaga (2008) in equation (4) are somewhat higher than those for Sens 2-simple (Sens 2-elas),

7. Assessment of tariff-cutting formulas is complicated for Japan and Korea by the existence of large tariff-rate quotas with prohibitive out-of-quota tariffs whose ad valorem equivalent is difficult to gauge. Assessments based on tariffs and observed price differentials were used to compute meaningful ad valorem tariff equivalents for rice in Japan and for rice and corn in Korea.

TABLE 2. Top 12 Agricultural Products Selected as Sensitive by Industrial and Developing Countries

Country group and product rank	Harmonized System code	Product description
Industrial countries		
1	0201 30	Fresh or chilled bovine meat, boneless
2	0202 30	Frozen, boneless meat of bovine animals
3	0207 14	Frozen cuts and edible offal of fowls of the species *Gallus domesticus*
4	0406 90	Cheese
5	0603 10	Fresh cut flowers and flower buds, for bouquets or ornamental purposes
6	0702 00	Tomatoes, fresh or chilled
7	1001 90	Wheat and meslin (excluding durum wheat)
8	1701 11	Raw cane sugar (excluding added flavoring or coloring)
9	2106 90	Food preparations, not elsewhere specified
10	2202 90	Non-alcoholic beverages (excluding water, fruit or vegetable juices, and milk)
11	2204 29	Grape juice (including grape must)
12	2402 20	Cigarettes containing tobacco
Developing countries		
1	2402 20	Cigarettes containing tobacco
2	2208 30	Whiskies
3	2203 00	Beer made from malt
4	1701 99	Cane or beet sugar
5	2204 21	Wine of fresh grapes (including fortified wines in bottles)
6	2208 70	Liqueurs and cordials
7	2208 90	Ethyl alcohol < 80 percent/volume, not denatured; spirits and other spirituous beverages
8	0207 14	Frozen cuts and edible offal of fowls of the species *Gallus domesticus*
9	2403 10	Smoking tobacco
10	2106 90	Food preparations, not elsewhere specified
11	2208 60	Grape juice
12	1006 30	Semi-milled or wholly milled rice, whether or not polished or glazed

Note: Products selected an equal number of times are ranked by Harmonized System code.

Source: Authors' analysis based on data from the MacMapHS6 v1.1 database (Bouët and others 2008).

reflecting the fact that the elasticity criterion used in selecting sensitive products does not enter the calculation of the standard trade-weighted averages.[8]

A key question is how the results here compare with the ad hoc alternatives used in earlier policy analyses. Scenario Sens 2-highest bound uses Sharma's (2006, p. 5) rule of thumb of selecting products with the highest bound tariffs. This approach yields dramatically lower estimates of the impact of sensitive products on applied rates: the cut in the average applied tariff is more than 1 percentage point when sensitive products are selected this way. If products with the highest applied tariffs are chosen as sensitive (Martin and Wang 2004; WTO 2006), the impact on average tariffs is still much smaller (Sens 2-highest applied). These two rules select many minor products with high tariffs. They also ignore the fact that binding overhang may greatly affect the size of the cut in applied rates associated with any given cut in a tariff binding.

Comparing the results for products most frequently selected as sensitive based on the political-economy criterion (equation A.3) with those for products selected using the highest bound or highest applied tariff rules (Jean, Laborde, and Martin 2010a) shows that selecting products based on the highest tariffs frequently leads to the inclusion of minor products. Examples include "foliage branches," "maize stalks," and "garlic" for industrial countries and "other cereals" in developing countries, with shares in agricultural imports of 0.01 percent or less.

A striking difference between the lists is in the share of agricultural imports covered (table 3). The political-economy approach (Sens 2) results in a list that contains 2 percent of tariff lines in each country and that covers 14 percent of agricultural imports into industrial and developing countries. The highest-bound-tariff rule leads to a list of sensitive products covering only 2 percent of agricultural imports into industrial countries and 8 percent into developing countries. And the highest-applied-duty rule results in a list covering 2 percent of agricultural imports into industrial countries and 9 percent into developing countries. The difference is even more striking for tariff revenue: 2 percent sensitive products account for 58 percent of tariff revenue in industrial countries and 26 percent in developing countries with the political-economy approach, 22 percent and 20 percent with the highest-bound-tariff rule, and 22 percent and 30 percent with the

8. As well as the conventional trade-weighted averages, the analysis was conducted using the estimated Trade Restrictiveness Index (TRI) and the Mercantilist Trade Restrictiveness Index (MTRI; Anderson and Neary 2003) following the approach of Kee, Nicita, and Olarreaga (2008). With the TRI, the estimated tariff cuts are slightly larger when the elasticity-based selection criterion is used. In most cases with the MTRI, the tariff cuts are slightly less when using this criterion, an outcome related to the correlation between the aggregator used and components of the selection criterion (trade value, elasticity, and the square of the tariff). The key result—that the tariff cut is greatly reduced when a theoretically consistent approach to product selection is used—proved robust to the choice of aggregator.

TABLE 3. Share of Sensitive Products in Total Agricultural Imports and in Tariff Revenues, for Industrial and Developing Countries

	Industrial countries		Developing countries	
Scenario	Percent of imports	Percent of tariff revenue	Percent of imports	Percent of tariff revenue
Sens 2	14	58	14	26
Sens 2-simple	17	60	15	26
Sens 2-highest bound	2	22	8	20
Sens 2-highest applied	2	22	9	30
Sens 4	17	66	17	30

Note: Sens 2 is tiered formula (TF) with 2 percent sensitive products (SPs), selected according to equation (5); *Sens 2-simple* is TF with 2 percent SPs, selected using only own-price effects from the constant elasticity of substitution function; *Sens 2-highest bound* is TF with 2 percent SPs, selected by highest bound rates; *Sens 2-highest applied* is TF with 2 percent SPs, selected by highest applied rates; *Sens 4* is 4 percent SPs, selected simultaneously. For instance, 14 percent in row 1, column 1, means that if each country selects its sensitive products according to Sens 2 (political-economy criterion with a limit of 2 percent of tariff lines), then sensitive products account for 14 percent of industrial countries' imports.

Source: Authors' analysis based on data from the MacMapHS6 v1.1 database (Bouët and others 2008).

highest-applied-tariff rule. These figures also illustrate the greater importance of any given percentage of sensitive products is greater in industrial countries, with their wider dispersion of tariffs, than in developing countries.

When sensitive products are selected to minimize tariff revenue losses (Sens 2-tariff loss column in table 1), the results at the aggregate level differ little from those using the political-economy approach (Sens 2). At a disaggregated level, some products that seem likely to be treated as sensitive products—such as virgin olive oil for the European Union—are not identified using the tariff-revenue-loss criterion but are picked up using the political-economy approach.

As is clear from table 2, some of the WTO agricultural products selected as sensitive are "sin tax" commodities such as alcohol and cigarettes. If high duties on these products are being used to raise revenues or to reduce externalities, countries may not follow a political-economy rule when choosing these sensitive products. To guard against this, Sens 2-sin is derived using the same approach as Sens 2 but excluding sin commodities such as alcohol and tobacco from the sensitive product category. This exclusion leads to cuts in average tariffs similar to those without this exclusion. The cut with this exclusion increases from 4.3 percent to 4.5 percent in the industrial countries and from 1.2 percent to 1.6 percent in developing countries. This exclusion does change the composition of the products selected. Meat and fish preparations and dairy products become more important in industrial countries, while dairy products, fruits, meats, and fats become more important in developing countries.

Although the analysis so far has focused on allowing flexibility for 2 percent of tariff lines, many WTO members have sought much higher percentages.[9] Raising the share of sensitive products to 4 percent (Sens 4) using the political-economy criterion in equation (3) has only a small impact, except in a few cases such as EFTA and Japan. Overall, the extent of delivered liberalization improves only slightly, because sheltering even 2 percent of products is enough to greatly reduce the cut in average tariffs. This diagnostic is confirmed by the shares of sensitive products in imports and tariff revenue (table 3, last row): doubling the share of sensitive products raises these shares 20 percent or less.

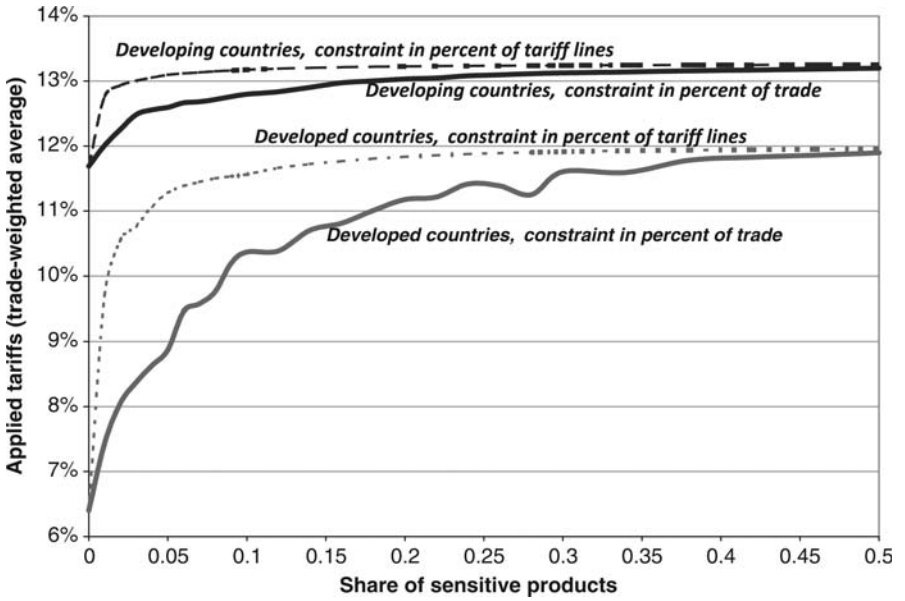
While the agricultural negotiations under the Doha Agenda have focused on restricting the share of sensitive products, some other negotiations have used constraints on the value of trade.[10] To shed light on the differences between constraints based on tariff lines and those based on trade, the results for Sens 2 are compared with those for imports constrained by import value—Sens 2-trade. The differences are considerable. The global reduction in average tariffs is 3.1 percent under Sens 2 and 4.8 percent under Sens 2-trade (see table 1). As compared with the Formula scenario, allowing 2 percent of imports as sensitive products based on trade reduces the decline in world average tariffs from 6.0 percent to 4.8 percent, with limited reductions in the resulting tariff cuts in most cases, in contrast with the dramatic and unpredictable reductions in disciplines associated with sensitive product limits based on tariff lines. Figure 1 illustrates the relationship between the share of sensitive products allowed and the average level of applied protection. When the constraint is expressed as a share of products, the curve is extremely steep near the y axis: a very small share of sensitive products is enough to nullify a large part of the applied tariff cut. This is clearer for developed countries than for developing countries. In contrast, when sensitive products are defined as a share of imports, changes in the share of sensitive products have a far less precipitous impact on tariff cuts. For developed countries, allowing 5 percent of the value of initial imports to be covered by sensitive products reduces tariff cuts by about a third; allowing 10 percent reduces them by almost two-thirds.

While the share of trade is also an imperfect criterion—since imports of highly restricted products are likely to be small—its deficiencies in specifying sensitive products are less serious than those associated with the share of tariff

9. While 2 percent and 4 percent of tariff lines have been the most widely discussed proposals for sensitive products, the EU earlier proposed allowing 8 percent of tariff lines in industrial countries. WTO (2008) would allow developing countries one-third more than industrial countries. In addition, many developing countries have sought flexibility for an additional 20 percent of "special products," which are also subject to criteria such as food and livelihood security.

10. The "substantially all trade" criterion for free trade areas under Article XXIV of the General Agreement on Tariffs and Trade is frequently interpreted as limiting exceptions under these agreements to no more than 10 percent of trade. The Doha negotiations on nonagricultural products restrict flexibilities using both trade and tariff lines.

FIGURE 1. Average Applied Tariffs Resulting from the Application of the Tiered Formula, by Criterion and Threshold Used to Define Sensitive Products



Source: Authors' analysis based on data from the MacMapHS6 v1.1 database (Bouët and others 2008).

lines. There is an important underlying reason for this better performance—external trade reflects the interests of the exporter rather than solely those of interest groups within the importing country.

Table 4 presents results for the tariffs faced by each country corresponding to the scenarios in table 1 for the case of 2 percent sensitive products. For developing countries, the difference in results for tariffs applied and tariffs faced is large. For most developing countries, allowing sensitive products reduces the extent of required own-liberalization very little because the cuts in their applied rates are quite small even in the absence of sensitive products. By contrast, allowing sensitive products results in substantial reductions in market access gains. The average reduction in tariffs facing developing countries declines by almost 3 percentage points—from 5.5 percent to 2.7 percent—when 2 percent of products are able to be treated as sensitive.

IV. IMPLICATIONS FOR WELFARE AND FOR MARKET ACCESS

The average tariff measures reported in tables 1 and 4 provide a broad—and widely understood—indication of the consequences of including flexibilities for economic welfare and for market access. However, the weighted average tariff is a flawed indicator of the efficiency or market access impacts of reform.

TABLE 4. Implications of Sensitive Products for Reductions in Average Agricultural Tariffs Faced (percentage point reduction unless otherwise noted)

Country or group	Base[a] (%)	Formula	Sens 2	Sens 2-simple	Sens 2-elas	Sens 2-highest bound	Sens 2-highest applied	Sens 2-tariff losses
Industrial countries	15.3	6.5	3.4	3.3	3.7	5.6	5.5	3.3
Australia	19.1	9.6	4.4	4.4	4.9	8.1	8.2	4.2
Canada	9.6	4.5	2.0	2.0	2.2	4.3	4.4	2.0
European Free Trade Association	15.6	6.3	4.7	3.5	4.3	5.8	5.3	3.9
European Union	15.7	5.6	3.3	3.3	3.6	4.9	4.9	3.2
Japan	10.5	2.4	1.6	1.6	1.8	2.3	2.3	1.6
United States	16.3	7.5	3.6	3.6	4.0	6.2	6.2	3.6
Developing countries	13.8	5.5	2.7	2.8	2.9	3.8	3.7	2.7
Association of Southeast Asian Nations	20.6	5.9	3.0	3.0	3.3	4.1	4.0	2.8
China	15.6	8.2	3.5	4.0	4.1	4.2	4.0	3.8
India	9.5	3.3	1.6	1.7	1.8	2.0	2.0	1.6
Korea	16.1	6.6	5.0	4.7	5.1	5.6	5.6	4.1
Maghreb	14.0	5.5	2.9	4.7	3.0	5.1	5.1	4.5
Mercosur	13.5	5.0	2.4	2.4	2.5	3.5	3.5	2.4
Mexico	3.8	1.6	0.8	1.0	1.1	1.4	1.4	0.8
Other Sub-Saharan Africa	10.5	5.2	2.3	2.3	2.3	2.8	2.8	2.2
Pakistan	14.3	6.0	3.2	3.2	3.7	4.0	4.0	3.1
South African Customs Union	18.1	7.2	4.5	4.4	4.3	6.3	6.1	4.4
Turkey	9.7	3.1	1.5	1.8	1.6	2.0	2.0	1.8
Rest of world	12.3	5.5	3.0	2.9	3.0	4.5	4.4	2.9
WTO, non–least developed countries	14.6	6.0	3.1	3.1	3.3	4.8	4.7	3.0

a. Weighted average agricultural tariffs in 2001 faced by non–least-developed-country World Trade Organization (WTO) members in WTO markets, adjusted for agreed reductions.

Note: Base is 2001 applied tariffs; *Formula* applies the G-20's tiered formula (TF), without sensitive products (SPs); *Sens 2* is TF with 2 percent SPs, selected according to equation 5; *Sens 2-simple* is TF with 2 percent SPs, selected using only own-price effects from the constant elasticity of substitution function; *Sens 2-elas* is TF with 2 percent SPs, selected using information on own-price elasticities; *Sens 2-highest bound* is TF with 2 percent SPs, selected by highest bound rates; *Sens 2-highest applied* is TF with 2 percent SPs, selected by highest applied rates; *Sens 2-tariff losses* is TF with 2 percent SPs, selected to minimize tariff loss.

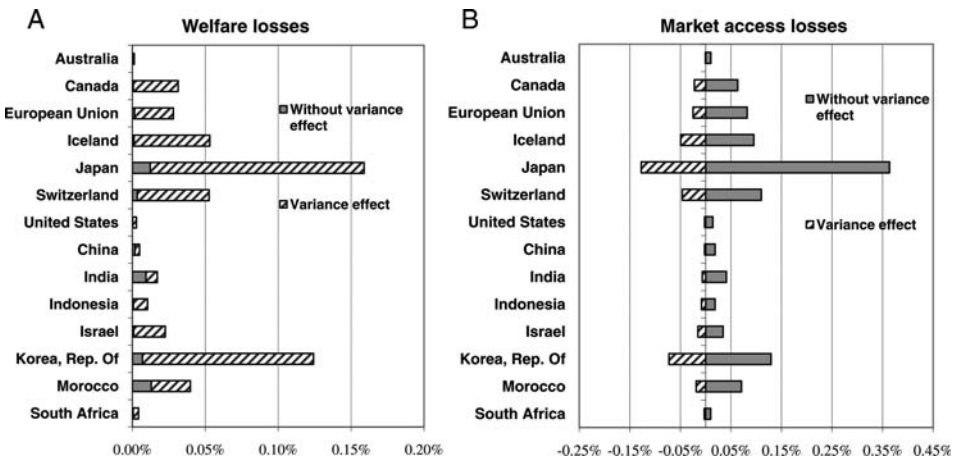
Source: Authors' analysis based on data from the MacMapHS6 v1.1 database (Bouët and others 2008).

Anderson and Neary (2007) propose an integrating treatment of the problems of aggregation and the implications of trade reforms for welfare and market access. Their results provide a rigorous link between the means and variances of tariffs (specifically, generalized means and generalized variances that reflect substitution relationships between goods) and key policy outcomes, including economic welfare and market access. For the special model in which the expenditure function over all goods (domestic and imported) takes the CES form, and domestic and imported goods are imperfect substitutes, the needed measures of the economywide generalized mean and variance can be calculated easily.

Estimates of the generalized means and variances can be used to assess the implications of the flexibilities considered in this article for welfare in the importing countries and for the market access available to their partners. A key finding of Anderson and Neary (2007) is that there are important differences in the impact of an increase in the variability of tariffs on welfare and on market access. Increases in the generalized variance of a tariff regime reduce welfare but will expand market access at a constant generalized mean (Anderson and Neary 2007, equation 16 and equation 17). It seems likely that allowing sensitive products will increase the variance of the trade regime. Policymakers face two questions: Does allowing sensitive products have a less adverse impact on partners' market access than on the welfare of the country using the flexibility, and what are the magnitudes of these impacts?

A key issue is the impact on welfare and market access of changes in the mean and variance of tariffs from allowing sensitive products. In most countries the real income loss due to sensitive products is more a function of the rise in the tariff variance than in the mean tariff (figure 2a). By contrast,

FIGURE 2. Welfare and Market Access Losses from Changes in Generalized Mean and Variance of Tariffs for 2% Sensitive Products



Source: Authors' analysis based on data from the MacMapHS6 v1.1 database (Bouët and others 2008).

the increased tariff variance associated with sensitive products substantially reduces the market-closing impacts of the increase in the mean (figure 2b). These findings are consistent with the demonstration by Kee (2007) and Kee, Nicita, and Olarreaga (2008) that increases in the weighted variance raise the efficiency-oriented Trade Restrictiveness Index without affecting the mercantilist measure of trade restrictiveness. The findings highlight why negotiators in a mercantilist forum like the WTO might choose deep tariff-cutting formulas combined with exceptions—the damage to market access is less than the damage to efficiency.

These results imply that it is important to look beyond averages when analyzing the impact of free trade on efficiency and market access. Reductions in tariffs resulting from the formula approach raise welfare through reductions in both the generalized mean tariff and the generalized variance. These results strongly reinforce the need to go beyond average impacts.

V. Concluding Remarks

Estimating the impact of exceptions from tariff-cutting formulas in the Doha negotiations has generated uncertainty and conflict. Some widely used rules of thumb for selecting the extent of the exceptions suggest only a minor overall impact.

Using approaches to selection based on application of a political-economy framework at a fine level of disaggregation shows that allowing even a limited number of products to be subjected to smaller tariff cuts could substantially reduce the extent of trade liberalization in industrial countries and yield little gain for developing countries in this mercantilist sense. The costs to exporters are shared, and developing countries see their market access gains fall substantially with exceptions for sensitive products.

Approaches to identifying sensitive products based only on the tariff level greatly underestimate the impact. A simple approach using readily available information on the share of sensitive products at domestic prices, the depth of the formula cut, and the "relief" provided by flexibility generates impacts consistent with more complex models. The tariff-revenue-loss criterion used in earlier work appears to track closely the overall impact of the full model results.

Allowing a certain share of tariff lines to be declared sensitive product exceptions does not take into account the importance of these tariff lines to the exporter. However, if sensitive products are instead limited by their share in total imports, the damage to market access is dramatically reduced.

In addition, since these exceptions increase the variance of tariffs relative to the formula outcome, the effects on economic welfare are much worse than the effects on market access. In this sense, the combination of steeply progressive tariff formulas and exceptions may be more rational from a mercantilist point of view than from an economic welfare or development perspective.

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