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Market Structure and the Demand for Free Trade
The Price Version

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Market Structure and the Demand for Free Trade the Price Version

1. Introduction

The literature on profit-shifting export policy in a third country market has rapidly grown since the pioneering work of Brander and Spencer (1985). Most of the papers in this area focus on the optimal policy under imperfect competition either in Cournot or Bertrand competition. One of the main features about this literature is the sensitivity of the results about the export policy to the assumptions of the model behind the analysis. For example, Brander and Spencer find that if a home and a foreign firm compete in Cournot fashion (that is, in quantity strategies) the optimal government policy is an export subsidy. However, Bandyopadhyay (1997) proves that if the demand is inelastic in Brander and Spencer's model the export policy turns out to be a tax. In contrast, Eaton and Grossman (1986), using the notion of conjectural variation, find that if firms are engaged in Bertrand competition the optimal export policy for the government is likely to be a tax. Carmichael (1987) and Gruenspen (1988) reverse the timing of movement of firms and governments in Eaton and Grossman's model. In Carmichael-Gruenspen model firms choose prices in the first stage of the game and then governments set the optimal policy. They find that the optimal policy is an export subsidy to offset the price setting of their firms.

The present research extends the static version of price competition models to include sequential pricing between firms (Stackelberg competition), using a two-stage game model with two firms: a home firm and a foreign firm compete in a third-country market. I assume in the first stage of the game the governments set the optimal tax-cum-subsidy policy on exports and in the second stage of the game firms choose prices, either simultaneously or sequentially. Thus, the market structure is Bertrand duopoly or Stackelberg duopoly, respectively. For the last market structure I assume the home firm to be leader and the foreign firm to be the follower. The idea is to demonstrate how the timing of movement between firms can affect the preferences over the trade regime and to analyze the impact of the trade regime on firms' and governments' preferences over the market structure.

Under Stackelberg competition I find that the optimal tax-cum-subsidy export policy for the country of the leader firm (home country) is neither tax nor subsidy, but the country of the follower firm (foreign country) has the incentive to impose an export tax. For the case of Bertrand competition there is always an incentive to impose an export tax (see Eaton and Grossman for details). Those results even hold when one of the governments faces a social cost for raising taxes. I also find that, when goods are substitutes, under a tax regime firms and governments' preferences over the market structure are completely different from those under a free trade regime. On the contrary, when goods are complements, firms' preferences over market structure under a tax regime are the same as under a free trade regime, but there is a partial reversal of governments' preferences over free trade. These features of the model become important when the market structure is endogenous because the government policy can influence the market structure. In particular, if the potential leader can choose not to be the leader, it will choose Bertrand competition when the goods are complements. Finally, for the case of a sequential market, I find that the follower government always prefers a tax regime to a free trade regime (even though the follower firm always prefers free trade) while the leader government prefers free trade only when the goods are complements.

This chapter is organized as follows. In Section 2, I set up the two-stage game model in which governments first simultaneously choose the export policy (subsidies or taxes) and then firms in a third-country market compete in prices, either simultaneously or sequentially. In Section 3, I present the solution of the model under free trade, which basically repeats the findings from the Industrial Organization literature. In Section 4 and 5, I solve the two-stage game when firms either simultaneously or sequentially choose prices, and governments simultaneously set their export taxes. In Section 6, I study the firms' and governments' preferences over the market structure under free trade and under the tax regime. In Section 7, I study the impact of market structure on preferences over the trade regime. In Section 8, I investigate the impact of the endogenous choice of market structure on preferences over roles and trade regime assuming that the potential leader has the option to choose the role of being leader or playing Bertrand-Nash. A summary of the results of these sections is included in Balboa, Daughety and Reinganum paper in Journal of Economics and Management Strategic (forthcoming). In Section 9, I study firms and government preferences over trade regimes when one of the governments faces a social cost of raising taxes. Finally, Section 10 is the conclusion. All proofs appear in the Appendix of the paper.

2. The model

Consider two firms, one located in the home country and the other in the foreign country, producing differentiated goods and selling them in a third-country market. I refer to the firm in the home country as the home firm and the firm in the foreign country as the foreign firm. As I pointed out before, I assume that firms choose their prices simultaneously, allowing later for sequential pricing. To simplify the model, I assume constant marginal cost, no fixed cost, and linear demands.Preferences can be summarized by the following demands: $q_i = u - vp_i + wp_j$ where i, j = h, f, $i \neq j$, $v > 0$, $v^2 > w^2$, where h denotes the home firm and f denotes the foreign firm. Note that if $w > 0$ then the goods are substitutes, while if $w < 0$ then the goods are complements (if $w = 0$ the goods are independent). The firm's cost function is $C(q_i) = cq_i$, where c is the firm's marginal cost. Let t_i denote a tax (if $t_i < 0$) or subsidy (if $t_i > 0$) applied by firm i's government on exports. Therefore, firm i's profit function is $\pi_i(p_i,p_j) = p_iq_i(p_i, p_j) - cq_i + t_iq_i$. As we might expect, the optimal price to be charged will, in general, depend on the tax-cum-subsidy export policy chosen by the government. Now, I will consider two types of market structure in order to analyze the optimal export policy: Bertrand and Stackelberg competition.

Under Bertrand competition both firms choose simultaneously and noncooperatively their levels of prices. Let $p_i^{BT}(t_i, t_j)$ be the equilibrium price and $\pi_i^{BT}(t_i, t_j) = \pi_i^{BT}(p_i(t_i, t_j),p_j(t_i, t_j), t_i)$ be the profits for any arbitrary tax-cum-subsidy policy when firms are engaged in Bertrand competition. In Stackelberg competition firms choose prices sequentially. Without loss generality, let the home firm be the leader and the foreign firm be the follower. Let t_h denote the home government's tax-cum-subsidy policy and t_f denote the foreign government's tax-cum-subsidy policy. Let $p_h^L(t_h, t_f)$ and $p_f^F(t_h, t_f)$ be the equilibrium prices when the home firm moves first and the foreign firm moves second. Finally, let $\pi_h^L(p_h^L(t_h, t_f), p_f^F(t_h, t_f), t_h)$ denote the home firm's profits and let $\pi_f^F(p_h^L(t_h, t_f), p_f^F(t_h, t_f), t_f)$ denote the foreign firm's profits. I assume the governments always choose simultaneously and noncooperatively the tax-cum-subsidy export policies before firms choose their prices.

The national welfare for country i, denoted by w_i, is defined as profits minus subsidy[1], which is also the government's payoff. Therefore, under Bertrand competition $w_i^{BT}(t_i, t_j) = \pi_i^{BT}(p_i(t_i, t_j), p_j(t_i, t_j), t_i) - t_i q_i(p_i(t_i, t_j), p_j(t_i, t_j))$. Under Stackelberg competition the national welfare for home country is

$$w_h^L(t_h, t_f) = \pi_h^L(p_h(t_h, t_f), p_f(t_h, t_f), t_h) - t_h q^L{}_h(p_h(t_h, t_f), p_f(t_h, t_f)).$$

Similarly, the national welfare for the foreign country is;

$$w_f^F(t_h, t_f) = \pi_f^F(p_h(t_h, t_f), p_f(t_h, t_f), t_f) - t_f q^F{}_f\,(p_h(t_h, t_f), p_f(t_h, t_f)).$$

I use upper case letter to denote payoffs and outcomes for both government and firm under free trade and lower case letter to denote payoffs and outcomes under a regime of taxes. Notice that in Bertrand competition the equilibrium outcomes are equivalent for both the home and the foreign country since firms and their respective governments are symmetric. Thus, to simplify notation $P^{BT*} = p_i^{BT}(0, 0)$ represents the firm's optimal price under free trade and $p^{BT*} = p_i^{BT}(t_i, t_j)$ represents the firm's equilibrium price under a tax regime when firms play Bertrand. Likewise, $\Pi^{BT*} = \pi_i^{BT}(0, 0)$ denotes the firm's profits under free trade equilibrium and $\pi^{BT*} = \pi_i^{BT}(t_i, t_j)$ denotes the firm's profits under a tax regime. Similarly, for the government notation we have $W^{BT*} = w_i^{BT}(0, 0)$ and $w^{BT*} = w_i^{BT}(t_i, t_j)$.

[1] Tax, if the optimal subsidy is negative.

3. Solution for Bertrand and Stackelberg competition under free trade

Under free trade t_h and t_f are set equal to zero. Therefore, in this scenario profits for firm i can be written as $\pi_i(p_i, p_j, 0) = (p_i - c)(u - vp_i + wp_j)$. Because firm i's objective is to maximize π_i, the firm i's best response function is $BR_i(q_j) = (cv + p_jw + u) /(2v)$, i =h, f. Notice that the Best Response is upward sloping only if the goods are substitutes ($w > 0$). Following Bulow, Geanakoplos and Kemplerer (1985), we say in this case that the prices are strategic complements if and only if the goods are substitutes. Now, I show how different market structures can affect the firm's preference over its role.

First consider the case of Bertrand competition. Table 1 below summarizes the Bertrand-Nash equilibrium for prices, profits and government's payoffs. As can be seen from Table 1, under free trade the government's payoff is equivalent to the firm's profits because firms compete in a third-country market and all production is exported.

Table 1: Bertrand-Nash equilibrium for prices, profits and government's payoff

P^{BT*}	$(cv + u)/(2v-w)$
Π^{BT*}	$v(c(v-w)-u)^2/(2v-w)^2$
W^{BT*}	$v(c(v-w)-u)^2/(2v-w)^2$

In Stackelberg competition the home firm' s profit function is $\pi_h^L(p_h^L, p_f^F\ t = 0) = (p_h - c)(u - vp_h + wp_f)$. Since by assumption the foreign firm is the follower, the foreign firm's best response is $BR_f(q_{f,}\ 0) = (cv + p_hw + u) /(2v)$. Substituting the $BR_f(q_f)$ into the home firm's profit function we have: $\pi_h^L(p_h^L, BR_f(q_f), t = 0) = (p_h - c)(u - v \cdot p_h + w \cdot (c \cdot v + p_h \cdot w + u) /(2v))$. Table 2 below provides the Stackelberg equilibrium for prices, profits and governments' payoffs.

Table 2: Stackelberg competition outcomes under free trade

P_h^{L*}	$(c(2v^2 + vw - w^2) + u(2v + w))/(2(2v^2 - w^2)$
P_f^{F*}	$(c(4v^3 + 2v^2w - vw^2 - w^3) + u(4v^2 + 2vw - w^2))/(4v(2v^2 - w^2))$
Π_h^{L*}	$(2v + w)^2(c(v - w) - u)^2/(8v(2v^2 - w^2)$
Π_f^{F*}	$(4v^2 + 2vw - w^2)^2(c(v - w) - u)^2/(16v(2v^2 - w^2)^2)$
W_h^{L*}	$(2v + w)^2 (c(v - w) - u)^2/(8v(2v^2 - w^2)$
W_f^{F*}	$(4v^2 + 2vw - w^2)^2(c(v - w) - u)^2/(16v(2v^2 - w^2)^2)$

As in the case of Bertrand competition, the governments' payoffs are the same as their firms.

Using the information in Tables 1 and 2, it is easy to prove that if goods are substitutes ($w > 0$) then $\Pi_f^{F*} > \Pi_h^{L*} > \Pi^{BT*}$. Thus, a firm would prefer being the follower to being the leader and both firms agree that Stackelberg competition is better than Bertrand competition. Also, if goods are complements ($w < 0$) then $\Pi_f^{L*} > \Pi_h^{BT*} > \Pi^{F*}$. Therefore, a firm prefers the role of the leader to being Bertrand-Nash players, which is preferred to the role of Stackelberg follower.

The conclusions presented above are completely consistent with the Industrial Organization literature. For example, Gal-Or (1985) proves that when best responses are upward-sloping (i.e., when firms choose prices and goods are substitutes[2]) in a sequential market game a firm is worse being the leader than being the follower. However, when the best responses are downward-sloping (i.e when firms choose prices and goods are

[2] Under this scenario, prices are strategic complements.

complements being a leader is advantageous).[3] On the other hand, Dowrick (1986) found that if best responses are downward-sloping the leader earns more profits than a Bertrand player but the follower earns less profits than Bertrand players. On the contrary, if best responses were upward sloping the leader and the follower would rather play Stackelberg than Bertrand.[4]

4. Optimal export policy under Bertrand competition

Eaton and Grossman (1986) have studied this scenario so I will provide a brief summary of the findings.

In the first stage of the game goverments simultaneously and noncooperatively choose the optimal export policy and in the second stage of the game firms simultaneously choose their export prices to the third-country market. To solve for the Nash equilibrium we have to proceed backward; that is, first find the Nash equilibrium for the price game between the home and domestic firm and then use this result to find the Nash equilibrium for the tax-cum-subsidy export policy game.

First, consider the second stage of the game wherein firms choose their prices given an arbitrary value for t_i. Firm i's problem is to maximize

$\pi_i(p_i, p_j, t_i) = (p_i - c + t_i)(u - vp_i + wp_j)$. We know from the first order condition that the best response function takes the following form: $p_i = (cv + p_jw - s_iv + u)/(2v)$ for i, j = h, f, and $i \neq j$. Again, by symmetry the Bertrand-Nash equilibrium for prices, profits, and government payoffs (for given t_i, t_j) are equivalent for both the home and the foreign countries. Table 3 provides the Bertrand-Nash equilibrium outcomes.

[3] That is, when prices are strategic substitutes.

Table 3: Bertrand-Nash equilibrium outcomes for arbitrary values for taxes

$p_i^{BT}(t_i, t_j)$	$cv(2v + w) - 2t_iv^2 - t_jvw + u(2v + w)/(4v^2 - w^2)$
$\pi_i^{BT}(t_i, t_j)$	$(v(c(v - w)(2v + w) + t_i(w^2 - 2v^2) + t_jvw – u(2v + w)))^2/((4v^2 - w^2)^2$
$w_i^{BT}(t_i, t_j)$	$\pi_i^{BT}(t_i, t_j) - t_i(v(c(v - w)(2v + w) + t_i(w^2 - 2v^2) + t_jvw - u(2v + w)))/(w^2 - 4v^2)$

Now, consider the first stage of the game in which governments set the optimal trade policy. Differentiating $w_i^{BT}(t_i, t_j)$ with respect to t_i, equating the result to zero, and invoking symmetry ($t_h^{BT} = t_f^{BT}$) the optimal tax-cum-subsidy is $t_i = w^2(c(v - w) - u)/$ $(v(4v^2 - 2vw – w^2))$. It is straightforward to prove that the optimal policy is a tax on exports ($t_i <0$ for i, j = h, f) regardless of the nature of the goods. Substituting the optimal tax into the equilibrium outcomes in Table 3 we have the following reduced form for prices, profits and governments' payoff.

Table 4: Reduced form for prices, profits and governments' payoff given optimal taxes

p_i^{BT*}	$(c(2v^2 - w^2) + 2uv)/(4v^2 - 2vw – w^2)$
π_i^{BT*}	$(2v^2 - w^2)^2(c(v - w) - u)^2/(v(4v^2 - 2vw – w^2)^2)$
w_i^{BT*}	$2v(2v^2 – w^2)(c(v - w) -u)^2/(4v^2 - 2vw – w^2)^2$

Using the information provided in Table 1 and 4 it is easy to verify that firms always prefer free trade ($\Pi_i^{BT*} > \pi_i^{BT*}$). The justification is the fact that the optimal trade policy is an export tax that increases prices but part of firm's revenues accrues to the government so the relevant price for the firm is less that the price prevails under free trade. However,

[4] But firms will disagree with respect to their roles.

governments only agree with their firm with respect to their preferences over free trade when goods are complements. When goods are substitutes governments prefer export tax because the impact of imposing a tax on exports is in part offset by the tax imposed by the other country.

5. Optimal export policy under Stackelberg competition.

Again, I assume that in the first stage of the game the governments choose the optimal tax-cum-subsidy export policy simultaneously and noncooperatively, while in the second stage of the game, firms sequentially choose price. I will show, as in the quantity case, that in the equilibrium the home government, whose firm is the leader, neither taxes nor subsidies exports but the foreign government imposes an export tax. This equilibrium will sometimes be beneficial for the leader. Finally, I will compare the equilibrium outcomes for Bertrand and Stackelberg competition under free trade and under a tax regime.

Consider the second stage of the game wherein the home firm is the leader. The home firm's profit can be written as $\pi_h = (p - c + t_h)(u - v \cdot p_h - wp_f)$. Since the best response function for the foreign firm is $p_f(p_h) = (c \cdot v + - t_f \cdot v + p_h w + u) /(2v)$, we can substitute this into π_h so the profit function is now given by $\pi_h(p_{h,} t_{h,} t_f) = (p_h - c + t_h)(u - vp_h - w(cv + p_h w + u- t_f \cdot v) /(2v))$. Table 5 shows the Stackelberg equilibrium outcomes for prices, profits and governments' payoff for arbitrary pair of taxes $(t_{h,} t_f)$.

Table 5: Stackelberg equilibrium outcomes for arbitrary pair of taxes (t_h, t_f).

$p_h(t_h, t_f)$	$(c(2v^2 + vw - w^2) - t_f vw + t_h(w^2 - 2v^2) + u(2v + w))/(2(2v^2 - w^2))$
$p_f(t_h, t_f)$	$(c(4v^3 + 2v^2w - vw^2 - w^3) + t_f v(w^2 - 4v^2) + t_h w(w^2 - 2v^2) + u(4v^2 + 2vw - w^2))/(4v(2v^2 - w^2))$
$\pi_h(t_h, t_f)$	$(c(2v^2 - vw - w^2) + t_f vw + t_h(w^2 - 2v^2) - u(2v + w))^2/(8v(2v^2 - w^2))$
$\pi_f(t_h, t_f)$	$(c(4v^3 - 2v^2w - 3vw^2 + w^3) + t_f v(3w^2 - 4v^2) + t_h w(2v^2 - w^2) - u(4v^2 + 2vw - w^2))^2/(16v(2v^2 - w^2)^2)$
$w_h(t_h, t_f)$	$(c^2(2v^2 - vw - w^2)^2 + 2c(2v^2 - vw - w^2)(t_f vw - u(2v + w)) + t_f^2v^2w^2 - 2t_f uvw(2v + w) - (t_h(2v^2 - w^2) + u(2v + w))(t_h(2v^2 - w^2) - u(2v + w)))/(8v(2v^2 - w^2))$
$w_f(t_h, t_f)$	$(c(4v^3 - 2v^2w - 3vw^2 + w^3) + t_f v(4v^2 - w^2) + t_h w(2v^2 - w^2) - u(4v^2 + 2vw - w^2))(c(4v^3 - 2v^2w - 3vw^2 + w^3) + t_f v(3w^2 - 4v^2) + t_h w(2v^2 - w^2) - u(4v^2 + 2vw - w^2))/(16v(2v^2 - w^2)^2)$

In the first stage of the game the governments choose t_i to maximize their national welfare w_i; that is, government i maximizes its firm's profits minus any government transfer to the firm (as a function of t_i). Therefore, the objective function for government i is to maximize $w_i(t_i, t_j) = \pi_h(t_h, t_f) - t_i q_i(t_i, t_j)$, with respect to t_i (i, j = h, f). [5]

The first order condition for the home firm is $\partial w_h/\partial t_h = t_h(w^2 - 2v^2)/(4v) = 0$ which implies $t_h = 0$. This finding means that the Stackelberg leader government (home country) neither taxes nor subsidies its firm. Basically, the idea of the optimal trade policy is to reach the Stackelberg leader equilibrium but by assumption the home firm is the leader in this game so there is no incentive for the home government to change the equilibrium price. Summarizing, laissez-faire is a dominant strategy for the home government. This simplifies the result for the optimal policy for the foreign country government.

Substituting $t_h = 0$ into the first order condition for the foreign country government and solving for t_f yields $t_f = w^2(4v^2 + 2vw - w^2)(c(v - w) - u)/(v(4v^2 - w^2)(4v^2 - 3w^2))$. Since $c(v - w) - u$ is negative the optimal trade policy for the foreign country is to impose a tax on

[5] See Table 5 for the specific form for w_i.

exports,[6] regardless of the nature of the goods (substitute or complements). This follows from the fact that under free trade the optimal price for the foreign firm is less that the optimal price charged by the home firm.[7]

Table 6 presents the equilibrium outcomes for prices, firms' profits and governments' payoffs when substituting the optimal taxes into Table 5.

Table 6: Equilibrium prices, firms'profits and governments' payoffs for optimal taxes

p_h^*	$c(8v^4 + 4v^3w - 8v^2w^2 - 3vw^3 + 2w^4) + u(8v^3 + 4v^2w - 4vw^2 - w^3)/$ $(4v^2 - w^2)(4v^2 - 3w^2)$
p_f^*	$c(4v^3 + 2v^2w - 3vw^2 - w^3) + u(4v^2 + 2vw - w^2)/(2v(4v^2 - 3w^2))$
π_h^*	$(2v^2 - w^2)(8v^3 + 4v^2w - 4vw^2 - w^3)^2(c(v - w) - u)^2/2v(4v^2 - w^2)^2(4v^2 - 3w^2)^2$
π_f^*	$(4v^2 + 2vw - w^2)^2(c(v - w) - u)^2/(4v(4v^2 - w^2)^2$
w_h^*	$(2v^2 - w^2)(8v^3 + 4v^2w - 4vw^2 - w^3)^2(c(v - w) - u)^2/(2v(4v^2 - w^2)^2(4v^2 - 3w^2)^2)$
w_f^*	$(4v^2 + 2vw - w^2)^2(c(v - w) - u)^2/(4v(4v^2 - w^2)(4v^2 - 3w^2)$

It can be proved that under a tax regime the price of the foreign firm is now greater than the price of the home firm because the home government does not impose a tax while the foreign government does. Given these findings and using the information provided in the previous sections, I am able to establish the impact of trade regimes on firms and governments' preferences over the market structure (Stackelberg versus Bertrand competition). I am also able to determine firms and governments' preferences over the trade regime.

[6] This relationship is simply that the marginal cost must be greater than the maximum willingness to pay for the first unit. In other words, this is the assumption that allows the market to exist.

6. Firms and governments' preferences over market structure under free trade and a tax regime

Under free trade governments' preferences over market structure are the same as those for their firms because governments' payoffs are equivalent to firms' profits. When goods are substitutes, being the follower is better than being the leader because the leader's optimal price is higher than that for the follower and goods are easy to substitute. Unlike the case of substitute goods, when goods are complements being the leader is advantageous because it is not easy to substitute goods when the price is higher. Also, Bertrand competition is less desirable for the two firms when the goods are substitutes. For complementary goods the follower (foreign firm) prefers Bertrand competition to Stackelberg competition but the home firm will prefer the role of the leader to that of the Bertrand-Nash player.

Now, consider how the tax regime can affect firms' and governments' preferences regarding the market structure and roles. First, considering firms' preferences, it can be proved that the leader is the most preferred role because profits are highest and the leader's government does not impose any export tax. Also, Bertrand-Nash profits after taxes are in between those of the follower and the leader. This means that being a follower is strongly disadvantageous for the foreign country independent of the nature of the goods. The justification is the following: the follower's government imposes a higher export tax in Stackelberg competition than in Bertrand competition, which increases the price for the follower firm and hence decreases its profits beyond those earned in Bertrand competition. Proposition 1a (below) summarizes these results.

[7] See Gal-Or (1985) for the necessary conditions for this to hold.

Second, consider the governments' preferences over market structure and roles under a tax regime. As shown in Proposition 1, when goods are substitutes, the government prefers the role of the leader to the role of the follower and Bertrand competition yields the lowest profits for the firm. That is, national welfare is highest for the home country when prices are the strategic variable, firms compete in Stackelberg fashion, and goods are substitutes. Thus, the government most prefers its firm to be the leader when goods are substitutes. However, under complementarity, being the leader is strongly disadvantageous for the home country, while being a Bertrand-Nash player is better than being the leader but worse than being the follower. These results are displayed in Proposition 1b.

Proposition 1 (see the appendix for the proof):

a. $\pi_h^* > \pi_i^{BT*} > \pi_f^*$ for susbtitutes and complements;

b. $w_h^* > w_f^* > w_i^{BT*}$ when goods are substitutes and $w_f^* > w_i^{BT*} > w_h^*$ when goods are complements.

Table 7 illustrates the impact of trade regime on firm and government preferences over market structure. Note that the middle column follows from the standard literature of Industrial Organization.

Table 7: Impact of trade regime on firm and government preferences over market structure.

	Equilibrium with free trade	Equilibrium with export tax
Substitutes	$W_f^* > W_h^* > W^{BT*}$	$w_h^* > w_f^* > w^{BT*}$
	$\Pi_f^* > \Pi_h^* > \Pi^{BT*}$	$\pi_h^* > \pi^{BT*} > \pi_f^*$
Complements	$W_h^* > W^{BT*} > W_f^*$	$w_f^* > w^{BT*} > w_h^*$
	$\Pi_h^* > \Pi^{BT*} > \Pi_f^*$	$\pi_h^* > \pi^{BT*} > \pi_f^*$

As can be seen from Table 7, the home firm always prefers being the leader to being a Bertrand–Nash player regardless of the trade regime but the home government's preference over market structure changes when the foreign government imposes export taxes and goods are complements. Therefore, under a tax regime, the home government's preferences over the market structure differ from those of its firm. For the substitute case, both the home firm and its government agree that being the leader is always better than being a Bertrand-Nash player. Contrary to the home firm case, the foreign firm will always prefer being a Bertrand-Nash player to being the follower under the tax regime. For this country, the foreign government will disagree with its firm about the desirability of Bertrand competition versus Stackelberg competition.

7. Impact of market structure on preferences over the trade regime

Recall that when firms choose price sequentially the home government does not impose an export tax and hence the home government has the same preferences as its firm. First, consider the home firm preference over the trade regime in Stackelberg competition. When the goods are complements the home firm profits are higher under free trade because in the tax regime the foreign government imposes an export tax that decreases exports and hence the home firm prefers free trade and so does its government. When the goods are substitutes the home firm profits under free trade are lower than those under the tax regime and therefore, the home firm and its government prefer the tax regime. Now, consider the foreign firm in Stackelberg competition. Since export taxes reduce the firm's profits, the foreign firm will always prefer free trade. Nevertheless, the foreign government always prefers the tax regime. This means that imposing export taxes increases national welfare (as compared to free trade) because the increase in tax revenues offsets the decline in the firm's profits. This situation contrasts with the quantity version in which the follower firm will always prefer a subsidy regime to free trade. These findings are summarized in Proposition 2a and 2b.

Proposition 2:

a. $\Pi_h^* > \pi_h^*$ for complements and $\pi_h^* > \Pi_h^*$ for substitutes, while $\Pi_f^* > \pi_f^*$;

b. $W_h^* > w_h^*$ for complements and $w_h^* > W_h^*$ for substitutes, while $w_f^* > W_f^*$

Table 8 shows the impact of market structure on firm and government preferences over trade regime.

Table 8: Market structure and preferences over the trade regime

	Bertrand competition	Stackelberg competition
Goods are substitutes	$w^{BT*} > W^{BT*}$	$w_h^* > W_h^*$
		$w_f^* > W_f^*$
	$\Pi^{BT*} > \pi^{BT*}$	$\pi_h^* > \Pi_h^*$
		$\Pi_f^* > \pi_f^*$
Goods are complements	$W^{BT*} > w^{BT*}$	$W_h^* > w_h^*$
		$w_f^* > W_f^*$
	$\Pi^{BT*} > \pi^{BT*}$	$\Pi_h^* > \pi_h^*$
		$\Pi_f^* > \pi_f^*$

The results for the Bertrand competition are the usual findings from the strategic trade literature. Firms always prefer free trade[8] and their governments prefer free trade only when the goods are complements. These mean that for complementary goods firms and governments will share preferences over the trade regime, even though imposing export taxes is a dominant strategy for the governments. When the goods are substitutes, the firm and its respective government disagree about their preferences regarding free trade.

For the case of Stackelberg competition, it is clear that the home firm and its government never disagree about the trade regime because the dominant strategy for the home government is neither to tax nor to subsidize. When the goods are substitutes both the home firm and its government prefer the tax regime and when the goods are complements both prefer free trade. Contrary to the home country, the foreign firm and its government

[8] This contrasts with the case of Cournot competition wherein firms always prefer subsidies and their governments prefer subsidies only when goods are substitutes.

will always disagree about the desirability of imposing an export tax. The foreign firm's profits are always higher under free trade than under the tax regime while the government's payoffs (national welfare) are higher under the tax regime. Therefore it is not possible for the home government to support free trade by threatening the foreign country with taxes if the latter imposes an export tax. However, in a multimarket framework, in which the home firm is the leader in some market and the follower in others, it is possible to support free trade. Using the notion of trigger strategy policy the leader government is able to punish any deviation from free trade by the foreign government in a market in wherein the home firm is the leader (and vise versa). Proposition 3 states the condition for this in the case of two third-country markets.

Proposition 3: $W^{L*} + W^{F*} > w^{L*} + w^{F*}$ for complementary goods. The subscript L denotes leader and F denotes follower.

According to Proposition 3, if there were two third-country markets, the home and the foreign governments would support free trade for complementary goods only if one firm (say for example, the home firm) is the leader in one market and the follower in the other market[9]. Therefore, if one country decides to impose an export tax in one market then the other country will impose export taxes in the other market wherein its firm is the follower.

Notice for the case of substitute goods the governments will always support a tax regime, for any type of market structure being considered in this paper.

Finally, I have assumed so far that the home country is the export leader and the foreign country is the export follower, as if these roles were determined outside the market.

[9] Using the following trigger strategies: do not impose export taxes if the other country has not imposed export taxes in any market in the past; otherwise, revert to the one-period Nash equilibrium tax policy.

Basically this means that if the home firm enters the market it would assume the role of the leader, while the other firm would assume the role of the follower. On the other hand, the nature of the goods and the market structure can determine the desirability of free trade. In particular, when goods are complements and the market structure is Bertrand duopoly both countries agree that free trade outcomes are better, but when the goods are substitutes both governments agree about the desirability of the tax regime over free trade for both Bertrand and Stackelberg competition.

8. Endogenous choice of market structure.

In this section I assume the home firm has the option to choose the role of being the leader or not, but the foreign does not. If the home firm decides to assume the role of the leader then both firms will engage in Stackelberg competition, while if the home firm decides not to exert this option then the market structure is Bertrand duopoly.

Consider the following three-stage game: In the first stage of the game the home firm chooses once and for all to be the leader or to be a Bertrand-Nash player. Then, in the second stage of the game the governments choose the optimal export tax. Finally, in the last stage, the firms choose their prices (sequentially, if the home firm has chosen to be the leader, and simultaneously, if the home firm has chosen to be a Bertrand-Nash player). I also assume that the second and third stages can be seen as being repeatedly played so governments could use trigger strategy to support free trade if this outcome is preferred to the outcome under the tax regime.

First, consider the case of substitute goods. If the home firm decides to exercise this option it will become the leader and the optimal trade policy involves an export tax with governments' payoffs (w_h^*, w_f^*). Note that, according to Table 8, these outcomes are preferred to free trade by both governments and, as a result, this equilibrium will prevail repeatedly over time. Since there is no uncertainty about the game, the home firm will anticipate a payoff of π_h^*. If the home firm decides not to exercise the option the equilibrium will be Bertrand-Nash with governments' payoffs (w^{BT*}, w^{BT*}) As can be seen from table 8, these payoffs are higher than those from free trade and hence, governments prefer the tax regime and the payoff for the home firm is π^{BT*}. Because $\pi_h^* > \pi^{BT*}$, the home firm will choose to be the leader.

Suppose now that the goods are complements. As can be shown from Table 8, if the home firm chooses to be the leader the equilibrium outcomes involves an export tax and governments' payoffs of w_h^* and w_f^*, respectively. Note in this case that the foreign government prefers an export tax to free trade[10] and hence the Nash equilibrium with export taxes will prevail in a repeated game. Therefore, if the home firm exercises the option, it will anticipate profits equal to π_h^*. However, if the home firm chooses not to exercise the option then the Bertrand-Nash equilibrium will lead to a free trade regime with governments' payoffs of (W^{BT*}, W^{BT*}), which can be supported in a repeated game using trigger strategies. Thus, the home firm will anticipate profits of Π^{BT*} if it chooses Bertrand. It can be proved[11] that $\Pi^{BT*} > \pi_h^*$; thus, the home firm will choose not to exercise the option and the trade regime is free trade.

Finally, Proposition 4 summarizes the findings for the endogenous choice of market structure.

[10] See Table 7.
[11] See the appendix for the formal proof.

Proposition 4: When goods are substitutes the home firm (potential leader) will choose to be the leader and the trade regime is a tax regime. When goods are complements the home firm will choose Bertrand-Nash Player and the trade regime is free trade.

9. Asymmetric social cost of collecting taxes

In this section I analyze the previous game but now assuming that one of the countries faces a cost of imposing export taxes. This assumption makes the problem of the asymmetric social cost of imposing taxes simple to analyze. One manner in which such a cost arises is that if the relative prices of the economy have changed after the imposition of the tax, and then this implies a reallocation of resources. Also, higher tax rates induce more evasion, requiring more enforcement expenditures. I first analyze the case when the government of the foreign firm faces a social cost of raising taxes. After that, I will assess the same scenario for the government of the home firm. In this scenario that any dollar collected by the government has a social cost for its economy greater than zero. To make the analysis tractable, I assume that the social cost is quadratic in the amount of the tax rate imposed, which is consistent with the deadweight lost associated to taxes when the demand is linear and firms have constant marginal cost.

When the government of country i faces a social cost of collecting taxes, the national welfare will be written as:

$$W_i(t_j, t_i) = \pi_i(p_i(t_i, t_j), p_j(t_j, t_i), t_i) - t_i q_i\, (p_i(t_i, t_j), p_j(t_i, t_j)) - \lambda(t_i)^2,\ \lambda > 0,\ i = h, f,\ j = f, h$$

The parameter λ reflects the deadweight cost of raising taxes; it could also reflect some administrative costs of collecting tax revenues explained before. I consider the case of Stackelberg and Bertrand competition. To simplify the analysis, I assume that everything else remains the same, including the welfare function for the other country that is, each government chooses the level of taxes in the first stage of the game, and in the second stage, firms choose their level of price either simultaneously or sequentially.

First, consider again the case of Stackelberg competition. Recall that in the previous analysis of this case the government of the home country (the leader firm) chose not to impose a tax while the government of the foreign country (the follower firm) had the incentive to impose a tax on exports. Now, if the foreign government faces a social cost of raising taxes (i = f in the new welfare function described above), then there is still an incentive for the foreign government to impose a tax on exports, and laissez-faire remains a dominant strategy for the home government. Nevertheless, the optimal tax per unit for the foreign country is lower than the previous case since it is costly for the foreign country to impose taxes.

Because the first order condition for the leader firm (home country firm) is $\partial w_h/\partial t_h = t_h(w^2 - 2v^2)/(4v) - 2t_i = 0$, the optimal trade policy is neither to tax nor to subsidy. Using the previous result we substitute $t_h = 0$ into the first order condition for maximizing the national welfare of the foreign country. This result yields $t_f = w^2(4v^2 + 2vw - 2w^2)(c(v-w) - u)/(16\lambda(2v^2 - w^2) + v(4v^2 - w^2)(4v^2 - 3w^2))$. Notice that if $\lambda = 0$, the result reduces to the previous case. As λ gets arbitrarily large (it is very expensive to raise taxes), the optimal export tax converges to zero; hence, the equilibrium is the free trade regime. Table 9 shows the equilibrium outcomes for prices, firms' profits and governments' payoffs for the optimal export tax.

Table 9: Equilibrium prices, firms' profits, and governments' payoffs for the optimal taxes

$p_h^*(\lambda)$	$c(8\lambda(2v^2 - w^2)(2v^2 + vw - w^2) + v(8v^4 + 4v^3w - 8v2w^2 - 3vw^3 + 2w^4)) + u(8\lambda(2v + w)(2v^2 - w^2) + v(8v^3 + 4v^2w - 4vw^2 - w^3))/(16\lambda(2v^2 - w^2)^2 + v(4v^2 - w^2)(4v^2 - 3w^2))$
$p_f^*(\lambda)$	$c(8\lambda(2v^2 - w^2)(4v^3 + 2v^2w - vw^2 - w^3) + v(4v^2 - w^2)(4v^3 + 2v^2w - 3vw^2 - w^3) + u(2v^2 + 2vw - w^2)(8\lambda(2v^2 - w^2) + v(4v^2 - w^2)/(2v(16\lambda(2v^2 - w^2)^2 + v(4v^2 - w^2)(4w^2 - 3w^2))$
$\pi_h^*(\lambda)$	$(2v^2 - w^2)(8\lambda(2v + w)(2v^2 - w^2) + v(8v^3 + 4v^2w - 4vw^2 - w^3))^2(c(v - w) - u)^2/ (2v(16\lambda(2v^2 - w^2)^2 + v(4v - w)(4v^2 - 3w^2))^2)$
$\pi_f^*(\lambda)$	$(4v^2 + 2vw - w^2)^2(8\lambda(2v^2 - w^2) + v(4v^2 - 3w^2)^2)(c(v - w) - u)^2/ 4v(16\lambda(2v^2 - w^2)^2 + v(4v^2 - w^2)(4v^2 - 3w^2))^2$
$w_h^*(\lambda)$	$(2v^2 - w^2)(8\lambda(2v + w)(2v^2 - w^2) + v(8v^3 + 4v^2w - 4vw^2 - w^3))^2(c(v - w) - u)^2/ (2v(16\lambda(2v^2 - w^2)^2 + v(4v^2 - w^2)(4v^2 - 3w^2))^2)$
$w_f^*(\lambda)$	$(4v^2 + 2vw - w^2)^2(4\lambda + v)(c(v - w) - u)^2/4v(16(2v^2 - w2)^2 + v(4v^2 - w^2)(4v^2 - 3w^2))$

Because the new tax is lower than when there is no cost of imposing taxes, prices are lower and profits are higher now for both firms. Also, the home firm's profits are higher than those for the foreign firm when the goods are complements. When the goods are substitutes, where is a critical value $\lambda^\wedge$ such that if $\lambda < \lambda^\wedge$ the home firm profits are higher than those of the foreign firm but if $\lambda > \lambda^\wedge$ the reverse is true. The explanation can be seen from Table 7: The new equilibrium is intermediate between that of the free trade equilibrium and the equilibrium with export taxes but no social cost of imposing them. As we can see in the case of complementary goods, profits in equilibrium are higher for the leader under the tax regime but this feature of the model reverses under free trade because there exists a critical value for the tax (critical value for λ) that makes both profits equal.

On the other hand, firms and governments' preferences over trade regime does not change when firms compete sequentially, even when the foreign government faces a cost of raising taxes it is still a best response for this government to levy export taxes. Meanwhile, free trade remains the dominant strategy for the home government. Therefore, even when the taxes are lower under this scenario, the foreign firm still prefers the free trade regime to the tax regime but its government still prefers the tax regime. The following proposition summarizes the discussion above.

Proposition 5:

(a) $p_i^*(\lambda) < p_i^*(0)$ and $\pi_i^*(\lambda) > \pi_i^*(0)$ for i = h, f.

(b) $\pi_h^*(\lambda) > \pi_f^*(\lambda)$, $w_h^*(\lambda) < w_f^*(\lambda)$ if $\lambda < \lambda^\wedge$, and $w_h^*(\lambda) > w_f^*(\lambda)$ if $\lambda > \lambda^\wedge$, when the goods are complements. When goods are substitutes; if $\lambda < \lambda^\wedge$, then $\pi_h^*(\lambda) > \pi_f^*(\lambda)$ and $w_h^*(\lambda) > w_f^*(\lambda)$; if $\lambda > \lambda^\wedge$, then $\pi_f^*(\lambda) > \pi_h^*(\lambda)$ and $w_h^*(\lambda) < w_f^*(\lambda)$.

(c) $\Pi_f^* > \pi_f^*(\lambda)$, $w_f^*(\lambda) > W_f^*$, $\Pi_h^* > \pi_h^*(\lambda)$ (when the goods are complements), and $\Pi_h^* < \pi_h^*(\lambda)$ (when the goods are substitutes).

Now, suppose that the government of the home country faces a social cost for imposing, taxes. Again - under the sequential subgame for the firms with the home firm as leader - the home government does not impose any export tax, but the follower does, so the equilibrium and outcomes reduce to those found in Section 5. Also, the results concerning the firms' and the governments' preferences over trade regimes are the same as those found in Section 7. Because the equilibrium is the same as the one found in Section 5, the home firm has higher profits than the foreign firms. Proposition 6 summarizes the findings.

Proposition 6:

(a) $p_i^*(\lambda) = p_i^*(0)$ and $\pi_i^*(\lambda) = \pi_i^*(0)$ for i = h, f.

(b) $\pi_h^*(\lambda) > \pi_f^*(\lambda)$. When the goods are complements $w_f^*(\lambda) > w_h^*(\lambda)$ and when the goods are substitutes $w_h^*(\lambda) > w_f^*(\lambda)$

(c) $\Pi_f^* > \pi_f^*(\lambda)$. When the goods are substitutes, $W_i^*(\lambda) > w_i^*(\lambda)$, $\Pi_h^* < \pi_h^*(\lambda)$. When the goods are complements, $W_h^*(\lambda) > w_h^*(\lambda)$, $W_f^*(\lambda) < w_f^*(\lambda)$, and $\Pi_h^* > \pi_h^*(\lambda)$.

Finally, consider the case of the simultaneous move subgame. Because of the symmetry of the Bertrand game, we can assume without loss of generality that the foreign government faces a cost of imposing taxes. Under this scenario the optimal tax on export for the foreign firm is

$$t_f(\lambda) = w^2(4v^2 + 2vw - w^2)(c(v - w) - u)/(8\lambda(2v^2 - w^2)(4v^2 - w^2) + v(16v^4 - 12v^2w^2 + w^4)).$$

The optimal tax on exports for the home country is:

$$t_h(\lambda) = w^2(2\lambda(2v - w)(2v+ w)^2 + v^2(4v^2 + 2vw - w^2))(c(v - w) - u)/(v^2(8\lambda(2v^2 - w^2)(4v^2 - w^2) + v(16v^4 - 12v^2w^2 + w^4))).$$

Simple algebra shows that the foreign firm has a lower tax on exports than the home firm because the home government is relatively more efficient in imposing taxes. Also, the optimal tax for the home country is lower than that found in Section 4, because now the home government is relatively more efficient in imposing taxes. Substituting the optimal taxes into Table 3 we have the Bertrand-Nash equilibrium outcomes shown in Table 10. Again, when $\lambda = 0$ the equilibrium outcomes reduce to those shown in Table 4.

Table 10 Bertrand-Nash equilibrium price, firms' profits, and governments' payoffs

$p_h^{BN}(\lambda)$	$c(4\lambda(8v^4 + 4v^3w - 6v^2w^2 - vw^3 + w^4) + v(8v^4 + 4v^3w - 6v^2w^2 - 2vw^3 + w^4)) + 2u(2\lambda(2v - w)(2v^2 + w^2) + v^2(4v^2 + 2vw - w^2))/(8\lambda(2v^2 - w^2)(4v^2 - w^2) + v(16v^4 - 12v^2w^2 + w^4))$
$p_f^{BN}(\lambda)$	$c(2\lambda(16v^5 + 8v^4w - 8v^3w^2 - 6v^2w^3 + vw^4 + w^5) + v^2(8v^4 + 4v^3w - 6v^2w^2 - 2vw^3 + w^4)) + 2u(4v^2 + 2vw - w^2)(\lambda(2v + w)(2v - w) + v^3)/(v(8\lambda(2v^2 - w^2)(4v^2 - w^2) + v(16v^4 - 12v^2w^2 + w^4)))$
$\pi_h^{BN}(\lambda)$	$(2v^2 - w^2)^2(2\lambda(2v - w)(2v + w)^2 + v^2(4v^2 + 2vw - w^2)^2)(c(v - w) - u)^2/(v^3(8\lambda(2v^2 - w^2)(4v^2 - w^2) + v(16v^2 - 12vw + w^2))^2)$
$\pi_f^{BN}(\lambda)$	$(4v^2 + 2vw - w^2)^2(2\lambda(4v^2 - w^2) + v(2v^2 - w^2))(c(v - w) - u)(c(v - w)(2\lambda(4v^2 - w^2) + v(2v^2 - w^2)) - u(2\lambda(2v + w)(2v - w) + v(2v^2 - w^2)))/v(8\lambda(2v^2 - w^2)(4v^2 - w^2) + v(16v^4 - 12v^2w^2 + w^4)^2)$
$w_h^{BN}(\lambda)$	$2(2v^2 - w^2)(2\lambda(2v - w)(2v^2 + w^2) + v^2(4v^2 + 2vw - w^2)^2)(c^2(v - w)^2 + 2cu(w - v) + u^2)/(v(8\lambda(2v - w)(4v - w) + v(16v - 12vw + w))$
$w_f^{BN}(\lambda)$	$(4v^2 + 2vw - w^2)^2(4\lambda + v)(c^2(v - w)^2 + 2cu(w - v) + u^2)(\lambda(4v^2 - w^2)^2 + 2v^3(2v^2 - w^2))/v(8\lambda(2v^2 - w^2)(4v^2 - w^2) + v(16v^4 - 12v^2w^2 + w^2)^2)$

When firms simultaneously compete in prices the home firm always prefers the free trade regime to the tax regime, but the foreign firm prefers free trade only if the goods are complements. When goods are substitutes, there is a critical value $\lambda^{\wedge}$ for which the foreign firm is indifferent between the free trade regime and the tax regime. If $\lambda < \lambda^{\wedge}$ the foreign firm prefers the free trade regime because the optimal export tax is closer to that found in section 4, and it is lower than the tax for the home firm which offset part of the impact of the tax on its own price. With respect to the governments, the home government prefers the tax regime only if the goods are substitutes. When the goods are complements there is a critical value $\lambda^{\wedge}$ for which the home government is indifferent between the free trade regime and the tax regime. If $\lambda < \lambda^{\wedge}$ the home government prefers the Free Trade regime (recall when $\lambda = 0$ both governments prefer the Free Trade regime). On the other hand, the foreign government prefers the free trade regime only if the goods are complements but its preferences reverse when goods are substitutes. Finally, profits for the home firms are lower than those of the foreign firm because, under Bertrand competition the tax on the home firm's exports is higher than the tax on the foreign firm. On the other hand, when goods are complements the government of the home firm is better off than the government of the foreign firm. When goods are substitutes, the reverse is true. Proposition 8 summarizes these findings.

Proposition 8.

(a) $t_f(\lambda) < t_h(\lambda)$, $t_h(\lambda) < t_h(0)$.

(b) $\Pi_h^{BN} > \pi_h^{BN}(\lambda)$ and $\Pi_f^{BN} > \pi_f^{BN}(\lambda)$ only if the goods are complements. When the goods are substitutes and if $\lambda < \lambda^{\wedge}$ then $\Pi_f^{BN} > \pi_f^{BN}(\lambda)$, but if $\lambda > \lambda^{\wedge}$ then $\Pi_f^{BN} < \pi_f^{BN}(\lambda)$.

(c) $W_h^{BN} < w_h^{BN}(\lambda)$ and $W_f^{BN} < w_f^{BN}(\lambda)$ only if the goods are substitutes. When the goods are complements $W_f^{BN} > w_f^{BN}(\lambda)$ and if $\lambda < \lambda^{\wedge}$ then $W_h^{BN} > w_h^{BN}(\lambda)$, but if $\lambda > \lambda^{\wedge}$ then $W_h^{BN} < w_h^{BN}(\lambda)$.

10. Conclusion

This chapter studies the relationship between market structure and the trade regime in a third-country market for heterogeneous goods. In the first stage of the game governments choose their trade policies simultaneously and noncooperatively; in the second stage firms compete in prices either sequentially (Stackelberg competition) or simultaneously (Bertrand competition). In contrast to the quantity competition that was analyzed in the previous chapter, the optimal trade policy turns out to be an export tax independent of the nature of the goods (complements or substitutes). Governments prefer the free trade to a tax regime only when goods are complements and prices are chosen simultaneously. This differs from the quantity case wherein free trade is desirable when the goods are substitutes (See Balboa, Daughety and Reinganum, forthcoming). Thus, free trade could be supported using trigger strategies. When firms choose prices sequentially with the home firm as the leader, free trade never arises as a trade regime because, as in the quantity game, it is a best response for the foreign government (follower) to impose an export tax, even though the home government never imposes a tax.

In Section 8, I allow the market structure to be endogenously determined by considering a previous stage of the game wherein the home firm has the option to be a leader or to be a Bertrand-Nash player. When goods are complements, the home firm will choose a simultaneous market structure. When goods are substitutes, the home firm will choose to be the leader. This contrasts to the case of quantity competition in which simultaneous market structure is a robust outcome. Finally, the equilibrium trade regime will be free trade when the goods are complements and a tax regime when the goods are substitutes. These outcomes are completely reversed when firms compete in quantities.

At the end of this paper I study the impact of the cost of raising taxes. Basically only one country faces this cost causing an asymmetry in treating the welfare function. This causes the tax per unit to decrease because for one country it is costly to impose a tax and for the other country its government has a comparative advantage in raising taxes. This means that prices are lower and profits are higher compared to the case of no social cost. Some findings are common to the previous section. For example, the home government does not impose any tax in the sequential game even when the government of the foreign firm has this cost. In the case of the simultaneous game, the firm of the country facing this cost could change its preferences over the trade regime depending on the critical value for this cost; nevertheless, the government in question does not change its preferences over trade regime. Meanwhile, the other government might change its preferences over the trade regime depending on the critical value for the cost.

A further contribution to this chapter is to analyze the desirability of free trade when a home firm and a foreign firm compete in the domestic market wherein prices are chosen simultaneously or sequentially with exogenous and endogenous market structure. It would be interesting to study different trade policies, such as an import tariff. Imposing an import tariff causes a distortion in domestic consumption. Hence it might be possible to incorporate additional (or alternative) policy instruments, such as consumption subsidies and/or production subsidies, and rank them in terms of their impact on national welfare. These types of policies have been studied in part by Krishna (1989) and Cheng (1988).

Appendix

Proof of Proposition 1:

a. $\pi_h^* > \pi_i^{BT*} > \pi_f^*$ for substitutes and complements

(1) $\pi_h^* > \pi_i^{BT*}$ is equivalent to $\pi_h^* - \pi_i^{BT*} > 0$, which is positive if and only if

$512v^8 - 1024v^6w^2 + 64v^5w^3 + 704v^4w^4 - 64v^3w^5 - 192v^2w^6 + 12vw^7 + 19w^8 > 0$ for all $w \in (-v, v)$. Set $w = sw$, where $s \in (-1, 1)$. The above expression reduces to $f_1(s)= 19s^8 + 12s^7 - 192s^6 - 64s^5 + 704s^4 + 64s^3 - 1024s^2 + 512$. Clearly $f_1(-1) > 0$,

$f_1(0) > 0$, $f_1(1) > 0$. First, we will prove that $f(s) > 0$ for $s < 0$. For $s \in (-1, 0)$, the graph for $f_1(s)$ is always above the s-axi. Now, for $s \in (0, 1)$ the expression $f_1(s)$ can be written as a combination of two expressions $f(s) = h_1(s) + h_2(s)$, each of which is positive. The expression

$h_1(s) = 64(1 + s)(1 - s)(3s^4 - 8s^2 + 8) > 0$ and the expression

$h_2(s) =s^3(19s^5 + 12s^4 - 64s^2 + 64) >0$ so $f_1(s)$ is clearly positive when $s \in (0, 1)$.

(2) $\pi_i^{BT*} > \pi_f^*$ is equivalent to $\pi_i^{BT*} - \pi_f^* >0$, which is positive if and only if

$32v^4 - 24v^2w^2 + 3w^4 > 0$, which clearly holds for all $w\in (-v, v)$.

(3) By transitivity, $\pi_h^* > \pi_f^*$.

b. $w_h^* > w_f^* > w_i^{BT*}$ when goods are substitute and $w_f^* > w_i^{BT*} > w_h^*$ when goods are complements.

Direct comparison and simplification yields:

(4) $w_h^* - w_f^* > 0$ if and only if $w^5(16v^3 + 16v^2w - 4vw^2 – 5w^3) > 0$. First, I will prove that $(16v^3 + 16v^2w - 4vw^2 – 5w^3) > 0$. Setting $w = sv$ for $s \in (0, 1)$, then the expression reduces to $f_2(t) = 16 + 16s – 4s^2 – 5s^3$. It is clear that $f_2(1) > 0$, $f_2(0) > 0$, $f_2(-1) > 0$. Now, For $s < 0$ we have $f_2^{'}(s) = 16 – 8s – 15s^2 > 0$. Therefore, $f_2(t) > 0$ when

$s \in (-1, 0)$. For $s > 0$ we can rewrite $f_2(s) = \{16 – 4s^2\} + s\{16 – 5s^2\}$. As we can see, both expression in the brackets are positive when $s \in (0, 1)$. Hence, inequality (4) holds if and only if $w > 0$. If $w < 0$ then inequality (4) reverses.

(5) $w_f^* - w_i^{BT*} > 0$ if and only if $w8(c(v – w) – u)^2 > 0$. Clearly this inequality holds for all w.

(6) $w_h^* - w_i^{BT*} > 0$ if and only if $w^5(64v^5 - 64v^3w^2 + 12vw^4 + w^5) > 0$. This inequality clearly holds for all $w > 0$. If $w < 0$ then inequality (6) reverses.

<u>Proof of Proposition 2:</u>

a. $\Pi_h^* > \pi_h^*$ for complements and $\pi_h^* > \Pi_h^*$ for substitutes, while $\Pi_f^* > \pi_f^*$;

Direct comparisons and simplifications yield:

(7) $\Pi_h^* > \pi_h^*$ if and only if $w^3(256v^7 + 256v^6w - 256v^5w^2 - 272v^4w^3 + 64v^3w^4 + 76v^2w^5 - 4vw^6 - 5w^7) < 0$. When goods are complements, $w < 0$, and setting $w = sv$ with $s \in (-1, 0)$, the above expression reduces to $f_3(s) = –5s^7 - 4(s^6 - 19s^5 – 16s^4 + 68s^3 + 64s^2 - 64s - 64)$. We can write $f_3(s) = -h_3(s)h_4(s)h_5(s)$ where $h_3(s) =$

$(s^2 + 2s - 4)$, $h_4(s) = (s^2 - 2s - 4)$, $h_5(s) = (5s^3 + 4s^2 - 16s - 16)$. Clearly,

$h_3(s) < 0$ $h_4(s) < 0$. Since $h_5(0) < 0$, $h_5(-1) < 0$, and $h_3{}'(s) = 15s + 8s – 16 < 0$, then $h_3(s) < 0$. Therefore, $f_3(s) > 0$ and inequality (7) holds when goods are complements.

(8) $\pi_h^* > \Pi_h^*$ if and only if $w^3(256v^7 + 256v^6w - 256v^5w^2 - 272v^4w^3 + 64v^3w^4 + 76v^2w^5 - 4vw^6 - 5w^7) > 0$, which is clearly positive because $f_3(s)$ is still positive (see proof above) and $w > 0$ (goods are substitutes).

(9) $\Pi_f^* > \pi_f^*$ if and only if $w^2(4v^2 + 2vw – w^2)^2(8v^2 - 3w)^2(c(v - w) - u)^2 > 0$. This inequality always holds.

b. $W_h^* > w_h^*$ for complements and $w_h^* > W_h^*$ for substitutes, while $w_f^* > W_f^*$

Direct comparisons and simplifications yield:

(10) $W_h^* > w_h^*$ if and only if $w^3(256v^7 + 256v^6w - 256v^5w^2 - 272v^4w^3 + 64v^3w^4 + 76v^2w^5 - 4vw^6 - 5w^7) < 0$. We already proved that this inequality holds when goods are complements (see proof for inequality (7)).

(11) $w_h^* > W_h^*$ if and only if $w^3(256v^7 + 256v^6w - 256v^5w^2 - 272v^4w^3 + 64v^3w^4 + 76v^2w^5 - 4vw^6 - 5w^7) < 0$ We already proved that this inequality holds when goods are substitutes (see proof for inequality (8)).

(12) $w_f^* > W_f^*$ if and only if $w^4(4v^2 + 2vw – w^2)^2(c(v - w) - u)^2 > 0$. This inequality always holds.

Proof of Proposition 3:

$W^{L*} + W^{F*} > w^{L*} + w^{F*}$ for complement goods.

Direct comparison and simplification yields $W^{L*} + W^{F*} > w^{L*} + w^{F*}$ if and only if

$-w(1024v^9 + 1280v^8w - 1280v^7w^2 - 1920v^6w^3 + 448v^5w^4 + 976v^4w^5 - 32v^3w^6 - 200v^2w^7 - 4vw^8 + 13w^9) > 0$. Substituting $w = sv$ for $s \in (-1, 0)$ and assuming complementarity, the above expression reduces to $f_4(s) = h_6(s)h_7(s)$, where

$h_6(s) = (s2 – 2s - 4)$ and $h_7(s) = (13s^7 + 22s^6 – 104s^5 - 152s^4 + 256s^3 + 352s^2 - 192s - 256)$. It is clear that $h_6(s) < 0$ and since, $h_7(0) < 0$, $h(-1) =-7 < 0$, and $h_7^{'}(s) < 0$ then $h_7(s) < 0$. To see $h_7^{'}(s) < 0$ for all $s \in (-1, 0)$, notice that $h_7^{'}(s) = 91s^6 + 132s^5 - 520s^4 – 608s^3 + 768s^2 + 704s – 192$ can be written as a combination of three negative functions when $s \in (-1, 0)$: $h_7^{'}(s) = h_8(s) + h_9(s) + h_{10}(s)$, where $h_8(s) = -192 + 192s^2 +576s + 576s^2$, $h_9(s) = (128s –608s^3-520s^4)$, and $h_{10}(s) = s^5 (132 + 91s)$. Clearly, $h_8(s) < 0$ and $h_{10}(s) < 0$. Notice that $h_9(s) =-8s (-16 + 65s^3 + 76s^4) = -8sH(s)$. Notice that $H(s) < 0$ for $s \in (-1, 0)$ because $H(0) < 0$ and $H(-1) = -5 < 0$ and $H(s)$ has two extreme points at $s = 0$ and $s = -152/195$. The latter provides a maximum point because $H''(s = -152/195) = -152 < 0$. $H(-152/195) = -0.60746$. Therefore $H(s) < 0$, which implies $h_9(s) < 0$, which implies $h_7(s) < 0$. Thus $f_4(s) > 0$ for $s \in (-1, 0)$.

<u>Proof of Proposition 4:</u>

a. When goods are substitutes, $w \in (0, v)$, $\pi_h^* > \pi_i^{BT*}$.

See prove for proposition 1, inequality (1).

b. When goods are complements, $w \in (-v, 0)$, $\Pi^{BT*} > \pi_h^*$,.

Direct comparison and simplification yields: $\Pi^{BT*} > \pi_h^*$ if and only if

$-w^3(32v^5 + 40v^4w - 8v^3w^2 - 24v^2w^3 - 8vw^4 - w^5) > 0$. When goods are complements the above inequality reduces to $32v^5 + 40v^4w - 8v^3w^2 - 24v^2w^3 - 8vw^4 - w^5 > 0$. Setting w =sv where $s \in (-1, 0)$, the expression above reduces to

$f_5(s) = -t^5 - 8s^4 - 24s^3 - 8s^2 + 40s + 32$. Since $f_5(-1) = 1 > 0$ and $f_5(0) = 32 > 0$. Now, $f_5(s)$ can be rewritten as $f_5(s) = 8(1 - 8s^2 - s - s^4) + h_{11}(s) = 24 \; +40s - 16s^3 - s^5$. Note that the expression in parentheses is positive and so is $h_{11}(s)$. To see that $h_{11}(s) > 0$, note that $h_{11}(-1) = 1> 0$, and $h_{11}(0) = 24 > 0$ and $h_{11}(s)$ has a maximum point at s = 0.878 and it is convex on (-1, 0). Therefore, $h_{11}(s) > 0$ and hence

$f_5(s) >$. QED: Proposition 4.

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