Welfare Effects of Tariff Reduction Formulas

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Abstract

WTO negotiations rely on tariff reduction formulas. It has been argued that formula approaches are of increasing importance in trade talks, because of the large number of countries involved, the wider dispersion in initial tariffs (e.g. tariff peaks) and gaps between bound and applied tariff rates. This paper presents a two country intra-industry trade model with heterogeneous firms subject to high and low tariffs. We examine the welfare effects of applying three different tariff reduction formulas proposed in the literature i) a proportional cut, ii) the Swiss formula and iii) a compression formula. No single formula dominates for all conditions. The ranking of the three tools depends on the degree of product differentiation in the industry, and the achieved reduction in the average tariff.

JEL: F12, F13, F15
Key Words: Welfare; monopolistic competition; intra-industry trade; WTO trade liberalization; formula approaches

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1 Introduction

WTO negotiations aim to reduce overall tariff levels and to increase market access. A longstanding policy objective of these negotiations has been to ensure a balanced exchange of concessions and a greater reduction of high tariff barriers than lower barriers, thus reducing the dispersion of tariffs. Tariff reduction formulas have been one of the main tools for achieving these goals. A formula means literally a simple mathematical rule for the conversion of pre-negotiation tariffs into new post-negotiation tariffs. The idea is that, given a broadly accepted formula for reducing trade restrictions in various sectors, the commitment of the countries involved in the negotiations can better be determined. Moreover, the likelihood of success increases with formula approaches compared to the situation with discretion in determining the protection level in different sectors and for different products (Francois and Martin (2003)). It has been argued that formula approaches will be needed even more in current and future negotiations in order to secure success, because of the large number of countries involved in the negotiations, the wider dispersion in initial tariffs (e.g. tariff peaks) and the gaps between bound and applied tariff rates.

Different formulas have been proposed in different GATT/WTO negotiation rounds. The literature has described and analyzed the various formulas and their characteristics (see e.g. Francois and Martin (2003) and Laird et al. (2003)). However, thus far the effects of these formulas have not been examined within the framework of an international trade model. On the other hand, international trade theory and intra-industry trade models in particular have thoroughly analyzed the welfare effects of reducing tariffs and comparing different types of tariffs and other forms of trade barriers such as quotas, real trade costs, technical barriers etc., see e.g. Gros (1987), Markusen and Venables (1988), Helpman and Krugman (1989), Lockwood and Wong (2000), and Jørgensen and Schröder (2005), but never directly connected to a formula approach. However, Kowalczyk (2002) analyzes tariff reforms in an international trade model. The analysis is not directly connected to the formula approaches discussed here, but looks at the reform of ad valorem tariffs and subsidies and applies a set-up different from ours.

The present paper examines the welfare effects of using different formulas to achieve a given reduction in the average tariff. We build a simple intra-industry trade model and use numerical simulations to show the welfare rankings of different tariff reduction formulas. The proposed model is a symmetric two-county Krugman-type (1980) intra-industry trade model, with firm level heterogeneous fixed costs of exporting as in Schmitt and Yu (2001). In this model, not all firms trade in equilibrium. Furthermore, we introduce two tariff levels, i.e. products with high and low tariffs. This enables us to examine different scenarios for the initial tariff dispersion, such as tariff peaks. In this model, the entry, exit and scale decisions of firms regarding both home market and exporting activities depend on the initial tariff structure, the degree of trade liberalization, the degree of product differentiation in the industry, and the tariff reduction formula applied. We analyze three different formulas that have been proposed in various GATT/WTO negotiation rounds to govern a reduction in the average tariff. We examine i) the proportional cut formula used in the Kennedy Round, ii) the Swiss formula, which was accepted in the Tokyo Round, and finally iii) the EU compression mechanism, which was proposed by the EU in the Doha Round, each time examining the impact on welfare when liberalizing trade with a given formula.

It is found that reductions in the trade restriction using the three formulas have a positive impact on welfare. We show that the ranking of the three different conversion formulas in terms of welfare depends on the degree of trade liberalization and the degree of product differentiation. However, the initial tariff structure – i.e. the initial degree of tariff dispersion/peaks – has no qualitative influence on the welfare ranking of the three tools. In particular, we show that the ranking of the Swiss formula and the proportional cut depends on the industry structure, so that for differentiated industries, the Swiss formula welfare dominates the proportional cut, while for more homogeneous industries, the proportional cut welfare dominates the Swiss formula. This result holds for all levels of trade liberalization. The ranking of the EU compression mechanism is more complex as it depends both on the industry structure and on the level of trade liberalization. In situations with only small reductions in the average tariff, the EU compression formula welfare dominates (is welfare dominated by) both the Swiss formula and the proportional cut for highly differentiated industries (homogeneous industries); and vise versa for large reductions in trade barriers.

The next section presents a two-country symmetric monopolistic competition intra-industry trade model with firm heterogeneous fixed costs when exporting. The three formula approaches are also introduced. In Section 3 we show the simulations and welfare results when liberalizing trade through tariff reduction formulas. Section 4 concludes.

2 The Model

The starting point of this model is the application of the Chamberlinian monopolistic competition model to international trade, developed by Krugman

(1980). However, we allow for firm heterogeneity with respect to exporting costs as in Schmitt and Yu (2001). In particular, it is assumed that the world consists of two symmetric countries. Firms are producing in the same industry; hence, there is intra-industry trade. Market conditions are described by monopolistic competition, increasing returns to scale in production and differentiated goods. The industry has a large number of potential variants, which enter symmetrically into demand. Variants at home and abroad are different. However, not all firms will trade due the the differences in exporting costs. Consumers' preferences are identical and there is a demand for both domestic and foreign products. As the two countries are identical, we concentrate on the specifications for the home country throughout the analysis. Foreign variables are indicated by a $*$. Adopting the utility function of Schmitt and Yu (2001) with the extension that imported goods are subject to either low or high tariffs, we have utility of each consumer given by:

$$U = \sum_{i_d=1}^{M_d} {c_{d,i_d}}^{\theta} + \sum_{i_t=1}^{M_t} {c_{t,i_t}}^{\theta} + \sum_{i_l^*=1}^{M_l} {c_{l,i_l^*}}^{\theta} + \sum_{i_h^*=1}^{M_h} {c_{h,i_h^*}}^{\theta} \ , \tag{1}$$

where $0 < \theta < 1$ and c_{d,i_d} is consumption of variant i_d of non-exported domestic products, c_{t,i_t} is consumption of variant i_t of the exported domestic products, c_{l,i_l^*} is consumption of variant i_l^* of imported low-tariff products, and c_{h,i_h^*} is consumption of variant i_h^* of imported high-tariff products[1]. The number of variants actually produced (n_d, n_t, n_l and n_h) is assumed to be large, although smaller than M_d, M_t, M_l and M_h.

On the supply side, we assume that there exists only one factor of production: labor. Firms can produce their specific variant for the home market alone or for both the home and foreign market. The decision to export is a firm-endogenous decision where some but not all firms will export. Each firm produces with the same type of cost function. However, the exporting costs of firms are heterogeneous. A cost function for a firm that only sells on the domestic market is given by $l = \alpha + \beta x_d$ and for a firm that both sells on the domestic market and is engaged in export activity is given by $l = \alpha + a_i + \beta(x_t + x_z)$, where l is labor used in production, x_d is production of a non-exporting firm for home market, x_t is production of an exporting firm for the home market, and $x_z, z = l, h$ is production of an exporting firm for the foreign market depending on whether the product is subject to low or high tariffs. To produce any differentiated good, labor is required to cover fixed costs α and constant marginal costs β. Furthermore, if the firm exports, then additional firm-specific fixed costs a_i are incurred, which results

[1] Since all goods enter symmetrically and since all firms behave identically within the two categories trading and non-trading, we can omit subscript i when unnecessary.

in heterogeneous firms. Labor requirements are converted into nominal costs by multiplying by the wage rate w.

We assume that all domestic firms are born with some firm-specific a_i and that a_i is distributed uniformly on $[0, \alpha]$. $F(x) = x/\alpha$ is the distribution function with $F(0) = 0$ and $F(\alpha) = 1$. There will be two types of firms: trading and non-trading firms. There will be a certain level of exporting cost determined endogenously in the model that divides the firms into trading and non-trading firms. Firms with higher exporting costs will not find it profitable to export and will stay out of the foreign market. On the other hand, firms with lower exporting costs will export and make a profit.

Not only do firms have to incur exporting costs, they are also faced with tariff barriers when exporting. We assume that all products are subject to foreign ad valorem tariffs (Schmitt and Yu (2001) assume an iceberg type of trade cost) when exported. We classify the products into two categories: a low-tariff category and a high-tariff category, as we assume that for some reasons some variants are facing low tariff barriers and some are facing high tariff barriers. A proportion γ, where $0 < \gamma < 1$, of products is subject to the high tariff τ_h, while a proportion $(1 - \gamma)$ is subject to the low tariff τ_l.

Finally, various market clearing conditions complete the model: labor market clearing demands that $L = n_d(\alpha+\beta x_d)+n_t(\alpha+\beta(x_t+x_z))+\sum a_i$ and similarly for the foreign country; the market clearing condition demands that the output of each variant should be equal to its total world consumption. Since each variant within the same type (domestic non-exporting, domestic exporting, imported low tariff and imported high tariff) behaves identically, we have omitted the subscripts i_d, i_t, i_l and i_h.

2.1 Non-exporting firms

To find equilibrium for a firm that does not export, we follow the standard procedure: free entry and exit; the zero-profit condition $\pi_d = p_d x_d - (\alpha + \beta x_d)w$ and labor market clearing at full employment (see e.g. Krugman, 1980). The equilibrium of a non-trading firm turns out to be:

$$x_d = \frac{\theta\alpha}{(1-\theta)\beta} \tag{2}$$

$$p_d = \frac{\beta w}{\theta} \tag{3}$$

In the special case where no firms export, we can find the autarkic number of firms by using the labor resource constraint $L = n_a(\alpha+\beta x_d)$. The autarkic number of firms is $n_a = L(1-\theta)/\alpha$.

2.2 Exporting firms

An exporting firm sells x_t on the domestic market and x_z on the foreign market, where $z = l, h$ depending on whether the product is subject to low or high tariffs. For the moment, no distinction is made between low and high tariffs and the analysis is carried out with a general ad valorem tariff τ_z. Hence, the profit of a trading firm is given by

$$\pi_z = p_t x_t + (1 - \tau_z) p_z x_z + (\alpha + a_i + \beta x_t + \beta x_z) \tag{4}$$

By maximizing (4) with respect to x_t and x_z the price decision of the firm is found to be:

$$p_t = \frac{\beta w}{\theta} = p_d \tag{5}$$

$$p_z = \frac{\beta w}{(1 - \tau_z)\theta} = \frac{p_d}{1 - \tau_z} \tag{6}$$

Note that since $p_t = p_d$ consumers do not distinguish between non-traded home products and traded home products; hence, production of exporting firms for their domestic market must be:

$$x_t = x_d = \frac{\theta \alpha}{(1 - \theta)\beta} \tag{7}$$

Sales on the foreign market of home firms – and import sales by foreign firms on the home market – however, are different. Note that from (6), we have that exported goods are more expensive than domestically produced goods and that by symmetry $p_z = p_z{}^*$, i.e. the price that a home firm charges abroad is the same as the price charged by foreign exporters on our home market. In equilibrium, utility maximization requires that the ratio of the marginal utility of an extra consumption unit of home exporting firms' goods for the home market and imported goods for the home market equals the price ratio; i.e. $\frac{\theta (c_d)^{\theta - 1}}{\theta (c_z)^{\theta - 1}} = \frac{p_d}{p_z}$. Using symmetry and $cL = x$ we get

$$x_z = x_d (1 - \tau_z)^{\frac{1}{1-\theta}} < x_t \tag{8}$$

Hence, an exporting firm is producing more of the variant for the home market than for the export market but charges a higher price on the foreign market. Thus, by symmetry, domestic consumers pay more and consume less of the imported product varieties than of the domestically produced varieties. Furthermore, goods that are subject to the high tariff are more expensive and are produced on a smaller scale than goods subject to the low tariff.

With these prices and quantities for exporting firms, we can now calculate which firms will export and which firms will not. Hence, we have to find the break-even exporting firm; i.e. given the heterogeneity of the firms in terms of their exporting costs, we will find the level of exporting costs $\bar{a_i}$ where the firm just makes zero exporting profit. Solving $\pi_i^{exp} = (1-\tau_z)p_z x_z - (a_i + \beta x_z)w = 0$ for a_i gives the break-even level of exporting costs:

$$\bar{a_z} = \alpha(1-\tau_z)^{\frac{1}{1-\theta}} < \alpha \tag{9}$$

All firms with $a_i \in [o, \bar{a_z}]$ make non-negative profits from exporting and will export, whereas firms with exporting costs higher than $\bar{a_z}$ will choose not to export due to negative profits from exporting. Note that an increase in the tariff level lowers the break-even exporting costs; i.e. the least efficient firms will cease their exporting activity in response to a tariff increase.

Finally, the distinction between high and low tariffs matters in equations (6), (8) and (9). Inserting τ_h and τ_l, one gets price, production volume and the break-even exporting costs for firms producing products subject to high and low tariffs respectively; in particular, notice that $\bar{a_h} < \bar{a_l}$.

2.3 Number of firms

For a full description of the equilibrium, we have to determine the number of the various types of firms: non-exporting firm, exporting firm subject to high tariffs, and exporting firm subject to low tariffs. To calculate the actual numbers of firms in total and in the various categories, we use the fact that the firm-specific exporting costs are uniformly distributed in the interval $[0;\alpha]$ with the distribution function $F(x) = x/\alpha$, and that the proportion γ of products are subject to the high tariff τ_h and that the proportion $1-\gamma$ of products are subject to the low tariff τ_l. Figure 1 illustrates the issue. Firms are evenly distributed in the rectangular area, yet subject to different firm-specific a_i's and to different tariff levels. However, as shown above, their resource use (scale) for the portion of their production that is aimed at the home market is identical. Firms in areas C, E, and F are pure home firms, i.e. not exporting. Firms in area D export subject to the high tariff, and have an according resource use determined by the smaller scale of the exporting activity. Firms in areas A and B export subject to the low tariff and have a larger exporting scale. More formally, the number of firms is given by:

$$\begin{aligned} n_d &= (1-F(\bar{a_l}))N + (F(\bar{a_l}) - F(\bar{a_h}))\gamma N && (10)\\ n_h &= F(\bar{a_h})\gamma N && (11)\\ n_l &= F(\bar{a_l})(1-\gamma)N && (12) \end{aligned}$$

where $N = n_d + n_h + n_l = n_d + n_t$ is the total number of domestic firms. Using the fact that the average exporting cost is given by $\bar{a}_l/2$ and $\bar{a}_h/2$ for goods subject to low and high tariffs respectively, the labor market clearing condition becomes:

$$n_d(x_d\beta + \alpha) + n_h(x_t\beta + \alpha + x_h\beta + \frac{\bar{a}_h}{2}) + n_l(x_t\beta + \alpha + x_l\beta + \frac{\bar{a}_l}{2}) = L \quad (13)$$

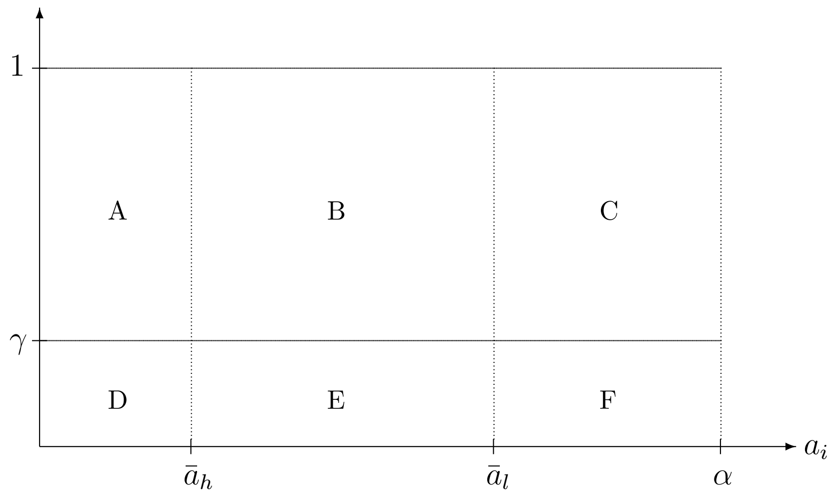

Figure 1: **The different types of firms**

Inserting the above relations into the labor market clearing condition, we get the number of exporting firms subject to low and high tariffs and the total number of domestic firms:

$$n_h = \frac{L(1-\theta)}{\alpha} \frac{2\gamma(1-\tau_h)^{\frac{1}{1-\theta}}}{2 + (1+\theta)(\gamma(1-\tau_h)^{\frac{2}{1-\theta}}) + (1-\gamma)(1-\tau_l)^{\frac{2}{1-\theta}})} \quad (14)$$

$$n_l = \frac{L(1-\theta)}{\alpha} \frac{2(1-\gamma)(1-\tau_l)^{\frac{1}{1-\theta}}}{2 + (1+\theta)(\gamma(1-\tau_h)^{\frac{2}{1-\theta}}) + (1-\gamma)(1-\tau_l)^{\frac{2}{1-\theta}})} \quad (15)$$

$$N = \frac{L(1-\theta)}{\alpha} \frac{2}{2 + (1+\theta)(\gamma(1-\tau_h)^{\frac{2}{1-\theta}}) + (1-\gamma)(1-\tau_l)^{\frac{2}{1-\theta}})} \quad (16)$$

From (16) it can easily be seen that the total number of firms under trade is less than the number of firms under autarky. Yet, because of trade, consumers also buy foreign varieties; in particular, due to symmetry, n_h and n_l also give the number of foreign varieties available at the domestic market.

2.4 Protection level

For given levels of the high and low tariffs, the corresponding average tariff level, $\bar{\tau}$, is calculated weighted by the fraction of goods that are subject to high and low tariffs respectively. Using the composition of home production as weights, $\bar{\tau}$ is simply given by:

$$\bar{\tau} = \gamma\tau_h + (1-\gamma)\tau_l \tag{17}$$

The starting point of our analysis of tariff reduction is $\bar{\tau}$, as we will be using three different formulas to determine the welfare effects of reducing this average tariff by a certain amount. In general, we will look at:

$$(1-\phi)\bar{\tau} = \gamma g_j(\tau_h) + (1-\gamma)g_j(\tau_l) \tag{18}$$

where ϕ measures the desired reduction in the average tariff level – i.e. the degree of trade liberalization – and $g_j(\tau)$ represents the various tariff reduction formulas; $j = P, S, C$.

2.5 Formula approaches

We deal with three formulas frequently discussed in the literature (see e.g. Francoise and Martin (2003), Laird et al (2003)). The first formula used is one of the simplest formulas; namely the proportional cut:

$$g_P(\tau) = \rho\tau \ , \tag{19}$$

where ρ is the constant proportion according to which the initial tariff is reduced. This formula approach was used in the GATT Kennedy Round (1963-67). The proportional cut formula leads to a large absolute reduction of high tariffs. However, it does not lead to a larger proportional reduction in higher tariffs than in lower tariffs. This conflicts with the political objective of eliminating tariff peaks expressed in the GATT and WTO negotiations.

The second formula that we analyze is the Swiss formula. It was accepted in the Tokyo Round and is given by:

$$g_S(\tau) = \frac{s\tau}{s+\tau} \ , \tag{20}$$

where s is a positive coefficient which indicates the highest level a tariff included in the negotiation list can take. The Swiss formula has a progressive nature as it leads to higher reductions in higher tariffs compared to lower tariffs, both in absolute and relative terms[2]. Hence, it is a tool that is in

[2] This is why it is also called a harmonizing approach, see Laird et al. (2003).

line with the policy objective of the WTO for reducing tariff peaks and tariff escalations.

The third formula that we analyze is the compression mechanism, which is currently proposed by the EU. In this case the new tariff level is given by the formula ${B_1}^{min} + (\tau - {B_0}^{min})\frac{{B_1}^{max} - {B_1}^{min}}{{B_0}^{max} - {B_0}^{min}}$. ${B_0}^{min}$ and ${B_0}^{max}$ are minimum and maximum limits in the initial brackets, and ${B_1}^{min}$ and ${B_1}^{max}$ are minimum and maximum limits in the new brackets. The number of brackets – or ranges – are subject to negotiation and so are the minimum and maximum bracket levels. An example is shown in Laird et al. (2003). The last part of the formula – the fraction – is the actual compression parameter that determines the compression of the tariffs in each bracket. The formula works like the proportional cut with a maximum ceiling on tariffs. Accordingly, it strongly reduces tariff peaks and is, in this respect, similar to the Swiss formula. For the purpose of this paper we simplify the compression formula to:

$$g_C(\tau) = B + (\tau - \tau_l)c \; , \tag{21}$$

where c is the compression parameter, B determines the new minimum tariff level and τ_l is the initial minimum level of tariffs; i.e. the lower tariff in our case.

3 Simulations and welfare results

We now have the tools to analyze the welfare effects of a reduction in the protection level using different formula approaches. Total utility derived from (1) is a measure of welfare. Given the clearing conditions for the market for goods and using symmetry, we can write $\sum U = N{x_d}^\theta + n_h {x_h}^\theta + n_l {x_l}^\theta$. Inserting the equilibrium values from above, the exact utility expression can be derived (see Appendix A.1).

For our analysis, we assume that both countries have imposed tariffs on imports leading to some average tariff level $\bar{\tau}$ given in (17). The formulas given by (19), (20) and (21) are used to achieve identical reductions in the average tariff level measured by ϕ. However, the resulting utility expressions of applying these formulas, when compared at equal reductions of the average tariff to (A.1), do not allow for analytical solutions of welfare rankings and we instead provide numerical simulations[3].

For these simulations we need to find the connection between the liberalization degree ϕ and the parameters in the different formulas; i.e. ρ, s and B

[3]The calculations and simulations can be obtained in a separate appendix from the authors upon request.

are determined endogenously in the model. From (19) it is straightforward to see that in the case of the proportional cut, a desired reduction in the average tariff of ϕ requires $\rho = 1 - \phi$. However, for the Swiss formula and the compression formula, it is not trivial to find the connection between the liberalization degree and the parameters s and B in equation (20) and (21) respectively[4].

The results of the simulations are shown in Figure 2. In the examples, we have set $\alpha = 1$, $\beta = 0.5$, $L = 100$ and the compression parameter $c = 0.7$. In the figure, we analyze two cases of tariff dispersions. In the left column, we look at tariff peaks. We identify this case as a situation where only a small fraction of the goods are subject to high tariffs but in return, the high tariff τ_h is indeed high relative to the low tariff τ_l. Specifically, we set $\tau_h = 0.9$, $\tau_l = 0.3$ and $\gamma = 1/6$. In the right panels, however, we look at tariff plateaus; i.e. compared to the case of peaks we have lower high tariffs but a larger fraction of goods subject to the high tariffs. Specifically, we set $\tau_h = 0.6$, $\tau_l = 0.3$ and $\gamma = 1/3$, leading in both situations to the initial average tariff level of $\bar{\tau} = 0.40$.

Figure 2 displays the ratio of utility after and before liberalization – that is, post-liberalization utility over pre-liberalization utility – as a function of θ; i.e the degree of product differentiation in the industry. Going from the top to the bottom, we analyze a higher degree of liberalization; i.e. higher values of ϕ. Utility under the proportional cut is plotted with a solid line; the curve with long dashes plots utility under the Swiss formula; and finally, utility under the EU compression formula is plotted with short dashes. We reach the following main result:

Result 1. *Reducing the average tariff level increases welfare independent of the formula used, the initial tariff structure, and the degree of product differentiation.*

It is evident from the figure that the strength of the trade liberalization (ϕ) and the degree of product differentiation (θ) have an impact on the welfare ranking of the three formulas, while the initial tariff structure has no influence on the qualitative results. Furthermore, as we approach $\theta \to 1$, the utility ratio becomes 1 in all cases, i.e. trade liberalization has a neutral welfare impact. This is the case, because as $\theta \to 1$, goods become close to perfect substitutes, and consumers prefer consumption volume to consumption variety. Since gains from trade and trade liberalization, in this

[4]The expression for s and B is found in the separate appendix. The compression parameter c is given as a specific value in the simulations.

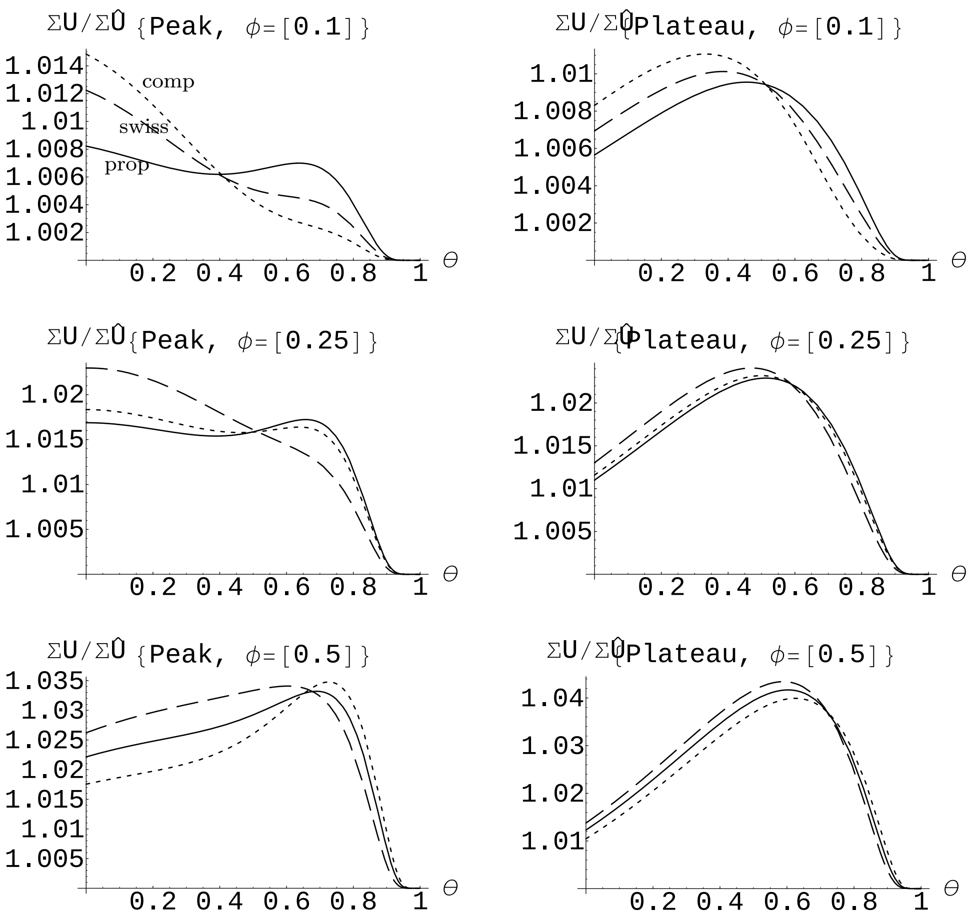

Figure 2: The ratio of utility before and after liberalization.

model, stem from the wider selection of foreign varieties available, and since variety does not matter in the limit, the positive effect of trade liberalization fades out. Comparing the Swiss formula to the proportional cut, we obtain:

Result 2. *There exists a $\hat{\theta}$ such that for differentiated industries, in the sense that $\theta < \hat{\theta}$, the Swiss formula welfare-dominates the proportional cut, while for homogeneous industries, in the sense that $\theta > \hat{\theta}$, the proportional cut welfare-dominates the Swiss formula.*

Notice that $\hat{\theta}$ depends on the initial tariff structure and the degree of liberalization so that a larger cut in the average tariff (larger ϕ) leads to an increase of $\hat{\theta}$ compared to a smaller cut in the average tariff. The ranking of the EU compression mechanism is more complex:

Result 3.

1. *For sufficiently small reductions in the average tariff, the EU compression mechanism welfare-dominates both the Swiss formula and the proportional cut for differentiated industries, in the sense that $\theta < \hat{\theta}$, while the EU compression mechanism is welfare-dominated by both the Swiss formula and the proportional cut for homogeneous industries, in the sense that $\theta > \hat{\theta}$.*

2. *For sufficiently large reductions in the average tariff, the EU compression mechanism is welfare-dominated by both the Swiss formula and the proportional cut for differentiated industries, in the sense that $\theta < \hat{\theta}$, while the EU compression mechanism welfare-dominates both the Swiss formula and the proportional cut for homogeneous industries, in the sense that $\theta > \hat{\theta}$.*

Notice that Result 3.1 even holds for $\phi = 0$. Thus, even though $\phi = 0$ implies unchanged average tariffs, the application of the compression formula still has a policy impact. In particular, applying the compression formula gives a higher utility level for differentiated industries, but reduces welfare for homogeneous industries. In contrast, the proportional cut and Swiss formula simply replicate the initial utility level. The reason for this is as follows. The proportional cut and the Swiss formula both reproduce the initial average tariff level by leaving the low and high tariff unchanged. In contrast, the compression mechanism obtains the initial average tariff level with altered low and high tariffs, namely by narrowing the gap between high and low tariffs. This results in a more equal distribution of tariffs among products, which in turn generates entry. This creates a welfare gain when goods are fairly differentiated and consumers love variety (low θ) but is welfare-neutral when goods are more homogeneous (high θ).

The above results give rise to a series of policy implications. Firstly, reductions in the trade restriction using three different formulas lead to non-trivial positive impact on welfare. Secondly, from a welfare perspective, different industries should be targeted by different tariff conversion formulas. For example, when aiming at substantial average tariff cuts in highly differentiated industries, the Swiss formula is the welfare-superior tool, while when only minor (even zero) average tariff cuts are implemented for the same type of industry, a compression mechanism might be superior. Thirdly, no single formula dominates for all conceivable combinations; on the contrary, for a different industry structure, tariff structure, and degree of liberalization, the dominating formula changes.

4 Conclusion

This paper examines the welfare effects of using different tariff reduction formulas proposed in various GATT/WTO negotiation rounds for achieving liberalization of trade barriers and improvements in market access. We employ a simple symmetric two-country general equilibrium model with intra-industry trade and use numerical simulations to establish welfare results. We introduce firm-level heterogeneous fixed costs of exporting, so that in this model, not all firms trade in equilibrium; entry, exit and scale decisions of exporting firms are determined endogenously and depend on the tariff conversion formula used. Furthermore, we introduce a tariff structure (e.g. tariff peaks) to allow for high and low tariffs on products. We analyze the welfare effects of applying three different conversion formulas to obtain the same average tariff cut. The formulas are the proportional cut formula used in the Kennedy Round; the Swiss formula, which was accepted in the Tokyo Round; and the EU compression mechanism, which was proposed by the EU in the Doha Round.

It is established that reduction in the trade restriction using the different formulas leads to a non-trivial positive impact on welfare. We show that the degree of trade liberalization and of product differentiation have an impact on the ranking of the three different tariff reduction formulas in terms of welfare. However, the initial tariff structure – i.e. the initial degree of tariff dispersion/peaks – has no qualitative influence on the results. In particular, we show that the ranking of the Swiss formula and the proportional cut depends on the industry structure, so that for differentiated industries, the Swiss formula welfare-dominates the proportional cut, while for homogeneous industries, the proportional cut welfare-dominates the Swiss formula. This result holds for all levels of trade liberalization. The ranking of the EU compression mechanism is more complex, as it depends both on the industry structure and on the level of trade liberalization. In situations with only small reductions in trade barriers, the EU compression formula welfare-dominates (is welfare-dominated by) both the Swiss formula and the proportional cut for highly differentiated industries (homogeneous industries) and vise versa for large reductions in trade barriers.

These welfare rankings carry important policy implications for the coming WTO negotiation rounds. Formula approaches have been – and will be – a central part of WTO negotiations. This paper shows that the welfare effects of trade liberalization are dependent of the actual tariff reduction formula used. Different industries should be targeted by different formulas, depending on their degree of product differentiation and the degree of liberalization aimed at.

A Appendix

A.1 Total utility

$$\sum \hat{U} = \frac{2\,L\,(1-\tau_h)^{\frac{1}{\theta-1}}\,(1-\tau_l)^{\frac{1}{\theta-1}}\,(1-\theta)}{\alpha\,\left(\left(-(1-\tau_h)^{\frac{2}{\theta-1}}+(1-\tau_l)^{\frac{2}{\theta-1}}\right)\gamma\,(1+\theta)+(1-\tau_h)^{\frac{2}{\theta-1}}\left(1+2\,(1-\tau_l)^{\frac{2}{\theta-1}}+\theta\right)\right)}$$
$$\times\left(\gamma\left((1-\tau_l)^{\frac{1}{\theta-1}}\left(\frac{(1-\tau_h)^{\frac{1}{1-\theta}}\,\alpha\,\theta}{\beta-\beta\,\theta}\right)^{\theta}-(1-\tau_h)^{\frac{1}{\theta-1}}\left(\frac{(1-\tau_l)^{\frac{1}{1-\theta}}\,\alpha\,\theta}{\beta-\beta\,\theta}\right)^{\theta}\right)\right.$$
$$\left.+\,(1-\tau_h)^{\frac{1}{\theta-1}}\left((1-\tau_l)^{\frac{1}{\theta-1}}\left(\frac{\alpha\,\theta}{\beta-\beta\,\theta}\right)^{\theta}+\left(\frac{(1-\tau_l)^{\frac{1}{1-\theta}}\,\alpha\,\theta}{\beta-\beta\,\theta}\right)^{\theta}\right)\right) \tag{A.1}$$

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