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North-South Competition, Policy Rivalry and Profitability

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Abstract

In the strategic trade policy literature, the firms typically make positive profits at equilibrium policy levels. We show that this is not always true when firms from the developed (North) and developing (South) countries compete in the Northern market. In particular, the South firm may be pushed out of the Northern market. On the other hand, the Northern firm always maintains a market share in the South market in policy equilibrium. The critical assumption is that the Northern firms produce products of a superior quality than do their Southern counterparts.

KEYWORDS: North-South trade, Vertically differentiated product, Strategic Trade Policy, Third market competition, Internal market competition.

JEL CLASSIFICATION: F 12, F 13.

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1 Introduction

Over the last two decades the global industrial organization has changed drastically in many respects. One facet of this change is that we increasingly find firms from both developed and developing countries together competing worldwide in the same markets. This is unlike in previous decades, especially in the manufacturing sector, when the world market used to be dominated almost entirely by firms from the developed countries.

That firms from developed North and developing South compete in the same market does not mean however that they face the same parameters. Typically, firms from the North produce and sell high-quality brands and those from the South, still lagging in technology, cater to the low-quality end consumers. For example, American, European or Japanese brands are usually associated with high quality, whereas products from East Asian countries are regarded to be of lower quality.

At the same time governments of both North and South are found to actively intervene in these markets, using both trade and trade-related 'domestic' policies.

The objective of this paper is to develop a model that captures the elements of North-South competition just outlined. Obviously, this is related very much to the vast literature on strategic trade policy (STP). However, compared to the original and seminal contributions by Brander and Spencer (1985) and Eaton and Grossman (1986) - and many papers by others - our model emphasizes that firms produce and compete in quality-differentiated products. There are of course papers that do consider oligopoly rivalry and trade in the context of vertically differentiated products, e. g., Das and Donnenfeld (1989) and Zhou, Spencer and Vertinsky (2000) (ZSV from now) . The former study how quotas and minimum quality standards affect the quality of imports, when a foreign firm competes with a domestic firm in the domestic market. But there is no policy rivalry.[1] ZSV develop an endogenous quality model, where the South firm is assumed to face a higher cost function of producing quality than the North firm. This implies that in equilibrium the former produces the low-quality brand and the latter the high-quality brand. They however consider competition in a third country market.

The emphasis of this paper is on internal markets and policy rivalry in the presence of

[1] Bond (1988) also considers the effects of trade policy on domestic social welfare, in a model where there are a continuum of goods that vary in quality. However, he considers perfect competition, and his model is not one of STP.

vertical product differentiation. We believe that internal market considerations are quite important – because the market sizes are large not only in the developed countries but also in developing countries like China and India.

The resulting analysis yields two principal results, which, we believe, are novel - and they explain some observed facts. First, and probably more striking, we show that policy rivalry may a drive a firm out of the market. More precisely, this could happen to the South firm in the North market. When trade taxes are the only policy instruments used by the respective governments, this happens under some permissible parameter configurations. But when the North uses production intervention also (along with trade taxes) it happens under all permissible parameter configurations. In other words, while free trade may sustain firms from both North and South (in terms of positive profits), policy rivalry may induce exit of low-quality producing firms from the South. Note that this is quite different - in a sense opposite – from the "Boeing-Airbus" entry/exit implications with which the STP literature originated. In the Boeing-Airbus example, a firm from at least one country was assumed not sustainable in free trade, and policy interventions *engendered* firm sustainability. In our model, policy rivalry may *endanger* sustainability of a firm.

This result then purports to explain why in industries like the automobiles, electronic goods and the cosmetics, the South firms have historically struggled to get a foothold in the North. Among the possible existing explanations, one is that, for South firms, the sunk costs of setting up operation in the North is very high compared to their profits. Another heuristic reason is that the South firms sell low quality products and hence cannot compete with the North firms. But this fails to explain why then the South firms cannot capture even the low-end consumers in the North market. This paper shows that the equilibrium policy responses from the North and South governments – rather than any deliberate entry-blockading strategy per se by the North firm or the North government – may be instrumental in driving the South firm out of the North market. It is thus a phenomenon of policy-rivalry-induced-forced-exit, which we call PRIFE.

Indeed, an interesting pattern of profit changes due to policy rivalry (compared to free trade) emerges across where the North and the South firms compete. This is shown in the following table.

Table 1: Profits of the North & South Firms in Policy —Equilibrium (compared to Free Trade)		
Third Country market	South market	North market
North firm: lower, but still positive	North firm: lower, but still positive	North firm: higher
South firm: higher	South firm: higher	South firm: lower; the firm *may not sustain itself*
Note: Policies include trade taxes and production subsidy		

Second, by comparing equilibrium policy outcomes in case of internal markets (i.e. the North or the South market), it is found that the South's tariff on imports from North are higher than North's tariff on imports from South. Thus this paper also provides a rationale as to why South countries are generally inclined to pursue a more restrictive import policy than do the North countries.

In what follows, section 2 builds a model of oligopoly competition in a vertically differentiated product industry. There are two countries, North and South, and one firm from each country. The North firm is more technologically advanced, and produce a superior quality brand than the South firm. Policy rivalry is analyzed in three settings. While section 3 applies it to a case where both the North and the South firms compete in the market of some third country, section 4 is devoted to analyzing competition in the South. Section 5 deals with the case of the North market wherein the PRIFE phenomenon arises. Till this point price competition is assumed. Section 6 shows that the main results of the paper hold in case of quantity competition as well. Section 7 concludes the paper.

2 The Basic Model

Consider two firms H (high-quality) and L (low-quality) located in a North and a South country respectively, producing the same generic good while their brand qualities differ. Let the variables relating to firm $H(L)$ be subscripted by $H(L)$. Later North and South countries will also be called H-country and L-country respectively (indicating 'highly-developed' and 'less developed' respectively). Due to exogenous technological differences, the product qualities of the H and L firms are set at predetermined levels s_H and s_L respectively, with $s_H > s_L > 0$.

Note that, in comparison, the ZSV model is more general in terms of having endogenous quality but less general in that it only considers the third-country market case. Our focus here is on internal markets, and, allowing for quality variation, competition in internal markets as well as multiple instruments in the hands of rival governments makes the analysis intractable. Besides, we do not pursue the issue of catching-up of quality or imitations by South firms. These are the reasons as to why we are led to assume that quality levels are given.

For notational simplicity, set $s_H = 1$. Thus $s_L < 1$. Price competition is assumed, following the usual practice in the literature on vertically differentiated industry (e.g. Shaked and Sutton (1982), Rosenkratz (1995)). The consumers buy either zero or one unit of the good. The brands are indexed by their quality s. The utility of a consumer with taste θ is given by:

$$U = \begin{cases} \theta s - P & \text{if she consumes one unit of quality } s \text{ at price } P, \\ 0 & \text{if she does not buy.} \end{cases}$$

For analytical simplicity, the parameter θ is assumed to be uniformly distributed. Let its support be $[0,1]$.[2] A θ-type consumer is indifferent between the two brands if and only if $\theta s_H - P_H = \theta s_L - P_L$. Define $\delta \equiv s_H - s_L = 1 - s_L$. Then consumers with $\theta > \bar{\theta} = \frac{P_H - P_L}{\delta}$ consume the high quality brand. The marginal consumer who is indifferent between buying the low quality brand and not buying at all is identified by $\hat{\theta} = P_L/s_L$. Consumers with $\hat{\theta} < \theta < \bar{\theta}$ consume the low quality brand. This yields the following demand functions for firms H and L:

$$D_H = 1 - \bar{\theta} = 1 - \frac{P_H - P_L}{\delta}; \quad D_L = \bar{\theta} - \hat{\theta} = \frac{P_H - P_L}{\delta} - \frac{P_L}{s_L}. \tag{1}$$

The own and cross price effects have expected signs.

The firm i ($=H, L$) maximizes its profit, given by $\pi_i = P_i D_i - c_i D_i$, c_i being the marginal cost of firm i. By substituting (1) into the respective profit expressions, the objective functions of the two firms can be formally represented as:

$$H\text{-Firm: } \max_{P_H} (P_H - c_H)\left(1 - \frac{P_H - P_L}{\delta}\right), \quad L\text{-Firm: } \max_{P_L} (P_L - c_L)\left(\frac{P_H - P_L}{\delta} - \frac{P_L}{s_L}\right).$$

Assuming that they simultaneously choose prices in the Bertrand-Nash fashion, the respective

[2]Normalizations of the lower limit and the upper limit of θ to 0 and 1 respectively doesn't affect the results.

first order conditions are obtained and they yield the following solution values:

$$P_H = \frac{2\delta + c_L + 2c_H}{4 - s_L}; \quad P_L = \frac{s_L\delta + c_H s_L + 2c_L}{4 - s_L} \tag{2}$$

Thus an exogenous rise in the cost of a firm will not only raise its own equilibrium price, but also that of its rival, albeit to a lesser degree.

The corresponding solutions of quantities are obtained by substituting the equilibrium values of P_H and P_L from (2) into (1):

$$D_H = \frac{2\delta - c_H(2 - s_L) + c_L}{(4 - s_L)\delta}; \quad D_L = \frac{[s_L\delta + s_L c_H - (2 - s_L)c_L]}{s_L(4 - s_L)\delta} \tag{3}$$

A rise in the rival's cost will increase the output produced by a firm, while a rise in its own cost reduces its output.

The underlying model, as outlined above, is pretty standard.

We wish to capture that firms from the North are technologically superior to those from the South. In terms of our model this translates into the ability of the H-firm to produce high quality with the same marginal cost as required to produce the low quality by the L-firm. Hence, from now on we further assume that the marginal costs of production are the same (equal to $\bar{c}$).

Firms may however be subject to taxes or subsidies. Let $t_i,\ i = H, L$, denote the specific tax/subsidy imposed on firm i. Then $c_H = \bar{c} + t_H$ and $c_L = \bar{c} + t_L$ are the effective marginal costs of the two firms respectively.

Before analyzing trade policy, it is necessary to note that we need to assume the following regularity condition, so that the output and price expressions in free trade are non-negative:

$$(1 >)\ s_L > 2\bar{c}. \tag{R1}$$

3 Competition in a third country market

Our analysis begins with this standard scenario. Although this case is not our focus, it yields a policy implication, which may be surprising.

Proceeding in the usual manner one obtains the following solutions of profits at the free-trade equilibrium.

$$\pi_H^0 = \frac{[\delta(2-\bar{c})^2}{(4-s_L)^2\delta} > 0; \quad \pi_L^0 = \frac{[\delta(s_L - 2\bar{c})]^2}{s_L(4-s_L)^2\delta} > 0. \tag{4}$$

Let the exporting countries now impose taxes. Let t_H and t_L denote the export taxes imposed by North and South respectively on their home firm. In stage 1 the countries set these taxes non-cooperatively and in stage 2 firms choose prices. Solving the model by backward induction, the following expressions of equilibrium taxes and profits are obtained:

$$t_H^R = \frac{s_L\delta(16 - 8s_L + 2s_L\bar{c} - 8\bar{c} + s_L^2)}{64 - 64s_L + 16s_L^2 - s_L^3} > 0, \quad t_L^R = \frac{s_L\delta(8s_L - 2s_L^2 - 16\bar{c} + 8\bar{c}s_L - \bar{c}s_L^2)}{64 - 64s_L + 16s_L^2 - s_L^3} > 0 \tag{5}$$

$$\pi_H^R = \frac{[(2-\bar{c})\delta + t_L^R - (2-s_L)t_H^R]^2}{\delta(4-s_L)^2} > 0; \quad \pi_L^R = \frac{[\delta(s_L - 2\bar{c}) + s_L t_H^R - (2-s_L)t_L^R]^2}{s_L\delta(4-s_L)^2} > 0. \tag{6}$$

Here the superscript R denotes the third country or rest of the world market.

We observe from (5) that $t_H^R > t_L^R$. Further comparing (6) with (4), we see that $\pi_H^R < \pi_H^0$ and $\pi_L^R > \pi_L^0$. Hence

Proposition 1 *(A) When H and L firms compete in the third country market, the North imposes a higher export tax than the South. (B) Compared to free trade, the L-firm's profit is higher and the H-firm's profit is less.*

The intuition behind part (A) is the following. The L-firm faces a more elastic demand curve than the H-firm: if it increases its price a little then, among its marginal consumers (at both ends), those with a higher valuation shifts to the high quality product while those with low valuations drop out of the industry. However for the H-firm, only those with low θ shifts to low quality, while it can extract more out of the high θ buyers. Therefore a tax induced price hike is accompanied by a steeper decline in the demand for L-firm compared to the H-firm. So the L-firm is taxed less by its government.

Part (B) is surprising in that it says that the L-firm 'wins' from the policy game while the H-firm 'loses'. However, it can be understood as follows. Since the H-firm has to pay a higher tax (from Proposition 1), P_H rises more than P_L in the tax-equilibrium. Compared to free trade, the relative price of the low quality brand (P_L/P_H) falls, which raises the demand for the L-firm's brand as well as its profits in the policy-equilibrium. However the demand for the high quality brand falls, as (P_H/P_L) is higher now, which reduces the H-firm's profit compared to the free trade level.

4 Competition in the South market

Following the extensive liberalization in the eighties and the nineties especially in the South countries, (which were earlier heavily protected) numerous North firms have entered the Southern markets to compete with the local firms. We now apply our model to study such a scenario.

4.1 Trade taxes only

To begin with, suppose that the South and the North use an import tariff and an export tax respectively as policy instruments. The difference with the third country analysis is that the South's policy maker must now consider changes in consumer surplus. Let t_L now represent a specific import tariff imposed by the South on the H-firm, while let t_H continue to denote the export tax by the North. The unit cost of the H-firm is then $c_H = \bar{c} + t_H + t_L$. The price and quantity expressions can now be expressed by simply defining c_H as above and $c_L = \bar{c}$ in equations (2) and (3). The objective of the L-country is

$\max_{t_L} W_L = \int_{\bar{\theta}}^{1} (\theta s_H - P_H)\, d\theta + \int_{\hat{\theta}}^{\bar{\theta}} (\theta s_L - P_L)\, d\theta + (P_L - \bar{c})D_L + t_L D_H,$

wherein the first two terms are the consumer surplus of those who buy high and low quality respectively, the third term is the profit of the home firm L and the last term is the tariff revenues. The objective function of the H-country remains similar to that in the third country case: $\max_{t_H} W_H = (P_H - \bar{c} - t_L)D_H$.

In stage 1, the first order conditions of maximization of W_L and W_H are

$$\begin{aligned} -D_H \tfrac{\partial P_H}{\partial t_L} - D_L \tfrac{\partial P_L}{\partial t_L} + (P_L - \bar{c})\tfrac{\partial D_L}{\partial t_L} + D_L \tfrac{\partial P_L}{\partial t_L} + t_L \tfrac{\partial D_H}{\partial t_L} + D_H = 0 \\ (P_H - \bar{c} - t_L)\tfrac{\partial D_H}{\partial t_H} + D_H \tfrac{\partial P_H}{\partial t_H} = 0 \end{aligned} \tag{7}$$

By substituting the expressions of P_H, P_L, D_H and D_L in terms of t_L and t_H into equations (8) we obtain the following reaction functions for the H-country and the L-country respectively:

$$\begin{aligned} t_L(12 - 11s_L + 2s_L^2) = (4 - s_L)(1 - \bar{c})\delta - (4 - 5s_L + s_L^2)t_H, \\ 4(2 - s_L)t_H = s_L(2 - \bar{c})\delta - s_L(2 - s_L)t_L. \end{aligned} \tag{8}$$

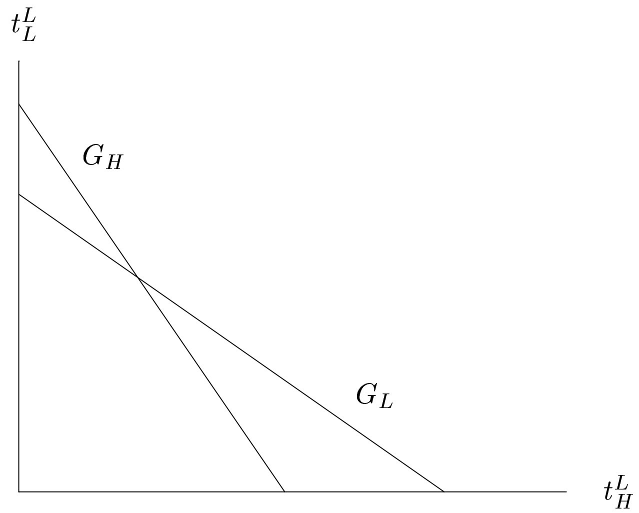

Figure 1: Policy rivalry in the South market

These reaction functions, depicted in Figure 1 by G_H and G_L, are downward sloping, indicating that the policies of the two countries are strategic substitutes, unlike in the third country case. Here substitutability arises because an increase in either t_L or t_H has the similar effect of raising c_H, the marginal cost of the H-firm. From equation (2), it is known that a rise in c_H increases P_H more than P_L, thus raising P_H/P_L, the relative price of good H. This tends to reduce the demand for high quality: D_H falls. Therefore, when t_L increases, the North is better off by reducing the tariff-induced cost disadvantage via lowering t_H. Alternatively, when t_H increases, D_H falls, so that there is less scope to exercise the standard monopsonistic power by the Southern policy-maker; hence the optimal t_L falls.

Solving the reaction functions, we get the equilibrium tax-tariff combination, denoted by t_L^L and t_H^L:

$$\begin{aligned} t_L^L &= \frac{[(32 - 32s_L + 14s_L^2 - 2s_L^3) - \bar{c}(32 - 28s_L + 9s_L^2 - s_L^3)]\delta}{96 - 144s_L + 74s_L^2 - 15s_L^3 + s_L^4} > 0, \\ t_H^L &= \frac{[(16s_L - 16s_L^2 + 3s_L^3) - \bar{c}(4s_L - 5s_L^2 + s_L^3)]\delta}{96 - 144s_L + 74s_L^2 - 15s_L^3 + s_L^4} > 0, \end{aligned} \tag{9}$$

where the superscript L stands for the South market. The standard terms of trade arguments explain these policy choices. Furthermore, it is straightforward to compute that, at these policy levels, the L-firm sells more and earns higher profit compared to free trade. The H-firm, as one would expect, is able to sell less. However, it is 'not' shut out of the market (i.e. $D_H > 0$).

Consequently, it earns less profit.[3]

4.2 Trade taxes and production subsidies

The above results continue to hold when the South grants a production subsidy also. Let z_L (≥ 0) denote such a subsidy. Accordingly, define $c_H = \bar{c} + t_H + t_L$ and $c_L = \bar{c} - z_L$ in equations (2) and (3). After a similar maximization exercise as in the earlier case (except that now South maximizes with respect to two variables), we find that at the policy Nash equilibrium, $t_L > 0$, $t_H > 0$, $z_L > 0$ (see Appendix 1 for details). Thus, with two policy instruments, the host country South subsidizes it's own firm while imposing a tariff on the imports, while the North taxes it's exporting firm.

This is evident since the tariff improves the L-firm's profits, while the subsidy reduces the $P > MC$ distortion. In equilibrium the North still finds it optimal to tax its firm. The North taxes its exports for the same reason as in the third-country market case. Moreover, profit rankings relative to free trade remain the same as before. These are eminently plausible outcomes. In summary,

Proposition 2 *In the Southern market, the Nash equilibrium policy responses of the North is a positive export tax, while for the South it is a positive import tariff, along with a production subsidy. The L-firm gets more profit than in free trade, while the H-firm gets less but sustains itself in the South market.*

However the nature of competition among firms and equilibrium policies are substantially different when firms compete in the North market – the case to which we now turn.

5 Competition in the North market

As just mentioned, very different outcomes follow in comparison to the Southern market situation. The main result is that the L-firm *may* be pushed out of the market when only trade

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[3]

$$\pi_H^f > \pi_H^L = \left[\frac{\delta(2-\bar{c}) - (2-s_L)(t_H + t_L)}{(4-s_L)\delta}\right]^2 \delta > 0$$

$$\pi_L^L = \left[\frac{\delta(s_L - 2\bar{c}) + s_L(t_H + t_L)}{(4-s_L)\delta}\right]^2 \delta > \pi_L^f > 0,$$

where the solution values of π_H^f and π_L^f are obtained from equations (4).

taxes constitute the policy space – in the sense that, for *some* permissible parametric configurations, it cannot sell any positive output in the equilibrium. More strongly, if the North uses production intervention also, the L-firm is pushed out for *any* permissible range of parametric values. This is the 'PRIFE phenomenon' (policy rivalry induced forced exit) introduced in section 1.

5.1 Trade taxes only

Let t_H and t_L now stand respectively for the import tariff and the export tax imposed by the North and the South respectively. Thus the price and quantity expressions are obtained by equating $c_H = \bar{c}$ and $c_L = \bar{c} + t_L + t_H$ in (2) and (3). The welfare functions of the two countries' government are just the reverse of the earlier case – for the North, it is the sum of its consumer surplus, producer's profits (net of tax/subsidy) and tariff revenue, while for the South it is the sum of profits of its exporting firm and export tax revenues. The respective objective functions are:

$$\text{North: } \max_{t_H} W_H = \int_{\bar{\theta}}^{1} (\theta s_H - P_H)\, d\theta + \int_{\hat{\theta}}^{\bar{\theta}} (\theta s_L - P_L)\, d\theta + (P_H - \bar{c})D_H + t_H D_L.$$

$$\text{South: } \max_{t_L} W_L = (P_L - \bar{c} - t_H)D_L.$$

To begin with, suppose that a Nash equilibrium exists at positive prices and outputs. The respective first order conditions are then:

$$\begin{aligned} -D_H\frac{\partial P_H}{\partial t_H} - D_L\frac{\partial P_L}{\partial t_H} + (P_H - \bar{c})\frac{\partial D_H}{\partial t_H} + D_H\frac{\partial P_H}{\partial t_H} + D_L + t_H\frac{\partial D_L}{\partial t_H} &= 0 \\ (P_L - \bar{c} - t_H)\frac{\partial D_L}{\partial t_L} + D_L\frac{\partial P_L}{\partial t_L} &= 0. \end{aligned} \tag{10}$$

On relevant substitutions in terms of t_H and t_L and rearranging, we obtain the reaction functions of the North and the South respectively:

$$\begin{aligned} t_H(12 - 11s_L + 2s_L^2) &= (4 - s_L)(s_L - \bar{c})\delta - (4 - 5s_L + s_L^2)t_L; \\ 4(2 - s_L)t_L &= s_L\delta(s_L - 2\bar{c}) - s_L(2 - s_L)t_H. \end{aligned} \tag{11}$$

These are plotted in Figure 2, where G_H and G_L denotes the reaction function of the North and South country respectively as implied by (11). For now ignore the $D_L = 0$ line.

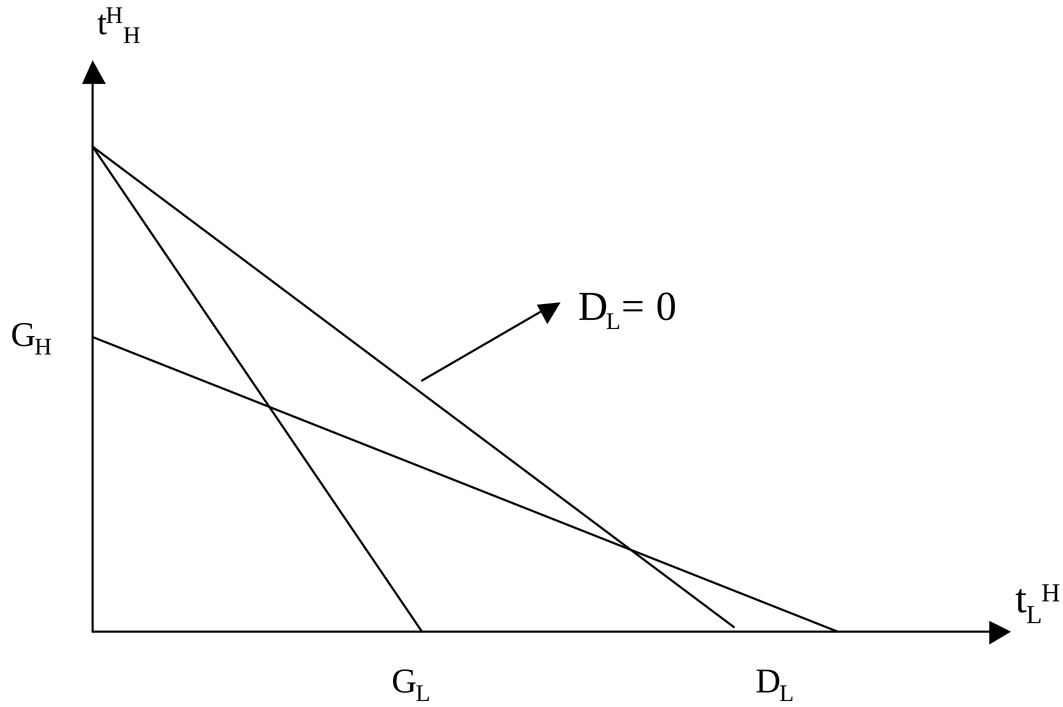

Figure 2: The non-PRIFE case

Solving equations (11), we obtain

$$\begin{aligned} t^H_H &= \frac{[32s_L - 28s_L^2 + 9s_L^3 - s_L^4 - \bar{c}(32 - 32s_L + 14s_L^2 - 2s_L^3)]\delta}{(2 - s_L)(48 - 48s_L + 13s_L^2 - s_L^3)} \\ t^H_L &= \frac{[(4s_L - 5s_L^2 + s_L^3) - \bar{c}(16 - 16s_L + 3s_L^2)]s_L\delta}{(2 - s_L)(48 - 48s_L + 13s_L^2 - s_L^3)}. \end{aligned} \tag{12}$$

where the superscript H stands for the North market. However, substituting these into the price and demand expressions (2) and (3), it is seen that while $P_H > 0$, $P_L > 0$ and $D_H > 0$, $D_L \gtrless 0$ depending on the parameter values. This proves that the North market may not sustain the L-firm – our main point. Formally,

$$D_L = \frac{s_L\delta - \bar{c}(4 - 3s_L)}{s_L(12 - 9s_L + s_L^2)} > 0 \text{ iff } \bar{c} < c^* \equiv \frac{s_L\delta}{4 - 3s_L}, \tag{13}$$

which means that the North market sustains the L-firm iff its marginal cost of production is low enough.

If we step back and substitute $c_H = \bar{c}$ and $c_L = \bar{c} + t_L + t_H$ into the expression for D_L

given in (3) and set it to zero, we have $\delta(s_L - 2\bar{c}) - (2 - s_L)(t_L + t_H) = 0$. Rearranging it,

$$t_H^H = \frac{\delta(s_L - 2\bar{c})}{2 - s_L} - t_L^H. \tag{14}$$

This defines the $D_L = 0$ line in Figure 2; it is a locus of trade taxes such that the L-firm is marginally able to sustain itself in the North market. The area to the left (right) of it marks $D_L >$ $(<)$ 0. If $\bar{c} < c^*$ the intersection of the two reaction functions occurs in the area wherein $D_L > 0$, and, as long as $D_L > 0$, it is easy to verify that both t_H^H and t_L^H are positive. Figure 2 illustrates this case.

Proposition 3 *(a) If the marginal cost is below a critical value ($\bar{c} < c^*$), both firms have positive market shares in the North market at the policy equilibrium. Otherwise the L-firm is pushed out of the market.*
(b) Given that both firms have a positive market share the North (South) imposes a positive import tariff (export tax).

Intuitively, being the low quality producer the L-firm must keep its price sufficiently low to stay in the market. A tariff imposed by the North has two effects. First, it raises the prices of both products thus causing some low quality consumers to drop out of the market. Second, it raises the relative price of the low quality brand compared to the high quality brand, implying that some low quality consumers shift to the high quality brand. Together these two effects tend to reduce the demand for the low quality brand. However, when the marginal cost of production is low enough, the L-firm, despite facing a tariff, can set P_L low enough to retain some low-end customers.

How does the Nash equilibrium look like when $\bar{c} > c^*$? The full characterization of it is complex and lengthy, and thus relegated to Appendix 2. In what follows we provide a sketch of the arguments involved.

Consider Figure 3. The D_L line represents $D_L = 0$ line (same as in Figure 2). The lines $G_L G_L'$ and $G_H G_H'$ denote the unconstrained reaction functions of firm-L and firm-H respectively, as given in (11). However, unlike when $\bar{c} < c^*$, they intersect *above* the $D_L = 0$ line, i.e. in the region where $D_L < 0$. Mark that the $D_L = 0$ line and $G_L G_L'$ intersect each other on the vertical axis where $t_L = 0$. As it turns out, there is a continuum of Nash equilibria, equal to a segment like EE^* of the $D_L = 0$ line, whose end-points are the points of intersection

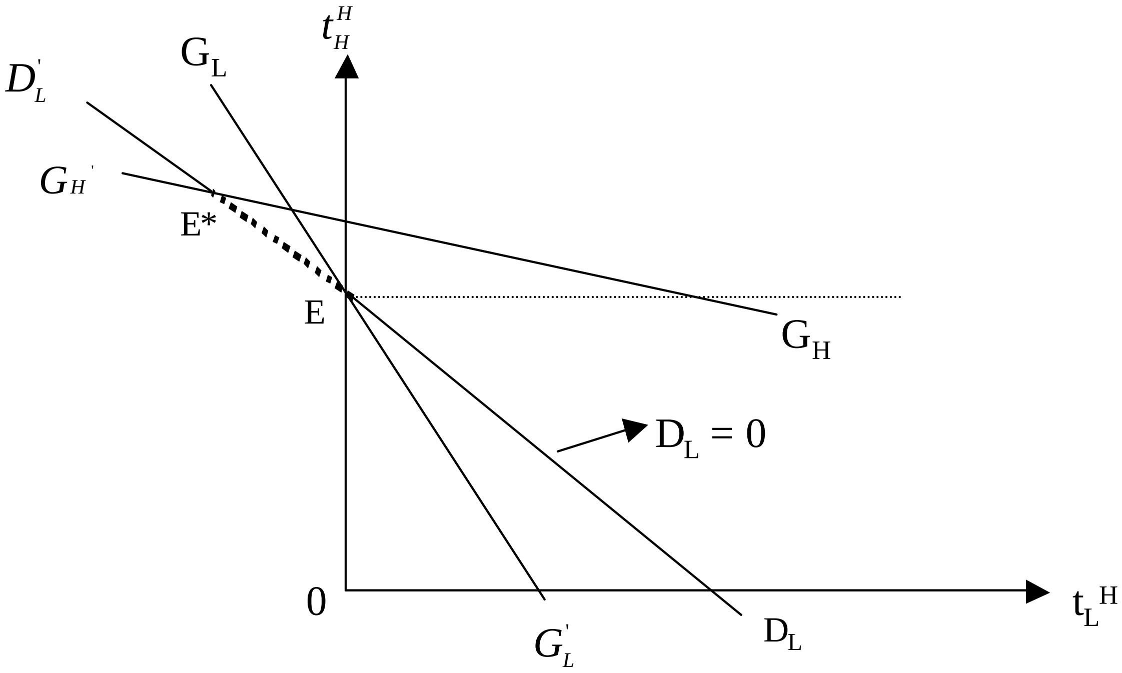

Figure 3: PRIFE case: $\bar{c} > c^*$.

of the $D_L = 0$ line with $G_L G'_L$ and $G_H G'_H$.

Consider first the best response behavior of the North. In the region of policy combinations such that $D_L > 0$ (i.e. to the left of the $D_L = 0$ line), the best response lies on the segment $G'_H E^*$, a part of its unconstrained reaction function. When $D_L \leq 0$, the best response is the corresponding point on the $D_L = 0$ line. Hence the North's best response function is given by the kinked line $G'_H E^* D_L$. For the South, as long as $D_L \geq 0$, the best response lies on $G_L G'_L$, i.e. on the segment EG'_L. When $G_L G'_L$ lies above the $D_L = 0$ line (where $D_L < 0$), any t_L greater than the minimum required to keep the L-firm out of the market, i.e. any t_L along or above the $D_L = 0$ line, is the best response. In other words, the best response is a correspondence, equal to the area on and to the right of $D_L = 0$ line and above the horizontal line at E.

The best response function of the South and the best response correspondence of the North intersect on the line segment EE^*, which denotes the set of Nash equilibria. We observe that, along EE^*, the North imposes an import tariff while, interestingly, the South either follows free trade or offers a *subsidy.* The subsidy policy reflects the South's endeavor to keep its firm afloat in the North market, although it does not actually succeed. Hence

Proposition 4 *In the PRIFE equilibrium, the optimal policy responses are an import tariff for the North and a zero or positive export subsidy for the South.*

However, the trade taxes and subsidies are somewhat inconsequential in the sense that they are not paid in equilibrium, since the South firm does not sell any positive quantity.[4]

Policy comparison

We can compare North's tariff on imports from South (t_H^H) and South's tariff on imports from North (t_L^L).

In the non-PRIFE case, the expression of the North's equilibrium import tariff t_H^H is given in equation (12). It is easily verified that this is less than t_L^L, the tariff by the South in its own market given in equation (9). The same inequality holds in the PRIFE case as well: the maximum t_H is the tariff at point E^*, equal to $\frac{s_L(1-\bar{c})\delta}{(2-s_L)^2}$, which is less than t_L^L.[5] Thus

Proposition 5 *The South tariff on North's exports is higher than the North tariff on the South's exports.*

The reason is that the market share of the L-firm in the North market is much lower compared to that of H-firm in the South market in free trade. Hence the South has greater scope to exercise its monopsonistic power and therefore its optimal tariff is higher.

It is a fact that till now the import tariffs by developing countries are, on the average, higher than import tariffs imposed by developed countries. In the development literature, this has been explained by various special, development oriented objectives (like infant-industry protection, foreign exchange generation etc.). Proposition 5 provides a different rationale.

5.2 Trade taxes and production subsidies

As said earlier, in this case the PRIFE equilibrium results unambiguously; it is the only equilibrium! Production subsidy by the North, like an import tariff, also tends to lower the L-firm's demand. Together with a trade tax, this results in the L-firm being unable to sustain

[4]fill it.

[5]Similarly, by comparing the export taxes imposed by the two countries on their exporters, we get that the North imposes a higher export tax on its own firm than does the South on its own firm.

itself in equilibrium *regardless* of whether $\bar{c} \gtrless c^*$. That is, PRIFE holds for *all* permissible parameter configurations.

Formally, let the North's production subsidy be denoted by z_H. The corresponding price and quantity expressions can be obtained by defining $c_H = \bar{c} - z_H$ and $c_L = \bar{c} + t_L + t_H$ in equations (3) and (4). The objective of the two governments are:

North: $\max\limits_{t_H, z_H} W_H = \int_{\bar{\theta}}^{1} (\theta s_H - P_H)\, d\theta + \int_{\hat{\theta}}^{\bar{\theta}} (\theta s_L - P_L)\, d\theta + (P_H - \bar{c})D_H + t_H D_L.$

South: $\max\limits_{t_L} W_L = (P_L - \bar{c} - t_H)D_L.$

The maximization exercises yield the reaction functions:

$$\begin{aligned} (12 - 11s_L + 2s_L^2)t_H &= \delta(4 - s_L)(s_L - \bar{c}) - s_L(4 - s_L)z_H - (4 - 5s_L + s_L^2)t_L \\ z_H &= -t_H + (1 - \bar{c})\delta \\ 4(2 - s_L)t_L &= s_L(s_L - 2\bar{c})\delta - s_L(2 - s_L)t_H - s_L^2 z_H. \end{aligned} \tag{15}$$

Solving these, and substituting the solution values of t_H, z_H and t_L into (2) and (3), one obtains $P_H > 0$, $P_L > 0$, $D_H > 0$, but

$$D_L = \frac{-\bar{c}\delta(128 - 288s_L + 232s_L^2 - 86s_L^3 + 15s_L^4 - s_L^5)}{96 - 176s_L + 102s_L^2 - 24s_L^3 + 2s_L^4} < 0. \tag{16}$$

Thus in contrast to (13), $D_L < 0$ irrespective of how small $\bar{c}$ may be. The production subsidy, along with an import tax, has the effect of further reducing P_H/P_L. In equilibrium this ratio is sufficiently low such that all the consumers of the L product now finds it optimal to shift to high quality. In other words, we obtain a strong prediction that

Proposition 6 *When the North government has two policy options, namely a production subsidy and an import tariff, the L-firm is pushed out of the North market under any permissible parametric configuration.*

What are the equilibrium policies in this situation? Note that the first-best (i.e. where its welfare is maximized) for the North is reached if every consumer with valuation high enough to cover the marginal costs of producing the good, that is $\theta \geq \bar{c}$, purchases one unit of the high quality good. In other words, the sales of the H-firm should be $D_H = 1 - \bar{c}$. The price at which the H-brand is sold does not matter, since it is just a transfer from domestic consumers to the domestic producer, as long as all consumers with $\theta \geq \bar{c}$ continue to puchase it. The North policy makers achieve this first-best by giving a sufficiently high production subsidy, and by setting a prohibitive import tariff which prevents keeps the firm L from selling any positive amount.

Faced with such a policy, the only consumers that the L-firm can cater to are those with $\theta < \bar{c}$, i.e. those with valuations less than the marginal cost of producing the L-brand. Hence, it can only sustain itself if it gets an export subsidy. However, it is not worthwhile for the South policymakers to subsidize and sustain their firm in the North market, since it does not earn any positive profits. As such, the optimal policy of the South policymakers is to set either a export tax, or a sufficiently low subsidy so that the L-firms sales are zero. However, in equilibrium, there are no export tax revenues or subsidy payments to be incurred, since the L-firm does not sell any positive output.

In summary, the South firm is shut out completely of the North market completely. In constrast, in the Southern market case, the North firm is not pushed out because it is the provider of the higher quality at the same marginal cost.

6 Quantity Competition

We now show that PRIFE equilibrium can arise in case of quantity competition also. Inverting the demand functions in equation (1), we have

$$P_H = 1 - D_H - s_L D_L; \quad P_L = s_L(1 - D_H - D_L). \tag{17}$$

By substituting these into the respective profit expressions, the objective functions of the two firms can be formally represented as:

H-Firm: $\max\limits_{D_H} (1 - D_H - s_L D_L - c_H) D_H$; L-Firm: $\max\limits_{D_L} (s_L - s_L D_H - s_L D_L - c_L) D_L$.

In Cournot-Nash equilibrium, the solutions are:

$$D_H = \frac{2 - s_L - 2c_H + c_L}{4 - s_L}; \quad D_L = \frac{s_L + s_L c_H - 2c_L}{s_L(4 - s_L)}. \tag{18}$$

The corresponding price expressions are obtained by substituting (18) into (17):

$$P_H = \frac{2 - s_L + c_H(2 - s_L) + c_L}{4 - s_L}; \quad P_L = \frac{s_L + s_L c_H + c_L(2 - s_L)}{4 - s_L}. \tag{19}$$

Note from (18) that in free trade (when $c_H = c_L = \bar{c}$), $D_H \geq 0,\ D_L \geq 0$ iff

$$\bar{c} \leq \frac{s_L}{2 - s_L} = \tilde{c}. \tag{20}$$

This is analogous to the regularity condition ($R1$) in case of price competition. We assume that (20) holds as a regularity condition.

For brevity let us consider the North market case only. Suppose the North uses one instrument, namely an import tariff t_H while the South uses an export subsidy r_L. The corresponding price-quantity expressions are obtained by substituting $c_H = \bar{c},\ c_L = \bar{c} + t_H - r_L$ on equations (18) and (19). The respective objective functions are:

North: $\max\limits_{t_H} W_H = \int\limits_{\bar{\theta}}^{1} (\theta s_H - P_H)\, d\theta + \int\limits_{\hat{\theta}}^{\bar{\theta}} (\theta s_L - P_L)\, d\theta + (P_H - \bar{c})D_H + t_H D_L.$

South: $\max\limits_{r_L} W_L = (P_L - \bar{c} - t_H)D_L.$

Given that a Nash equilibrium exists (at positive prices and quantities), the respective first order conditions are:

$$\begin{aligned} -D_H \frac{\partial P_H}{\partial t_H} - D_L \frac{\partial P_L}{\partial t_H} + (P_H - \bar{c}) \frac{\partial D_H}{\partial t_H} + D_H \frac{\partial P_H}{\partial t_H} + D_L + \tau_H \frac{\partial D_L}{\partial t_H} &= 0 \\ (P_L - \bar{c} - t_H) \frac{\partial D_L}{\partial r_L} + D_L \frac{\partial P_L}{\partial r_L} &= 0. \end{aligned}$$

On relevant substitutions in terms of t_H and t_L and rearranging, we obtain the following policy reaction functions of the North and the South respectively:

$$3t_H = s_L - \bar{c} + r_L; \quad 4(2 - s_L)r_L = s_L^2(1 + \bar{c}) - 2\bar{c}s_L - 2s_L t_H. \tag{21}$$

The first equation shows the North uses a countervailing duty, that is, if the South offers a higher export subsidy to the L-firm, the North will impose a higher import tariff on the L-firm. Solving the reaction functions, we get the equilibrium subsidy-tariff combination as follows:

$$t_H = \frac{8s_L - 3s_L^2 - 8\bar{c} + 2\bar{c}s_L + \bar{c}s_L^2}{12 - 5s_L}; \quad r_L = \frac{s_L^2 - 4\bar{c}s_L + 3\bar{c}s_L^2}{2(12 - 5s_L)}. \tag{22}$$

Using the regularity condition (20), it is straightforward to show that $t_H > 0$, but r_L can be positive or negative. However, for all parametric configurations where the L-firm has a positive market share, we have $r_L > 0$. Thus the equilibrium policy for the South in the non-PRIFE case in a subsidy, in contrast to the case of price competition where the South was imposing an export tax in the non-PRIFE equilibrium.

Also it can be derived that at these equilibrium values of t_H and r_L,

$$D_L = \frac{4s_L - s_L^2 - \bar{c}(16 - 6s_L + 3s_L^2)}{s_L(12 - 5s_L)(4 - s_L)},$$

and this is negative when $\bar{c} > \frac{4s_L - s_L^2}{16 - 6s_L + 3s_L^2} = \hat{c}$. It is easy to check that $\hat{c} < \tilde{c}$. Thus PRIFE holds when $\hat{c} < \bar{c} < \tilde{c}$.

Next assume that the North can impose a production intervention also, along with the import tax t_H. Let z_H denote a specific production subsidy by the North to the H-firm. As before, r_L denotes the export subsidy by the South to its firm. The corresponding price-quantity expressions are obtained by substituting $c_H = \bar{c} - z_H$, $c_L = \bar{c} + t_H - r_L$ into equations (18) and (19). The respective objective functions are:

North: $\max\limits_{t_H,\, z_H} W_H = \int\limits_{\bar{\theta}}^{1} (\theta s_H - P_H)\, d\theta + \int\limits_{\hat{\theta}}^{\bar{\theta}} (\theta s_L - P_L)\, d\theta + (P_H - \bar{c})D_H + t_H D_L.$

South: $\max\limits_{r_L} W_L = (P_L - \bar{c} - t_H)D_L.$

The maximization exercises yield the reaction functions:

$$3t_H = s_L - \bar{c} - s_L z_H - r_L, \quad z_H = 1 - \bar{c} - t_H,$$

$$4(2 - s_L)r_L = s_L^2(1 + \bar{c}) - 2\bar{c}s_L - 2s_L t_H - s_L^2 t_H.$$

Solving these, we get the equilibrium values of t_H, z_H and r_L. Substituting these equilibrium values into the expression for D_L in (18), we get

$$D_L = \frac{-2\bar{c}\delta}{3s_L(2 - s_L)} < 0,$$

unambiguously. Hence, similar to the price competition, the L-firm fails to get a foothold in the Northern market *for any permissible parametric configuration.*

7 Conclusion

This paper has explored a model that captures some of the features of global competition that is typical in the present post liberalization era: that is, firms from the North and the South compete in different regions of the world market, with the North firms usually producing brands of a superior quality. The main result is that in the North markets, in the presence of policy rivalry, the South firms may not survive. On the other hand, in the South markets, the North firms always survive. The exit of South firms from the Northern market is quite different – indeed, opposite to – the standard textbook Boeing-Airbus example in the following way. Whereas the Boeing-Airbus row depicts a situation in which without policy intervention firms from at least one country cannot survive, here in free trade both firms have a positive market share – but in policy equilibrium one firm is driven out of the market. This result then provides a theory as to why the firms from developing countries have developed countries have historically struggled to get a foothold in the developed country markets, while firms from the developed countries have managed to keep some market share in the South.

Our analysis also provides a new reason as to why the developing countries in general follow more restrictive trade practices than do the developed countries in that the Northern tariffs on imports from the South are lower than Southern tariffs on imports from the North.

An obvious extension would be to consider the case when quality levels are not fixed but are choice variables by the firms, as in Das and Donnenfeld (1989) or Zhou, Spencer and Vertinsky (2000). A more ambitious research agenda would be to consider technological gap between North and South firms and the policy rivalry between these countries in a dynamic context of innovation by firms in the North and subsequent imitation by the South firms.

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Appendix 1

It is shown here that in the South market case, in equilibrium, t_L, z_L and t_H are all positive. In stage 1, the respective objective functions are:

South: $\max_{t_L, z_L} W_L = \int_{\bar{\theta}}^{1} (\theta s_H - P_H)\, d\theta + \int_{\hat{\theta}}^{\bar{\theta}} (\theta s_L - P_L)\, d\theta + (P_L - \bar{c}) D_L + t_L D_H$

North: $\max_{t_H} W_H = (P_H - \bar{c} - t_L) D_H$.

The maximization exercises yield the following reaction functions:

$$\begin{aligned} (12 - 11 s_L + 2 s_L^2) t_L &= (4 - s_L)(1 - \bar{c})\delta - (4 - 5 s_L + s_L^2) t_H - (4 - s_L) z_L \\ s_L t_L &= -z_L + (s_L - \bar{c})\delta \\ 4(2 - s_L) t_H &= s_L (2 - \bar{c})\delta - s_L (2 - s_L) \tau_L - s_L z_L, \end{aligned}$$

and solving these,

$$\begin{aligned} t_L &= \frac{(32 - 64 s_L + 42 s_L^2 - 11 s_L^3 + s_L^4)\delta}{2(48 - 88 s_L + 51 s_L^2 - 12 s_L^3 + s_L^4)} > 0 \\ z_L &= \frac{\delta(64 s_L - 112 s_L^2 + 60 s_L^3 - 13 s_L^4 + s_L^5)}{2(48 - 88 s_L + 51 s_L^2 - 12 s_L^3 + s_L^4)} + \bar{c} > 0 \\ t_H &= \frac{\delta(16 s_L - 24 s_L^2 + 9 s_L^3 - s_L^4)}{2(48 - 88 s_L + 51 s_L^2 - 12 s_L^3 + s_L^4)} > 0. \end{aligned}$$

Appendix 2

Proposition 5 is proved here. We solve this equilibrium explicitly by backward induction. Consider first the stage 2 subgame, where given the trade policies, the firms choose prices.

The stage 2 subgame: First consider the strategy of the L-firm. At given values of t_H and t_L (from stage 1), let $\pi_L(P_H, P_L \mid t_H, t_L)$ denote the profit of the L-firm as a function of P_H and P_L. Given P_H the L-firm's optimal strategy is given by the solution of the following problem: $\max_{P_L} \pi_L(P_H, P_L \mid t_H, t_L)$. As long as $D_L(P_H, P_L) \geq 0$, its optimal strategy is given by its unconstrained reaction function obtained from the first order condition of the above maximization exercise (with $c_L = \bar{c} + t_L + t_H$), that is

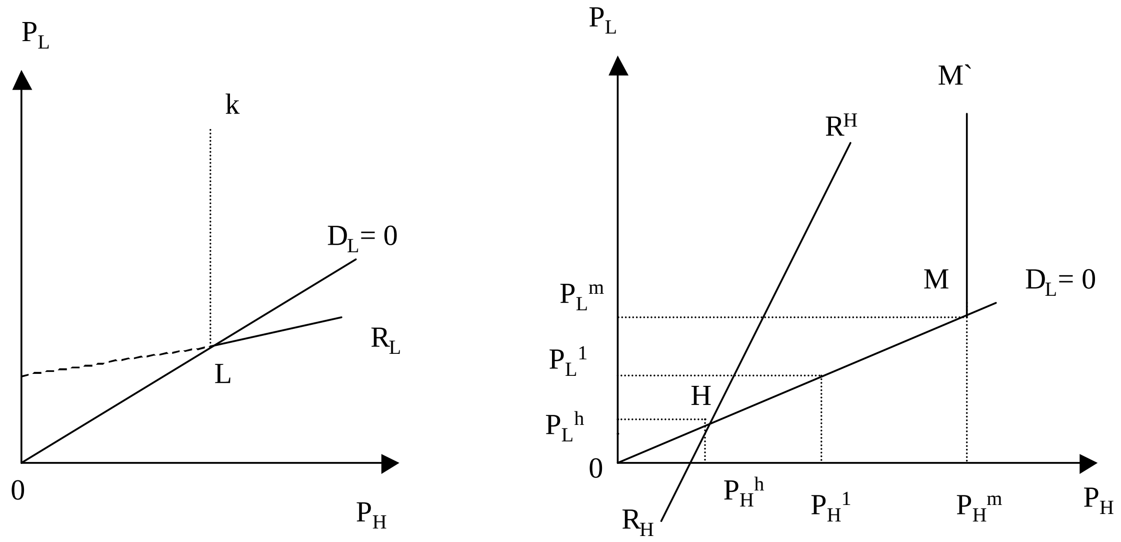
$$2 P_L = s_L P_H + \bar{c} + t_L + t_H. \tag{A1}$$

The $D_L = 0$ line is given by $D_L = \frac{P_H - P_L}{\delta} - \frac{P_L}{s_L} = 0$, that is,

$$P_L = s_L P_H. \tag{A2}$$

In other words, as long as $P_L < s_L P_H$, the $L - firm$ has a positive market share in the North market, and its optimal P_L is given by equation (A1). What happens when $P_L > s_L P_H$? Note that the intersection of equations (A1-A2) yields $P_L = \bar{c} + t_L + t_H$. This is the price that exactly equals the effective marginal cost faced by the L-firm, inclusive of the import tariff and the export tax. Hence, when by charging a price given by its reaction function the L-firm fails to keep any market share, it is still not worthwhile for it to charge a lower price and retain some market share. This is because it can only retain market share by selling at a price less than its effective marginal cost, leading to losses. As such, the best response here is any P_L such that $P_L \geq s_L P_H$, so that its demand and profits are zero.

We plot the unconstrained best response function given in equation (A1) as the line $R^L R_L$ in Figure 5(a). The line $D_L = 0$ in (A2) is the ray through the origin. At any (P_H, P_L) above (below) this line we have $D_L < 0$ (> 0). So the unconstrained best response given in (A1) is valid below the $D_L = 0$ line, and is given by the segment LR_L. Hence the bold line LR_L is the best response of the L-firm above point L in Figure 4(a), while below L, it is any P_L above the $D_L = 0$ line, depicted by $kL0P_L$.



(a) Best Response of L-firm

(b) Best Response of H-firm

Figure 4: Best responses of the two firms

Next, consider the H-firm whose objective is $\max_{P_H} \pi_H(P_H, P_L \mid t_H, t_L)$, where $\pi_H(P_H, P_L \mid t_H, t_L)$ is the profit of the H-firm. When $D_L > 0$, the optimal P_H is given by the solution of P_H from equation (2), that is $2P_H = P_L + \bar{c} + \delta$. In Figure 4(b), equation (2) is plotted as the line $R_H R^H$. It intersects the $D_L = 0$ line from below at point H, whose co-ordinates are (P_H^h, P_L^h). It follows that, as long as $P_L \leq P_L^H$, the best response of the H-firm is given by the segment $R_H H$.

Now we find the best response of the H-firm when $P_L > P_L^H$. In Figure 4(b), the point M on the $D_L = 0$ line has co-ordinates $(P_H^m,\ P_L^m)$, where $P_H^m = (\frac{1+\bar{c}}{2})$ corresponds to the monopoly price of the H-firm. When $P_L \geq P_L^m$, charging $P_H = P_H^m$ (that is, the vertical segment originating at M) is obviously the best response for the H-firm, since that is the price which maximizes its profits under monopoly.

When $P_L^H < P_L < P_L^m$, the best response of the H-firm is to set P_H along the $D_L = 0$ line. The argument is as follows. Suppose $P_L = P_L^1$, where $P_L^1 \in (P_L^H, P_L^m)$ as shown in Figure 4(b). The point P_H^1 marks that P_H such that at the price vector $(P_L^1,\ P_H^1)$, $D_L = 0$. If $P_H \in (0,\ P_H^1)$, the H-firm enjoys monopoly power, but the monopoly profit is increasing in P_H. So $P_H = P_H^1 = \frac{P_L^1}{s_L}$ is preferred to any price less than P_H^1. Now if $P_H > P_H^1$, there is duopoly competition. So the profit of the H-firm would be less than that at $P_H = P_H^1$.

Hence this price is the best response to $P_L = P_L^1$. Note that the profit earned by the H-firm at $P_H = P_H^1$ is not the standard monopoly profits (denoted π_H^m), for P_H^1 is a 'limit' price, that just ensures that the L-firm is prevented from entering. The profit associated with any $P_L \in (P_L^H, P_L^m)$ is equal to

$$\pi_H = (P_H - \bar{c})(1 - P_H)\mid_{P_H = \frac{P_L}{s_L}} = (\frac{P_L}{s_L} - \bar{c})(1 - \frac{P_L}{s_L}) < \pi_H^m = (\frac{1 - \bar{c}}{4})^2$$

In summary, the best response function of the H-firm is given by the kinked bold line $R_H HMM'$ in Figure 4(b).

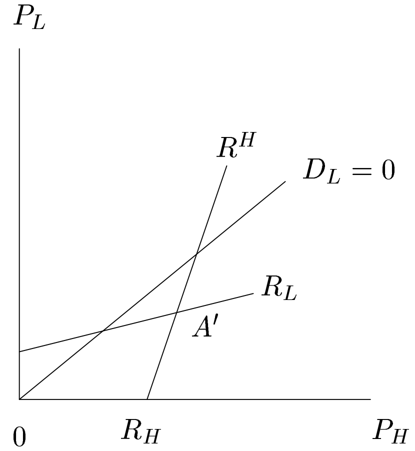


Figure 5(a): Unconstrained case

Unique Nash equilibrium: A'

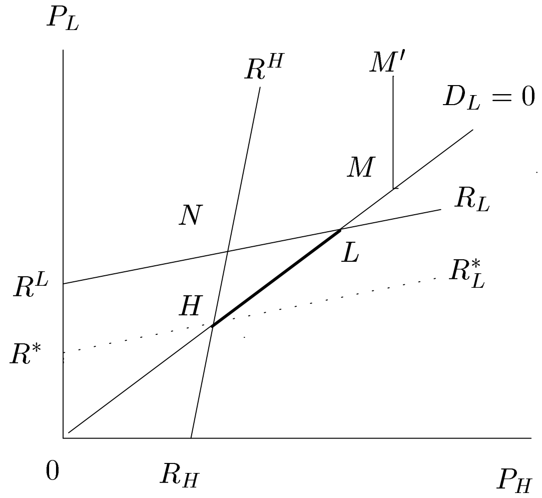


Figure 5(b): PRIFE case

Nash equilibria: HL line

Figure 5 depicts the two best response functions. There are two kinds of equilibria. One is when the L-firm can enter the market. In this case the equilibrium is characterized by the intersection of the two unconstrained reaction functions below the $D_L = 0$ line as shown in Figure 5(a). In contrast in the PRIFE equilibrium, the unconstrained reaction functions intersect above the $D_L = 0$ line, as shown in Figure 5(b). The constrained best response mappings of the H-firm ($R_H HMM'$) and the L-firm do not intersect but they coincide on the segment HL along the $D_L = 0$ line. Hence this segment constitutes the set of Nash equilibria in this subgame.

Now we proceed to the stage 1 game.

The stage 1 game:

Figure 7 depicts the best response functions of the two countries as well as the $D_L = 0$ line in the policy space (14). This is an elaborate representation of Figures 2 and 3 in the text. The dashed lines refer to the lines in Figure 2 – the case where $\bar{c} < c^*$ (no PRIFE equilibrium). The equilibrium policies are indicated at a point such as A – the point of intersection of the reaction functions. Notice that A lies in the left-hand region of $D_L = 0$, wherein $D_L > 0$. This corresponds to panel (a) of Figure 6. Point A in Figure 7 maps to a Nash equilibrium in price competition such as point A' in Figure 6(a).

When $\bar{c} > c^*$, the respective G_H and G_L lines intersect to the right of the respective $D_L = 0$

line. These are the solid lines in Figure 7. Observe that the portions of G_H and G_L lines to the left of the $D_L = 0$ line remain the same as in the unconstrained case: $E^*G'_H$ and $G'_L E$ respectively. The coordinates of points E^* and E are (t_L^*, t_H^*) and $(0, t_H^0)$. The whole segment EE^* corresponds to point H in Figure 6(b).

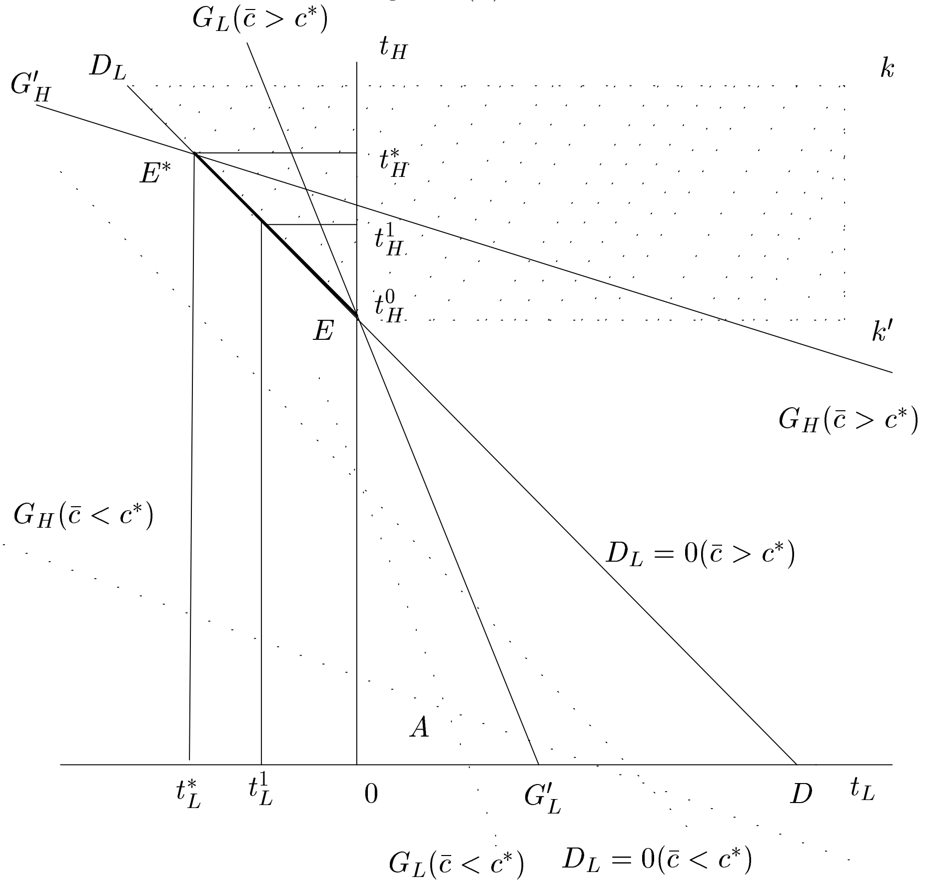


Figure 7

Now consider the best response of the North when t_L exceeds t_L^*, say $t_L = t_L^1$. If t_H is kept unchanged at t_H^*, in Figure 6(b) the R_L line will be at a level higher than R_L^* such as R_L. There is a continuum of Bertrand-Nash equilibria, equal to the segment HL. The welfare of the North at H is same as when $t_L = t_L^*$, but less at other points on HL. This is because among points in HL, P_H is minimum at point H; with only one seller (H-firm) in the market, an increase in P_H means a movement towards the monopoly price to the domestic consumers and hence entails less welfare. In other words, there is a welfare correspondence to this value of t_H, with highest welfare at point H. The same welfare implication holds when $t_H \neq t_H^*$ also, but still $t_H > t_H^1$, where t_H^1 is the ordinate of the point on the $D_L = 0$ line corresponding to $t_L = t_L^1$. However, if t_H is chosen equal to t_H^1, R_L shifts back to R_L^*. There is a unique Bertrand-Nash equilibrium at H and a unique level of welfare of the North, which is higher than that associated with any other point on the segment HL. In the range $t_H < t_H^1$, there will be duopoly competition but the North's welfare is an increasing function in t_H since (t_L^1, t_H) is below the $G_H G'_H$ line. Hence the best response of the North is to levy t_H^1 when $t_L = t_L^1 > t_L^*$. The same argument holds for any $t_L > t_L^*$. In summary, when $t_L > t_L^*$, the best response function of the North is equal to that segment of $D_L = 0$ line which lies below E^*. The overall best response function of the North is then the kinked line $G'_H E^* D$.

Turning to the best response of the South, if $t_H > t_H^0$, any value of t_L such that (t_L, t_H) lies on or to the right of the $D_L = 0$ line forces out the L-firm from the North market and yields zero level of welfare. If t_L is chosen such that $D_L > 0$ (in this range $t_L < 0$ necessarily) there will be duopoly competition and the Bertrand-Nash equilibrium will be at a point like A' in Figure 6(a). However, since such (t_L, t_H) lies to the left of $G_L G'_L$, the South's welfare is an increasing function of t_L. Intuitively, the cost of the subsidy program exceeds the profit of the L-firm and a decrease in the subsidy would lower the net loss. It is not worth helping the L-firm to have a positive market share in the North market (in which case, social welfare will be negative). The best response of the South is to choose t_L along or above the $D_L = 0$ line. In other words, if $t_H > t_H^0$, the best response is a correspondence, shown by the dotted area $D_L k k' E$ in Figure 7. The overall best response of the South is then the correspondence just discussed when $t_H > t_H^0$, and the segment EG'_L when $t_H \leq t_H^0$.

From the best response functions (and correspondences) it is easy to see that the Nash equilibria in the policy space is the segment EE^*. The sum $t_H + t_L$ remains unchanged and any point on it corresponds to (the unique) point H in Figure 6(b).