Tariff (De-) Escalation with Successive Oligopoly

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Abstract

In this paper, we explore the issue of a simultaneous reduction in tariffs at different stages of a vertically-related market where each stage is oligopolistic. When vertically-related markets are characterized as a successive oligopoly, reducing tariffs by an equivalent amount on upstream and downstream imports will have a differential effect on market access and hence profits at each stage due to a combination of horizontal and vertical effects. These differential effects have implications for the tariff structure post-trade reform.

Keywords: Vertical markets, successive oligopoly, tariff (de-) escalation

JEL Classification: F12, F13

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Introduction

Tariff escalation, and the associated concept of effective protection, has been a long-recognized issue in the trade policy literature (Balassa, 1965; Corden, 1971; Ethier, 1977, Anderson, 1998; Greenaway and Milner, 2003, *inter alia*). Tariff escalation occurs when tariffs on downstream imports tend to be higher than tariffs on upstream imports such that the level of protection offered downstream, where goods are typically more processed, exceeds that upstream for less-processed intermediate goods. In particular, for developing countries, tariff escalation inhibits access to potentially greater returns from more highly-processed exports. Cadot *et al*. (2004), drawing on World Trade Organization (WTO) data, report that nominal protection escalates with the degree of processing for both industrial and agricultural goods in developing and developed countries.

Though the issue of tariff escalation as a barrier to developing country exports of processed goods is generally well-known, less well-publicized is that tariff escalation increased in a number of sectors following the negotiated tariff reductions in the Uruguay Round of GATT. Based on OECD weighted average tariffs, the OECD reported that tariff escalation increased in 20 sectors covering both agricultural and industrial goods (OECD, 1996). The extent of tariff escalation, especially its impact on developing country food and agricultural exports, has also been highlighted in the context of the current Doha Round negotiations (UNCTAD, 2002; Oxfam, 2003; World Bank, 2003). The existence of tariff escalation provides a rationale for formula approaches to reducing tariffs in trade negotiating rounds since they have the aim of reducing high tariffs by a

greater proportion than lower tariffs that, in turn, would reduce the incidence of tariff escalation. Francois and Martin (2003) summarize the use of formula approaches and how they may reduce tariff escalation.

In this paper, we focus on the issue of tariff structure in a vertically-related market with imperfect competition at each stage. Though not contingent on some pre-existing level of tariff escalation, we show that, in the context of a successively-oligopolistic, vertically-related market, a simultaneous and equal reduction of tariffs affecting upstream and downstream imports will have non-equivalent effects on market access to upstream and downstream stages respectively and correspondingly on the domestic firms who compete with imports at these stages. To the extent that the former has implications for exporting countries gaining access to downstream (higher value) markets, and the latter creates the potential for increased opposition to trade liberalization, the framework offers a new insight as to why formula approaches to reducing tariffs may be necessary. The main point is that, in the context of successive oligopoly with non-equivalent horizontal and vertical effects that do not offset each other, trade reform has implications for the tariff structure post-reform. This, in turn, could provide further justification for formula approaches to trade negotiations.

This paper also relates to a relatively small literature on protection in vertically-related markets. For example, Hoekman and Leidy (1992) highlight the possibility of cascading protection whereby protection targeted at an upstream stage will have a spillover effect and increase the probability of protection at the related downstream stage.[1] Due to the vertical linkages between stages, upstream firms have the incentive to

[1] It should be noted that the insights from this literature differ from those offered by recent models on endogenous trade policy. For example, Gawade, Krishna and Olarreaga (2005) outline a framework based

seek protection in order to induce downstream firms to seek protection as well. Sleuwaegen *et al*. (1998) extend this analysis to account for market structure issues. In an analysis of US anti-dumping cases, Feinberg and Kaplan (1993) find support for the conjecture that levels of protection at the upstream stage have an impact on protection in the downstream stage. In this context, we spell out the mechanisms via which either tariffs (or anti-dumping/countervailing duties) affect each stage in a vertically-related market where each stage is oligopolistic.

The analysis presented does, however, differ considerably from previous research that has addressed the issue of optimal tariffs in a vertically-related market set-up (Spencer and Jones, 1991, 1992; Bernhofen, 1997; Ishikawa and Lee, 1997; Ishikawa and Spencer, 1999) in that we are not concerned with optimality of tariffs.[2] It is also worth mentioning that in the context of vertical market models that incorporate imperfect competition, the impact of simultaneous tariff reductions differs from the standard insights drawn from competitive models. For example, in Corden's (1966) discussion of effective protection, it is indeed true that reducing tariffs at the upstream stage will increase effective protection. In the framework outlined here, we address the issue of simultaneous tariff reductions with imperfect competition and show that the mechanisms associated with pass-through and pass-back between the vertical stages, provides insights into the impact of trade liberalization in a successively oligopolistic environment and, in turn, market access and the motivation behind political opposition to trade reform.[3]

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on the Grossman and Helpman (1994) model suggesting that, in the context of lobbying by different interest groups, firms at the downstream stage will lobby against protection to firms at the upstream stage.

[2] Other papers that analyze vertically-related markets, but focus on different issues include, Aksoy and Riyanto (2000) and Chang and Sugeta (2004).

[3] We do not add any explicit political mechanisms in the model but focus on the motivations behind the interests of domestic firms opposing trade reform as a result of simultaneous tariff reductions. For example, in the spirit of Grossman and Helpman (2004), adding relative weights to the profit functions of the

The paper is organized as follows. In section 1, we outline a basic model of successive oligopoly where tariffs are applied on imported goods that enter both the downstream and upstream stages. The model is sufficiently general to allow intermediate and final goods to be either strategic substitutes or complements. In section 2, we explore the effect of simultaneous reductions in tariffs on downstream and upstream imports and consider the relative effect on market access for the two stages. In section 3, we focus on what would be the appropriate reduction in the downstream tariff for a given reduction in the upstream tariff, if a policymaker were aiming to avoid differential effects on domestic firm's profitability at each stage. In section 4, we present a general discussion of the potential implication(s) of the results, addressing both tariff reforms, as well as the implications for developing countries more generally. In section 5, we summarize and conclude.

1. Model Structure

The model introduced here is one of successive oligopoly, i.e., both the upstream (intermediate good) and downstream (final good) stages are imperfectly competitive and one that is standard when dealing with trade issues in vertically-related markets (for example, Sleuwaegen *et al*., 1998; Ishikawa and Spencer, 1999). At the downstream stage, a domestic firm competes with imports of the final good that are subject to a tariff t^d. At the upstream stage, a domestic firm competes with imports, where the intermediate good is homogeneous and sold at a common price such that the domestic downstream firm is indifferent between alternative sources for the intermediate good. Imports of the intermediate good are also subject to a tariff t^u. With tariff escalation in

domestic upstream and downstream firms will influence the extent of the tariff reductions at each stage but will not impinge upon the mechanisms that give rise to non-equivalent impacts on profits which is the primary focus of this paper.

the initial set-up, the tariff on the final good exceeds the tariff on the intermediate good, i.e., $t^d > t^u$, although the initial degree of tariff escalation is not crucial for the analysis. The technology linking domestic downstream production and the upstream intermediate good is one of fixed proportions. Formally, $x_1 = \phi x^u$, where x_1 and x^u represent output of the domestic downstream firm and upstream stage respectively, and where ϕ is the constant coefficient of production. To ease the exposition, ϕ is set equal to one in the framework outlined below. Like much of the previous literature on vertical markets, arms' length pricing between the domestic downstream firm and the upstream stage is also assumed, i.e., the downstream firm takes the price of the intermediate good as given (for example, Abiru, 1988; Salinger, 1988).

The model consists of a three-part game. First, the domestic government sets tariffs on both downstream and upstream imports, while the second and third parts consist of Nash equilibria at the upstream and downstream stages. The timing of firm's strategy choice goes from upstream to downstream. Specifically, given costs and the derived demand curve facing the upstream stage, upstream firms simultaneously choose output to maximize profits, which generates Nash equilibrium at the upstream stage. The price of the intermediate good is taken as given by the domestic downstream firm which, simultaneously with its foreign competitor, chooses output to maximize profits, thus giving Nash equilibrium at the downstream stage. In terms of solving the model, equilibrium at the downstream stage is derived first and then the upstream stage. In addition, all equilibria are assumed to be sub-game perfect.

Equilibrium at the Downstream Stage

Let x_1 equal the output choice of the domestic downstream firm and x_2 the output choice of its foreign competitor. Their revenue functions can be written as:

$$R_1(x_1, x_2) \tag{1}$$

$$R_2(x_1, x_2). \tag{2}$$

We assume downward sloping demands and substitute goods.

Given (1) and (2), the relevant profit functions are given as:

$$\pi_1^d = R_1(x_1, x_2) - c_1 x_1 \tag{3}$$

$$\pi_2^d = R_2(x_1, x_2) - c_2 x_2 - t^d x_2, \tag{4}$$

where c_1 and c_2 are the domestic and foreign downstream firms' respective costs, and t^d is the tariff on imports of the final good. Downstream firms' costs relate to the purchase of an intermediate input and excluding any other costs, the costs for the domestic downstream firm are equal to the price of the intermediate input, p_1^u.

The first-order conditions for profit maximization are given as:

$$R_{1,1} = c_1 \tag{5}$$

$$R_{2,2} = c_2 + t^d, \tag{6}$$

Equilibrium at the downstream stage can be derived by totally differentiating the first-order conditions (5) and (6):

$$\begin{bmatrix} R_{1,11} & R_{1,12} \\ R_{2,21} & R_{2,22} \end{bmatrix} \begin{bmatrix} dx_1 \\ dx_2 \end{bmatrix} = \begin{bmatrix} dp_1^u \\ dc_2 + dt^d \end{bmatrix}. \tag{7}$$

The slopes of the reaction functions are found by implicitly differentiating the firms' first-order conditions:

$$\frac{dx_1}{dx_2} = r_1 = -\frac{R_{1,12}}{R_{1,11}} \tag{8}$$

$$\frac{dx_2}{dx_1} = r_2 = -\frac{R_{2,21}}{R_{2,22}}. \tag{9}$$

With this set-up, we can deal with both strategic substitutes and strategic complements where the variable of interest is the cross-partial effect on marginal profitability, i.e., given $R_{i,ii} < 0$, i=1,2, then sign r_i = sign $R_{i,ij}$. Consequently, with reference to equations (8) and (9), if $R_{i,ij} < 0$, then $r_i < 0$. In this case, we have the case of strategic substitutes, and the reaction functions are downward sloping. However, if $R_{i,ij} > 0$, the reaction functions are upward sloping and we have strategic complements. The distinction between strategic substitutes/complements relates to the "aggressiveness" of firms' strategies (Bulow *et al*., 1985). Whether we have strategic substitutes or complements depends on the second derivatives of the demand function.

Given (7), the solution to the system is found by re-arranging in terms of dx_i and inverting where Δ is the determinant of the left-hand side of (7):

$$\begin{bmatrix} dx_1 \\ dx_2 \end{bmatrix} = \Delta^{-1} \begin{bmatrix} R_{2,22} & -R_{1,12} \\ -R_{2,21} & R_{1,11} \end{bmatrix} \begin{bmatrix} dp_1^u \\ dc_2 + dt^d \end{bmatrix}. \tag{10}$$

To simplify the notation re-write (10) as:

$$\begin{bmatrix} dx_1 \\ dx_2 \end{bmatrix} = \Delta^{-1} \begin{bmatrix} a_2 & a_1 r_1 \\ a_2 r_2 & a_1 \end{bmatrix} \begin{bmatrix} dp_1^u \\ dc_2 + dt^d \end{bmatrix}, \tag{11}$$

where $a_1 = R_{1,11}$ $a_2 = R_{2,22}$. For stability of the duopoly equilibrium, the diagonal of the matrix has to be negative, i.e., $a_i < 0$, and the determinant positive, $\Delta^{-1} = a_1 a_2 (1 - r_1 r_2) > 0$.

Equilibrium at the Upstream Stage

Given the fixed proportions technology and $\phi = 1$, total output at the domestic upstream stage is given by $x^u (= x_1)$. It is assumed that there are two upstream firms, one domestic and one foreign whose combined output equals x^u, i.e., $x_1^u + x_2^u = x^u$. As noted earlier, given the intermediate good is assumed to be homogeneous, the domestic downstream firm is indifferent about the relative proportions of x_1^u and x_2^u used in its production process. The foreign upstream firm is subject to a tariff on its exports of the intermediate good as given by t^u. Assuming that the domestic downstream firm faces no costs other than the price it pays for the intermediate good, the inverse derived demand function facing firms at the upstream stage can be found by substituting $p_1{}^u$ for c_1 in (5) where superscript u denotes the upstream stage. Firms' profits at the upstream stage are, therefore, given by:

$$\pi_1^u = R_1^u(x_1^u, x_2^u) - c_1^u x_1^u \tag{12}$$

$$\pi_2^u = R_2^u(x_1^u, x_2^u) - c_2^u x_2 - t^u x_2, \tag{13}$$

where c_1^u and c_2^u are the domestic and foreign upstream firms' costs respectively.

Given this, and following the outline above, equilibrium at the upstream stage is:

$$\begin{bmatrix} dx_1^u \\ dx_2^u \end{bmatrix} = (\Delta^u)^{-1} \begin{bmatrix} a_2^u & a_1^u r_1^u \\ a_2^u r_2^u & a_1^u \end{bmatrix} \begin{bmatrix} dc_1^u \\ dc_2^u + dt^u \end{bmatrix}, \tag{14}$$

where $a_i^u < 0$ and $(\Delta^u)^{-1} > 0$ for stability.

Equations (11) and (14) characterize equilibria at the downstream and upstream stages respectively. However, while the signs of the elements of (11) and (14) are the same, they differ in magnitude. This is because in models of successive oligopoly, perceived marginal revenue declines at a greater rate at the upstream compared with the

downstream stage. This feature of successive oligopoly is summarized in the following lemma:

Lemma 1: Since the slope of firms' perceived marginal revenue functions at the upstream stage are steeper than firms' perceived marginal revenue functions at the downstream stage, then $\left|a_i^u\right| > \left|a_i\right|$.

Proof: $R_{1,11}$ is equal to $2p'+p''(q)$. Note that by definition, $R_{1,1} = c_1$ and hence, $c_1^{'} = R_{1,1}^u = c + c'(q)$. By extension, $R_{1,11}^u = 2c'+c''(q)$. Note that c' can also be written as $2p'+p''(q)$. Given this:

$$\frac{R_{1,11}}{R_{1,11}^u} = \frac{2p'+p''(q)}{2c'+c''(q)} = \frac{2p'+p''(q)}{2(2p'+p''(q))+c''} = \frac{2p'+p''(q)}{4p'+2p''(q)+c''}.$$

Since $R_{1,11} = a_1$ and $R_{1,11}^u = a_1^u$, then it follows that $\left|a_i^u\right| > \left|a_i\right|$. For example, with monopoly at each stage and linear demand such that $p'' = c'' = 0$, the slope of the perceived inverse derived demand function facing the firm upstream is twice the slope of the inverse demand function facing the firm downstream.

With this model of successive oligopoly, where tariffs apply to both upstream and downstream imports, we can now consider the potential effects on market access at each stage arising from a simultaneous change in t^d and t^u.

2. Impact of Tariff Reductions on Market Access

Consider a scenario of tariff reform in this vertically-related market where both t^d and t^u are reduced, and initially the tariffs are assumed to be reduced by the same amount. We focus first on the effects on market access at the downstream and upstream stages, i.e., by how much imports change in both these stages, in order to capture the potential differential effects of tariffs at each stage. Note that though we are specifically interested in the issue of simultaneous reductions of tariffs at successive stages in the vertical chain,

to highlight the mechanisms associated with changes in tariffs with successive oligopoly (principally 'pass-through' and 'pass-back' effects), we initially take the tariff changes at each stage separately.

Key to identifying the effects of tariff changes in this setting is to note that changing a tariff at one stage has an effect not only on market equilibrium at the stage which the tariff affects directly but also on the vertically-related stage. So, for example, a change in the upstream tariff will not only change the level of imports of the intermediate good but by doing so, will also affect the competitiveness of the domestic downstream firm vis-à-vis its foreign competitor since the change in level of market access upstream changes the price of the intermediate good purchased by the domestic downstream firm. If the upstream tariff is reduced, and for a given level of costs and tariff facing the foreign downstream firm, the domestic downstream firm will benefit from a fall in the price of the intermediate good. The change in the price of the intermediate good arising from the change in the upstream tariff is known as the 'pass-through' effect.

Similarly, keeping the upstream tariff unchanged, a change in the downstream tariff will not only directly affect equilibrium at the downstream stage but also generates feedback to the upstream stage which in turn affects the price of the intermediate good. For example, suppose there is a reduction in the downstream tariff. This decreases the market share of the domestic downstream firm which then purchases less of the intermediate good. This decrease in derived demand changes the price of the intermediate good which (typically but not always) falls and, therefore, partly offsets the decrease in market share of the domestic downstream firm arising from the reduction in the downstream tariff. This feedback effect on the upstream market arising from changes in

the downstream market is known as the 'pass-back' effect (Ishikawa and Lee, 1997; Colangelo and Galmarini, 2002). Importantly, the 'pass-through' and 'pass-back' effects are unlikely to be equal.

Specifically, the pass-through of changes in the upstream tariff into changes in the price of the intermediate good is given by $dp_1^u / dt^u = p_{1,1}^u (dx_1^u + dx_2^u) = p_{1,1}^u D$, where $p_{1,1}^u$ is the derivative of the upstream price with respect to x^u, and D is given by $\left\{(\Delta^u)^{-1}\left[a_1^u(1+r_1^u)\right]\right\}$. Since $p_{1,1}^u$ is negative, and D is negative, a reduction in the upstream tariff will decrease the domestic downstream firm's costs. As is well-known from the public finance literature, the impact of a tax on the price of a good can be greater or less than the level of the tax when industries are imperfectly competitive. For reasonable characterizations of the demand function, we are likely to have 'under-shifting', i.e., $p_{1,1}^u D < 1$. For example, a linear, or, more generally, a weakly convex, demand curve will generate under-shifting.[4]

For the pass-back effect, the focus is on the impact of the tariff on the downstream imported good on demand for the intermediate good. Specifically, the tariff will lead to a shift in the derived demand for the intermediate good which subsequently changes its price. Formally, and noting that $dx_1 = d(x_1^u + x_2^u)$, the pass-back effect is given by:

$$\frac{dp_1^u}{dt^d} = \frac{dp_1^u}{d(x_1^u + x_2^u)} \frac{d(x_1^u + x_2^u)}{dt^d},$$

which can be re-written as:

$$\frac{dp_1^u}{dt^d} = \Delta^{-1} a_1 r_1 (1 + p_{1,1}^u). \qquad (15)$$

[4] See Fullerton and Metcalf (2002) for a summary of tax incidence in imperfectly competitive markets.

With strategic substitutes, $r_1 < 0$, the pass-back effect is positive and is likely less than one for reasonable characterizations of the demand function. With strategic complements, the pass-back effect is negative. Intuitively, with strategic substitutes, a reduction in the tariff on the final good decreases the demand for the intermediate good, thereby lowering its price. However, with strategic complements, a reduction in the tariff increases imports of the final good, and output of the domestic downstream firm also increases, leading to an increase in demand for the intermediate good, thereby raising its price. We summarize the pass-through and pass-back effects in the following lemma:

Lemma 2: In a vertically-related market, tariff changes at one stage have an impact on prices faced by the related stage. The pass-through and pass-back effects associated with these related market changes are not equivalent. Moreover, with strategic substitutes, a tariff reduction at either the downstream or upstream stage will reduce the price of the intermediate good. However, with strategic complements, a reduction in the upstream (downstream) tariff will reduce (increase) the price of the intermediate good.

Proof: It is easy to see that $p_{1,1}^u(\Delta^{-1})^u[a_1^u(1+r_1^u)] \neq \Delta^{-1}a_1 r_1(1+p_{1,1}^u)$.

Consider now the effects of reductions in tariffs in this successive oligopoly at both the stage in which the tariffs directly apply and also at the vertically-related stage:

(i) *Effect of a change in upstream tariff on imports of intermediate good*:

$$\frac{dx_2^u}{dt^u} = (\Delta^{-1})^u a_1^u . \tag{16}$$

Since $a_1^u < 0$ and $(\Delta^{-1})^u > 0$, a decrease in the upstream tariff increases imports of the intermediate good.

(ii) *Effect of change in the upstream tariff on imports of final good*:

$$\frac{dx_2}{dt^u} = \frac{dx_2}{dp_1^u}\frac{dp_1^u}{dt^u} = (\Delta^{-1})a_2 r_2 p_{1,1}^u[(\Delta^{-1})^u(a_1^u(1+r_1^u))]. \tag{17}$$

With $a_2 < 0$ and $(\Delta^{-1}) > 0$, the impact of a reduction in the upstream tariff on downstream market access depends on the sign of r_2. With strategic substitutes (complements), imports of the final good fall (rise) with a reduction in the upstream tariff. Intuitively, since the fall in the upstream tariff lowers the price of the intermediate good, this makes the domestic downstream firm more competitive. As a result, with strategic substitutes, imports of the final good fall. With strategic complements, the increase in sales of the domestic downstream firm is matched by an increase in imports of the final good.

(iii) *Effect of reduction in downstream tariff on imports of final good*:

$$\frac{dx_2}{dt^d} = \Delta^{-1} a_1 [1 + a_2 r_1 r_2 \Delta^{-1} (1 + p^u_{1,1})]. \qquad (18)$$

Since [.]<1, $a_1 < 0$ and $(\Delta^{-1}) > 0$, (18) is negative. Intuitively, as the downstream tariff is reduced, imports of the final good increase even though the magnitude of this impact is conditioned by the pass-back effect to the intermediate good price.

(iv) *Effect of reduction in downstream tariff on imports of intermediate good*:

There are two factors to be taken into account in considering the impact upstream of a reduction in the downstream tariff. First, reduction of the downstream tariff affects the derived demand for imports of the intermediate good. Second, the reduction in the downstream tariff also affects the price of the intermediate good upstream which, in turn, affects the extent of the change in derived demand for imports of the intermediate good.

Note that in deriving the effect on the upstream stage, we are interested only in the effects of reducing the downstream tariff on imports of the intermediate good, i.e., dx^u_2 / dx_1. Since $x_1 = x^u = (x^u_1 + x^u_2)$, it is the case that $dx_1 = d(x^u_1 + x^u_2)$. Re-arranging, we have $(dx^u_2 / dx_1) = 1 - (dx^u_1 / dx_1) = s$ which corresponds to a change in upstream imports

for a given change in output by the domestic downstream firm. The effect of reducing the downstream tariff on upstream imports can therefore be given by:

$$\frac{dx_2^u}{dt^d} = s(\Delta^{-1})a_1 r_1[1 + a_2\Delta^{-1}(1 + p_{1,1}^u)]. \tag{19}$$

In the case of strategic substitutes ($r_1 < 0$), and given that [.]<1, $(\Delta^{-1}) > 0$ and $a_1 < 0$, imports of the intermediate good will fall following a decrease in the downstream tariff. This is due to the decline in the sales of the domestic downstream firm that reduces demand for imports of the intermediate good, although the extent is ameliorated somewhat by the decrease in the upstream price. In the case of strategic complements ($r_1 > 0$), imports of the intermediate good will increase following a reduction in the downstream tariff.

Finally, we want to consider the net change in market access for each stage following a simultaneous reduction in tariffs downstream and upstream. For the upstream stage, the net change is given by (16) and (19) and, for the downstream stage, by (17) and (18). For the upstream stage, the net change in market access is given by:

$$\frac{dx_2^u}{dt^u} + \frac{dx_2^u}{dt^d} = (\Delta^{-1})^u a_1^u + s(\Delta^{-1})a_1 r_1[1 + a_2\Delta^{-1}(1 + p_{1,1}^u)]. \tag{20}$$

This is likely negative since the second argument is weighted by $s < 1$ and by [.] < 1. This will hold in both the strategic substitutes and complements cases. With trade liberalization, tariff reductions at the upstream stage will reduce imports which is partly offset by the effect of a decrease in derived demand from the downstream stage as the tariff reduction at the downstream stage reduces the competitiveness of the domestic downstream firm.

For the downstream stage, the net change in market access is given by:

$$\frac{dx_2}{dt^u} + \frac{dx_2}{dt^d} = (\Delta^{-1})a_2 r_2 p_{1,1}^u \left\{(\Delta^{-1})^u [a_1^u (1 + r_1^u)]\right\} + \Delta^{-1} a_1 [1 + a_2 r_1 r_2 \Delta^{-1} (1 + p_{1,1}^u)], \quad (21)$$

where $a_1 \approx a_2 = a$ has been assumed to make the interpretation of the key results more transparent. Since [.] > 0, and since $(\Delta^{-1} > 0)$, and $a_{1,2} < 0$, then imports of the final good increase when both downstream and upstream tariffs are simultaneously reduced. This holds for both the strategic substitutes and complements cases. However, to some extent, this horizontal effect on downstream imports is offset by the lower prices resulting from tariff reductions at the upstream stage which improves the competitiveness of the domestic downstream firm. As long as this vertical effect is not 'too' strong, imports will be expected to rise, as a result of trade liberalization though the net effect is tempered by trade liberalization affecting the upstream market.

We are, however, interested in the question of which stage is most affected by the simultaneous change in tariffs. This can be derived by comparing (21) with (20), the net effect on market access between the two stages is given by:

$$\left.\frac{dx_2}{dx_2^u}\right|_{dt^u + dt^d} = \frac{\Delta^{-1} a_2 r_2 \left\{p_{1,1}^u (\Delta^{-1})^u [a_1^u (1 + r_1^u)] + a_1 [1 + a_2 r_1 r_2 \Delta^{-1} (1 + p_{1,1}^u)]\right\}}{(\Delta^{-1})^u a_1^u + s\Delta^{-1} a_1 r_1 (1 + a_2 (1 + p_{1,1}^u)\Delta^{-1})}. \quad (22)$$

Several observations can be made concerning (22). First, by (20) and (21), tariffs affect imports in the same way whatever the nature of strategic interaction so (22) will be positive. Second, it is unlikely that (22) equals one. Given the slope of the perceived revenue functions at the downstream and upstream stages as well as the vertical (pass-through and pass-back) effects not being equal, a simultaneous reduction in tariffs for both stages in this successive oligopoly will lead to differential changes in market access.

However, whether the differential effect falls more on the domestic downstream or upstream firm depends on whether (22) is greater or less than one.

To investigate further, recall (Δ^{-1}), $(\Delta^{-1})^u > 0$ and $a_1, a_1^u < 0$. Note also that by *Lemma 1* $\left|a_1^u\right| > \left|a_1\right|$, and noting that the determinant can be written as (suppressing the superscripts for the upstream stage for convenience) $\Delta^{-1} = a_1 a_2 (1 - r_1 r_2)$, then the second term in the numerator is greater than the first term making (22) positive. The denominator is also positive given that $\left|a_1^u\right| > \left|a_1\right|$ and $(\Delta^{-1})^u > \Delta^{-1}$, the positive effect being reinforced if the pass-back is sufficiently low. The tendency for the numerator to be less than the denominator is reinforced if $\{1 + [.]\} < 1$. This would arise with strategic substitutes, a relatively high degree of pass-through and a low value of *s* for upstream imports. Noting that $\left|a_i^u\right| > \left|a_i\right|$ and $(\Delta^{-1})^u > \Delta^{-1}$, this will also be true in the case of strategic complements. These effects are summarized in the following proposition.

Proposition 1: A simultaneous reduction in tariffs on imports of final and intermediate goods will have differential effects on market access at each stage. Final good imports are likely to change by less than imports of the intermediate good if competition is characterized by a sufficiently high degree of pass-through, a sufficiently low degree of pass-back and a sufficiently low level of change for imports of the intermediate good following the change in domestic downstream output. These effects will also arise in the case of strategic complements.

To the extent that one stage in this vertically-related market is more affected by an equivalent change in tariffs is crucial in understanding the potential implications of trade reform. Specifically, it may provide a rationalization for why some firms within the same (vertically-related) industry may take a different stance on the magnitude of the trade reform proposals and why tariff escalation could rise even if the industry as a whole faces reduced tariffs. We explore the effect on profits in the following section.

3. Relative Tariff Changes and Profits

With any proposed trade reform, there are two dimensions of interest. The first is market access which has an impact on exporters and is often the focus of exporting countries' trade negotiators; and, second there are domestic concerns arising from the impact on firms who have to deal with the increase in import penetration. The changes in relative market access were addressed in the previous section; in this section, we focus on the implications for domestic firms in each of the successive stages. Given that opposition to trade reform focuses on the potential losers from increased imports (which, in turn, is the source for political opposition), in this section we focus on domestic firms' profits and the potential non-equivalent impact on firms at the upstream and downstream stages. We take the framework outlined above to explore whether there are varying effects on the profits of firms at different vertical stages.

Totally differentiate profits as given by (3) and (12) above, so that for the domestic downstream firm:

$$d\pi_1^d = R_{1,1}dx_1 + R_{1,2}dx_2 - c_1 dx_1 + \pi_{1,c_1}^d dc_1, \tag{23}$$

and, for the domestic upstream firm:

$$d\pi_1^u = R_{1,1}^u dx_1^u + R_{1,2}^u dx_2^u - c_1^u dx_1^u + \pi_{1,c_1}^u dc_1^u. \tag{24}$$

Taking the downstream firm first, divide (23) by dt^d, then:

$$\frac{d\pi_1^d}{dt^d} = \Delta^{-1} a_1 [r_1 R_{1,1} \Delta^{-1} a_2 (1 + p_{1,1}^u) + R_{1,2}]. \tag{25}$$

Assuming the pass-back effect is not 'too strong', i.e., $R_{1,2} > r_1 R_{1,1} \Delta^{-1} a_2 (1 + p_{1,1}^u)$, profits will be reduced with a reduction in the tariff on imports of the final good (which is what one should expect).

In order to consider the effect of the upstream tariff on the downstream firm's profits, divide (23) by dt^u, giving:

$$\frac{d\pi_1^d}{dt^u} = R_{1,1}\frac{dx_1}{dt^u} + R_{1,2}\frac{dx_2}{dt^u} - c_1\frac{dx_1}{dt^u} + \pi_{1,c_1}^d\frac{dc_1}{dt^u}, \tag{26}$$

which can be re-written as:

$$\frac{d\pi_1^d}{dt^u} = [(\Delta^{-1})(R_{1,1}a_1 + R_{1,2}a_2r_2) - x_1]p_{1,1}^u(\Delta^{-1})^u[a_1^u(1+r_1^u)]. \tag{27}$$

Consider (24) for the upstream case. This time, there is no pass-back, only pass-through. So, $c_1\frac{dx_1}{dt^u} = 0$ and $\frac{dc_1}{dt^u}$ is the pass-through effect. So, we have for the effect of the upstream tariff:

$$\frac{d\pi_1^u}{dt^u} = (\Delta^{-1})^u a_1^u[R_{1,1}^u r_1^u + R_{1,2}^u]. \tag{28}$$

This is positive but note that the effect on upstream profits will be different from the downstream case (even setting aside the differences in $R_{1,1}, R_{1,2}$ in the downstream market from the corresponding $R_{1,1}^u, R_{1,2}^u$ in the upstream market) because here upstream costs are constant and do not change unlike in the downstream case. Hence (27) and (28) will not be equal.

Taking (24) and dividing through by dt^d gives:

$$\frac{d\pi_1^u}{dt^d} = (\Delta^{-1})a_2[\Delta^{-1}a_1r_1(1+p_{1,1}^u)](sR_{1,1}^u + (1-s)R_{1,2}^u), \tag{29}$$

for the effect of the downstream tariff. Assuming the pass-back effect is positive (but note the possibility it is not in the strategic complements case), and s is not too small, given $R_{1,1}^u > R_{1,2}^u$, the effect on profits is positive i.e., the expansion at the downstream

stage will benefit the upstream firms, the extent to which this happens depending on s. Again, casual observation suggests that (28) and (29) will not be equal. These effects are summarised in *Proposition 2*:

Proposition 2: Reductions in tariffs at either stage will have a differential effect on firms' profits depending on the stage in which they are located. Reducing tariffs on downstream imports will lower profits for the domestic downstream and upstream firms but the effects will not be equal. Reducing tariffs on the upstream imported good, will lower profits for the domestic upstream firm, but likely increase profits for the domestic downstream firm. The relative magnitude of these effects will depend on the perceived marginal revenue functions at each stage, pass-through and pass-back effects and whether the goods are strategic substitutes or complements.

To focus directly on the issue of tariff (de-)escalation, we take the effects on profits due to a simultaneous change in upstream and downstream tariffs and pose the following question: by how much would the downstream tariff have to change given a unit reduction in the upstream tariff, in order to keep the change in domestic firms' profits equal between the two stages? This rule is implicit in the literature on cascading protection in vertically-related markets (for example, Sleuwaegen *et al*., 1998). There, since the upstream anti-dumping duty transmits injury downstream, firms downstream would seek further anti-dumping protection to counter the negative effects that arise from upstream protection. [5] Formally, this tariff rule is to find $d\hat{t}^{\,d}$ such that:

$$d\hat{t}^{\,d} = \frac{\left[\left(\frac{d\pi_1^d}{dt^u}\right)+\left(\frac{d\pi_1^u}{dt^u}\right)\right]dt^u}{\left(\frac{d\pi_1^d}{dt^d}+\frac{d\pi_1^u}{dt^d}\right)} \qquad (30)$$

It is not clear from casual inspection of (30) what the outcome is since it reflects a combination of the simultaneous change in tariffs at both stages on profits. While the

[5] In this context, the converse of the above rule (30) would be to identify the corresponding antidumping duty for the downstream stage that would arise following the use of an anti-dumping duty in the upstream stage such that the change in profits is the same at both stages.

components of the denominator have the same sign for a reduction in the downstream tariff, the components of the numerator have opposite signs i.e., a reduction in the upstream tariff will increase profits of the domestic downstream firm while a reduction in the upstream tariff will reduce profits of the upstream domestic firm. The net effect will depend on a number of factors including the relative differences in the perceived marginal revenue functions at each stage, coupled with the non-equivalence of the pass-through and pass-back effects. However, depending on the size of the second term in the numerator, (30) will either be greater than or less than one.

Consider, first of all, only the horizontal effects of tariff reductions affecting profits only at the stage in which the tariffs directly apply. Reducing tariffs will reduce profits at both stages though the effect on upstream profits will be greater. This arises from *Proposition 1* which showed that the effect on the upstream stage is greater because of the differences in the perceived marginal revenue functions between the two stages. Adding in the vertical effects changes the outcome but does not outweigh the horizontal effect: both the pass-through and pass-back effects will (typically) be less than 1 and also, given the differences in the perceived marginal revenue functions, pass-back will have a greater impact in reducing profits at the upstream stage than the impact of pass-through in reducing profits at the downstream stage.

The differential effects of tariff reductions on profits in this vertically-related set-up also carry over to the case of strategic complements. The mechanisms are broadly the same though the precise magnitudes will obviously differ. There are two additional points to note about the strategic complements case. First, tariff reductions will likely increase output of the domestic firms given the slope of the reaction functions (see equations (8)

and (9)). Second, the pass-back effect will imply an increase in costs for the domestic downstream firm which serves to disadvantage it and benefit the domestic upstream firm. Again, the non-equivalent effect on downstream and upstream firms' profits persists, though the role that each mechanism plays differs in the strategic complements case.

Clearly, if (30) is greater than one, this would imply tariff de-escalation. In this case, market access and profits for the domestic upstream firm will change by more than those for the domestic downstream firm, and in order to restore vertical parity, downstream tariffs should be reduced by more. Not doing so, results in a differential effect on upstream and downstream firms. If (30) less than one, this would imply downstream tariffs should be reduced by a lesser amount to restore parity. But if this were the case, tariff escalation would have to increase in order to maintain vertical parity, an outcome which would not be satisfactory to exporting countries. In either case, the non-differential impact on profits between stages will have implications for the tariff structure. To deal with vertical parity, if the domestic upstream firm suffers more than the domestic downstream firm, there is a case for downstream tariffs to be reduced by more than upstream tariffs; if the domestic downstream firm suffers more than the domestic upstream domestic firm, then there will be pressure to reduce downstream tariffs by less, but at the expense of market access for exporters.

These results are summarized in the following proposition:

Proposition 3: The differential impact of simultaneous reductions in tariffs, measured by the effect on domestic upstream versus downstream profits has potential implications for the tariff structure post-reform.

To see the relevance of vertical-relatedness in determining the tariff structure from another perspective, suppose we had two unrelated industries that were oligopolistic and

the characteristics of these industries were identical, including the level of tariffs. In this case, reducing tariffs would be identical in terms of market access and profits. Amendment of (30) above would imply changing tariffs by an equal amount; and (30) would therefore equal to 1. However, in the case of successive oligopoly with industries that are vertically-related, the links between stages, coupled with the nature of the downstream stage affecting competition in the upstream stage, give rise to non-equivalent effects such that (30) will unlikely be equal to 1. It is these differences that give rise to the implications for the tariff structure in a vertically-related market set-up.

4. Discussion and Policy Implications

The framework outlined suggests that interaction of horizontal and vertical effects in a successive oligopoly has potential implications for the tariff structure in the context of trade reform. With a benchmark of vertical parity between stages, either tariff escalation or de-escalation could arise. Most obviously, the analysis implies an important justification for formula approaches to tariff reductions that has not been identified before. Not only do they make negotiations potentially simpler (the common justification for such approaches), but they also have some formal basis in terms of the mechanisms that arise in successively oligopolistic markets. The differential impact on market access between stages (*Proposition 1*), and the incentive of domestic upstream and downstream firms to maintain vertical parity in terms of profits (*Proposition 3*), creates an additional limit to the extent of trade liberalization. Restoring vertical parity (in terms of equal losses of profits for the domestic upstream and downstream stages), requires *either*: (i) a benchmark based on highest proportionate losses, where if the domestic upstream firm loses by more, then the downstream firm should lose by an equivalent amount, which

suggests tariff de-escalation; *or* (ii) a benchmark based on the lowest level of profit losses for the domestic downstream firm, which suggests tariff escalation, an outcome that comes at the expense of exporters. A formula approach ensures either that tariff escalation will not arise or that tariff de-escalation will occur.

5. Summary and Conclusions

In this paper, we have focused on the issue of simultaneous changes in tariffs in a vertically-related market where each stage can be imperfectly competitive. We show that, due to a combination of horizontal and vertical mechanisms that arise in a vertically-related market, an identical and simultaneous change in tariffs at each stage is likely to have a differential effect on both market access and profits for domestic firms at each stage; specifically the domestic upstream (downstream) firm will see its profits changing by more than the domestic downstream (upstream). This has potential insights for trade reform and the resulting tariff structure in vertically-related markets that have been largely unexplored. Though tariff reduction formulae have been widely employed as part of the trade negotiating process, their advocacy has often been on an *ad hoc* basis relating to the reduction in tariff peaks that typically arise in more processed goods. As such, rules that promote tariff de-escalation ensure either (a greater extent of) vertical parity in terms of the changes in profits between domestic upstream and downstream firms in successively-oligopolistic markets, or avoid the burden of adjustment falling on exporters if there were tariff escalation. Taken together, in the context of successively oligopolistic markets, the issues addressed here also have implications for developing countries accessing developed country markets, most obviously for more highly-processed/manufactured goods.

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