Market Size and Antidumping in Duopolistic Competition

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1 Introduction

While trade barriers such as tariffs and quotas have been considerably reduced under the role of GATT/WTO, antidumping (AD) actions, first introduced by Canada in 1904, are threatening to become the most important trade restricting device. A product is considered as being dumped "...if the export price...is less than the comparable price...for consumption in the exportimg country" (Article 2.1 WTO AntiDumping Agreement). Most studies view dumping as a sign of price discrimination across national markets, and that is the approach we take here. Our main interest is in the incentives that the existence of an AD Law provides for strategic behaviour on the part of oligopolistic firms selling in each others' segmented national markets.

In this paper we consider a world composed of two country markets, with one firm located in each. Both firms sell in both markets. The countries differ in terms of size, and markets are segmented. In the free trade equilibrium the larger country has the higher price and the firm located in that country "dumps" on the other market. We then consider a two period version of the model, and suppose that the smaller country has in place an Antidumping (AD) law under which dumping in the first period would result in an AD duty imposed in the second, equal to the dumping margin in the first period.

The existence of the AD law provides an incentive for both firms to act strategically in the first period. The dumper will act so as to reduce the duty it faces in the second period. The other firm will act so as to increase the duty faced by its rival. The equilibrium outcome of these strategic interactions is shown to depend on the difference in market sizes.

The remainder of this paper is structured as follows. Section 2 reviews the related literature. Section 3 sets up the model where AD policy is absent, solves for the equilibrium outcomes and identifies the conditions under which one firm dumps in the other country. In section 4, we incorporate AD policy duty and show how this influences the strategic actions of the firms and equilibrium outcomes. The following section show why the dumping firm prefers to moderate its sales in the other market than to behave as in free trade in the first period and leaves that market in the other. Section 6 provides a summary and conclusions.

2 Related Literature (Incomplete)

While Viner's (1923) view of dumping as price discrimination between national markets has been followed by the majority of authors (Zarnic, 2002), other (complementary) explanations have been offered (see e.g. Ethier (1982), Davies and McGuinness (1982) and Anderson (1993)) Our focus is on price discrimination due to differences in market size. Where this happens, an industry in the country where the price is lower, i.e. where dumping takes place, could initiate an AD case by filing an AD petition against the dumping firm. The procedure for investigating the case is divided into two parts. Firstly, the dumping margin (in our case the price difference between two countries) is calculated. Secondly, where the dumping margin is sufficiently high, evidence that dumping causes material injury to the domestic industry is sought. Both dumping and material injury must be found before an AD action can be taken. Since our interest is in the incentives for strategic actions in the markets by the firms involved, we minimise the administrative aspects by assuming that if there is a difference in the prices at which a product is sold in the two markets, dumping will be found in the lower priced market, and, if the firm in that market chooses to file an AD petition, material injury will also be found.

If dumping and material injury are found, an AD duty, usually equal to the dumping margin, can be imposed on each unit of imports from the dumping firm. However, the government may not levy a duty but end the case with some kind of official agreement. For example, in the past the dumping firm may agree to meet a negotiated price (price undertaking) or limit the amount of exports (voluntary export restraint). Anderson (1992) shows that if the export volume permitted under the VER is a proportion of the current sales, allowing a VER would stimulate the foreign firm to dump even further. However, the implementation of voluntary export restraint is now inconsistent with the WTO Agreement Below we therefotren focus on AD actions in the form of AD duty.

Previous studies investigating the effects of AD Laws on firms incentives and actions have included Webb (1992), Reitzes (1993),Veugelers and Vandenbussche (1998) and Pauwels et al. (2001). That such policies may provide an incentive for foreign direct investment has been noted and examined by Haaland and Wooton (1998), Blonigen (1998) and Vandenbussche et al. (1999). The conditions under which the rival firms prefer one or other of the alternative outcomes (i.e. AD duty or price undertaking) has been considered by Prusa (1992), Gupta (1999) and Gupta and Panagariya (1998).

3 Free Trade

In this section we set up a very simple model, designed to highlight the implications of market size differences for the equilibrium outcomes. Here we consider the free trade equilibrium, while in later sections we allow for an AD Law. Let there be two countries, home and foreign (H and F). Each country has one firm, both firms produce a homogeneous product at zero production costs and supply both markets. The two markets are segmented and there are no transport costs. The firms engage in Cournot competition Assume the demand functions for the home and foreign country are, respectively

$$D = A - p; D^* = A^* - p^* \tag{1}$$

where D, p and A denote home demand, price and market size respectively, and * indicates the corrresponding variables for the foreign country[1]. If we let x, x^* denote the home firm's sales in the home and foreign markets, and y, y^* the corresponding sales of the foreign firm, their respective profits are

$$\pi = px + p^*x^* \qquad \text{and} \qquad \pi^* = py + p^*y^*$$

[1]Given that the slope coefficients on the two demand curves are identical, we are using the intercept to designate differences in market size. This implies that the larger market will have the higher price for any given sales volume. clearly this is not the only way to represent differences in market size, and under other representations (e.g. constant price elasticity) there is no particular reason why the larger market should have the higher price.

Maximising profits under the Cournot assumptions yields first order conditions and equilibrium outcomes

$$\frac{\partial \pi}{\partial x} = p - x; \frac{\partial \pi}{\partial x^*} = p^* - x; \frac{\partial \pi^*}{\partial y} = p - y; \frac{\partial \pi^*}{\partial y^*} = p^* - y^* \tag{2}$$

$$x = y = \frac{A}{3}; x^* = y^* = \frac{A^*}{3}; p = \frac{A}{3}; p^* = \frac{A^*}{3} \tag{3}$$

$$\pi = \pi^* = \left[\frac{A}{3}\right]^2 + \left[\frac{A^*}{3}\right]^2; CS = \frac{1}{2}\left[\frac{2A}{3}\right]^2; CS^* = \frac{1}{2}\left[\frac{2A^*}{3}\right]^2 \tag{4}$$

Both firms sell the same amount in each market (but more in the larger market) and earn the same total profits. The price is higher in the larger market, which generates the possibility that the firm from the larger market could be subject to a claim of dumping in the smaller market. The dumping margin (in this case the price difference) will depend on the difference in market size (e.g. in free trade. $p - p^* = \frac{A - A^*}{3}$).

4 Dumping

Now consider a two period, present (1) and future (2), version of this model. For simplicity we assume that the demand functions are as above in both periods, and that agents do not discount the future. Without loss of generality we assume that the home market is larger (i.e. $A > A^*$) and that the foreign country has in place AD Legislation which provides that if the foreign firm files an AD petition and the home firm is found to have dumped in the present (period 1) it will be subject to a tax on its future (period 2) sales in the foreign market equal to the dumping margin (price difference) in the present. It will always be in the interests of the foreign firm to file such a petition if dumping has ocurred in the first period. If the home firm were to ignore this threat and to continue to act as above it would be subject to an antidumping duty of $t = \frac{A - A^*}{3}$ in the future. Given that the home firm recognises that it is able to influence period 1 prices in the two markets, there are essentially four types of response that it can make to the threat of antidumping action - it may ignore it; it may moderate its sales so as to equalise prices in the two markets (at least in the present period); it may moderate its present sales so as to reduce (but not remove) the dumping margin; or it may withdraw from the foreign market entirely in the future (or in the present). We now examine the circumstances (i.e. ranges of market size differences) for which each of these would be the preferred option. Two points are worth emphasising. First, the home firm can adjust its sales in *both* markets in order to reduce or remove the dumping margin. Second, the foreign firm can also influence the dumping margin through its present period sales in both markets and can be expected to strategically modify its behaviour accordingly. The strategic actions of both firms are important in determining the range of possible outcomes.

In the second period, firms maximise their profits, with the home firm subject to antidumping duty t. Hence

$$\text{Home Firm} \qquad \max_{x_2, x_2^*} \; \pi_2 = p_2 x_2 + [p_2^* - t] x_2^* \tag{5}$$

$$\text{Foreign Firm} \qquad \max_{y_2, y_2^*} \; \pi_2^* = p_2 y_2 + p_2^* y_2^* \tag{6}$$

Where $t = \max\{0, p_1 - p_1^*\}$. The equilibrium outcomes are

$$x_2 = y_2 = \frac{A}{3}; x_2^* = \frac{A^* - 2t}{3}; y_2^* = \frac{A^* + t}{3}; p_2 = \frac{A}{3}; p_2^* = \frac{A^* + t}{3} \tag{7}$$

$$\pi_2 = \left[\frac{A}{3}\right]^2 + \left[\frac{A^* - 2t}{3}\right]^2; \pi_2^* = \left[\frac{A}{3}\right]^2 + \left[\frac{A^* + t}{3}\right]^2 \tag{8}$$

Home firm exports are reduced (but are positive as long as $t < \frac{A^*}{2}$) and the foreign price is increased by the antidumping action. Home firm profits fall, foreign firm profits increase. In this case the outcomes in the two periods are linked by the antidumping duty, and we must explicitly consider this link in analysing firm strategies in the first period. Both firms understand these second period consequences at the time that they determine their first period sales.

4.1 Only the Dumping Firm Behaves Strategically

It will assist in the interpretation of our results, if we first solve a more restricted model, where only the home firm acts strategically so as to influence the dumping margin. First, the antidumping duty cannot be negative (i.e. cannot be a subsidy). We can capture this requirement by imposing the the constraint that $p_1 - p_1^* \geq 0$ on the "dumping" firm (since the other firm has no incentive to take actions that reduce the duty).In this case the home firm's optimization problem and corresponding first order conditions are

$$\begin{aligned} \text{Home Firm} \qquad \operatorname*{Max}_{x_1,x_1^*} \pi &= p_1 x_1 + p_1^* x_1^* + \pi_2(p_1 - p_1^*) \qquad (9) \\ \text{subject to} \qquad p_1 - p_1^* &\geq 0 \end{aligned}$$

$$\frac{\partial \pi}{\partial x_1} = p_1 - x_1 + \frac{4}{9}\{A^* - 2[p_1 - p_1^*]\} - \lambda \qquad (10)$$

$$\frac{\partial \pi}{\partial x_1^*} = p_1^* - x_1^* - \frac{4}{9}\{A^* - 2[p_1 - p_1^*]\} + \lambda \qquad (11)$$

where $x_1, x_1^*, \lambda \geq 0$, and λ is the Lagrange multiplier for the price inequality constraint, implying that $\lambda[p_1 - p_1^*] = 0$. Compared with free trade, the home firm tends to switch sales from the foreign to the home market, thereby reducing the antidumping duty that it faces next period. Two points should be noted. First, the incentives to adjust sales in the two markets are equal in magnitude but of opposite sign. This implies a tendency to switch sales between markets, rather than to adjust total production and sales. Second, the incentive to switch sales in this way is stronger the larger are the firm's second period sales in the foreign market (i.e. the larger are the profits obtained in that market in the second period). Since these second period sales are negatively related to the dumping margin, the smaller the (free trade) dumping margin the larger the incentive to switch sales. These feature is reflected in the solutions that follow, where the dumping firm takes no strategic action once the difference in market sizes is sufficient to generate a prohibitive antidumping duty in free trade. The foreign firm's optimisation function and first order conditions are

$$\max_{y_1, y_1^*} \pi_1^* = p_1 y_1 + p_1^* y_1^* \qquad (12)$$

$$\frac{\partial \pi^*}{\partial y_1} = p_1 - y_1 \qquad (13)$$

$$\frac{\partial \pi^*}{\partial y_1^*} = p_1^* - y_1^* \qquad (14)$$

Solving (11), (12), (16) and (17) yields three potential types of equilibrium outcomes, depending on the difference in market size. We consider each in turn.

4.1.1 Temporary Market Integration.

In this case $p_1 = p_1^* = p_i$ and the equilibrium solutions are

$$x_1 = \frac{2A - A^*}{3}; x_1^* = \frac{2A^* - A}{3}; y_1 = y_1^* = \frac{A + A^*}{6} = p_i \tag{15}$$

$$\lambda = \frac{17A^* - 9A}{18} \tag{16}$$

The second period outcomes are as in free trade. For this to be a feasible equilibrium we require that all outputs, prices and λ be non-negative, which holds if $A^* \leq A \leq \frac{17}{9}A^*$. At the upper bound of this range $\lambda = 0$. Compared with free trade, the total sales of the two firms are unchanged, with the home (foreign) firm selling more (less) in the home market and less (more) in the foreign, but the net result is that total sales rise in the home market and fall in the foreign so that the prices are equalised. Total trade falls in the first period.

$$\Delta[x_1 + x_1^*] = \Delta[y_1 + y_1^*] = 0; \Delta[x_1 + y_1] = -\Delta[x_1^* + y_1^*] = \frac{A - A^*}{6}$$

$$\Delta x_1 = -\Delta x_1^* = \frac{A - A^*}{3}; \Delta y_1 = -\Delta y_1^* = -\frac{A - A^*}{6}; \Delta[x_1^* + y_1] = -\frac{A - A^*}{2}$$

The profits of the home (foreign) firm rise (fall) in the home market and fall (rise) in the foreign, but the net change is a fall in first period profits, and therefore a fall in overall profits, for both firms. Consumer surplus rises in the home country and falls in the foreign, following the equalisation of prices When these terms are combined we find that home welfare rises, but foreign welfare falls.

$$\Delta\pi = \Delta\pi^* = -\frac{[A - A^*]^2}{18}$$

$$\Delta CS = \frac{1}{2}\frac{[A - A^*]}{6}\frac{[9A - A^*]}{6} > 0; \Delta CS^* = -\frac{1}{2}\frac{[A - A^*]}{6}\frac{[9A^* - A]}{6} < 0$$

$$\Delta W = \frac{[A - A^*]}{6}\frac{[5A + 3A^*]}{12} > 0; \Delta W^* = -\frac{[A - A^*]}{6}\frac{[3A + 5A^*]}{12} < 0$$

Thus if the difference in market size is small, the threat of an antidumping duty in the second period is sufficient for the potential dumper to adjust its sales so that prices are equalised in the first period and therefore no dumping is found and no duty imposed in the second period. The result is that both firms profits fall, and home consumers gain and foreign consumers lose. Overall, there is a net gain to the larger country and a net loss to the smaller. The country that threatens the antidumping action is actually worse off, both in terms of profit and consumer surplus. One can see that it is in the interests of large countries to encourage their smaller trading partners to adopt antidumping legislation in such circumstances.

4.1.2 Moderated Dumping.

Where the difference in market sizes is larger the dumping firm moderates its behaviour but not to the point of full price equalisation. Now $p_1 > p_1^*$ and $\lambda = 0$, and the equilibrium solutions are

$$x_1 = \frac{40A - 5A^*}{33}; x_1^* = \frac{16A - 29A^*}{33}; x_2^* = 3\frac{[5A^* - 2A]}{11} \tag{17}$$

$$p_1 = \frac{19A - 20A^*}{33}; p_1^* = \frac{31A^* - 8A}{33}; p_1 - p_1^* = \frac{9A - 17A^*}{11} \tag{18}$$

$$y_1 = \frac{19A - 20A^*}{33}; y_1^* = \frac{31A^* - 8A}{33}; y_2^* = \frac{3A - 2A^*}{11} \tag{19}$$

The range of demand differences for which this is a feasible equilibrium is $\frac{17}{9}A^* < A < \frac{5}{2}A^*$, with $p_1 = p_1^*$ at the lower bound and $x_2^* = 0$ at the upper bound. In this case an antidumping duty is imposed on the home firm's sales in the foreign market in the second period, and as a consequence total sales in that market fall. Again the total first period sales of the two firms are unchanged, but the home firm sells more in the home market and less in the foreign, and the foreign firm does the opposite. Total sales in the home market rise, while total sales in the foreign market fall, but not by enough to equalise prices.

$$\begin{aligned}
\Delta[x_2^* + y_2^*] &= -\frac{[9A - 17A^*]}{33} < 0; \Delta[x_1 + x_1^*] = \Delta[y_1 + y_1^*] = 0 \\
\Delta x_1 &= -\Delta x_1^* = \frac{8[5A^* - 2A]}{33}; \Delta y_1 = -\Delta y_1^* = -\frac{4[5A^* - 2A]}{33} \\
\Delta[x_1 + y_1] &= -\Delta[x_1^* + y_1^*] = \frac{4[5A^* - 2A]}{33}
\end{aligned}$$

As in the case of temporary market integration, the home firm's first period profits rise in the home market, fall in the foreign market and fall overall. Its second period profits in the foreign market are adversely affected by the antidumping duty, and thus its profits over the two periods decline. The foreign firm's first period profits decline in the home market, rise in the foreign market and decline overall. Its second period profits increase. The change in the foreign firm's total profits switches sign within this range. Early on, the first period prices are almost equalised and the antidumping duty imposed on its rival in the second perod is quite small. Thus foreign firm profits fall. However, towards the end of the range, first period prices, and hence profits, are almost unchanged from free trade, while the antidumping duty levied in the second period is quite large. The net result is an increase in the foreign firm's profits.

$$\begin{aligned} \Delta\pi_1 &< 0; \Delta\pi_2 < 0; \Delta\pi < 0; \Delta\pi_1^* < 0; \Delta\pi_2^* > 0 \\ \Delta\pi^* &\gtreqless 0 \text{ as } A \gtreqless 2.14A^* \end{aligned}$$

Consumer surplus increases in the home country in the first period, but the gain is small later in the range, as the home market price is very similar to free trade. When the change in home firm profits and home consumer surplus are combined, the net result is a gain in home welfare early in the range, and a net loss of home welfare later in the range. Foreign consumer surplus declines in both periods, but foreign welfare now consists of consumer surplus plus profits plus antidumping revenues (R*). The latter is zero at each end of the range, and peaks when $A = 2.19A^*$. when these terms are combined we find a foreign welfare loss early in the range becomes a foreign welfare gain towards the end.

$$\begin{aligned} \Delta CS &> 0; \Delta CS^* < 0; R^* = 3\frac{[9A - 17A^*]}{11}\frac{[5A^* - 2A]}{11} > 0 \\ \Delta W &\lesseqgtr 0 \text{ as } A \gtreqless 2.27A^*; \Delta W^* \gtreqless 0 \text{ as } A \gtreqless 2.35A^* \end{aligned}$$

4.1.3 Unconstrained Dumping

However, when the difference in market sizes becomes sufficiently large, the outcome has the first period equilibrium as in free trade and the home firm does not sell in the foreign market in the second period, because the antidumping duty is prohibitive. The second period equilibrium solutions are then as in free trade in the home market and a foreign firm monopoly in the foreign market.

$$x_2 = y_2 = p_2 = \frac{A}{3}; x_2^* = 0; y_2^* = p_2^* = \frac{A^*}{2} \tag{20}$$

The home firm's profits fall, the foreign firm's profits rise. Home consumer surplus is unchanged, foreign consumer surplus falls. There is no antidumping revenue. Home welfare falls, foreign welfare rises.

$$\begin{aligned} \Delta CS &= 0; \Delta\pi = \Delta W = -[\frac{A^*}{3}]^2 < 0; \\ \Delta\pi^* &= 5[\frac{A^*}{6}]^2 > 0; \Delta CS^* = -\frac{7}{2}[\frac{A^*}{6}]^2 < 0; \Delta W^* = \frac{3}{2}[\frac{A^*}{6}]^2 > 0 \end{aligned}$$

These price outcomes are illustrated, in Figure 1 (not included). If the difference in market size is sufficiently small ($A < \frac{17}{9}A^*$), then the home firm adjusts its sales in the two markets so as to equalise product prices, thereby avoiding the antidumping duty in the second period. Where the market size difference is slightly larger ($\frac{17}{9}A^* < A < \frac{5}{2}A^*$), the home firm adjusts its sales so as to moderate the duty it faces in the second period. For larger market size differences, the home firm finds it optimal to abandon the foreign market in the second period as the antidumping duty is prohibitive.

These are the outcomes of the strategic actions the home firm would undertake were the foreign firm to remain a passive Cournot competitor. The threat of the antidumping duty will remove or moderate dumping, except where the difference in market sizes is large. The dumping firm is worse off and the foreign firm is only better off if the difference in market sizes is large enough that moderation of the price difference is slight. But given that the foreign firm also has an incentive to act strategically, we now return to the more general case.

4.2 Both Firms Behave Strategically (Incomplete)

As noted above, the antidumping duty imposed on the home (dumping) firm's sales in the foreign market in the second period is equal to any dumping margin (price differential) found in period 1. However, regardless of this price differential, no duty will be imposed if the home firm makes no sales in the foreign country in the first period. This has the complication of generating a discontinuity in our functions at $x_1^* = 0$, for as x_1^* approaches 0 from above a finite dumping margin applies, but this drops to zero when first period exports cease. We show in the Appendix that abandoning the foreign market is not an equilibrium outcome for the home firm in the first period. But reducing "dumped" foreign sales to a minimal level in the first period will be an equilibrium outcome for some differences in market sizes. To encompass this feature we therefore constrain $x_1^* \geq \varepsilon$, where ε is some arbitrarily small positive amount, which can be thought of as the minimum detectable level of dumping.

The second period equilibrium outcomes are as in (7) and (8) above, and these solutions indicate a further constraint that must be imposed on the antidumping duty. These expressions for second period profits only apply if the antidumping duty is no greater than the prohibitive duty. From that point the home firm ceases to export in the second period, leaving the foreign firm to act as a monopolist in the foreign market. We can capture this requirement by imposing the constraint that $p_1 - p_1^* \leq \frac{A^*}{2}$on the firm in the dumped market (since the dumping firm has no incentive to take actions that raise the duty), and restrict attention to the range of market sizes for which the free trade dumping margin would be less than the prohibitive duty (i.e. $A \leq \frac{5A^*}{2}$) in the first instance.

Both firms understand these second period consequences at the time that they determine their first period sales. The profit maximisation problems facing the two firms at the beginning of the first period are now

$$\max_{x_1, x_1^*} \pi = p_1 x_1 + p_1^* x_1^* + (\frac{A}{3})^2 + \pi_2$$

subject to $x_1^* \geq \varepsilon$ and $p_1 - p_1^* \geq 0$

$$\max_{y_1, y_1^*} \pi^* = p_1 y_1 + p_1^* y_1^* + (\frac{A}{3})^2 + \pi_2^*$$

subject to $p_1 - p_1^* \geq \frac{A^*}{2}$

Including these constraints, the respective objective functions for the home and foreign firm can be written as

$$\max_{x_1, x_1^*} \Pi = p_1 x_1 + p_1^* x_1^* + (\frac{A}{3})^2 + \left[\frac{A^* - 2(p_1 - p_1^*)}{3}\right]^2 + \lambda(p_1 - p_1^*) + \eta(x_1^* - \varepsilon) \quad (21)$$

$$\max_{y_1,y_1^*} \Pi^* = p_1y_1+p_1^*y_1^*+(\frac{A}{3})^2+\left[\frac{A^*+(p_1-p_1^*)}{3}\right]^2+\gamma\left[\frac{A^*}{2}-(p_1-p_1^*)\right] \quad (22)$$

where λ, η, and γ are lagrange multipliers for the inequality constraints, $p_1-p_1^*\geq 0$, $x_1^*\geq\varepsilon$, and $\frac{A^*}{2}\geq(p_1-p_1^*)$ respectively.

The demand functions for the home and foreign country are

$$p_1 = A - x_1 - y_1$$

$$p_1^* = A^* - x_1^* - y_1^*.$$

For () and (), the Kuhn-Tucker conditions are

$\frac{\partial\Pi}{\partial x_1}\leq 0; x_1\geq 0; x_1\frac{\partial\Pi}{\partial x_1}=0;$ $\frac{\partial\Pi}{\partial x_1^*}\leq 0; x_1^*\geq\varepsilon;$ $\frac{\partial\Pi^*}{\partial y_1}\leq 0; y_1\geq 0 y_1\frac{\partial\Pi^*}{\partial y_1}=0;$ $\frac{\partial\Pi^*}{\partial y_1^*}\leq 0; y_1^*\geq 0; y_1^*\frac{\partial\Pi}{\partial y_1^*}=0$

$\frac{\partial\Pi}{\partial\lambda}=p_1-p_1^*\geq 0;\lambda\geq 0;\lambda\frac{\partial\Pi}{\partial\lambda}=0;$ $\frac{\partial\Pi}{\partial\eta}=x_1^*-\varepsilon\geq 0;\eta\geq 0;\eta\frac{\partial\Pi}{\partial\eta}= 0$

$\frac{\partial\Pi^*}{\partial\gamma}=\frac{A^*}{2}-[p_1-p_1^*]\geq 0;\gamma\geq 0;\gamma\frac{\partial\Pi^*}{\partial\gamma}=0$

In this case the derivatives of the optimisation function with respect to each of the sales are:

$$\frac{\partial\Pi}{\partial x_1} = p_1 - x_1 + \frac{4}{9}\left[A^* - 2(p_1-p_1^*)\right] - \lambda \quad (23)$$

$$\frac{\partial\Pi}{\partial x_1^*} = p_1^* - x_1^* - \frac{4}{9}\left[A^* - 2(p_1-p_1^*)\right] + \lambda + \eta \quad (24)$$

$$\frac{\partial\Pi}{\partial y_1} = p_1 - y_1 - \frac{2}{9}\left[A^* + (p_1-p_1^*)\right] + \gamma \quad (25)$$

$$\frac{\partial\Pi^*}{\partial y_1^*} = p_1^* - y_1^* + \frac{2}{9}\left[A^* + (p_1-p_1^*)\right] - \gamma \quad (26)$$

These conditions are again informative about the properties of the equilibrium outcomes. Compared with free trade, the dumping firm has an incentive towards higher domestic sales and smaller exports, thereby moderating the price difference. The foreign firm's incentives are to do the opposite. For each firm the incentives to adjust domestic sales and exports are equal in magnitude and opposite in sign, except when the home firm is bound by the minimum export constraint ($x_1^* - \varepsilon \geq 0$). This again implies equilibrium outcomes where sales are switched between markets, but each firm's total output is unchanged from free trade. The strengths of these incentives to reallocate sales between markets depends on the size of second period sales in the foreign market (which determines second period profits in that market). Thus the incentive for the home firm to reallocate sales so as to reduce the price differential is larger the smaller the dumping margin (price differential), while the incentive for the foreign firm to reallocate sales is larger the larger the dumping margin. [In fact the home firm has no incentive to reallocate sales when the free trade dumping margin is prohibitive - i.e.$\frac{A^*}{2} = [p_1 - p_1^*]$] These considerations are reflected in the solutions discussed below (and derived in the Appendix). For small differences in market size, when the underlying free trade price differential is also small, the strategic behaviour of the home firm dominates the equilibrium and the dumping margin is reduced. But for larger differences in market size it is the strategic behaviour of the foreign firm that dominates, and the dumping margin increases relative to free trade. [The cross over point is where the two firms face equal incentives - i.e. $\frac{2}{9}[A^* + (p_1 - p_1^*)] = \frac{4}{9}[A^* - 2(p_1 - p_1^*)]$ which occurs when $A = \frac{8}{5}A^*$].

Equating the first order conditions for each of the first period sales with zero and using the demand functions, we can solve for p_1 and p_1^* in terms of parameters and Lagrange multipliers as

$$p_1 = \frac{17A - 16A^* + 27\lambda + 10\eta - 27\gamma}{21} \tag{27}$$

$$p_1^* = \frac{23A^* - 10A - 27\lambda - 17\eta + 27\gamma}{21}. \tag{28}$$

Then the price differential, which determines the size of duty, is

$$p_1 - p_1^* = \frac{9A - 13A^* + 18\lambda + 9\eta - 18\gamma}{7}. \tag{29}$$

Three main types of outcomes arise, depending on the relative market size.

4.2.1 Temporary Market Integration

Where this is the case, the two prices are equalised in the first period (i.e. $p_1 - p_1^* = 0$ implying $\lambda \geq 0$). In the second period, the solutions are the same as in free trade since there is no duty being collected. There are two subcases of market integration.

If $x_1^* > \varepsilon$ ($\eta = 0$), then

$$p_1 - p_1^* = \frac{9A - 13A^* + 18\lambda}{7} = 0 \qquad \text{and} \qquad \lambda = \frac{13A^* - 9A}{18}$$

Substituting λ into () or () yields the equilibrium prices as

$$p_1 = p_1^* = \frac{A + A^*}{6}.$$

Then substitute p_1, p_1^* and λ into the first order conditions. The output equilibria then can be solved as

$$x_1 = \frac{6A - A^*}{9}; x_1^* = \frac{4A^* - 3A}{9}$$

$$y_1 = \frac{3A - A^*}{18}; y_1^* = \frac{3A + 7A^*}{18}.$$

All outputs and prices are positive, as long as $A^* < A \leq \frac{4}{3}A^* - 3\ \varepsilon$. At the upper bound, x_1^* becomes ε and we switch to the second subcase. Compared with free trade, the total sales of each firm is unchanged, but each has switched sales towards its domestic market, thereby reducing trade. The net result is that the total sales rise in the home market and fall in the foreign, thereby equalising prices. This is the same price outcome as occurred when only the dumping firm behaved strategically, but the extent of sales diversion towards domestic markets is larger and trade shrinks by more as a consequence.

$$\begin{aligned}
\Delta[x_1 + x_1^*] &= \Delta[y_1 + y_1^*] = 0; \Delta[x_1 + y_1] = -\Delta[x_1^* + y_1^*] = \frac{A - A^*}{6} \\
\Delta x_1 &= -\Delta x_1^* = \frac{3A - A^*}{9}; \Delta y_1 = -\Delta y_1^* = -\frac{3A + A^*}{18}; \Delta[x_1^* + y_1] = -\frac{9A - A^*}{18}
\end{aligned}$$

Eventually home exports become negligable leading to the second subcase where $x_1^* = \varepsilon$ ($\eta \geq 0$). Equilibrium prices and outputs then are

$$\lambda = \frac{25A^* - 18A - 27\varepsilon}{18} \qquad \text{and} \qquad \frac{9\varepsilon + 3A - 4A^*}{3} \geq \eta \geq 0 \tag{30}$$

$$p_1 = p_1^* = \frac{7A^* - 9\epsilon}{18}$$

$$x_1 = \frac{9A - 5A^* + 9\varepsilon}{9}; x_1^* = \varepsilon; y_1 = \frac{A^* - 3\varepsilon}{6}; y_1^* = \frac{11A^* - 9\varepsilon}{18}$$

This yields a feasible equilibrium as long as $\frac{4}{3}A^* - 3\varepsilon \leq A < \frac{25}{18}A^* - \frac{3}{2}\varepsilon$. The lower bound to this range coincides with the upper bound of the previous case, and it is the point at which the constraint $x_1^* \geq \varepsilon$ starts to bind ($\eta = 0$). At the upper bound we have $\lambda = 0$, indicating that this is the maximum market size difference for which $p_1 - p_1^* = 0$ is an equilibrium outcome. For larger market size differences we switch from temporary market integration to moderated dumping.

In this range the home firm's ability to switch sales from exports to its domestic market is constrainedbecause exports are at the minimal level. Compared with free trade, total home firm output rises, since domestic sales increase over the range. Total foreign firm sales are constant over this range, and are less than in free trade (reflecting that firm's outputs are strategic substitutes). this firm exports less and sells more in its domestic masrket. Total sales in the home market increase, total sales in the foreign market fall, and trade is reduced.

$$\begin{aligned}
\Delta[x_1 + x_1^*] &= -2\Delta[y_1 + y_1^*] = \frac{6A - 8A^* + 18\varepsilon}{9} > 0; \\
\Delta[x_1 + y_1] &= \frac{6A - 7A^* + 9\varepsilon}{18} > 0; \quad \Delta[x_1^* + y_1^*] = -\frac{A^* - 9\varepsilon}{18} \\
\Delta x_1 &= \frac{6A - 5A^* + 9\varepsilon}{9} > 0; \Delta x_1^* = -\frac{A^* - 3\varepsilon}{3} < 0; \\
\Delta y_1 &= \frac{A^* - 2A - 2\varepsilon}{6} < 0; \Delta y_1^* = \frac{5A^* - 9\varepsilon}{18} > 0 \\
\Delta[x_1^* + y_1] &= -\frac{2A + A^* - 3\varepsilon}{6} < 0
\end{aligned}$$

4.2.2 Moderated Dumping

Where moderated dumping is the outcome, a less than prohibitive duty is actually imposed in period 2. Again there are two subcases. For small differences in market size in this range we have $x_1^* = \varepsilon$ $(\eta \geq 0)$ .The solution we obtain has

$$0 \leq \eta \leq \frac{3A^* - 2A + 3\varepsilon}{4}. \tag{31}$$

Using (45), (46), and (48) obtain the price equilibria as

$$p_1 = \frac{24A - 17A^* + 15\varepsilon}{42} \quad \text{and} \quad p_1^* = \frac{41A^* - 6A - 51\varepsilon}{84}$$

And the dumping margin becomes

$$p_1 - p_1^* = \frac{18A - 25A^* + 27\varepsilon}{28}.$$

The period-1 output equilibria are

$$x_1 = \frac{5A^* - 3\varepsilon}{6}; x_1^* = \varepsilon$$

$$y_1 = \frac{3A - 3A^* + \varepsilon}{7}; \quad \text{and} \quad y_1^* = \frac{6A + 43A^* - 33\varepsilon}{84}.$$

As regards the period-2 equilibrium, sales in the foreign country now reflect the duty as follows.

$$p_2^* = y_2^* = \frac{6A + A^* + 9\varepsilon}{28}.$$

And

$$x_2^* = \frac{13A^* - 6A - 9\varepsilon}{14}.$$

This solution is feasible over the range $\frac{25}{18}A^* - \frac{3}{2}\varepsilon < A < \frac{3}{2}A^* + \frac{3}{2}\varepsilon$, with $p_1 = p_1^*$ at the lower bound and $\eta = 0$ at the upper bound (i.e. $x_1^* = \varepsilon$ ceases to be binding). Again in this range the home firm's ability to switch sales from exports to its domestic market is constrained by the lower bound on exports. Compared with free trade, the home firm exports less, sells more domestically and produces more overall. The foreign firm also exports less and sells more domestically, but produces less overall. Total sales in the home market rise and in the foreign market fall, but not enough to equalise prices. Trade falls.

$$
\begin{aligned}
\Delta[x_1 + x_1^*] &= -2\Delta[y_1 + y_1^*] = \frac{3A^* - 2A + 3\varepsilon}{6} \geq 0; \\
\Delta[x_1 + y_1] &= \frac{17A^* - 10A - 15\varepsilon}{42} > 0; \quad \Delta[x_1^* + y_1^*] = \frac{6A - 13A^* + 51\varepsilon}{84} < 0 \\
\Delta x_1 &= \frac{5A^* - 2A - 3\varepsilon}{6} > 0; \Delta x_1^* = -\frac{A^* - 3\varepsilon}{3} < 0; \\
\Delta y_1 &= \frac{2A - 9A^* + 3\varepsilon}{21} < 0; \Delta y_1^* = \frac{2A + 5A^* - 11\varepsilon}{28} > 0 \\
\Delta[x_1^* + y_1] &= \frac{2A - 16A^* + 24\varepsilon}{21} < 0
\end{aligned}
$$

We then moveto the second subcase where no constraints are binding, and

$$p_1 = \frac{17A - 16A^*}{21}; p_1^* = \frac{23A^* - 10A}{21}$$

$$p_1 - p_1^* = \frac{9A - 13A^*}{7}$$

$$x_1 = \frac{4A^* - A}{3}; x_1^* = \frac{2A - 3A^*}{3}$$

$$y_1 = \frac{11A - 12A^*}{21}; y_1^* = \frac{19A^* - 4A}{21}$$

$$p_2^* = y_2^* = \frac{3A - 2A^*}{7}$$

$$x_2^* = \frac{11A^* - 6A}{7}.$$

For these equilibrium prices and outputs to be positive, we require that $\frac{3}{2}A^* + \frac{3}{2}\varepsilon < A < \frac{11}{6}A^*$. At the lower bound $x_1^* = \varepsilon$. At the upper bound, $x_2^* = 0$ because when $A = \frac{11}{6}A^*$, the duty reaches the prohibitive level $(\frac{A^*}{2})$. For this range of relative market sizes, neither firm is 2constrained" and each produces the same total output as in free trade, but sells more in its domestic maket and consequently exports less. Trade falls, The most striking feature of these outcomes is that the dumping margin actually increases, relative to free trade, in the latter part of the range (i.e. once $A \geq \frac{8}{5}A^*$). Prior to this point, sales in the home market are higher, and the price is lower than in free trade, while after this point the reverse is true. The opposite holds for the foreign market. The AD Law has increased the dumping margin due to the strategic actions of the two firms. As noted above, once $A \geq \frac{8}{5}A^*$, the incentiive for strategic action is stronger for the foreign firm, hence this apparently counterintuitive outcome.

$$\begin{aligned}
\Delta[x_1 + x_1^*] &= \Delta[y_1 + y_1^*] = 0; \Delta[x_1 + y_1] = -\Delta[x_1^* + y_1^*] \gtreqqless 0 \; ; \Delta DM \lesseqqgtr 0 \text{ as } A \lesseqqgtr \frac{8}{5}A^* \\
\Delta x_1 &= -\Delta x_1^* > 0; \Delta y_1 = -\Delta y_1^* < 0; \Delta[x_1^* + y_1] < 0
\end{aligned}$$

4.2.3 Prohibitive Dumping ($\frac{A^*}{2} = p_1 - p_1^*$ and $\gamma \geq 0$)

In this range the first period price differential implies an antidumping duty at the prohibitive level (i.e. $\frac{A^*}{2} = p_1 - p_1^*$). The foreign firm then becomes a monopolist in its local market in the final period.

$$p_1 - p_1^* = \frac{9A - 13A^* - 18\gamma}{7} = \frac{A^*}{2} \tag{32}$$

Equation (51) can be rearranged as

$$\gamma = \frac{6A - 11A^*}{12}. \tag{33}$$

Substituting (52) into (49) and (50) yields the following equilibrium prices

$$p_1 = \frac{2A + 5A^*}{12} \text{ and } p_1^* = \frac{2A - A^*}{12}$$

Using the equilibrium prices and the first order conditions, it follows that

$$x_1 = \frac{2A + 5A^*}{12}; \quad x_1^* = \frac{2A - A^*}{12}$$

$$y_1 = \frac{4A - 5A^*}{6}; \quad y_1^* = \frac{7A^* - 2A}{6}.$$

The relevant range of relative market sizes in this case is $\frac{11}{6}A^* < A < \frac{5}{2}A^*$ where $\gamma = 0$ at the lower bound and we remain with the free trade equilibrium at the upper bound. In this range the strategic actions of the firms, particularly the foreign firm, result in a higher dumping margin than in free trade in the first period. Firms total sales are unchanged from free trade, with more sold domestically and less exported. Total sales fall in the home market and rise in the foreign, which generates the higher dumping margin. Total trade falls. At the end point of this range , the first period equilibrium is unchanged from free trade, and this is the outcome that prevails for market size differences where $A \geq \frac{5}{2}A^*$.

$$\begin{aligned}
\Delta[x_1 + x_1^*] &= \Delta[y_1 + y_1^*] = 0; \Delta[x_1^* + y_1^*] = -\Delta[x_1 + y_1] = \frac{5A^* - 2A}{12} = \frac{1}{2}\Delta DM \geq 0 \ ; \\
\Delta x_1 &= -\Delta x_1^* = -\frac{1}{2}\Delta y_1 = \frac{1}{2}\Delta y_1^* \geq 0; \Delta[x_1^* + y_1] = \frac{2A - 5A^*}{4} \leq 0.
\end{aligned}$$

4.3 Price Undertakings (Incomplete)

In this section we introduce the possibility that a firm found to have dumped in the first period may undertake to equalise prices across markets in the second period (i.e. stop dumping) in preference to paying an AD duty. We assume that the choice of price undertaking or AD duty is made by the dumper alone. Clearly the presence of this option will affect the equilibrium outcomes in both periods. We assume that the foreign firm continues to act as a Cournot competitor in the second period. We begin by determining the range of market size differences over which the price undertaking option is feasible. The equilibrium outputs correspond to those under temporary market integration when only the home firm behaves strategically. We can see from ( ) above that this requires $A \leq 2A^*$. When the market size difference exceeds this, then a price undertaking is not feasible.

The price undertaking involves lower profits for the dumping firm, relative to free trade, as does an AD duty. We can solve for the "equivalent duty" (τ) - i.e. the duty that leaves the dumping firm with the same second period profits as under the price undetaking from

$$\left[\frac{A}{3}\right]^2 + \left[\frac{A^* - 2\tau}{3}\right]^2 = \frac{1}{2}\left[\frac{A + A^*}{3}\right]^2$$

which yields solution

$$\tau = \frac{A^*}{2} - \left[\frac{A^{*2} + 2AA^* - A^2}{8}\right]^{\frac{1}{2}}$$

Thus the dumping firm chooses the price undertaking if the first period dumping margin $DM_1 = p_1 - p_1^* \geq \tau$ and pays the duty otherwise.

An interesting aspect of the comparison between the AD duty and the price undertaking, is that while the foreign firm will always file a dumping claim if this leads the home firm being subject to a duty, the foreign firm prefers free trade in the second period to a home firm price undertaking, since

$$\left[\frac{A}{3}\right]^2 + \left[\frac{A^* + \tau}{3}\right]^2 > \left[\frac{A}{3}\right]^2 + \left[\frac{A^*}{3}\right]^2 > \frac{1}{2}\left[\frac{A + A^*}{3}\right]^2$$

This implies that the foreign firm will never file a dumping claim if it knows that the home firm will choose the price undertaking option. The second period profits for the two firms when the price undertaking option is included are then

$$\pi_2 = \left[\frac{A}{3}\right]^2 + \left[\frac{A^* - 2DM_1}{3}\right]^2 \quad \text{if } DM_1 < \tau; \text{ and } = \left[\frac{A}{3}\right]^2 + \left[\frac{A^*}{3}\right]^2 \quad \text{if } DM_1 \geq \tau \tag{34}$$

$$\pi_2^* = \left[\frac{A}{3}\right]^2 + \left[\frac{A^* + DM_1}{3}\right]^2 \quad \text{if } DM_1 < \tau; \text{ and } = \left[\frac{A}{3}\right]^2 + \left[\frac{A^*}{3}\right]^2 \quad \text{if } DM_1 \geq \tau \tag{35}$$

A second interesting aspect of the comparison between policies, is that there is a sense in which the first period objectives of the two firms have been reversed. Now the home firm would prefer a first period dumping margin above the equivalent duty, as then the foreign firm will not file, while the foreign firm will prefer a dumping margin below the equivalent duty as then it can file knowing that the home firm will opt for the duty.

One can also show that the free trade dumping margin DM_1^f is larger than the equivalent duty over the range of market size differences for which the price undertaking is feasible. This involves solving from

$$DM_1^f = \frac{A - A^*}{3} = \frac{A^*}{2} - \left[\frac{A^{*2} + 2AA^* - A^2}{8}\right]^{\frac{1}{2}} = \tau$$

and finding two solutions, $A = A^*$ and $A = \frac{41}{17}A^* > 2A^*$. So we have $DM_1^f > \tau$ over the relevant range. If only the dumping firm behaves strategically then, it will note that the profit maximising free trade output in the first period will lead to a dumping margin that exceeds the equivalent duty and hence would lead the firm to choose the price undertaking in the second period if an AD action were filed. The foreign firm will not file in such circumstances, leading to the free trade output in the second period also. Hence the home firm will not vary its behaviour from one period Cournot, and free trade will continue in both periods.

When both firms behave strategically, we now have the potential for two equilibria. If $DM_1 \geq \tau$, then the first order conditions are as for free trade, and the free trade outcome is therefore a potential first period solution over the relevant range. If $DM_1 < \tau$, then the first order conditions are as derived in the duty only case above, and hence that equilibrium is also possible here, AS LONG AS the implied dumping margin (DM_1^t) is less than the equivalent duty. This is clearly true over the full range of temporary market integration. It is also true for part of the range of moderated dumping where the constraint applies to dumped sales (i.e. $x_1^* = \varepsilon$) as found by solving

$$DM_1^t = \frac{18A - 25A^*}{28} = \frac{A^*}{2} - \left[\frac{A^{*2} + 2AA^* - A^2}{8}\right]^{\frac{1}{2}} = \tau$$

So when $A \leq 1.42A^*$, the first period outcome under the duty only option is still an equilibrium solution. When $A > 1.42A^*$, we have $A \leq 1.42A^* > \tau$ the price undertaking will be preferred by the dumper and no action will be filed.

In summary, if both firms act strategically, there are two possible equilibria when market sizes are not too different (i.e. $A \leq 1.42A^*$). These are free trade in both periods and the solutions derived for the duty only case above. Interestingly both firms prefer the free trade outcome, so one expects they would have no difficulty coordinating on that equilibrium. When market sizes less similar, free trade is the only equilibrium, despite the existence of the AD Law and the presence of dumping in the first period.

5 Conclusion (Incomplete)

This paper has examined the incentives for strategic action by duopolistic competitors generated by the existence of an AD Law in the smaller market. To do this we set up a simple model of two country markets, with linear demands differering only in their intercepts (our indicator of country size). There were two firms, identical except for their locations (one in each market). The equilibrium generated by these actions depends on the difference in market sizes. For small difference, the outcome is market integration.

APPENDIX In this Appendix we derive the solutions for the case where

both firms behave strategically. We also show that it will never be in the interests of the dumping firm to completely withdraw from the foreign market in the first period.

$x_1^* > \varepsilon(\eta = 0)$, $p_1 = p_1^*$ $(\lambda \geq 0)$, and $\gamma = 0$:

Equation (34), (35), and (36) now reduce to

$$p_1 = \frac{17A - 16A^* + 27\lambda}{21} \tag{36}$$

$$p_1^* = \frac{23A^* - 10A - 27\lambda}{21} \tag{37}$$

$$p_1 - p_1^* = \frac{9A - 13A^* + 18\lambda}{7} = 0 \tag{38}$$

From (39), it follows that $\lambda = \frac{13A^* - 9A}{18}$. Substituting λ into (37) or (38) yields the equilibrium prices as

$$p_1 = p_1^* = \frac{A + A^*}{6}.$$

Then substitute p_1, p_1^* and λ into the first order conditions. The output equilibria then can be solved as

$$x_1 = \frac{6A - A^*}{9}; x_1^* = \frac{4A^* - 3A}{9}$$

$$y_1 = \frac{3A - A^*}{18}; y_1^* = \frac{3A + 7A^*}{18}.$$

All outputs and prices are positive, as long as $A^* < A \leq \frac{4}{3}A^* - 3\ \varepsilon$. At the upper bound, x_1^* becomes ε. Hence when the upper bound is reached, we switch to another regime where one more constraint, $x_1^* = \varepsilon$, is binding.

$x_1^* = \varepsilon$ $(\eta \geq 0)$, $p_1 = p_1^*$ $(\lambda \geq 0)$, **and** $\gamma = 0$: In (31), we replace x_1^* with ε, and rearrange the equation as

$$\eta = \varepsilon - p_1^* + \frac{4}{9}\left[A^* - 2(p_1 - p_1^*)\right] - \lambda. \tag{39}$$

Using (35), (36), and (40), we obtain

$$\eta = \frac{3\varepsilon + 3A^* - 2A - 6\lambda}{4}. \quad (40)$$

Substituting (41) into (36) yields

$$\lambda = \frac{25A^* - 18A - 27\varepsilon}{18}. \quad (41)$$

So

$$\eta = \frac{9\varepsilon + 3A - 4A^*}{3}. \quad (42)$$

Now we can solve for the equilibrium prices and outputs. They turn out to be

$$p_1 = p_1^* = \frac{7A^* - 9\epsilon}{18}$$

$$x_1 = \frac{13A^* - 6A - 63\varepsilon}{6}; x_1^* = \varepsilon$$

$$y_1 = \frac{3A - 2A^*}{27}; y_1^* = \frac{11A^* - 9\varepsilon}{18}.$$

This yields a feasible equilibrium as long as $\frac{4}{3}A^* - 3\varepsilon \leq A < \frac{25}{18}A^* - \frac{3}{2}\varepsilon$. The lower bound to this range coincides with the upper bound of the previous case, and it is the point at which the constraint $x_1^* \geq \varepsilon$ starts to be binding ($\eta = 0$). At the upper bound we have $\lambda = 0$,indicating that this is the maximum market size difference for which $p_1 - p_1^* = 0$ is an equilibrium outcome. For larger market size differences we switch from temporary market integration to moderated dumping.

5.0.1 Moderated Dumping

Where modearted dumping is the outcome, both firms try to manipulate the size of the dumping margin in period 1. Thus a duty is actually imposed in period 2.

$x_1^* = \varepsilon$ **(**$\eta \geq 0$), $\frac{A^*}{2} > p_1 - p_1^* > 0$, **(**$\lambda = 0$ **and** $\gamma = 0$) : As above, x_1^* is to be replaced with ε in (31) so that we can express η as

$$\eta = \varepsilon - p_1^* + \frac{4}{9}\left[A^* - 2(p_1 - p_1^*)\right]. \tag{43}$$

With $\lambda = 0$, we rewrite (34), (35), and (36) as

$$p_1 = \frac{17A - 16A^* + 10\eta}{21} \tag{44}$$

$$p_1^* = \frac{23A^* - 10A - 17\eta}{21} \tag{45}$$

$$p_1 - p_1^* = \frac{9A - 13A^* + 9\eta}{7}. \tag{46}$$

Substitute (46) and (47) into (44). This yields

$$\eta = \frac{3\varepsilon - 2A + 3A^*}{4}. \tag{47}$$

Using (45), (46), and (48) obtains the price equilibria as

$$p_1 = \frac{24A - 17A^* + 15\varepsilon}{42}$$

$$p_1^* = \frac{41A^* - 6A - 51\varepsilon}{84}.$$

And the dumping margin becomes

$$p_1 - p_1^* = \frac{18A - 25A^* + 27\varepsilon}{28}.$$

The period-1 output equilibria are

$$x_1 = \frac{5A^* - 3\varepsilon}{6}; x_1^* = \varepsilon$$

$$y_1 = \frac{3A - 3A^* + \varepsilon}{7}; y_1^* = \frac{6A + 43A^* - 33\varepsilon}{84}.$$

As regards the period-2 equilibrium, sales in the foreign country now reflect the duty as follows.

$$p_2^* = y_2^* = \frac{6A + A^* + 9\varepsilon}{28}.$$

And

$$x_2^* = \frac{13A^* - 6A - 9\varepsilon}{14}.$$

This solution is feasible over the range $\frac{25}{18}A^* - \frac{3}{2}\varepsilon < A < \frac{3}{2}A^* + \frac{3}{2}\varepsilon$, with $p_1 = p_1^*$ at the lower bound and $\eta = 0$ at the upper bound (i.e. $x_1^* = \varepsilon$ ceases to be binding). We then have a range in which no constraints are binding.

$x_1^* > \varepsilon$, $\frac{A^*}{2} > p_1 - p_1^* > 0$, $\lambda = \eta = \gamma = 0$: In this case, all multipliers are zero, so solving for the solutions here is quite straightforward. Using the first order conditions and the demand functions, it follows that

$$p_1 = \frac{17A - 16A^*}{21}; p_1^* = \frac{23A^* - 10A}{21}$$

$$p_1 - p_1^* = \frac{9A - 13A^*}{7}$$

$$x_1 = \frac{4A^* - A}{3}; x_1^* = \frac{2A - 3A^*}{3}$$

$$y_1 = \frac{11A - 12A^*}{21}; y_1^* = \frac{19A^* - 4A}{21}$$

$$p_2^* = y_2^* = \frac{3A - 2A^*}{7}$$

$$x_2^* = \frac{11A^* - 6A}{7}.$$

For these equilibrium prices and outputs to be positive, we require that $\frac{3}{2}A^* + \frac{3}{2}\varepsilon < A < \frac{11}{6}A^*$. At the lower bound $x_1^* = \varepsilon$. At the upper bound, $x_2^* = 0$ because when $A = \frac{11}{6}A^*$, the duty reaches the prohibitive level ($\frac{A^*}{2}$).

5.0.2 Prohibitive Dumping ($x_1^* > \varepsilon$, $\frac{A^*}{2} = p_1 - p_1^* > 0$, $\lambda = \eta = 0$,**and** $\gamma \geq 0$)

In this range the first period price differential implies an antidumping duty at the prohibitive level (i.e. the constraint $\frac{A^*}{2} \geq p_1 - p_1^*$ is binding). The foreign firm then becomes a monopolist in its local market in the final period.

Equation (34), (35), and (36) reduce to

$$p_1 = \frac{17A - 16A^* - 27\gamma}{21} \tag{48}$$

$$p_1^* = \frac{23A^* - 10A + 27\gamma}{21} \tag{49}$$

$$p_1 - p_1^* = \frac{9A - 13A^* - 18\gamma}{7} = \frac{A^*}{2} \tag{50}$$

Equation (51) can be rearranged as

$$\gamma = \frac{6A - 11A^*}{12}. \tag{51}$$

Substituting (52) into (49) and (50) yoields the following equilibrium prices

$$p_1 = \frac{2A + 5A^*}{12}$$

$$p_1^* = \frac{2A - A^*}{12}.$$

Using the equilibrium prices and the first order conditions, it follows that

$$x_1 = \frac{2A + 5A^*}{12}; \quad x_1^* = \frac{2A - A^*}{12}$$

$$y_1 = \frac{4A - 5A^*}{6}; \quad y_1^* = \frac{7A^* - 2A}{6}.$$

A range of relative market size required in this case is $\frac{11}{6}A^* < A < \frac{7}{2}A^*$ where $\gamma = 0$ at the lower bound and $y_1^* = 0$ at the upper bound. When $A > \frac{7}{2}A^*$, the duty is greater than the prohibitive level, so the home firm does not sell in the foreign market in one period. As concerns the firms' strategic actions, both firms do not behave strategically because it is not sensible to influence the size of duty whereas the duty is in fact not imposed.

6 Will the Dumper withdraw from the Foreign Market?

So far we have assumed that the "dumping" firm continues to sell in the foreign market in the first period (i.e. that $x_1^* \geq \varepsilon$). If the dumper withdrew from the foreign market in that period (i.e. $x_1^* = 0$) then the foreign firm becomes a monopolist in its own market in the first period, and we would have the free-trade equilibrium in the second - i.e.

$$\pi_w = 2(\frac{A}{3})^2 + (\frac{A^*}{3})^2 \tag{52}$$

$$\pi_w^* = 2(\frac{A}{3})^2 + (\frac{A^*}{3})^2 + (\frac{A^*}{2})^2. \tag{53}$$

Clearly this gives the foreign firm higher profits than in free trade, and clearly the home firm could choose this option for any difference in market sizes. But is it ever an attractive option for the home firm? We show that it is not by showing that $\pi_w$is less than the profits obtained under each of the outcomes derived above (denoted by π_a)

6.1 Temporary Market Integration

6.1.1 $p_1 = p_1^*,\ x_1^* > \varepsilon$

$$\pi_w = 2(\frac{A}{3})^2 + (\frac{A^*}{3})^2 \tag{54}$$

$$\begin{aligned}\pi_a \quad = \quad & \left(\frac{A+A^*}{6}\right)\left(\frac{6A-A^*}{9}\right) + \left(\frac{A+A^*}{6}\right)\left(\frac{4A^*-3A}{9}\right) \\ & +(\frac{A}{3})^2 + (\frac{A^*}{3})^2\end{aligned} \tag{55}$$

Subtract (55) from (56). We have

$$\Delta\pi = \pi_a - \pi_w = \frac{(A+A^*) - 2A^2}{18} > 0 \tag{56}$$

Given that $A^* < A < \frac{4}{3}A^*$, $\Delta\pi$ is always greater than zero. Hence the home firm would prefer temporary market integration than withdrawal.

6.1.2 $p_1 = p_1^*$, $x_1^* = \varepsilon$

$$\begin{aligned} \pi_a &= \left(\frac{7A^* - 9\varepsilon}{18}\right)\left(\frac{13A^* - 6A - 63\varepsilon}{9}\right) + \left(\frac{7A^* - 9\varepsilon}{18}\right)(\varepsilon) \\ &\quad + (\frac{A}{3})^2 + (\frac{A^*}{3})^2 \end{aligned} \tag{57}$$

If we treat ε as a very small amount close to zero and subtract (55) from (58), we get

$$\Delta\pi = \pi_a - \pi_w = \frac{(7A^*)(39A^* - 18A) - 36A^2}{18^2} > 0 \tag{58}$$

As long as $\frac{4}{3}A^* < A < \frac{25}{18}A^*$, $\Delta\pi$ is positive. Then the home firm prefers temporary market integration with $x_1^* = \varepsilon$ than withdrawal in the first period.

6.2 Moderated Dumping

6.2.1 $\frac{A*}{2} > p_1 - p_1^* > 0$, $x_1^* = \varepsilon$

$$\begin{aligned} \pi_a &= \left(\frac{24A - 17A^* + 15\varepsilon}{42}\right)\left(\frac{5A^* - 3\varepsilon}{6}\right) + \\ &\quad \left(\frac{41A^* - 6A - 51\varepsilon}{84}\right)(\varepsilon) + (\frac{A}{3})^2 + (\frac{13A^* - 6A}{14})^2 \end{aligned} \tag{59}$$

Treat ε as negligibly small, then subtract (55) from (60). This obtains

$$\begin{aligned} \Delta\pi &= \frac{(24A - 17A^*)(35A^*) + (39A^* - 18A)^2}{42^2} \\ &\quad - \frac{(14A)^2 - (14A^*)^2}{42^2} \end{aligned} \tag{60}$$

With $\frac{25}{18}A^* < A < \frac{3}{2}A^*$, the home firm prefers moderated dumping with $x_1^* = \varepsilon$ than withdrawal in period 1.

6.2.2 $\frac{A*}{2} > p_1 - p_1^* > 0,\ x_1^* > \varepsilon$

$$\pi_a = \left(\frac{17A - 16A^*}{21}\right)\left(\frac{4A^* - A}{3}\right) + \left(\frac{23A^* - 10A}{21}\right)\left(\frac{2A^* - 3A}{3}\right) + (\frac{A}{3})^2 + (\frac{11A^* - 6A}{7})^2 \quad (61)$$

From (55) and (62),

$$\Delta\pi = \frac{(17A - 16A^*)(28A^* - 7A) - (23A^* - 10A)(14A - 21A^*)}{21^2} + \frac{(33A^* - 18A)^2 - (7A)^2 + (7A^*)^2}{21^2} \quad (62)$$

As $\frac{3}{2}A^* < A < \frac{11}{6}A^*$, $\Delta\pi$ is positive. Once again, moderated dumping is preferred to withdrawal from the foreign market in the first period.

6.3 Prohibitive Dumping; $\frac{A*}{2} = p_1 - p_1^*$

$$\pi_a = \left(\frac{2A + 5A^*}{12}\right)^2 + \left(\frac{2A - A^*}{12}\right)^2 + (\frac{A}{3})^2 \quad (63)$$

The difference in profit is now

$$\Delta\pi = \pi_a - \pi_w = \frac{(2A + 5A^*)^2 + (2A - A^*)^2 - (4A)^2 + (4A^*)^2}{12^2} \gtreqless 0 \quad (64)$$

The range of relative market size that makes prohibitive dumping a feasible outcome is $\frac{11}{6}A^* < A < \frac{7}{2}A^*$. Within this range, $\Delta\pi$ could be either negative, zero, or positive. If $\frac{11}{6}A^* < A < \frac{5}{2}A^*$, $\Delta\pi > 0$. If $\frac{5}{2}A^* = A$, $\Delta\pi = 0$. If $\frac{5}{2}A^* < A < \frac{7}{2}A^*$, $\Delta\pi < 0$. This suggests that when A gets bigger than $\frac{5}{2}A^*$, the home firm withdraws from the foreign market in one period and behaves as in free trade in the other. Then both firms' profits would be like those when the duty exceeds prohibitive level.

6.4 $p_1 - p_1^* > \frac{A^*}{2}$

From the foreign frm's standpoint, it can maintain the size of duty at $\frac{A^*}{2}$ as long as $\frac{11}{6}A^* < A < \frac{7}{2}A^*$. Nonetheless, as shown above, when $A > \frac{5}{2}A^*$, it is sensible for the home (dumping) firm to ignore the duty and sell in the foreign market only in one period. Thus there is no reason for the foreign firm to keep the duty at $\frac{A^*}{2}$, given that the home firm does not take accont of it.

It is immediate that when $A > \frac{5}{2}A^*$, we see free-trade equilibrium in one period. In the other, the home firm withdraws from the foreign market because of a very large duty, i.e., $p_1 - p_1^* > \frac{A^*}{2}$.

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