

Competition Policy as Strategic Trade with Differentiated Products*

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Abstract

The paper analyses how countries use competition policy as a tool for strategic trade. In the model, two countries export to a third country. Each exporting country is endowed with a set of differentiated products. Each government chooses the number of exporters for its country and the products that each exporter sells in the first period, and a tax policy in the second period. Firms choose prices or quantities independently in the third period. In the unique Subgame Perfect Equilibrium, both countries group all their products within a single firm - the “national champion policy”. We study the implication of different assumptions about the timing of the game.

1 Introduction

Growth in the share of goods traded in the international market has made domestic competition policy into an international issue. Competition policy is entering the realm of international trade negotiations and, even in the United States, can no longer be seen simply as a matter of intra-national industrial policy. This paper presents a model of competition policy as a tool for strategic trade. The paper looks

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at competition policy, and competition policy in conjunction with subsidy policy, in order to predict government strategies.

In our model, two countries export to a third consuming country. Each exporting country starts the game endowed with a given set of differentiated products. We represent competition policy by allowing governments to choose the ownership structure of their products. For example, governments can assign all goods to a single firm, or they can assign each good to a separate firm, creating competition between their own goods. They can choose any market structure in between. We study a three-stage game. In the first period, governments choose simultaneously the market structure for their goods. In the second period, each country chooses a tax system. In the third period, exporters choose their strategies independently. We consider both the cases of price-setting and quantity-setting.

We show that in the only Subgame Perfect Equilibrium, each country decides to have one firm controlling all national goods, the *national champion policy*. This happens both when firms compete in price and when they compete in quantity. The result hinges on the fact that competition policy and production taxes can be used interchangeably to achieve desired outcomes. We show that in the absence of foreign country taxation, the home country can choose taxes to achieve any set of prices it desires regardless of its choice of market structure. Therefore, the only impact of market structure can be on how it induces the foreign country to choose taxes. We show that a less competitive market structure induces the foreign country to choose less aggressive taxes.

We consider whether separate exporters from the same country would themselves choose to merge. We show that a merger among firms from the same country always increases the profit of all firms from that country and reduces the profit of firms from the other country.

We also consider the two-stage game where countries choose market structure in the first period and exporters pick strategies in the second period. We show that each country would like to pick a market structure that mimics committing to desired second stage results. For instance, in a price setting game, each country would like to commit to higher prices than would result in a simultaneous game, so they choose to have a national champion in the first period. In a quantity setting game, each country would like to commit to higher quantities than would result from a simultaneous game. Therefore, they

choose a competitive market structure, using competition between their domestic exporters as a method to commit to high quantities.

We consider the implications of a different assumption about the timing of the game. We study a two-stage game where governments choose taxes and market structure simultaneously in the first period, and firms compete in price or quantity in the following period. We show that there is a multiplicity of equilibria. Given any market structure for the two exporting countries, there is a system of taxes that, together with the given market structures, represents the first stage part of a Subgame Perfect Equilibrium of the game.

Our work follows in the tradition of the Brander and Spencer (1985) model of export subsidization. As is well known, the results of the Brander-Spencer model turn crucially on the market structure, in particular on the number of firms in each country. In our model, market structure is endogenised.

Policy analysts and legal researchers have long recognized a possible relation between trade policy and antitrust policy. Recently, there has been some work by economists as well.

An important early contribution is Dixit (1984). He studies strategic trade policy in a two-country model. Each country hosts oligopolistic firms that compete in both markets. He performs comparative analysis and studies how domestic welfare is related to the number of home and foreign firms, and to export tariffs and import subsidies. Cowan (1989) develops a model with one importing country and one exporting country. The producing country seeks to maximize the profit of its firms by choosing its competition policy (number of exporters) and its export subsidy, while the importing country chooses its import tariff. With linear demand the optimal number of firms from the point of view of the producing country is shown to be infinity, while it is one if the demand is isoelastic. Horn and Levinsohn (2001) study the interaction between trade liberalization and merger policy using partial equilibrium models similar to ours. They develop a two-country model with home consumption and intra-industry trade (there is no third country). As in Horn and Levinsohn (2001), Richardson (1999) develops a model in which countries strategically choose both merger and trade policy. He focuses exclusively on tariffs and studies the case of custom unions as well.

All previous papers assume that firms compete in quantities of homogenous goods. However, it is

well known that the predictions of strategic trade models are highly sensitive to assumptions about the type of competition (see Grossman and Eaton (1986)). An important contribution of our paper is to consider the arguably more realistic case of differentiated products and price-setting games. A natural extension of models such as Horn and Levinsohn (2001) to differentiated products might be to allow countries to choose their number of products. However, changing the number of products in a differentiated products framework affects demand as well as strategic incentives. Our approach of taking the products as given and allowing countries to choose only ownership structure allows us to focus on strategic issues.

A related paper is Miller and Pazgal (2003). They combine the strategic trade literature and the strategic delegation literature in a three-stage game in which governments choose subsidies, firms' owners choose incentive schemes for their managers, and then the managers compete in the product market. They show that the optimal trade policy does not depend on whether firms compete by setting prices or quantities, but only depends on factors such as the firms' cost and demand functions. Although in our paper the optimal trade policy is sensitive to the nature of product-market competition, the optimal competition policy is not. In our three-stage game, the national champion policy is the only Subgame Perfect Equilibrium, whether firms compete in quantity or price.

A related industrial organization literature uses similar models to analyze games in which firms pick their number of franchises or independent divisions, and then choose two-part tariffs. Saggi and Vettas (2002) and Rysman (2001b) study a linear Cournot duopoly model and show that in the unique Subgame Perfect equilibrium both firms choose to have only one franchise. Rysman (2001b) considers the homogeneous product case, while Vettas and Saggi (2002) study a duopoly with differentiated products, where, however, divisions of the same firm sell an homogeneous good. Their results are in sharp contrast to previous literature which did not model contracts and concluded that competitors benefit by creating a large number of independent divisions (for example Baye et. al (1996), Corchon (1991) and Polasky (1992)). Most of the papers on this topic adopt an homogeneous good assumption and assume Cournot competition. Gonzalez-Maestre (2001) is the first to study heterogeneous goods and price competition.¹

¹Gonzales-Maestre (2001) allows competing firms to choose their number of products located on a circle, where each

The rest of the paper proceeds as follows. In section 2 we introduce the model and study the case where countries use competition policy but not subsidy policy. Section 3 introduces subsidy policy and shows that in the only equilibrium firms choose a national champion policy. Section 4 studies the implication of a different timing assumption. The last section concludes. Most proofs are contained in the appendix.

2 A Model of Competition Policy

In this section, we consider a two period model in which two countries choose the structure of their exporting market in the first period and exporters set prices in the second period. We follow with a discussion of the quantity-setting case. In the next section, we study a three-period model in which countries choose market structure in the first period, countries choose a production tax in the second period and exporters set prices or quantities in the third. Note that all results could be easily extended to more than two countries exporting to an importing country.

2.1 Competition Policy

Two countries, h (home) and f (foreign) export to a third consuming country.² The two exporting countries are endowed with a set of differentiated products. In the first period, each exporting country chooses its number of exporters and the exporters' products. They can assign all goods to a single firm, or they can assign each good to a separate firm, creating competition between their own goods, or they can choose any market structure in between. In the second period, those exporters choose prices for their products independently. The solution concept is Subgame Perfection. Formally, the home country

product is produced by an independent division. He finds that the principal prefers many divisions where we find the principal preferring only one. We believe that this discrepancy is due to the fact that allowing the principal to choose the number of products has demand-inducing as well as strategic effects.

²This assumption is usual in the strategic trade literature, since Brander and Spencer (1985) contribution. The assumption allows us to ignore consumers' welfare issues and concentrate on the strategic incentives to manipulate market structure. Arguably, this assumption can also be motivated as a representation of laws that allow cartels to form for the purposes of exporting.

exports n^h products and the foreign country exports n^f products. The total number of products is $n = n^h + n^f$. Utility for the representative agent in the consuming country is:

$$U = \sum_{i=1}^n \alpha_i q_i - \frac{1}{2} \left(\sum_{i=1}^n q_i^2 + 2\gamma \sum_{i \neq j} q_i q_j \right) + I - \sum_{i=1}^n p_i q_i$$

The parameter $\gamma \in [0, 1)$ captures the degree of substitutability between products: the higher γ , the higher the degree of substitutability³. From the first order (sufficient) condition we can derive the following inverse demand functions:

$$p_i = \alpha_i - q_i - \gamma \sum_{j \neq i} q_j$$

The demand functions are obtained by inverting the previous functions:

$$q_i = a_i - \beta p_i + \sigma \sum_{j \neq i} p_j$$

With a_i , β and σ appropriately defined functions of α_i and γ . Linear demand systems have been extensively used in the industrial organization literature. See for example Singh and Vives (1984) or Hackner (2000).

Let \mathcal{G}^h be the set of all partitions (or groupings) of the n^h home products. Then, in the first period, the home government chooses a partition of products $G^h \in \mathcal{G}^h$ that contains J^h elements. Each element $G_j^h \in G^h$ is a set of products. By the definition of a partition, $\cup_{j=1}^{J^h} G_j^h$ contains the entire set of home products and $G_j^h \cap G_k^h = \emptyset, \forall j \neq k$. Country h is interpreted to have J^h firms and firm j sells the n_j^h products contained in the set G_j^h . We say that market structure $G^{h'}$ is more competitive than market structure G^h if $G^{h'}$ is a finer partition of home products than G^h .⁴ The foreign country is characterized in an analogous way. Firm are assumed to have constant marginal cost, which for simplicity is taken to be zero.

In the second period, each exporter chooses prices independently. Let \mathbf{p}_j^c be the vector of prices for products controlled by firm j in country c , and let \mathbf{p}_{-j}^c be the vector of all other prices. Define

³At cost of a more cumbersome notation, we could allow more general substitution patterns. For example, we could assume that goods from the same country are better substitutes than goods from different countries (Armington assumption). The main results of the paper would stay unaltered.

⁴Note that this method of ordering market structures is not complete. However, to prove the results of this paper, it will be sufficient to consider changes in market structure in the direction of increasing or decreasing competitiveness.

$\mathbf{q}_j^c(\mathbf{p}_j^c, \mathbf{p}_{-j}^c) : \mathbb{R}^n \rightarrow \mathbb{R}^{n_j^c}$ to be the function mapping prices into the vector of quantities for products controlled by firm j in country c . Each firm solves:

$$\max_{\mathbf{p}_j^c} \mathbf{p}_j^{c'} \mathbf{q}_j^c(\mathbf{p}_j^c, \mathbf{p}_{-j}^c)$$

Here, \mathbf{x}' represents the transpose of the vector \mathbf{x} . It is straightforward to show that equilibrium exists and is unique. Let $\mathbf{p}^c(G^h, G^f)$ be the function returning the vector of equilibrium prices that arise for country c when the two countries choose partitions G^h and G^f . In the appendix we present the closed form solution and prove the following Lemma.

Lemma 1 *A less competitive home market structure or a less competitive foreign market structure imply higher price for both home and foreign country's products.*

Proof. See Appendix. ■

In the first period, each country chooses a partition for its products. Country h solves:

$$\max_{G^h \in \mathcal{G}^h} \Pi^h(G^h, G^f) = \mathbf{p}^h(G^h, G^f)' \mathbf{q}^h(\mathbf{p}^h(G^h, G^f), \mathbf{p}^f(G^h, G^f))$$

We show that the optimal strategy for each country is to group all of its products into a single firm - the *national champions strategy*. The intuition is straightforward. Two principals are playing a price-setting game through their agents. In a price-setting game, each of the principals would like to commit to higher prices than would normally occur in a simultaneous-move game. They use the partition of firms to achieve an outcome as close as possible to what they would have chosen if they could just choose prices directly in the first period. Let $\mathbf{p}_{ST}^h(G^f)$ be the function returning the “Stackelberg price vector”, the prices that the home government would pick if it could pick prices in the first period knowing that the market structure G^f was to set prices in the second period. That is:

$$\mathbf{p}_{ST}^h(G^f) = \operatorname{argmax}_{\mathbf{p}^h} \Pi^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f)) = \mathbf{p}^{h'} \mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f)) \quad (1)$$

Governments try to use the tools at their disposal, such as competition policy and tax policy (in the next section), to try to achieve these prices. In other terms, the home country chooses G^h such that $\mathbf{p}^h(G^h, G^f)$ is as close as possible to $\mathbf{p}_{ST}^h(G^f)$. To see this, note that prices set by foreign exporters

depend on home country's partition only through their effect on home country prices. That is, we can abuse notation and write $\mathbf{p}^f(G^h, G^f)$ as $\mathbf{p}^f(\mathbf{p}^h(G^h, G^f), G^f)$. Therefore, the home country solves:

$$\max_{G^h \in \mathcal{G}^h} \Pi^h(G^h, G^f) = \mathbf{p}^h(G^h, G^f)' \mathbf{q}^h(\mathbf{p}^h(G^h, G^f), \mathbf{p}^f(\mathbf{p}^h(G^h, G^f), G^f))$$

The objective function is identical to the objective function of 1. Countries use pre-production strategies to try to mimic a “Stackelberg outcome” in the production stage. This result appears in many principal agent papers, such as Brander and Spencer (1985) and Fershtman and Judd (1987). In our case, choosing a partition of firms may not be enough to do as well as choosing prices directly because choosing the partition of firms is not as flexible (more specifically, it is not continuous).⁵

It is easy to show that the equilibrium prices are lower than the Stackelberg prices, so that each country would like to raise prices above them.

Lemma 2 *A country that could pick prices directly in the first period would choose higher prices than the equilibrium prices.*

Proof. See Appendix. ■

The highest prices a country can achieve are by selling all of its products through a single exporter (see Lemma 1). Each country would like to set prices even higher if it could. Therefore, partitioning products into separate exporters in any way must reduce profits.

Theorem 1 *In equilibrium, each country sells all of its products through a single exporter.*

Proof. See Appendix. ■

Note that because separate exporters would themselves choose to merge, a government need only give them the opportunity, as opposed to actually brokering an agreement (see Deneckere and Davidson (1985) and Salant et al. (1983) in an industrial organization context and Horn and Persson (2001) in a trade context). Therefore, a government can simply take a lax approach to enforcing antitrust rules. If the cost of doing so to domestic consumer surplus (un-modelled here) is too high, a government

⁵Note that the proof of the following Theorem 1 is more involved than this intuition because a differentiated products setting implies multiple prices. Picking a partition with prices “close” to the desired prices must be defined properly.

can specifically allow cartels for the purposes of exporting, such as the United States does under the Webb-Pomerene Act of 1918 and the Export Trading Company Act of 1982.

2.2 Quantity Setting

Results differ in intuitive ways if exporters choose quantities in the second stage instead of prices. Whether we have a quantity setting game or a price setting game, each country would like to pick its exporter partition to mimic what it would do if it could pick the second stage strategy directly in the first period. Also, a Stackelberg quantity-setter chooses a higher quantities than a national champion in the simultaneous quantity setting game. While a Stackelberg price-setter acts less aggressively than a simultaneous national champion chooser, a Stackelberg quantity setter acts more aggressively, which has important implications for export policy. A country can extract higher quantities by relying on a more competitive market structure. That is, we expect in this game to see relatively fine partitions in G^h and G^f , as countries use competition among their exporters as a way to make a first-period commitment to high quantity. Rysman (2001a) shows that if $\gamma = 1$ (perfect substitutes), each country would like to have one more exporter than the other, leading to maximally competitive markets. This result appears in a number of other papers, such as Baye et al. (1996).

Note that if γ is close to zero, it is possible that countries still choose to have a national champion. Given the dependence of the result on the parameters and the discrete nature of the problem, we do not fully characterize equilibrium in the game with quantity setting.

3 Taxes and Subsidies

Production subsidies are the most widely studied tool for strategic trade and among the most important for policy consideration. How does the presence of taxes or subsidies affect the use of competition policy? In this section, we consider a three-period game in which governments choose their market structure in the first period, governments choose a per-unit tax policy in the second period, and exporters choose prices in the third period. We also discuss the quantity-setting case. We allow countries to choose market structure before they choose tax policy because antitrust policy tends to be encoded in law and

is presumably difficult to change, whereas taxes can be quickly adjusted for a given need. However, the timing affects the result so we will consider a different timing in Section 4.

3.1 The Bertrand Case

3.1.1 The Tax Sub-Game

Consider the tax setting game in the third period. Let \mathbf{t} be the n vector of taxes with \mathbf{t}^c being the n^c vector of taxes for country c . Note that each element of \mathbf{t} may be different and any element of \mathbf{t} can be negative. In the final period, the profit to the exporter for each product in country c is $(p_i^c - t_i^c)q_i^c$ and the revenue to the government from product i is $t_i^c q_i^c$. As usual in such games, the tax does not enter directly into the government's objective function. The government views the taxes as a pure transfer to the firm, but it can be an effective way to get the firm to choose prices that maximize the country's welfare. It is straightforward to solve the third stage problem. Closed form expressions for the linear case are presented in appendix.

Let $\mathbf{p}^c(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f)$ be the third stage equilibrium prices. We now consider the second stage of the game. Each government chooses taxes taking the taxes in the other country as given, as well as market structure in both countries. Therefore, the home government solves:

$$\max_{\mathbf{t}^h} \Pi^h \left(\mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f), \mathbf{p}^f(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) \right) = \mathbf{p}^h(\cdot) \mathbf{q}^h(\mathbf{p}^h(\cdot), \mathbf{p}^f(\cdot))$$

It is straightforward to show that the equilibrium exists in this game, given the linearity of demand and the constant marginal cost.

As above, each country uses strategies in this stage to impact outcomes in the production stage. First, we consider the vector of prices that the government would like to achieve. Consider the set of prices the home government would choose if it could choose prices directly in the second stage, knowing that exporters in the foreign country will know its prices before making their own choices. This "Stackelberg leader" takes market structure and taxes in the foreign country as given. We denote these prices as $\mathbf{p}_{ST}^h(G^f, \mathbf{t}^f)$, defined as:

$$\mathbf{p}_{ST}^h(G^f, \mathbf{t}^f) = \operatorname{argmax}_{\mathbf{p}^h} \Pi^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f, \mathbf{t}^f)) = \mathbf{p}^{h'} \mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f, \mathbf{t}^f)) \quad (2)$$

and similarly for $\mathbf{p}_{ST}^f(G^h, \mathbf{t}^h)$. The functions $\mathbf{p}^f(\mathbf{p}^h, G^f, \mathbf{t}^f)$ give the optimal prices for foreign products, given \mathbf{p}^h , G^f and \mathbf{t}^f . We show first that governments would like to mimic these prices, and second that doing so is feasible.

Lemma 3 *In the second stage of the game, the home government would like to pick taxes such that*

$$\mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) = \mathbf{p}_{ST}^h(G^f, \mathbf{t}^f)$$

and similarly for the foreign country.

Proof. Note that prices set by foreign exporters depend on home market structure and subsidies only through their effect on home country prices. That is, we can abuse notation and write $\mathbf{p}^f(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f)$ as $\mathbf{p}^f(\mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f), G^f, \mathbf{t}^f)$. Therefore, the home country wants to solve:

$$\max_{\mathbf{t}^h} \mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f)' \mathbf{q}^h \left(\mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f), \mathbf{p}^f(\mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f), G^f, \mathbf{t}^f) \right)$$

This objective function is identical to the one in equation 2. ■

We will show that, unlike the case analyzed in the previous section, governments can achieve this result. An important result for this section is that a country can implement any set of prices through the appropriate set of taxes. This result follows from the fact that taxes are a continuous choice variable and prices are monotone in each tax.

Lemma 4 *For any $\mathbf{p}^h \in [0, a_i]^{n^h}$, there exists a tax system \mathbf{t}^h that induces $\mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) = \mathbf{p}^h$.*

Proof. See Appendix. ■

Therefore, we have the following theorem characterizing the second stage of this game.

Theorem 2 *The home government picks taxes \mathbf{t}^h such that:*

$$\mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) = \mathbf{p}_{ST}^h(G^f, \mathbf{t}^f).$$

With an export tax, the home government can reach any set of prices it wishes. Note that it can do so regardless of the market structure G^h . In a unilateral game, where the foreign country did not tax, the home country would be indifferent between all market structures. Regardless of which it chooses,

it could simply choose taxes in the second period to reach $\mathbf{p}_{ST}^h(G^f, \mathbf{0})$. In this sense, tax policy is more flexible and powerful than competition policy as a form of strategic intervention into trade. The choice of market structure becomes irrelevant if it does not have an impact on the other country's choice of taxes.

Of course, we are considering a game in which both countries intervene with tax policy. It is useful to keep in mind that, in equilibrium, both countries achieve the Stackelberg outcome. Both achieve the prices that a Stackelberg leader would choose against a market structure of G^{-c} with marginal costs \mathbf{t}^{-c} .

An important issue for solving the equilibrium in the first period is to determine the effect of market structure in country c on taxes in country $-c$. The next Lemma shows that a less competitive market structure in the home country (a coarser partition of goods) induces higher taxes on foreign products. Intuitively, governments compensate firms that face competitive foreigners by giving them a lower marginal cost. Let the optimal tax for country c be denoted $\mathbf{t}^c(G^h, G^f)$. We have the following Lemma:

Lemma 5 *Let $G^{h'}$ be a finer partition than G^h . Then $\mathbf{t}^f(G^h, G^f) > \mathbf{t}^f(G^{h'}, G^f)$.*

Proof. See Appendix. ■

3.1.2 Market Structure

Now we consider the government's problem in the first period. The government recognizes the effect that its choice of market structure will have on tax choices in the second period and consequently on prices in the production stage. The home government solves:

$$\max_{G^h} \Pi^h(\mathbf{p}^h(G^h, \mathbf{t}^h(G^h, G^f)), G^f, \mathbf{t}^f(G^h, G^f), \mathbf{p}^f(G^h, \mathbf{t}^h(G^h, G^f), G^f, \mathbf{t}^f(G^h, G^f)))$$

As above, foreign products' prices depend on home country choices only through their effect on home prices and taxes. Therefore, we can rewrite $\mathbf{p}^f(G^f, \mathbf{t}^f(G^f, G^h), G^h, \mathbf{t}^h(G^h, G^f))$ as $\mathbf{p}^f(\mathbf{p}^h, G^f, \mathbf{t}^f(G^h, G^f))$ where \mathbf{p}^h is determined by the function $\mathbf{p}^h(G^h, \mathbf{t}^h(G^h, G^f), G^f, \mathbf{t}^f(G^h, G^f))$. Also, governments recognize that taxes depend on market structure, so we write the Stackelberg price vector as $\mathbf{p}_{ST}^h(G^f, \mathbf{t}^f(G^h, G^f))$.

Using Lemma 3, we can rewrite the objective function as:

$$\begin{aligned} \max_{G^h} \Pi^h(\mathbf{p}_{ST}^h, \mathbf{p}^f(\mathbf{p}_{ST}^h, G^f, \mathbf{t}^f(G^h, G^f))) \\ \text{where } \mathbf{p}_{ST}^h = \mathbf{p}_{ST}^h(G^f, \mathbf{t}^f(G^h, G^f)) \end{aligned}$$

The important point to see from writing the objective function in this way is that the market structure in the home country affects profit in the home country only via its effect on the foreign taxes. As pointed out above, if the foreign country were not to use taxes for some reason, the home country would be indifferent to its choice of market structure in the first period. The home country taxes serve to “undo” any direct effect from its choice of market structure. With the foreign country setting taxes optimally in the second period, home country market structure matters because foreign taxes will be affected. Each country would like the other country to set taxes as high as possible. Lemma 5 tells us that a country induces higher taxes on the other country’s products by choosing the less competitive market structure. Thus, each country benefits by grouping its exporters into a national champion. We have the following theorem:

Theorem 3 *In the unique Subgame Perfect Equilibrium, the first period strategies are for each country to assign all products to a single firm.*

Proof. The home country solves:

$$\begin{aligned} \max_{G^h} \Pi^h(\mathbf{p}_{ST}^h, \mathbf{p}^f(\mathbf{p}_{ST}^h, G^f, \mathbf{t}^f(G^h, G^f))) \\ \text{where } \mathbf{p}_{ST}^h = \mathbf{p}_{ST}^h(G^f, \mathbf{t}^f(G^h, G^f)) \end{aligned}$$

In an abuse of notation, we write df/dG^c to be the change in function f from a change in G^c , where the change is the direction of the market structure becoming less competitive. A change in G^h affects home profit in the following way:

$$\frac{d\Pi^h}{dG^h} = \left[\left(\frac{\partial \Pi^h}{\partial \mathbf{p}_{ST}^h} + \frac{\partial \Pi^h}{\partial \mathbf{p}^f} \frac{\partial \mathbf{p}^f}{\partial \mathbf{p}_{ST}^h} \right) \frac{\partial \mathbf{p}_{ST}^h}{\partial \mathbf{t}^f} \frac{\partial \mathbf{t}^f}{\partial G^h} \right] + \left[\frac{\partial \Pi^h}{\partial \mathbf{p}^f} \frac{\partial \mathbf{p}^f}{\partial \mathbf{t}^f} \frac{\partial \mathbf{t}^f}{\partial G^h} \right]$$

The quantity in the first squared parentheses is zero, because of the first order condition of the Stackelberg leader ($\frac{\partial \Pi^h}{\partial \mathbf{p}_{ST}^h} + \frac{\partial \Pi^h}{\partial \mathbf{p}^f} \frac{\partial \mathbf{p}^f}{\partial \mathbf{p}_{ST}^h} = \mathbf{0}$). Hence:

$$\frac{d\Pi^h}{dG^h} = \left(\frac{\partial \Pi^h}{\partial \mathbf{p}^f} \frac{\partial \mathbf{p}^f}{\partial \mathbf{t}^f} \right) \frac{\partial \mathbf{t}^f}{\partial G^h} \quad (3)$$

Notice that, if products are substitutes, it must be that $\left(\frac{\partial \Pi^h}{\partial \mathbf{p}^f} \frac{\partial \mathbf{p}^f}{\partial \mathbf{t}^f}\right) > \mathbf{0}$. An increase in the tax on a foreign good is equivalent to an increase of its perceived marginal cost. If the marginal cost of a foreign good increases, the home country profit cannot decrease (see appendix for an analytic proof in the case of linear demand).

Lemma 5 shows that foreign taxes increase as G^h becomes less competitive: $\frac{\partial \mathbf{t}^f}{\partial G^h} > \mathbf{0}$. Hence:

$$\frac{d\Pi^h}{dG^h} = \left(\frac{\partial \Pi^h}{\partial \mathbf{p}^f} \frac{\partial \mathbf{p}^f}{\partial \mathbf{t}^f}\right) \frac{\partial \mathbf{t}^f}{\partial G^h} > 0$$

Therefore, the home country chooses the least competitive market structure. By symmetry, so does the foreign country. ■

The proof makes clear that choosing a national monopoly is a dominant strategy in the first stage of the game. The only important condition is that the other country sets taxes optimally in the second stage of the game.

An important issue is whether, absent government brokering, firms have an incentive to merge in the first stage of the game. Remember that firms incentives are based on net profits: $(p_i^c - t_i^c)q_i^c$ for good i . If given the opportunity, would separate exporters from the same country choose to merge? We prove that they would:

Theorem 4 *A merger in the home country increases the profit, net of tax, of each home product.*

Proof. See Appendix. ■

On the other hand, a merger in the home country has a negative effect on foreign products' profit:

Theorem 5 *A merger in the home country decreases the profit, net of tax, of each foreign product.*

Proof. See Appendix. ■

A less competitive home market structure induces the foreign country to increase the taxes on its goods. This will make foreign firms weaker competitors, increasing the net profit of home firms.

3.2 The Cournot Case

In this section, we study we study a three period game in which governments choose their market structure in the first period, governments choose a per-unit tax in the second period, and exporters

choose quantities independently in the third stage. We will show that, as in the case of Bertrand competition, countries decide to group all their goods with a single exporter.

Relabeling prices as quantities, Theorem 2 and the associated Lemmas are unchanged. That is, each country can pick taxes to reach any vector of quantities it likes and picks taxes to reach the vector of quantities it would have chosen if it could choose quantities directly in the second period, taking foreign market structure and tax policy as given. Note that in the quantity setting case, taxes are typically negative. Countries subsidize their exporters.

The fact that quantities are strategic substitutes does not reverse the result in Lemma 5. We still have that:

Lemma 6 *Let $G^{h'}$ be a finer partition than G^h . Then $\mathbf{t}^f(G^h, G^f) > \mathbf{t}^f(G^{h'}, G^f)$.*

Proof. See Appendix. ■

Now we consider the government's problem in the first period. As above, the fact that home taxes can “undo” the choice of home market structure means that the only impact of home market structure is on foreign taxation. Since the home country prefers high foreign taxes, Lemma 6 tells us that the home country would like to pick the least competitive market structure, the national champion policy.

Theorem 6 *In the unique Subgame Perfect Equilibrium, the first period strategies are for each country to assign all products to a single firm.*

Proof. Relabeling prices as quantities, the steps are the same as in Theorem 3 up to line 3, which is now:

$$\frac{d\Pi^h}{dG^h} = \left(\frac{\partial \Pi^h}{\partial \mathbf{q}^f} \frac{\partial \mathbf{q}^f}{\partial \mathbf{t}^f} \right) \frac{\partial \mathbf{t}^f}{\partial G^h}$$

We show in appendix that for the case of a linear demand function the term in parenthesis is positive. The intuition is the same: if the marginal cost (including taxes) of a foreign good increases, the home country total profit increases. The last term is positive by Lemma 6. Therefore, local surplus increases in local concentration. ■

As for the case of price competition, each country's choice of assigning all goods to a single exporter is a dominant strategy, given optimal behavior from the second stage of the game on. In general, a

move toward a less competitive market structure for country c , for example through mergers, increases always country c 's total profit.

An important issue is whether exporters would themselves choose to merge, if given the opportunity. A striking result of Salant et al. (1983) is that in a standard Cournot oligopoly with linear demand and constant marginal costs, horizontal mergers tend to be not profitable for the merging firms, while they always increase the profit of non merging firms. For example, a two firms merger is always unprofitable for the merging firms, unless the merger leads to monopoly. In our model, any merger among home firms increases profit from any home good and decreases profit from any foreign good:

Theorem 7 *A merger in the home country increases the profit, net of tax, of each home product and decreases the profit, net of tax, of each foreign product.*

Proof. See Appendix. ■

Furthermore, it is possible to prove that the profit of merging home firms tend to increase more than the profit of non merging firms from the same country. In sharp contrast to the result in Salant et al. (1983), a mergers between home firms is always profitable for both the merging and non merging home firms, and tend to be more profitable for the merging firms. Besides it will decrease the profit of foreign firms. This implies that a government does not need to force an agreement, as firms have themselves an incentive to merge.

The reason for this result is that a less competitive home market structure induces the foreign country to decrease subsidies to its products, making foreign firms weaker competitors. At the same time, the home country will increase subsidies to the merging firms and decrease subsidies to the non merging firms in order to determine an increase in the quantity of all home goods.

4 A Different Timing Assumption

In the previous sections, we allowed the countries to choose market structure before they choose taxes. Antitrust policy tends to be encoded in laws and is difficult to change, whereas taxes can be quickly adjusted. However, results crucially depend on the timing assumption, and this section explores the

implication of a different timing assumption. We consider the following two-stage game. Governments choose taxes and market structure simultaneously in the first period. In the following period firms compete in price. The case of firm competing in quantities can be analysed in a similar fashion.

We show that this game exhibits multiple equilibria. Given any market structure for the home and foreign market, there is a corresponding Subgame Perfect Nash equilibrium.

The second stage equilibrium prices are identical to the third stage equilibrium price of the game analyzed in section 3.1. Let $\mathbf{p}^c(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f)$, for $c = h$ or $c = f$, be these prices for country c . In the first stage, each government chooses taxes and market structure taking the taxes and market structure in the other country as given. Therefore, the home government solves:

$$\max_{\mathbf{t}^h, G^h} \Pi^h \left(\mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f), \mathbf{p}^f(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) \right)$$

Lemma 3 is valid in this context as well. As before, the home country would like to mimic the Stackelberg leader prices, and choose \mathbf{t}^h and G^h such that:

$$\mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) = \mathbf{p}_{ST}^h(G^f, \mathbf{t}^f)$$

Given foreign market structure and taxes, the home Stackelberg prices represent an optimal vector of prices that the home country would like to reach in the two-stage game by appropriately using its choice of market structure and taxes. Theorem 2 is still valid. It shows that, given any market structure G^h , there is a choice of taxes \mathbf{t}^h that induces the Stackelberg prices. Given G^f and \mathbf{t}^f , there is a single optimal home products' vector of prices. However, given any home market structure, these prices can be reached with an appropriate choice of taxes. The optimal response in the first stage of the game is a correspondence.

Consider the second stage optimal taxes in the three-stage game analyzed in section 3.1: $\mathbf{t}^h(G^h, G^f)$ and $\mathbf{t}^f(G^h, G^f)$. By definition, $\mathbf{t}^c(G^h, G^f)$ represents the optimal choice of taxes for country c , given the other country's taxes $\mathbf{t}^{-c}(G^h, G^f)$ and the market structure (G^h, G^f) . These taxes induce the Stackelberg prices. This implies that $(G^c, \mathbf{t}^c(G^h, G^f))$ is an optimal response to $(G^{-c}, \mathbf{t}^{-c}(G^h, G^f))$.

The two-stage game has as many Subgame Perfect equilibria as possible market structures (G^h, G^f) . Each equilibrium is equivalent to the equilibrium in the corresponding subgame of the three-stage game analysed in section 3.1.

We can understand the result by thinking to the reason why choosing a national champion policy is optimal in the three-stage game. Above we showed that the first period choice of market structure for country c is important because of its impact on the second period choice of taxes by country $-c$. If country $-c$ does not chooses taxes, country c 's market structure choice is irrelevant. In a two-stage game where governments choose taxes and market structure simultaneously, country c has no possibility to influence the other country's choice of taxes. Given the other country's market structure and taxes, the choice of a market structure becomes irrelevant for country c . There is a unique "best response price", and taxes can "undo" any effect of market structure choice.

5 Conclusion

This paper contributes to the literature on the interaction between competition policy and trade policy. We study a three-stage game in which firms from two countries export to a third consuming country. In the first stage, governments choose simultaneously the market structure for their goods, each country chooses a tax system in the second stage, and then firms choose their strategies independently. We consider both the cases of price-setting and quantity-setting, and show that in the only Subgame Perfect Equilibrium each country decides to have one firm controlling all national goods, the national champion policy. We show that this result is explained by the impact that each country's first period choice of market structure has on the second period tax system choice of the other country. In particular, a less competitive market structure induces the other country to choose less aggressive taxes. We further show that separate exporters from the same country have themselves incentive to merge.

One important contribution of this paper is to expand the literature in considering the case of differentiated products and price competition, while previous papers have focused mainly on quantity competition and homogeneous goods.

6 Appendix

In this appendix we will repeatedly make use of the definition of dominant diagonal matrix and its properties.

Definition 1 An $n \times n$ matrix $A = [a_{ij}]$ is said to have a dominant diagonal (d.d.) if there exist positive numbers d_1, d_2, \dots, d_n such that:

$$d_i |a_{ii}| > \sum_{j \neq i} d_j |a_{ij}| \quad \text{for } i = 1, 2, \dots, n.$$

Remark 1 Assume that an $n \times n$ matrix $A = [a_{ij}]$ has positive diagonal elements and non-positive off-diagonal elements. A sufficient condition for \mathbf{A} to have d.d. is that $\mathbf{A}\mathbf{e} > \mathbf{0}$, where \mathbf{e} is a vector of ones. That is, a sufficient condition is that its row sums are all positive.

Lemma 7 Assume that an $n \times n$ matrix \mathbf{B} is such that $\mathbf{B} \geq \mathbf{0}$. If the matrix $(\mathbf{I} - \mathbf{B})$ has the d.d. property, then it is definite positive and it has a nonnegative inverse, which can be computed as $(\mathbf{I} - \mathbf{B})^{-1} = \mathbf{I} + \mathbf{B} + \mathbf{B}^2 + \dots$ where the series is converging. Given two matrices $\mathbf{B}_1 \geq \mathbf{B}_2$, then $(\mathbf{I} - \mathbf{B}_2)^{-1} \geq (\mathbf{I} - \mathbf{B}_1)^{-1}$.

Lemma 8 A d.d. matrix \mathbf{B} with positive diagonal elements and negative off diagonal elements, has a nonnegative inverse $\mathbf{B}^{-1} \geq \mathbf{0}$.

Before proceeding, we discuss a few issues of notation. We write market structure G^c in matrix notation as $\mathbf{\Omega}_c$, where $\mathbf{\Omega}_c$ is $n^c \times n^c$ and element $\omega_{ij} = 1$ if i and j are sold by the same firm, and $\omega_{ij} = 0$ otherwise. We define $\mathbf{\Omega} = \begin{bmatrix} \mathbf{\Omega}_h & \mathbf{0} \\ \mathbf{0} & \mathbf{\Omega}_f \end{bmatrix}$. Throughout this paper, we use a bold $\mathbf{1}$ to represent an $n \times n$ matrix of ones and $\mathbf{1}^{cs}$ to represent an $n^c \times n^s$ matrix of ones, where c and s are either h or f .

6.1 Solution of the Third Stage Bertrand Game

The demand functions are:

$$q_i = a_i - \beta p_i + \sigma \sum_{j \neq i} p_j$$

Where the parameters are given by:

$$a_i = \frac{\alpha_i [\gamma(n-2) + 1] - \gamma \sum_{j \neq i} \alpha_j}{(1-\gamma)[\gamma(n-1) + 1]}; \quad \beta = \frac{\gamma(n-2) + 1}{(1-\gamma)[\gamma(n-1) + 1]}; \quad \sigma = \frac{\gamma}{(1-\gamma)[\gamma(n-1) + 1]}.$$

and $0 \leq \gamma < 1$. In the last period, exporters take ownership structure and taxes as given and maximize profit independently. Our assumptions assure that the objective functions are concave. For

each product i , the first order condition is:

$$a_i - 2(\beta + \sigma)p_i + 2\sigma \sum_{j \in \mathcal{F}_i} p_j + \sigma \sum_{j \notin \mathcal{F}_i} p_j + (\beta + \sigma)t_i - \sigma \sum_{j \in \mathcal{F}_i} t_j = 0$$

Where \mathcal{F}_i is the set of products produced by the same firm producing product i (including product i) and t_i is the tax rate for product i . Note that tax rates are assumed to be product specific. Assuming an interior equilibrium, the n first order conditions can be written as:

$$[2(\beta + \sigma)\mathbf{I} - \sigma(\mathbf{\Omega} + \mathbf{1})] \mathbf{p}(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) = \mathbf{a} + [(\beta + \sigma)\mathbf{I} - \sigma\mathbf{\Omega}] \mathbf{t}$$

Where $\mathbf{p} = \begin{bmatrix} \mathbf{p}^h \\ \mathbf{p}^f \end{bmatrix}$ is the $n \times 1$ vector of prices and $\mathbf{a} = \begin{bmatrix} \mathbf{a}_h \\ \mathbf{a}_f \end{bmatrix}$ is the $n \times 1$ vector of intercepts. To show that the matrix $[2(\beta + \sigma)\mathbf{I} - \sigma(\mathbf{\Omega} + \mathbf{1})]$ is invertible, we will prove that it has the d.d. property. Note that all diagonal elements are positive (they are 2β) and all off-diagonal elements are negative (they are either $-\sigma$ or -2σ). To prove the d.d. property it is sufficient to show that:

$$[2(\beta + \sigma)\mathbf{I} - \sigma(\mathbf{\Omega} + \mathbf{1})] \mathbf{e} > \mathbf{0} \implies 2(\beta + \sigma)\mathbf{e} - \sigma\mathbf{\Omega}\mathbf{e} - n\sigma\mathbf{e} > \mathbf{0}$$

where \mathbf{e} is an $n \times 1$ vector of ones. As $\mathbf{\Omega}\mathbf{e} \leq n\mathbf{e}$, it is sufficient to show that:

$$2(\beta + \sigma)\mathbf{e} - 2n\sigma\mathbf{e} > \mathbf{0} \iff 2(\beta + \sigma) > 2n\sigma \iff \beta > (n - 1)\sigma$$

Using the definition of β and σ :

$$\beta > (n - 1)\sigma \iff 1 > \gamma$$

Which is true by assumption. Hence, the equilibrium prices are given by:

$$\mathbf{p}(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) = [2(\beta + \sigma)\mathbf{I} - \sigma(\mathbf{\Omega} + \mathbf{1})]^{-1} [\mathbf{a} + ((\beta + \sigma)\mathbf{I} - \sigma\mathbf{\Omega}) \mathbf{t}] \quad (4)$$

6.2 Proof of Lemma (1)

When countries do not impose taxes, equilibrium prices are given by:

$$\mathbf{p}(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) = [2(\beta + \sigma)\mathbf{I} - \sigma(\mathbf{\Omega} + \mathbf{1})]^{-1} \mathbf{a}$$

Note that a less competitive market structure corresponds to a “more positive” $\mathbf{\Omega}$ matrix, some zeros are replaced by ones. To prove the Lemma, just use Lemma 7 and the fact that the matrix $[2(\beta + \sigma)\mathbf{I} - \sigma(\mathbf{\Omega} + \mathbf{1})]$ has the d.d. property.

6.3 Proof of Lemma (2)

From Lemma (1) we know that, given the foreign market structure, the highest equilibrium home country prices are obtained when the home country assigns all goods to the same firm. A home country monopolist solves:

$$\max_{\mathbf{p}^h} \Pi^h(\mathbf{p}^h, \mathbf{p}^f(G^f)) = \mathbf{p}^{h'} \mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(G^f))$$

Where $\mathbf{p}^f(G^f)$ is the equilibrium foreign prices when the home country chooses a monopoly and the foreign market structure is G^f . The vector of first-order conditions is:

$$\mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(G^f)) + \frac{\partial \mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(G^f))}{\partial \mathbf{p}^h} \mathbf{p}^h = \mathbf{0}. \quad (5)$$

In contrast, the first-order condition for problem 1 is:

$$\mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f)) + \left(\frac{\partial \mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f))}{\partial \mathbf{p}^h} + \frac{\partial \mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f))}{\partial \mathbf{p}^f(\mathbf{p}^h, G^f)} \frac{\partial \mathbf{p}^f(\mathbf{p}^h, G^f)}{\partial \mathbf{p}^h} \right)' \mathbf{p}^h = \mathbf{0} \quad (6)$$

Let $\mathbf{p}^h(G^f)$ be the equilibrium home prices when the home country chooses a monopoly and the foreign market structure is G^f . Note that $\mathbf{p}^f(G^f) = \mathbf{p}^f(\mathbf{p}^h(G^f), G^f)$. Hence, using (5):

$$\begin{aligned} & \mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f)) + \left(\frac{\partial \mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f))}{\partial \mathbf{p}^h} + \frac{\partial \mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f))}{\partial \mathbf{p}^f(\mathbf{p}^h, G^f)} \frac{\partial \mathbf{p}^f(\mathbf{p}^h, G^f)}{\partial \mathbf{p}^h} \right)' \mathbf{p}^h \Bigg|_{\mathbf{p}^h = \mathbf{p}^h(G^f)} \\ = & \frac{\partial \mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f))}{\partial \mathbf{p}^f(\mathbf{p}^h, G^f)} \frac{\partial \mathbf{p}^f(\mathbf{p}^h, G^f)'}{\partial \mathbf{p}^h} \mathbf{p}^h \Bigg|_{\mathbf{p}^h = \mathbf{p}^h(G^f)} > \mathbf{0} \end{aligned}$$

Where the inequality comes from the fact that $\frac{\partial \mathbf{q}^h(\mathbf{p}^h, \mathbf{p}^f(\mathbf{p}^h, G^f))}{\partial \mathbf{p}^f(\mathbf{p}^h, G^f)} > \mathbf{0}$ and $\frac{\partial \mathbf{p}^f(\mathbf{p}^h, G^f)}{\partial \mathbf{p}^h} > \mathbf{0}$. Therefore, the vector of prices that solves equation 5 must be lower (element by element) than the vector that solves equation 6.

6.4 Proof of Theorem (1)

The home country solves:

$$\max_{G^h \in \mathcal{G}^h} \Pi^h(G^h, G^f) = \mathbf{p}^h(G^h, G^f)' \left[\mathbf{a}_h - (\beta + \sigma) \mathbf{p}^h(G^h, G^f) + \sigma \mathbf{1}^{hh} \mathbf{p}^h(G^h, G^f) + \sigma \mathbf{1}^{hf} \mathbf{p}^f(G^h, G^f) \right]$$

In an abuse of notation, we write df/dG^c to be the change in function f from a change in G^c , where the change is the direction of the market structure becoming less competitive.

$$\frac{d\Pi^h}{dG^h} = \left[\mathbf{a}_h - 2(\beta + \sigma)\mathbf{p}^h + 2\sigma\mathbf{1}^{hh}\mathbf{p}^h + \sigma\mathbf{1}^{hf}\mathbf{p}^f \right]' \frac{\partial \mathbf{p}^h}{\partial G^h} + \sigma \mathbf{p}^{h'} \mathbf{1}^{hf} \frac{\partial \mathbf{p}^f}{\partial G^h} \quad (7)$$

From the first order conditions for the home products, we can derive:

$$\mathbf{a}_h - 2(\beta + \sigma)\mathbf{p}^h + 2\sigma\mathbf{1}^{hh}\mathbf{p}^h + \sigma\mathbf{1}^{hf}\mathbf{p}^f = \sigma \left[\mathbf{1}^{hh} - \mathbf{\Omega}_h \right] \mathbf{p}^h$$

Substituting in 7:

$$\frac{d\Pi^h}{dG^h} = \sigma \mathbf{p}_h \left[\mathbf{1}^{hh} - \mathbf{\Omega}_h \right] \frac{\partial \mathbf{p}^h(G^h, G^f)}{\partial G^h} + \sigma \mathbf{p}^h(G^h, G^f)' \mathbf{1}^{hf} \frac{\partial \mathbf{p}^f(G^h, G^f)}{\partial G^h}$$

In order to sign this expression, note that:

- $[\mathbf{1}^{hh} - \mathbf{\Omega}_h] \geq \mathbf{0}$: unless the home market structure is a monopoly, $\mathbf{\Omega}_h < \mathbf{1}^{hh}$.
- $\frac{\partial \mathbf{p}^h(G^h, G^f)}{\partial G^h} > \mathbf{0}$ and $\frac{\partial \mathbf{p}^f(G^h, G^f)}{\partial G^h} > \mathbf{0}$: see Lemma 1.

The previous conditions imply that $\frac{d\Pi^h}{dG^h} > 0$, which proves the theorem.

6.5 Proof of Lemma (4)

The equilibrium prices arising when the countries choose partitions G^h and G^f are given by:

$$\begin{bmatrix} \mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) \\ \mathbf{p}^f(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) \end{bmatrix} = [2(\beta + \sigma)\mathbf{I} - \sigma(\mathbf{\Omega} + \mathbf{1})]^{-1} \left\{ \mathbf{a} + ((\beta + \sigma)\mathbf{I} - \sigma\mathbf{\Omega}) \begin{bmatrix} \mathbf{t}^h \\ \mathbf{t}^f \end{bmatrix} \right\}$$

To prove the theorem, it is sufficient to show that the $n \times n$ matrix multiplying the vector of taxes is full rank. We previously proved that the matrix $[2(\beta + \sigma)\mathbf{I} - \sigma(\mathbf{\Omega} + \mathbf{1})]$ is full rank. We will prove that the matrix $((\beta + \sigma)\mathbf{I} - \sigma\mathbf{\Omega})$ is full rank as well. We show that it has the d.d. property. It has positive diagonal elements and negative off-diagonal elements. It is sufficient to show that:

$$((\beta + \sigma)\mathbf{I} - \sigma\mathbf{\Omega})\mathbf{e} > \mathbf{0}$$

Where \mathbf{e} is a $n \times 1$ vector of ones. Given that $\mathbf{\Omega}\mathbf{e} < n\mathbf{e}$, using the definition of β and σ , it is sufficient to show that:

$$(\beta + \sigma) - n\sigma > 0 \iff \gamma < 1$$

Which is true by assumption. Now, just note that the product of full rank matrices is full rank.

6.6 Proof of Lemma (5)

6.6.1 Step 1

We first will show how the equilibrium prices, $\mathbf{p}^h(G^h, G^f)$ and $\mathbf{p}^f(G^h, G^f)$, change when the market structure changes.

We use the fact that the home and foreign governments will pick taxes \mathbf{t}^h and \mathbf{t}^f such that (see Lemma 3):

$$\begin{aligned}\mathbf{p}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) &= \mathbf{p}_{ST}^h(G^f, \mathbf{t}^f) \\ \mathbf{p}^f(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) &= \mathbf{p}_{ST}^f(G^h, \mathbf{t}^h)\end{aligned}\tag{8}$$

The equilibrium prices are such that (see equation 4):

$$\begin{bmatrix} \mathbf{A}_h & -\sigma \mathbf{1}^{hf} \\ -\sigma \mathbf{1}^{fh} & \mathbf{A}_f \end{bmatrix} \begin{bmatrix} \mathbf{p}^h \\ \mathbf{p}^f \end{bmatrix} = \begin{bmatrix} \mathbf{a}_h + [(\beta + \sigma)\mathbf{I}_h - \sigma\mathbf{\Omega}_h] \mathbf{t}^h \\ \mathbf{a}_f + [(\beta + \sigma)\mathbf{I}_f - \sigma\mathbf{\Omega}_f] \mathbf{t}^f \end{bmatrix}\tag{9}$$

Where we defined:

$$\begin{aligned}\mathbf{A}_h &= 2(\beta + \sigma)\mathbf{I}_h - \sigma(\mathbf{\Omega}_h + \mathbf{1}^{hh}) \\ \mathbf{A}_f &= 2(\beta + \sigma)\mathbf{I}_f - \sigma(\mathbf{\Omega}_f + \mathbf{1}^{ff})\end{aligned}$$

It is easy to solve the Stackelberg problems. The home country Stackelberg problem is:

$$\begin{aligned}\max_{\mathbf{p}^h} \mathbf{p}^{h'} &\left[\mathbf{a}_h - (\beta + \sigma)\mathbf{p}^h + \sigma \mathbf{1}^{hh} \mathbf{p}^h + \sigma \mathbf{1}^{hf} \mathbf{p}^f(\mathbf{p}^h, G^f, \mathbf{t}^f) \right] \\ \text{subject to } \mathbf{p}^f(\mathbf{p}^h, G^f, \mathbf{t}^f) &= \sigma \mathbf{A}_f^{-1} \mathbf{1}^{fh} \mathbf{p}^h + \mathbf{A}_f^{-1} \left[\mathbf{a}_f + ((\beta + \sigma)\mathbf{I}_f - \sigma\mathbf{\Omega}_f) \mathbf{t}^f \right]\end{aligned}$$

It is easy to show that the Stackelberg prices are such that:

$$\begin{bmatrix} \mathbf{B}_h & \mathbf{0} \\ \mathbf{0} & \mathbf{B}_f \end{bmatrix} \begin{bmatrix} \mathbf{p}_{ST}^h(G^f, \mathbf{t}^f) \\ \mathbf{p}_{ST}^f(G^h, \mathbf{t}^h) \end{bmatrix} = \begin{bmatrix} \mathbf{a}_h \\ \mathbf{a}_f \end{bmatrix} + \sigma \begin{bmatrix} \mathbf{0} & \mathbf{1}^{hf} \mathbf{A}_f^{-1} \\ \mathbf{1}^{fh} \mathbf{A}_h^{-1} & \mathbf{0} \end{bmatrix} \begin{bmatrix} \mathbf{a}_h + [(\beta + \sigma)\mathbf{I}_h - \sigma\mathbf{\Omega}_h] \mathbf{t}^h \\ \mathbf{a}_f + [(\beta + \sigma)\mathbf{I}_f - \sigma\mathbf{\Omega}_f] \mathbf{t}^f \end{bmatrix}\tag{10}$$

Where we defined:

$$\begin{aligned}\mathbf{B}_h &= 2(\beta + \sigma)\mathbf{I}_h - 2\sigma \left(\mathbf{1}^{hh} + \sigma(\mathbf{1}^{hf} \mathbf{A}_f^{-1} \mathbf{1}^{fh}) \right) \\ \mathbf{B}_f &= 2(\beta + \sigma)\mathbf{I}_f - 2\sigma \left(\mathbf{1}^{ff} + \sigma \left(\mathbf{1}^{fh} \mathbf{A}_h^{-1} \mathbf{1}^{hf} \right) \right)\end{aligned}$$

Equations 9 and 10 have to be both verified at the equilibrium. They represent $2n$ equations in $2n$ unknowns, prices and taxes. It a matter of algebraic manipulation to derive equilibrium prices:

$$\begin{aligned} & \begin{bmatrix} \mathbf{p}^h(G^h, G^f) \\ \mathbf{p}^f(G^h, G^f) \end{bmatrix} = \\ & \left\{ 2(\beta + \sigma)\mathbf{I} - \sigma \begin{bmatrix} 2\left(\mathbf{1}^{hh} + \frac{1}{2}\sigma\left(\mathbf{1}^{hf}\mathbf{A}_f^{-1}\mathbf{1}^{fh}\right)\right) & \mathbf{1}^{hf} \\ \mathbf{1}^{fh} & 2\left(\mathbf{1}^{ff} + \frac{1}{2}\sigma\left(\mathbf{1}^{fh}\mathbf{A}_h^{-1}\mathbf{1}^{hf}\right)\right) \end{bmatrix} \right\}^{-1} \begin{bmatrix} \mathbf{a}_h \\ \mathbf{a}_f \end{bmatrix} \end{aligned}$$

Where the matrix in curled parentheses can be proved to have the d.d. property (the proof is omitted for brevity). We want to show that equilibrium prices increase if market structure becomes less competitive. Assume that the home market becomes less competitive. Some zeros in the matrix $\mathbf{\Omega}_h$ are replaced by ones. Given that \mathbf{A}_h has the d.d. property, Lemma 7 implies that \mathbf{A}_h^{-1} is positive and it becomes more positive as home market structure becomes less competitive. This implies that $\left(\mathbf{1}^{hf}\mathbf{A}_f^{-1}\mathbf{1}^{fh}\right)$ becomes more positive. Applying Lemma 7 again to the matrix in curled parentheses, we can show that its inverse is positive and it becomes more positive as the home market structure becomes less competitive. This proves that a less competitive home market structure increases equilibrium prices.

6.6.2 Step 2

Using 9, we can write the equilibrium taxes as:

$$\begin{aligned} \mathbf{t}^h(G^h, G^f) &= -[(\beta + \sigma)\mathbf{I}_h - \sigma\mathbf{\Omega}_h]^{-1} [\mathbf{a}_h - \mathbf{A}_h\mathbf{p}^h(G^h, G^f) + \sigma\mathbf{1}^{hf}\mathbf{p}^f(G^h, G^f)] \\ \mathbf{t}^f(G^h, G^f) &= -[(\beta + \sigma)\mathbf{I}_f - \sigma\mathbf{\Omega}_f]^{-1} [\mathbf{a}_f - \mathbf{A}_f\mathbf{p}^f(G^h, G^f) + \sigma\mathbf{1}^{fh}\mathbf{p}^h(G^h, G^f)] \end{aligned}$$

Consider that the equilibrium prices have to satisfy the condition:

$$\begin{aligned} & \left\{ 2(\beta + \sigma)\mathbf{I} - \sigma \begin{bmatrix} 2\left(\mathbf{1}^{hh} + \frac{1}{2}\sigma\left(\mathbf{1}^{hf}\mathbf{A}_f^{-1}\mathbf{1}^{fh}\right)\right) & \mathbf{1}^{hf} \\ \mathbf{1}^{fh} & 2\left(\mathbf{1}^{ff} + \frac{1}{2}\sigma\left(\mathbf{1}^{fh}\mathbf{A}_h^{-1}\mathbf{1}^{hf}\right)\right) \end{bmatrix} \right\} \begin{bmatrix} \mathbf{p}^h(G^h, G^f) \\ \mathbf{p}^f(G^h, G^f) \end{bmatrix} \\ &= \begin{bmatrix} \mathbf{a}_h \\ \mathbf{a}_f \end{bmatrix} \end{aligned} \tag{11}$$

From the second set of equations, we can derive:

$$\begin{aligned} & 2(\beta + \sigma)\mathbf{p}^f(G^h, G^f) - 2\sigma \left(\mathbf{1}^{ff} + \frac{1}{2}\sigma \left(\mathbf{1}^{fh} \mathbf{A}_h^{-1} \mathbf{1}^{hf} \right) \right) \mathbf{p}^f(G^h, G^f) - \sigma \mathbf{1}^{fh} \mathbf{p}^h(G^h, G^f) = \mathbf{a}_f \\ \implies & 2(\beta + \sigma)\mathbf{p}^f(G^h, G^f) - 2\sigma \left(\mathbf{1}^{ff} + \frac{1}{2}\sigma \left(\mathbf{1}^{fh} \mathbf{A}_h^{-1} \mathbf{1}^{hf} \right) \right) \mathbf{p}^f(G^h, G^f) = \mathbf{a}_f + \sigma \mathbf{1}^{fh} \mathbf{p}^h(G^h, G^f) \end{aligned}$$

Replace in the expression for $\mathbf{t}^f(G^h, G^f)$:

$$\mathbf{t}^f(G^h, G^f) = \sigma [(\beta + \sigma)\mathbf{I}_f - \sigma\mathbf{\Omega}_f]^{-1} \left[\mathbf{1}^{ff} - \mathbf{\Omega}_f + \sigma \left(\mathbf{1}^{fh} \mathbf{A}_h^{-1} \mathbf{1}^{hf} \right) \right] \mathbf{p}^f(G^h, G^f) > \mathbf{0} \quad (12)$$

Where we used the fact that $\mathbf{A}_f = 2(\beta + \sigma)\mathbf{I}_f - \sigma(\mathbf{\Omega}_f + \mathbf{1}^{ff})$. Notice that a country will always tax (it will never subsidize) its goods. We noted before that if a country, in particular country h , chooses a less competitive market structure, given the other country's market structure, the equilibrium prices increase, in particular $\mathbf{p}^f(G^h, G^f)$ increases. Besides \mathbf{A}_h^{-1} becomes more positive for less competitive home market structures. Given that $[(\beta + \sigma)\mathbf{I}_f - \sigma\mathbf{\Omega}_f]^{-1} > \mathbf{0}$ and $[\mathbf{1}^{ff} - \mathbf{\Omega}_f + \sigma(\mathbf{1}^{fh} \mathbf{A}_h^{-1} \mathbf{1}^{hf})] > \mathbf{0}$, it is clear that if country h makes its market structure less competitive, the equilibrium foreign taxes $\mathbf{t}^f(G^h, G^f)$ increase:

$$\frac{\partial \mathbf{t}^f(G^h, G^f)}{\partial G^h} > \mathbf{0}$$

6.7 Proof of Theorem (3)

Here we analytically prove that $\left(\frac{\partial \Pi^h}{\partial \mathbf{p}^f} \frac{\partial \mathbf{p}^f}{\partial \mathbf{t}^f} \right) > \mathbf{0}$. It is easy to derive that:

- $\frac{\partial \Pi^h}{\partial \mathbf{p}^f} = \sigma \mathbf{p}^h \mathbf{1}^{hf}$.
- $\frac{\partial \mathbf{p}^f}{\partial \mathbf{t}^f} = [2(\beta + \sigma)\mathbf{I}_f - \sigma(\mathbf{\Omega}_f + \mathbf{1}^{ff})]^{-1} [(\beta + \sigma)\mathbf{I}_f - \sigma\mathbf{\Omega}_f]$.

We prove that $\frac{\partial \mathbf{p}^f}{\partial \mathbf{t}^f} \geq \mathbf{0}$. The following are easy algebraic manipulations:

$$\begin{aligned} & \left[2(\beta + \sigma)\mathbf{I}_f - \sigma(\mathbf{\Omega}_f + \mathbf{1}^{ff}) \right]^{-1} [(\beta + \sigma)\mathbf{I}_f - \sigma\mathbf{\Omega}_f] = \\ & = \frac{1}{2(\beta + \sigma)} \left[\mathbf{I}_f - \frac{\sigma}{2(\beta + \sigma)}(\mathbf{\Omega}_f + \mathbf{1}^{ff}) \right]^{-1} (\beta + \sigma) \left[\mathbf{I}_f - \frac{\sigma}{(\beta + \sigma)}\mathbf{\Omega}_f \right] = \\ & = \frac{1}{2} \left[\mathbf{I}_f - \frac{\sigma}{2(\beta + \sigma)}(\mathbf{\Omega}_f + \mathbf{1}^{ff}) \right]^{-1} \left[\mathbf{I}_f - \frac{\sigma}{(\beta + \sigma)}\mathbf{\Omega}_f \right] = \\ & = \frac{1}{2} \left[\mathbf{I}_f - \frac{\sigma}{2(\beta + \sigma)}(\mathbf{\Omega}_f + \mathbf{1}^{ff}) \right]^{-1} \left[\mathbf{I}_f - \frac{\sigma}{2(\beta + \sigma)}(\mathbf{\Omega}_f + \mathbf{1}^{ff}) + \frac{\sigma}{2(\beta + \sigma)}(\mathbf{1}^{ff} - \mathbf{\Omega}_f) \right] = \\ & = \frac{1}{2}\mathbf{I}_f + \frac{\sigma}{4(\beta + \sigma)} \left[\mathbf{I}_f - \frac{\sigma}{2(\beta + \sigma)}(\mathbf{\Omega}_f + \mathbf{1}^{ff}) \right]^{-1} (\mathbf{1}^{ff} - \mathbf{\Omega}_f) \end{aligned}$$

Now, just observe that the matrix $\left[\mathbf{I}_f - \frac{\sigma}{2(\beta+\sigma)}(\boldsymbol{\Omega}_f + \mathbf{1}^{ff})\right]$ has positive diagonal elements, negative off-diagonal elements, and a d.d.. Its inverse is positive. Besides $(\mathbf{1}^{ff} - \boldsymbol{\Omega}_f) \geq \mathbf{0}$.

6.8 Proof of Theorem (4)

The profit to the exporter for each product in the country c is:

$$(p_i^c - t_i^c)q_i^c = (p_i^c - t_i^c) \left(a_i - \beta p_i + \sigma \sum_{j \neq i} p_j \right) \quad (13)$$

Each exporter chooses prices by taking into account the cross effect among all goods she owns. The first order condition for good i is:

$$q_i^c - (\beta + \sigma)(p_i^c - t_i^c) + \sigma \sum_{j \in \mathcal{F}_i} (p_j^c - t_j^c) = 0$$

where \mathcal{F}_i is the set of products produced by the same firm producing product i (including product i). Using the first order conditions corresponding to all goods in \mathcal{F}_i , it is possible to derive:

$$(p_i^c - t_i^c) = \frac{1}{\beta + \sigma} \left[q_i^c + \frac{\sigma}{\beta - (n^p - 1)\sigma} \sum_{j \in \mathcal{F}_i} q_j^c \right]$$

Replacing in 13:

$$(p_i^c - t_i^c)q_i^c = \frac{1}{\beta + \sigma} \left[q_i^c + \frac{\sigma}{\beta - (n^p - 1)\sigma} \sum_{j \in \mathcal{F}_i} q_j^c \right] q_i^c$$

Where n^p is the number of goods produced by the firm that produces product i . To prove the theorem, it is sufficient to show that a merger among home firms increases the quantity produced of all home goods (note that $\beta - (n^p - 1)\sigma > 0$). We will prove that $\frac{dq^h}{dG^h} > \mathbf{0}$. From 11 we can derive:

$$\left[(\beta + \sigma)\mathbf{I}_h - \sigma\mathbf{1}^{hh} - \sigma^2(\mathbf{1}^{hf}\mathbf{A}_f^{-1}\mathbf{1}^{fh}) \right] \mathbf{p}^h = \mathbf{a}_h - (\beta + \sigma)\mathbf{p}^h + \sigma\mathbf{1}^{hh}\mathbf{p}^h + \sigma\mathbf{1}^{hf}\mathbf{p}^f = \mathbf{q}^h \quad (14)$$

It is sufficient to show that the quantity on the left increases if home market structure becomes less competitive. Consider the Stackelber leader price for the home country (see 10):

$$2 \left[(\beta + \sigma)\mathbf{I}_h - \sigma\mathbf{1}^{hh} - \sigma^2(\mathbf{1}^{hf}\mathbf{A}_f^{-1}\mathbf{1}^{fh}) \right] \mathbf{p}^h = \mathbf{a}_h + \mathbf{1}^{hf}\mathbf{A}_f^{-1} \left\{ \mathbf{a}_f + [(\beta + \sigma)\mathbf{I}_f - \sigma\boldsymbol{\Omega}_f]\mathbf{t}^f \right\}$$

It is sufficient to show that $\mathbf{A}_f^{-1}[(\beta + \sigma)\mathbf{I}_f - \sigma\boldsymbol{\Omega}_f]\mathbf{t}^f$ increases as home market structure becomes less competitive. Note that $\mathbf{A}_f^{-1}[(\beta + \sigma)\mathbf{I}_f - \sigma\boldsymbol{\Omega}_f]$ does not depend on home market structure and that it is a positive matrix (see proof of theorem 3). It is now sufficient to note that \mathbf{t}^f increases if the home market structure becomes less competitive (see Lemma 5).

6.9 Proof of Theorem (5)

From previous results, we know that a less competitive home market structure determines an increase of all prices and an increase in the quantity of all home goods (see previous theorem). This implies that the quantity of at least one foreign product decreases (prices and quantities cannot increase all at the same time). We will now show that the quantity of all foreign goods change in the same direction as the home market structure becomes less competitive. Use the equivalent of 14:

$$\mathbf{q}^f = \left[(\beta + \sigma)\mathbf{I}_f - \sigma\mathbf{1}^{ff} - \sigma^2 \left(\mathbf{1}^{fh} \mathbf{A}_h^{-1} \mathbf{1}^{hf} \right) \right] \mathbf{p}^f = \mathbf{a}_f - (\beta + \sigma)\mathbf{p}^f + \sigma\mathbf{1}^{ff}\mathbf{p}^f + \sigma\mathbf{1}^{fh}\mathbf{p}^h$$

After some manipulations:

$$2\mathbf{q}^f = 2 \left[(\beta + \sigma)\mathbf{I}_f - \sigma\mathbf{1}^{ff} - \sigma^2 \left(\mathbf{1}^{fh} \mathbf{A}_h^{-1} \mathbf{1}^{hf} \right) \right] \mathbf{p}^f = \mathbf{a}_f + \sigma\mathbf{1}^{fh}\mathbf{p}^h - \sigma^2 \left(\mathbf{1}^{fh} \mathbf{A}_h^{-1} \mathbf{1}^{hf} \right) \mathbf{p}^f$$

Differentiate the previous expression, and use the fact that $(\mathbf{1}^{fh} \mathbf{A}_h^{-1} \mathbf{1}^{hf}) = (\mathbf{e}'_h \mathbf{A}_h^{-1} \mathbf{e}_h) \mathbf{e}_f \mathbf{e}'_f$ and $\mathbf{1}^{fh} = \mathbf{e}_f \mathbf{e}'_h$, where \mathbf{e}_f and \mathbf{e}_h are $n^f \times 1$ and $n^h \times 1$ vectors of ones.:

$$\begin{aligned} 2 \frac{d\mathbf{q}^f}{dG^h} &= \sigma \mathbf{e}_f \mathbf{e}'_h \frac{d\mathbf{p}^h}{dG^h} - \sigma^2 (\mathbf{e}'_h \mathbf{A}_h^{-1} \mathbf{e}_h) \mathbf{e}_f \mathbf{e}'_f \frac{d\mathbf{p}^f}{dG^h} - \sigma^2 \mathbf{e}_f \mathbf{e}'_f \mathbf{p}^f \frac{d(\mathbf{e}'_h \mathbf{A}_h^{-1} \mathbf{e}_h)}{dG^h} \\ &= \left(\sigma \mathbf{e}'_h \frac{d\mathbf{p}^h}{dG^f} - \sigma^2 (\mathbf{e}'_h \mathbf{A}_h^{-1} \mathbf{e}_h) \mathbf{e}'_f \frac{d\mathbf{p}^f}{dG^f} - \sigma^2 \mathbf{e}'_f \mathbf{p}^f \frac{d(\mathbf{e}'_h \mathbf{A}_h^{-1} \mathbf{e}_h)}{dG^h} \right) \mathbf{e}_f \end{aligned}$$

where the quantity in parentheses is a scalar. Given that the quantity of at least one foreign product decreases as the home market structure becomes less competitive, this quantity must be negative.

6.10 Solution of the Third Stage Cournot Game

The inverse demand functions are:

$$p_i = \alpha_i - q_i - \gamma \sum_{j \neq i} q_j$$

In the third period, firms choose quantities, given market structure and taxes. For each product i , the first order condition is:

$$\alpha_i - t_i - 2(1 - \gamma)q_i - 2\gamma \sum_{j \in \mathcal{F}_i} q_j - \gamma \sum_{j \notin \mathcal{F}_i} q_j = 0$$

In matrix formula:

$$\boldsymbol{\alpha} - \mathbf{t} - [2(1 - \gamma)\mathbf{I} + \gamma\boldsymbol{\Omega} + \gamma\mathbf{1}]\mathbf{q} = \mathbf{0}$$

Define:

$$\begin{aligned}\Delta_h &= 2(1 - \gamma)\mathbf{I}_h + \gamma\Omega_h + \gamma\mathbf{1}^{hh} \\ \Delta_f &= 2(1 - \gamma)\mathbf{I}_f + \gamma\Omega_f + \gamma\mathbf{1}^{ff}\end{aligned}$$

The first order conditions can be written:

$$\begin{bmatrix} \Delta_h & \gamma\mathbf{1}^{hf} \\ \gamma\mathbf{1}^{fh} & \Delta_f \end{bmatrix} \begin{bmatrix} \mathbf{q}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) \\ \mathbf{q}^f(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) \end{bmatrix} = \begin{bmatrix} \alpha_h \\ \alpha_f \end{bmatrix} - \begin{bmatrix} \mathbf{t}_h \\ \mathbf{t}_f \end{bmatrix} \quad (15)$$

It is now easy to show that for $\gamma \in [0, 1)$ the matrix $2(1 - \gamma)\mathbf{I} + \gamma\Omega + \gamma\mathbf{1}$ is definite positive, hence non singular, so that:

$$\begin{bmatrix} \mathbf{q}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) \\ \mathbf{q}^f(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) \end{bmatrix} = \begin{bmatrix} \Delta_h & \gamma\mathbf{1}^{hf} \\ \gamma\mathbf{1}^{fh} & \Delta_f \end{bmatrix}^{-1} \left\{ \begin{bmatrix} \alpha_h \\ \alpha_f \end{bmatrix} - \begin{bmatrix} \mathbf{t}_h \\ \mathbf{t}_f \end{bmatrix} \right\}$$

The fact that the matrix multiplying the tax vector has rank n , proves the equivalent of Lemma (4) for the case of quantity competition.

6.11 Proof of Lemma (6)

6.11.1 Step 1

We first will show how the equilibrium quantities, $\mathbf{q}^h(G^h, G^f)$ and $\mathbf{q}^f(G^h, G^f)$, change when the market structure changes.

We use the fact that the home and foreign governments will pick taxes \mathbf{t}^h and \mathbf{t}^f such that:

$$\begin{aligned}\mathbf{q}^h(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) &= \mathbf{q}_{ST}^h(G^f, \mathbf{t}^f) \\ \mathbf{q}^f(G^h, \mathbf{t}^h, G^f, \mathbf{t}^f) &= \mathbf{q}_{ST}^f(G^h, \mathbf{t}^h)\end{aligned}$$

It is easy to solve the Stackelberg problem:

$$\begin{aligned}\max_{\mathbf{q}^h} & \mathbf{q}^{hj}[\alpha_h - (1 - \gamma)\mathbf{q}^h - \gamma\mathbf{1}^{hh}\mathbf{q}^h - \gamma\mathbf{1}^{hf}\mathbf{q}^f(\mathbf{q}^h, \Omega_f, \mathbf{t}^f)] \\ \text{subject to: } & \mathbf{q}^f(\mathbf{q}^h, \Omega_f, \mathbf{t}^f) = \Delta_f^{-1}(\alpha_f - \mathbf{t}^f) - \gamma\Delta_f^{-1}\mathbf{1}^{fh}\mathbf{q}^h\end{aligned}$$

Where the constraint can be derived from (15). The Stackelberg quantities are:

$$\begin{bmatrix} \mathbf{q}_{ST}^h(\boldsymbol{\Omega}_f, \mathbf{t}^f) \\ \mathbf{q}_{ST}^f(\boldsymbol{\Omega}_h, \mathbf{t}^h) \end{bmatrix} = \begin{bmatrix} \mathbf{L}_h & \mathbf{0} \\ \mathbf{0} & \mathbf{L}_f \end{bmatrix}^{-1} \left\{ \begin{bmatrix} \boldsymbol{\alpha}_h \\ \boldsymbol{\alpha}_f \end{bmatrix} - \gamma \begin{bmatrix} \mathbf{0} & \mathbf{1}^{hf} \boldsymbol{\Delta}_f^{-1} \\ \mathbf{1}^{fh} \boldsymbol{\Delta}_h^{-1} & \mathbf{0} \end{bmatrix} \begin{bmatrix} \boldsymbol{\alpha}_h - \mathbf{t}^h \\ \boldsymbol{\alpha}_f - \mathbf{t}^f \end{bmatrix} \right\} \quad (16)$$

Where we defined:

$$\begin{aligned} \mathbf{L}_h &= 2(1 - \gamma)\mathbf{I}_h + 2\gamma \left(1 - \gamma \left(\mathbf{e}'_f \boldsymbol{\Delta}_f^{-1} \mathbf{e}_f \right) \right) \mathbf{1}^{hh} \\ \mathbf{L}_f &= 2(1 - \gamma)\mathbf{I}_f + 2\gamma \left(1 - \gamma \left(\mathbf{e}'_h \boldsymbol{\Delta}_h^{-1} \mathbf{e}_h \right) \right) \mathbf{1}^{ff} \end{aligned}$$

and \mathbf{e}_f and \mathbf{e}_h are $n^f \times 1$ and $n^h \times 1$ vectors of ones. It is possible to show that \mathbf{L}_h and \mathbf{L}_f are definite positive and, hence, invertible.

Equations 16 and 15 have both to be verified at the equilibrium. They represent $2n$ equations in $2n$ unknowns, quantities and subsidies. It a matter of algebraic manipulation to derive equilibrium quantities:

$$\begin{bmatrix} \mathbf{q}^h(G^h, G^f) \\ \mathbf{q}^f(G^h, G^f) \end{bmatrix} = \begin{bmatrix} \mathbf{W}_h & \gamma \mathbf{1}^{hf} \\ \gamma \mathbf{1}^{fh} & \mathbf{W}_f \end{bmatrix}^{-1} \begin{bmatrix} \boldsymbol{\alpha}_h \\ \boldsymbol{\alpha}_f \end{bmatrix} \quad (17)$$

Where:

$$\begin{aligned} \mathbf{W}_h &= 2(1 - \gamma)\mathbf{I}_h + 2\gamma \mathbf{1}^{hh} - \gamma^2 \left(\mathbf{e}'_f \boldsymbol{\Delta}_f^{-1} \mathbf{e}_f \right) \mathbf{1}^{hh} \\ \mathbf{W}_f &= 2(1 - \gamma)\mathbf{I}_f + 2\gamma \mathbf{1}^{ff} - \gamma^2 \left(\mathbf{e}'_h \boldsymbol{\Delta}_h^{-1} \mathbf{e}_h \right) \mathbf{1}^{ff} \end{aligned}$$

Note that the equilibrium quantities depend on $\boldsymbol{\Omega}_h$ only through the scalar $\left(\mathbf{e}'_h \boldsymbol{\Delta}_h^{-1} \mathbf{e}_h \right)$. The link between market structure and $\left(\mathbf{e}'_h \boldsymbol{\Delta}_h^{-1} \mathbf{e}_h \right)$ is given by the following Lemma (whose proof is omitted for sake of brevity).

Lemma 9 $\left(\mathbf{e}'_h \boldsymbol{\Delta}_h^{-1} \mathbf{e}_h \right) = \mathbf{e}'_h [2(1 - \gamma)\mathbf{I}_h + \gamma \boldsymbol{\Omega}_h + \gamma \mathbf{1}^{hh}]^{-1} \mathbf{e}_h$ decreases if the market structure is made less competitive.

Differentiate 17 with respect to $\left(\mathbf{e}'_h \boldsymbol{\Delta}_h^{-1} \mathbf{e}_h \right)$ (treating it as a continuous variable):

$$\begin{bmatrix} \mathbf{W}_h & \gamma \mathbf{1}^{hf} \\ \gamma \mathbf{1}^{fh} & \mathbf{W}_f \end{bmatrix} \begin{bmatrix} \frac{\partial \mathbf{q}^h(G^h, G^f)}{\partial (\mathbf{e}'_h \boldsymbol{\Delta}_h^{-1} \mathbf{e}_h)} \\ \frac{\partial \mathbf{q}^f(G^h, G^f)}{\partial (\mathbf{e}'_h \boldsymbol{\Delta}_h^{-1} \mathbf{e}_h)} \end{bmatrix} = \begin{bmatrix} \mathbf{0} \\ \gamma^2 \mathbf{1}^{ff} \mathbf{q}^f(G^h, G^f) \end{bmatrix} \quad (18)$$

Solving the system of equations 18:

$$\frac{\partial \mathbf{q}^h(G^h, G^f)}{\partial (\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h)} = - \frac{n^f}{2(1-\gamma) + \gamma (2 - \gamma \mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h) n^f} \frac{\gamma^3 \mathbf{1}^{hf} \mathbf{q}^f(G^h, G^f)}{2(1-\gamma) + \gamma (2 - \gamma \mathbf{e}'_f \Delta_f^{-1} \mathbf{e}_f - \gamma \mathbf{e}'_f \mathbf{W}_f^{-1} \mathbf{e}_f) n^h}$$

$$\frac{\partial \mathbf{q}^f(G^h, G^f)}{\partial (\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h)} = \frac{\gamma^2 \mathbf{1}^{ff} \mathbf{q}^f(G^h, G^f)}{2(1-\gamma) + \gamma (2 - \gamma \mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h - \gamma \mathbf{e}'_h \mathbf{W}_h^{-1} \mathbf{e}_h) n^f}$$

Note that:

$$(2 - \gamma \mathbf{e}'_f \Delta_f^{-1} \mathbf{e}_f - \gamma \mathbf{e}'_f \mathbf{W}_f^{-1} \mathbf{e}_f) = (1 - \gamma \mathbf{e}'_f \Delta_f^{-1} \mathbf{e}_f) + (1 - \gamma \mathbf{e}'_f \mathbf{W}_f^{-1} \mathbf{e}_f)$$

To sign $\frac{\partial \mathbf{q}^h(G^h, G^f)}{\partial (\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h)}$, note that the expression in the first round parentheses on the right is positive (proof is omitted):

$$(1 - \gamma \mathbf{e}'_c \Delta_c^{-1} \mathbf{e}_c) > 0$$

for $c = h$ or $c = f$, and that:

$$(1 - \gamma \mathbf{e}'_f \mathbf{W}_f^{-1} \mathbf{e}_f) = \frac{2(1-\gamma) + \gamma (1 - \gamma \mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h) n^f}{2(1-\gamma) + \gamma (2 - \gamma \mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h) n^f} > 0$$

Hence $\frac{\partial \mathbf{q}^h(G^h, G^f)}{\partial (\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h)} < 0$. Similarly we can sign $\frac{\partial \mathbf{q}^f(G^h, G^f)}{\partial (\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h)} > 0$.

6.11.2 Step 2

From 15 we can derive that equilibrium taxes must satisfy:

$$\mathbf{t}^h(G^h, G^f) = [\boldsymbol{\alpha}_h - \gamma \mathbf{1}^{hf} \mathbf{q}^f(G^h, G^f) - \Delta_h \mathbf{q}^h(G^h, G^f)]$$

$$\mathbf{t}^f(G^h, G^f) = [\boldsymbol{\alpha}_f - \gamma \mathbf{1}^{fh} \mathbf{q}^h(G^h, G^f) - \Delta_f \mathbf{q}^f(G^h, G^f)]$$

From 17 we can derive that:

$$\boldsymbol{\alpha}_f - \gamma \mathbf{1}^{fh} \mathbf{q}^h(G^h, G^f) = \mathbf{W}_f \mathbf{q}^f(G^h, G^f)$$

And replacing in the expression for $\mathbf{t}^f(G^h, G^f)$:

$$\mathbf{t}^f(G^h, G^f) = [\mathbf{W}_f - \Delta_f] \mathbf{q}^f(G^h, G^f)$$

$$= -\gamma [\gamma (\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h) \mathbf{1}^{ff} + \boldsymbol{\Omega}_f - \mathbf{1}^{ff}] \mathbf{q}^f(G^h, G^f)$$

If the foreign country market structure is of the national champion type ($\Omega_f = \mathbf{1}^{ff}$), then $\mathbf{t}^f(G^h, G^f) = -\gamma^2 \left(\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h \right) \mathbf{1}^{ff} \mathbf{q}_f(\Omega_h, \Omega_f) < \mathbf{0}$, so that country f subsidizes its firms. If market structure for the foreign country is not of the national champion type, the subsidies could be negative (taxes) because a country does not want to create competition between its firms. It is easy to prove that, given any foreign country's market structure, a move to monopoly ($\Omega_f = \mathbf{1}^{ff}$) always increases foreign subsidies.

Note that the foreign taxes depend on Ω_h only through the scalar $\left(\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h \right)$ (see 17).

$$\begin{aligned}
\frac{1}{\gamma} \frac{\partial \mathbf{t}^f(G^h, G^f)}{\partial (\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h)} &= -\gamma \mathbf{1}^{ff} \mathbf{q}_f(G^h, G^f) - \left[\gamma \left(\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h \right) \mathbf{1}^{ff} + \Omega_f - \mathbf{1}^{ff} \right] \frac{\partial \mathbf{q}_f(G^h, G^f)}{\partial (\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h)} \\
&= -\gamma \left\{ \mathbf{I}_f + \gamma \frac{\left[\gamma \left(\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h \right) \mathbf{1}^{ff} + \Omega_f - \mathbf{1}^{ff} \right]}{2(1-\gamma) + \gamma \left(2 - \gamma \mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h - \gamma \mathbf{e}'_h \mathbf{W}_h^{-1} \mathbf{e}_h \right) n^f} \right\} \mathbf{1}^{ff} \mathbf{q}_f(G^h, G^f) \\
&= -\gamma \left\{ \mathbf{e}_f + \gamma \frac{\left[\gamma \left(\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h \right) \mathbf{e}_f \mathbf{e}'_f - \left(\mathbf{e}_f \mathbf{e}'_f - \Omega_f \right) \right]}{2(1-\gamma) + \gamma \left(2 - \gamma \mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h - \gamma \mathbf{e}'_h \mathbf{W}_h^{-1} \mathbf{e}_h \right) n^f} \right\} \mathbf{e}'_f \mathbf{q}_f(G^h, G^f) \\
&= -\gamma \left\{ \mathbf{e}_f + \gamma \frac{\left[n^f \gamma \left(\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h \right) \mathbf{e}_f - n^f \mathbf{e}_f + \Omega_f \mathbf{e}_f \right]}{2(1-\gamma) + \gamma \left(2 - \gamma \mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h - \gamma \mathbf{e}'_h \mathbf{W}_h^{-1} \mathbf{e}_h \right) n^f} \right\} \mathbf{e}'_f \mathbf{q}_f(G^h, G^f)
\end{aligned}$$

Where we used the fact that $\mathbf{1}^{ff} = \mathbf{e}_f \mathbf{e}'_f$. The i 's element of this vector has opposite sign of:

$$1 + \gamma \frac{\left[n^f \gamma \left(\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h \right) - n^f + n^p \right]}{2(1-\gamma) + \gamma \left(2 - \gamma \mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h - \gamma \mathbf{e}'_h \mathbf{W}_h^{-1} \mathbf{e}_h \right) n^f}$$

Where n^p is the number of products owned by the firm owning good i . This quantity is positive if:

$$\begin{aligned}
&2(1-\gamma) + \gamma \left(2 - \gamma \left(\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h \right) - \gamma \mathbf{e}'_h \mathbf{W}_h^{-1} \mathbf{e}_h \right) n^f + \gamma \left[n^f \gamma \left(\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h \right) - n^f + n^p \right] = \\
&= 2(1-\gamma) + \gamma \left(1 - \gamma \mathbf{e}'_h \mathbf{W}_h^{-1} \mathbf{e}_h \right) n^f + \gamma n^p > 0
\end{aligned}$$

We noted before that $\left(1 - \gamma \mathbf{e}'_f \mathbf{W}_f^{-1} \mathbf{e}_f \right) > 0$. This proves that:

$$\frac{\partial \mathbf{t}^f(G^h, G^f)}{\partial (\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h)} < \mathbf{0}$$

If country h chooses a less competitive market structure, $\left(\mathbf{e}'_h \Delta_h^{-1} \mathbf{e}_h \right)$ decreases. A less competitive home market structure induces lower foreign equilibrium subsidies (higher taxes) in the second stage of the game.

6.12 Proof of Theorem (6)

We want to prove that $\left(\frac{\partial \Pi^h}{\partial \mathbf{q}^f} \frac{\partial \mathbf{q}^f}{\partial \mathbf{t}^f}\right) > \mathbf{0}$. It is easy to show that:

- $\frac{\partial \Pi^h}{\partial \mathbf{q}^f} = -\gamma \mathbf{q}^h(G^h, G^f) \mathbf{1}^{hf} < \mathbf{0}$.
- $\frac{\partial \mathbf{q}^f}{\partial \mathbf{t}^f} = -\Delta_f^{-1}$.

So that:

$$\left(\frac{\partial \Pi^h}{\partial \mathbf{q}^f} \frac{\partial \mathbf{q}^f}{\partial \mathbf{t}^f}\right) = \gamma \mathbf{q}^h(G^h, G^f) \mathbf{1}^{hf} \Delta_f^{-1}$$

It is sufficient to show that $\mathbf{1}^{hf} \Delta_f^{-1} > \mathbf{0}$. Remember that:

$$\Delta_f = 2(1 - \gamma) \mathbf{I}_f + \gamma \Omega_f + \gamma \mathbf{1}^{ff}$$

It is sufficient to show that $\Delta_f^{-1} \mathbf{e}_f > \mathbf{0}$. Define $\Delta_f^{-1} \mathbf{e}_f = \mathbf{x} \implies \Delta_f \mathbf{x} = \mathbf{e}_f$. Row i of the previous equation is: $2(1 - \gamma)x_i + \gamma \sum_{j \in \mathcal{F}_i} x_j + \gamma \sum_{j=1}^{n^f} x_j = 1$, where \mathcal{F}_i is the set of products produced by the same firm producing product i (including product i). First, note that it must be that $\sum_{j=1}^{n^f} x_j > 0$. If not, there would be a product i for which $\sum_{j \in \mathcal{F}_i} x_j < 0$ and $x_i < 0$, so that $2(1 - \gamma)x_i + \gamma \sum_{j \in \mathcal{F}_i} x_j + \gamma \sum_{j=1}^{n^f} x_j = 1$ could not be one. Besides it is clear that, for two goods i and k belonging to the same group, it must be that $x_i = x_k$ (just subtract the lines corresponding to the two products, to obtain $2(1 - \gamma)x_i = 2(1 - \gamma)x_k$). We can rewrite the equation for a given group p as: $[2(1 - \gamma) + \gamma n^p]x_p + \gamma \sum_{j=1}^{n^f} x_j = 1$, where n^p is the number of goods in product p and x_p is the common value of x for all goods in group p . Consider two groups, p and q , and subtract the two equations. We have: $[2(1 - \gamma) + \gamma n_p]x_p = [2(1 - \gamma) + \gamma n_q]x_q$ so that all x_i must have the same sign and as their sum must be positive they must all be positive.

6.13 Proof of Theorem (7)

The profit to the exporter for each product in the country c is:

$$(p_i^c - t_i^c)q_i^c = \left(\alpha_i - q_i - \gamma \sum_{j \neq i} q_j - t_i^h \right) q_i^h \quad (19)$$

The exporter chooses quantity by taking into account the cross effect among all goods she owns. From the first order condition we can easily derive:

$$(p_i^c - t_i^c) = (1 - \gamma)q_i^c + \gamma \sum_{j \in \mathcal{F}_i} q_j^c$$

where \mathcal{F}_i is the set of products produced by the same firm producing product i (including product i). Replacing in 19:

$$(p_i^c - t_i^c)q_i^c = \left[(1 - \gamma)q_i^c + \gamma \sum_{j \in \mathcal{F}_i} q_j^c \right] q_i^c$$

From the proof of Lemma 6 we know that a merger in country c increases the quantity of all country c 's goods and decreases the quantity of all country $-c$'s goods. Given the previous expression (remember that $(1 - \gamma) > 0$), this proves the theorem.

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