Essays on Multinational Firms: Strategic Trade Policy, Exporting and Productivity

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ABSTRACT

Chapter 1 explores the possibility of strategic use of antidumping duties by multinational firms. There is evidence that the subsidiaries of some multinational firms file antidumping protection from their own parents or remain inactive during the investigation period while other firms pursue protection. Using a duopoly model, I analyze this phenomenon in a two-stage capacity-constrained price competition framework. I find that in most cases, the foreign multinational corporations benefit from the antidumping duties on themselves, which deter them from exporting, thus, reduce competition in the foreign market. In some cases, the outcome is ambiguous and is determined by the costs of exporting as well as the capacity decisions of the firms.

Chapter 2 studies strategic import policy in a model of capacity-constrained price competition. I consider an environment of two firms, a domestic firm and a foreign

multinational firm, both producing in the domestic country. The multinational firm is able to support its local production with exports from its parent plant. Imposition of a tariff by the domestic government improves the profits of the domestic firm as in standard models of strategic trade policy, confirming the profit-shifting effects of protectionist policies. However, when initial trade costs are low enough, the multinational firm also benefits from the tariff imposition, making the net change in total domestic welfare negative. When trade is costly and the degree of differentiation between firms' products is high enough, the gain in the domestic firm's profits outweighs the loss in the consumer surplus, resulting in a net welfare gain for the domestic country.

Chapter 3 adds to the empirical evidence on the direction of causality between exporting and firm performance by using firm-level data from Indian manufacturing firms. Recent empirical studies have documented the superior characteristics of exporting firms relative to non-exporters using micro-level data. There are two main hypotheses proposed to explain this gap. According to the self-selection hypothesis, it is the better firms that become exporters as these firms have a greater chance of covering the high fixed costs of serving foreign markets. The learning-by-exporting hypothesis suggests that entering export markets can result in post-entry productivity improvements. I find clear evidence on self-selection. To test the learning-by-exporting hypothesis, I use propensity score matching. Although the results indicate that there some benefits to exporting firms in the form of higher sales and capital, I do not detect any major further productivity improvements following entry into export markets.

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Introduction

Strategic import policy changes the strategic relationship between domestic and foreign firms and introduces additional motives for the policy-makers, over and above terms of trade and other effects that arise in perfect competition. The key point is that import policies such as tariffs, quotas, etc. raise the import costs, limit quantities, and thus distort the optimal choices of the exporting firms.

Although most of the studies in this literature have shed light on the profit-shifting (from foreign firms to domestic firms) motives of these policy tools, some studies have also shown that protection may also be beneficial to the foreign firms. For example, Krishna (1989) shows that under duopolistic price competition, a voluntary export restraint on the foreign firm improves the profits for both the domestic firm and the foreign firm. An equivalent import tariff, however, does not have the same impact on the foreign firm. The first two chapters of my dissertation focus on this possibility that foreign firms can also benefit from trade protection.

Chapter 1 studies how the imposition of a common antidumping duty by the home government will affect the profits of two foreign multinational firms competing in the home market. Different than the standard third-market models, I assume that the multinational firms can produce locally in the home market at their local subsidiaries in addition to exporting to the home market. The antidumping duties on the multinational firms' exports are brought on by their local subsidiaries. As controversial as this assumption might sound, this chapter can actually be seen as a theoretical reconciliation of an observed firm behavior. Because, in reality, we observe cases in which the subsidiaries file for protection from their own parents or remain inactive while other domestic firms pursue protection.

I find that in most cases, it is profitable for the multinational firms have the antidumping duties imposed on them. The sole effect of the antidumping duties in this case is to deter both firms from exporting and reduce competition in the domestic market. For some cases, the results are ambiguous and depend on the degree of asymmetry between firms' export costs.

The second chapter studies a standard import policy model where a foreign multinational firm competes with a domestic firm in the domestic country and the domestic government imposes a tariff on the multinational firm's exports. Similar to the first chapter, the multinational firm can serve the domestic markets via local production and exports simultaneously. Thus, this chapter fills a gap in the literature by studying the welfare implications of a strategic import policy tool (specific tariff) for the domestic country in the presence of a flexible foreign multinational firm. For a certain range of export costs, the results confirm the common findings in this literature. That is, the tariff imposition hurts the multinational firm by shifting the profits from the multinational firm to the domestic firm. However, for a range of export costs, the multinational firm also benefits from the tariff. The presence of local production is crucial for this result. Due to this flexibility of production, the multinational firm can avoid the cost of the tariff (fully in the present model) but still benefit from the price increases caused by the tariff. There is a net loss in the domestic national welfare in this case. When the tariff acts as a profit-shifting device, the implications of the tariff for the total domestic welfare depend on the initial costs of exporting as well as the degree of differentiation of the products of the domestic and the multinational firm.

The third chapter empirically examines the relationship between exporting and economic performance using firm-level panel data. The two alternative but not mutually exclusive hypotheses that attempt to address the causality between exporting and productivity are self-selection and learning-by-exporting. According to the former argument, only more productive firms that can afford paying for the high entry costs associated with export markets can enter export markets. The learning hypothesis mainly suggests that increased competition in foreign markets, interaction with foreign customers who demand higher product quality and better service force exporting firms to become more efficient, increase innovation, and enhance their productivity.

I test these two main hypotheses by using a firm-level panel data set from India. The results for self-selection confirm the robust findings in this literature. Firms that engage in foreign competition perform are already more productive and cost efficient than their domestic competitors years before they enter export markets. They pay higher wages and produce more output.

The evidence on learning is very weak for the exporting firms. An initial comparison of the changes in characteristics of exporters and non-exporters during the post-entry period suggests that the exporting firms seem to benefit from the export markets. However, the use of all non-exporting firms as a comparison group for exporting firms might bias the estimations in that the exporting firms have already the better performance characteristics than non-exporting firms before entering export market. To address this issue, I employ propensity score matching, which helps to identify non-exporting firms that are similar to the exporting firms during the pre-entry period. The results of this suggest that exporting firms do not experience any significant productivity gains (only during the first year after entry, if at all) compared to non-exporting firms. The exporting firms experience greater growth in capital accumulation and sales relative to the domestic firms. However, this could merely be due market expansion. Therefore, I have found very weak evidence for learning effects of exporting for Indian manufacturing firms.

Chapter 1: Antidumping and Self-protection of Multinational Firms

1. Introduction

The endogenous nature of antidumping duties ("AD") has led many researchers to focus on them as a strategic competition tool employed by the import-competing firms rather than a trade policy tool of a country.[1,2] Blonigen and Prusa (2001) note: "…all but AD's staunchest supporters agree that AD has nothing to do with keeping trade fair. AD has nothing to do with moral right or wrong, it is simply another tool to improve the competitive position of the complainant against other companies…"

Keeping firm behavior as the center of attention, some authors analyzed how the strategic use of ADs might lead to collusion in imperfectly competitive markets.[3] Among these studies, Davies and Liebman (2003) is the only one which considers the possibility that one (or more) of the protection-filing domestic firms could be the subsidiary(s) of the exporting firm(s). Given the endogenous nature of filing, legal decision and manipulability of the outcome, this assumption may change things considerably.

[1] Messerlin and Reed (1995): "...the convergence of the United States and the Community in their AD measures is much less the consequence of an upsurge in the practice of dumping than of a 'protection engineering process'... We should think in terms of the strategies of firms rather than of countries. There is no doubt that similar regulations, leading to similar outcomes, allow global firms to master the AD procedures of many countries…"

[2] In an empirical study, Moore (2004) finds that domestic firms requesting the continuation of antidumping orders come from industries with low concentration ratios but current healthy profits. He suggests that firms in highly competitive markets may be using the antidumping process to prop up artificially-high profits.

[3] See Prusa (1992), Veugelers and Vandenbussche (1999), Zanardi (2004).

Although it may seem more natural to think that the subsidiaries of foreign multinational corporations ("MNC"s) would try to weaken the efforts of other domestic firms to impose ADs on their parent firms, in reality, we observe cases in which the subsidiaries file for protection from their own parents or remain inactive while other domestic firms pursue protection.[4]

In this paper, I address the more intriguing latter case. I use the capacity-constrained price competition framework developed in Maggi (1996). In a duopoly framework where the multinational firms can serve a foreign market through their local plants (subsidiaries) and exports from their domestic plants, I show that the subsidiaries may benefit from filing ADs against their own parents and improve their competitive positions in the foreign market under certain circumstances.[5] The competition takes place in two stages. In the first stage, the multinational firms decide how much to invest in the foreign market, that is, they choose the capacities of their subsidiaries. In the second-stage, after the capacity decisions are revealed to both firms, they simultaneously choose prices and produce to satisfy demand. The subsidiaries produce at a constant marginal cost and their parents can increase the local sales by exporting from their domestic plants.

I study how the imposition of a common AD by the home government will affect the profits of the MNCs in the foreign market by doing a comparative-statics exercise on the equilibria of the full game. I find that the impact of the tariff is very sensitive to how

[4] Some of these cases are discussed in section 2. See Davies and Liebman (2003) for a more extensive background.

[5] Lommerud and Sørgard (2001) develop a model in which two firms collude by serving in only their domestic markets and not exporting into each other's markets. Besides the motivational and structural differences, the abstention from exporting in their model is due to a reduction in trade barriers under price competition. Under quantity competition, this conclusion is reversed.

flexible firms are (flexibility of production is determined by the magnitude of the export costs) as well as the degree of asymmetry if the firms have different export costs. I find that in most cases, it is profitable for the MNCs to have ADs imposed on them. It is important to note that the underlying incentive for the MNCs to want trade barriers cannot be explained by "protection-building trade" argument of Blonigen and Ohlo (1998). In their model, a foreign firm supports the domestic government to impose tariffs on itself and its rivals so that it can tariff-jump and do foreign direct investment (FDI) in the targeted market while the rivals with insufficient capabilities cannot. In the present model, both of the firms are MNCs and have already done FDI. The sole effect of the ADs in this case is to deter both firms from exporting and reduce competition in the domestic market.

The remainder of the paper is structured as follows. Section 2 discusses the literature on protection and collusion in general comparing it to the present approach and provides more motivation for the current analysis. Section 3 presents the capacity-constrained price competition model for symmetric firms developed by Maggi (1996). I extend the model to allow firms to have asymmetric costs in section 4. Section 5 examines the effects of a small common AD imposition on the equilibrium structure of the model for the symmetric and asymmetric cases. Section 6 concludes.

2. Trade Protection and Collusion

Trade protection policies such as tariffs, quotas, etc. raise the import costs, limit quantities, and thus distort the optimal choices of the exporting firms. In Brander and

Spencer (1982), and Dixit (1983), for example, tariffs have profit shifting effects for the domestic firms at the expense of the exporters. The traditional view has evolved over the last decades and economists have explored different channels through which trade protection influences strategic behavior of firms in imperfectly competitive markets. Taking into account the strategic nature of competition, some researchers have shown that protection may also be beneficial to the exporting firms. Krishna (1989) shows that under duopolistic price competition, a voluntary export restraint ("VER") on the foreign firm improves the profits for both the domestic firm and the foreign firm. An equivalent import tariff, however, does not have the same impact on the foreign firm. Thus, while a quantity restriction acts as a "facilitating practice" and leads to a less aggressive behavior, a price restriction does not.[6]

Other authors have analyzed the possibility of collusion within the antidumping (AD) legislation. Veugelers and Vandenbussche (1999) investigate how AD legislation affects firm preferences over collusive structures with a model of two domestic firms and a foreign firm. They find that introducing AD can lead to a full cartel between all three firms, cooperation only between domestic firms, or no cooperation depending on the degree of product heterogeneity and cost asymmetry between foreign and domestic firms.

Prusa (1992) and Zanardi (2004) offer models on withdrawal of AD petitions. Prusa (1992) develops an oligopolistic price competition model and shows that the threat of an AD duty induces the domestic and foreign firms to bargain over price-fixing

[6] The term "facilitating practice" was first used in Krishna (1989). Krishna (1989) shows that under price competition, a voluntary export restraint on the foreign firm improves the profits of both the domestic firm and the foreign firm, helping the firms to achieve a favorable outcome they would otherwise not be able to.

arrangements. With all the petitions withdrawn, they show that the firms could reach an agreement, which improves the profits of all firms. Zanardi (2004), on the other hand, shows that only some of the petitions are drawn, thus AD duties may be used in equilibrium. In their model, the optimal choice of withdrawing a petition or not depends on coordination cost and bargaining power of the foreign and domestic firms, and collusion fails to exist under the imposition of duties.

Although these papers follow different approaches, one common feature they have is that the foreign firm is a pure exporter. Davies and Liebman (2003) analyze the possibility of collusion allowing the foreign exporter to be an MNC, that is, one of the domestic firms to be a foreign subsidiary. This assumption may alter some of the conclusions of the previous studies. The verdict of an AD case can be influenced by the involved parties. The continuation of ADs requires at least one-fourth of the domestic industry to seek protection and at least one half of the domestic industry must not oppose the petition. If the foreign subsidiaries decide to participate in the investigation to support their exporting parents; the chances of the continuation of the ADs will be diminished.[7]

Interestingly, Davies and Liebman (2003) finds cases in which the subsidiaries of foreign firms have filed protection from their own parents or did not participate in the investigation, thus, making the continuation of the ADs more feasible. For example, in the AD case for antifriction bearings imports from Europe and Asia, many of the targeted foreign firms were affiliated with US producers. Similarly, in the ball bearings industry,

[7] Davies and Liebman (2003): "The ITC considers whether domestic producers are related parties of foreign subsidiaries and may choose to exclude these firms when it records testimony and analyzes the domestic industry. In most cases, however, purely domestic firms do not argue for the exclusion of foreign subsidiaries, and the ITC rarely exercises its discretion to separate such subsidiaries when it considers the domestic industry."

most or all of the German, Italian, Japanese and Singaporean exporters under investigation had U.S. affiliates. The antidumping orders were continued for all countries but Sweden and Romania, which had fewer U.S. subsidiaries than the others.[8]

Davies and Liebman (2003) uses a dynamic game in quantities with trigger strategies, and show that the AD imposition leads to an expansion of possible collusive outcomes, some of which could potentially enhance the profits of both the domestic firm and the MNC.

In this paper, I consider the possibility that successful lobbying of subsidiaries for protection from the parent firms enhances the profits of the multinational firms. Different than the aforementioned studies, I use a non-cooperative competition framework (i.e. no collusion).[9] The competition takes in a purely global foreign market, that is, all the domestic firms are affiliates of foreign exporters.[10] This is obviously the case with many markets (e.g. pharmaceuticals) and is becoming a likely scenario around the world, given the increasing dominance of big global firms.

3. The Model – Symmetric firms

Consider two symmetric multinational firms investing in a third country. Both firms have local plants that produce two (symmetrically) differentiated products at a common

[8] See Davies and Liebman (2003) for details and discussion of other similar cases.
[9] My methodology can be seen most similar to Krishna (1989)'s in that she also investigates how trade protection affects Nash equilibrium in a non-cooperative framework. The other papers mentioned in this section assume bargaining between the firms, and consider how a tariff imposition affects the set of collusive outcomes. They do not say that one of these collusive outcomes will actually occur.
[10] Richardson (2004) analyzes the possibility of third-party antidumping (the case in which a firm files protection in a foreign market against third-party dumpers) discussing a recent case in New Zealand and offers explanations for why the domestic government would sometimes welcome such attempts.

marginal cost c up to the capacity level. They both have the capability to increase sales in the foreign market through exports. The export cost θ reflects the additional marginal cost of providing an additional unit beyond capacity, that is, the marginal cost of each unit sold in the foreign market beyond capacity is $c+\theta$.[11] The demand is linear for each product:

$$q_i = D(p_i, p_{-i}) = a - b_1 p_i + b_2 p_{-i},\ i = 1,2 \text{ and } b_1 > b_2 > 0.^{12} \tag{1}$$

The short-run total cost for firm i is

$$TC = \begin{cases} cq_i & \text{for } q_i \le k_i \\ cq_i + \theta_i (q_i - k_i) & \text{for } q_i > k_i \end{cases} \tag{2}$$

The unit cost of capacity (c_0) is constant. The standard assumption $c_0 < \theta$ guarantees that the firm has an incentive to build capacity. Thus, the long-run marginal cost is $c + c_0$. The game has two stages. In the first stage, the firms simultaneously choose capacities. In the second stage, after the capacity decisions are revealed to both firms, they simultaneously choose prices and produce to satisfy demand. The game can be solved by backward induction.

3.1. The Second Stage: Price Subgame

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[11] The implicit assumption is that the MNCs are not constrained by capacity in their domestic plants and can produce at a constant marginal cost c.
[12] This condition indicates that the goods are substitutes and strategic complements, and own price effects dominate cross price effects in demand.

Taking the capacities as given, each firm chooses its optimal price, thus, the equilibria of the price subgame are given by the intersection of the subgame reaction functions. The key functions used to derive the subgame reaction function are the Bertrand reaction function and the isoquantity curve. Bertrand reaction function for firm i is the solution to $\arg\max_p (p-x)D(p, p_{-i})$ given constant marginal cost x and is denoted by $r^i(p_{-i};x)$. The price combinations such that the demand for firm i is constant at k_i are represented by $p_i = \Phi^i(p_{-i};k_i)$, that is, $\Phi^i(p_{-i};k_i)$ is an isoquantity curve. The bold line in figure 1 shows the reaction function $R^i(p_{-i};k_i)$ of the price subgame for firm i. This can be explained as follows. When its rival's price is low, firm i can either produce at capacity and choose a price on its isoquantity curve $\Phi^i(p_{-i};k_i)$ or it can produce less than its capacity and choose a price on its Bertrand reaction curve $r^i(p_{-i};c)$. In figure 2, which demonstrates the short run marginal cost and the residual marginal revenue curve ($MR_i^r(q_i, p_{-i})$) for firm i, the capacities in these two scenarios correspond to k_i^B and k_i^A, respectively. Producing at capacity and charging a price on its isoquantity curve is not optimal for firm i in this case because, given the low price of its rival firm, firm i has an incentive to raise its price and not fully utilize its capacity. The best response of firm i in this case is given by its Bertrand price (lower bold segment in figure 1.) Similarly, when its rival is charging a high price, firm i benefits from cutting its price and produce more than its capacity level. Thus, the upper bold segment in figure 1 is part of the best response function for firm i and the corresponding capacity choice is k_i^C.

When rival's price is at an intermediate level, firm i's residual marginal revenue curve intersects its marginal cost at the vertical segment in figure 2 and the firm chooses to produce at capacity. This is true for a range of its rival's prices and firm i is more aggressive compared to the other two scenarios (i.e., the isoquantity curve has a smaller slope than the Bertrand reaction functions). The equilibrium is given by the intersection of the subgame reaction functions of the two firms. One nice characteristic of this pure-strategy equilibrium is that it is unique, that is, for any pair of capacities, the two subgame reaction functions intersect only once. The profit functions are continuous and quasi-concave.[13]

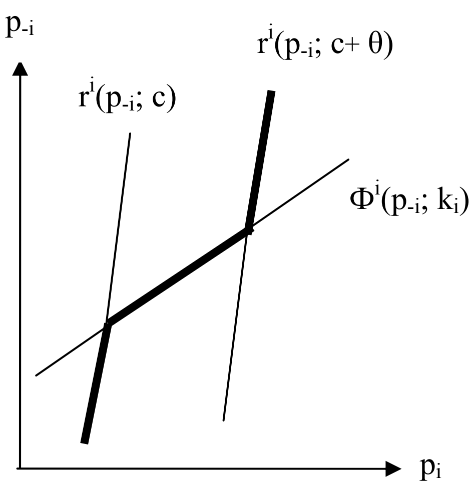

Figure 1
Subgame reaction function

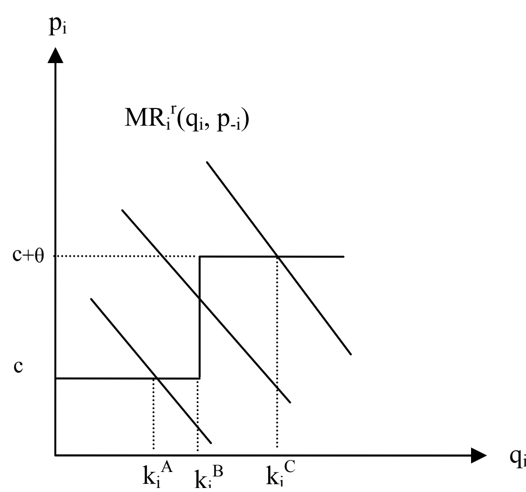

Figure 2

[13] In Krishna (1989), the game does not admit pure-strategy equilibrium in the presence of a VER. The VER acts like a capacity constraint on the foreign firm. This leads to rationing of the foreign firm's product and discontinuity in the home firm's reaction function. With the assumptions of differentiated goods and rigid capacities, Friedman (1988) shows that if the degree of product differentiation dominates the size of the demand spillover caused by rationing consumers, the quasi-concavity of profit functions is preserved, thus, the price game may admit pure-strategy equilibria.

3.2. The First Stage

In equilibrium, each firm produces builds its capacity to satisfy the demand, that is, $k_i = D(p^*_i, p^*_{-i})$ for $i = 1,2$ where (p^*_i, p^*_{-i}) is the optimal price pair chosen in the second stage. Thus, the equilibrium price pair lies on the segment of the isoquantity curve of firm i between the two Bertrand reaction functions. (the middle branch in figure 1) This result can be explained by figure 2. The initial capacity level is denoted by k_i^B. If firm i's residual marginal revenue curve intersects its marginal cost curve at the lowest horizontal segment ($MC = c$), then the capacity is not fully utilized. This case corresponds to the lower bold segment in the subgame reaction function in figure 1 where firm i's price given by the Bertrand reaction function $r^i(p_{-i};c)$ is higher than its price when it produces at capacity. Firm i can reduce its capacity level to k_i^A without affecting the equilibrium prices and incur lower costs. Similarly, the case in which firm i produces above the capacity limit ($MC = c + \theta$) corresponds to the upper bold segment in the subgame reaction function in figure 1. In this case, firm i can increase its capacity level to k_i^C and save costs since producing within capacity is less expensive than exporting.

3.3. The Equilibria of the Full Game

Let $\{p^b(x), q^b(x)\}$ and $\{p^c(x), q^c(x)\}$ denote the Bertrand and Cournot price-quantity pairs for a constant marginal cost x, respectively. The long-run marginal cost is $c + c_0$, thus, the Bertrand benchmark $p^b(c+c_0)$ is given by the intersection of the Bertrand reaction functions $r^1(p_2;c+c_0)$ and $r^2(p_1;c+c_0)$. The Cournot benchmark can be identified by introducing a new curve: $C^i(p_{-i};c+c_0)$. Let firm i maximize its profits by choosing the optimal price pair taking its rival's quantity as fixed at its capacity. Thus, firm i chooses the tangency point between its highest isoprofit curve and rival's isoquantity curve $\Phi^{-i}(p_i;k_{-i})$. As the rival's capacity k_{-i} changes, connecting these tangency points trace the curve $C^i(p_{-i};c+c_0)$ in the price space.

The intersection of $C^i(p_{-i};c+c_0)$ and $C^{-i}(p_i;c+c_0)$ defines the Cournot benchmark $p^c(c+c_0)$, the point at which each firm's isoprofit function is tangent to its rival's isoquantity.

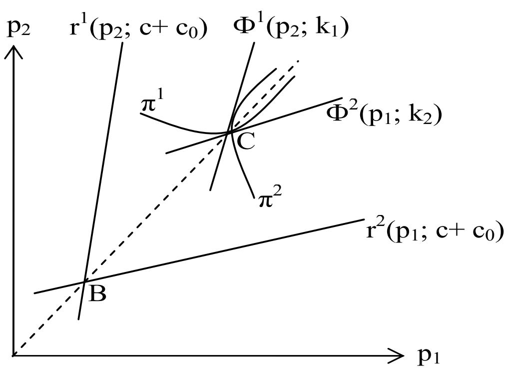

Figure 3
Bertrand and Cournot Benchmarks

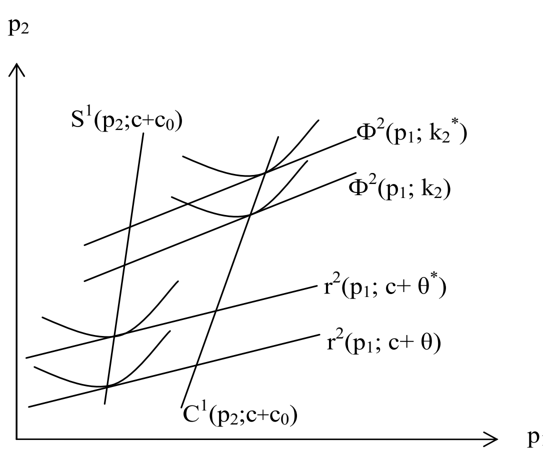

Figure 4
The curves $C^1(.)$and $S^1(.)$

These benchmark points are shown in figure 3. Another curve that needs to be defined to identify the equilibria of the full game is $S^i(p_{-i};c+c_0)$. The points of tangencies between firm i's highest isoprofit curve and $r^{-i}(p_i;c+\theta)$ as θ changes trace the curve $S^i(p_{-i};c+c_0)$ in the price space. The curves $C^1(p_2;c+c_0)$ and $S^1(p_2;c+c_0)$ are shown in figure 4.

The nature of the equilibria of the model is sensitive to the value of θ. θ has three critical values: θ_S, θ_V and θ_C. The ordering between these parameters are as follows by definition: $\theta_C > \theta_V > \theta_S$. θ_C is the value of θ for which the Bertrand price $p^b(c+\theta)$ is equal to the Cournot price $p^c(c+c_0)$. For lower values of θ, the Cournot price exceeds the Bertrand price. The value of θ for which $r^{-i}(p_i;c+\theta)$ crosses the diagonal at the same point as $S^i(p_{-i};c+c_0)$ does is denoted by θ_S, $i=1,2$. For $\theta > \theta_S$, the intersection point of $S^1(p_2;c+c_0)$ and $S^2(p_1;c+c_0)$ on the diagonal is lower than the Bertrand price $p^b(c+\theta)$. Finally, θ_V is the value of θ for which $C^i(p_{-i};c+c_0)$ passes through the point of intersection between $S^{-i}(p_i;c+c_0)$ and $r^i(p_{-i};c+\theta)$, $i=1,2$. Thus, for $\theta > \theta_V$, $C^i(p_{-i};c+c_0)$ intersects $S^{-i}(p_i;c+c_0)$ at a lower point than $r^i(p_{-i};c+\theta)$ does, $i=1,2$.

As explained in the previous section, each firm produces at its capacity $(q_i = k_i)$ in equilibrium, thus, the long-run profit function (isoprofit) of firm i can be rewritten as $\pi_i = (p_i - c - c_0)D(p_i, p_{-i})$, $i=1,2$. Firm i chooses the optimal price pair to maximize its profits given k_{-i} subject to two constraints. The first one requires that the optimal price pair that it chooses lies on the price reaction function $R^{-i}(p_{-i};k_{-i})$ of the rival firm. The second one is that the price pair should lie in the band between $r^i(p_{-i};c)$ and

$r^i(p_{-i};c+\theta)$. (see figure 1) These can be seen as IC constraints. Formally, firm i's maximization problem is as follows:

$$Max_{p_i,p_{-i}}(p_i - c - c_0)D(p_i, p_{-i}) \text{ s.t.}$$

$$(1) \quad p_{-i} = R^{-i}(p_{-i};k_{-i}) \qquad (2) \quad r^i(p_{-i};c) \le p_i \le r^i(p_{-i};c+\theta)$$

Then, the optimal capacity choice of firm i is given by the demand for firm i evaluated at this optimal price pair, that is, $k_i = D(p_i(k_{-i}), p_{-i}(k_{-i}))$. For symmetric firms, Maggi (1996) shows that the symmetric equilibrium of the subgame is unique and entails

$$\begin{cases} p^b(c+\theta) & \text{if } c_0 \le \theta < \theta_C \\ p^c(c+c_0) & \text{if } \theta \ge \theta_C \end{cases} \qquad \begin{cases} q^b(c+\theta) & \text{if } c_0 \le \theta < \theta_C \\ q^c(c+c_0) & \text{if } \theta \ge \theta_C \end{cases}$$

$$k = D(p,p) \text{ and } \pi = (p - c - c_0)k$$

For a certain parameter range $(\theta_S < \theta \le \theta_V)$, the game has robust asymmetric equilibria as well. The proofs regarding the equilibria of the full game are discussed in section A of the Appendix.

4. The Extended Model - Asymmetric firms

In this section, I introduce asymmetry between the export costs of the firms. All the proofs are presented in section B of the Appendix. Assume one of the multinational firms, namely firm 2, has a proximity advantage, thus it is cheaper for it to export goods from its home plant, if necessary $(\theta_1 > \theta_2)$. I study the equilibria of the full game for three different cases: flexible firms, moderately flexible firms, and inflexible firms.[14]

Case 1: Flexible firms – $\theta_S > \theta_1 > \theta_2$

For low values of θ_1 and θ_2, the capacity constraints are weak, and the firms are relatively flexible, that is, they both could conveniently export from their home plants if they choose to. As shown in Appendix B.1, for this given range of θ_1 and θ_2, the game has a unique (asymmetric) subgame perfect equilibrium and the equilibrium price pair (p_1, p_2) is given by the intersection of the subgame reaction functions $r^1(p_2; c+\theta_1)$ and $r^2(p_1; c+\theta_2)$. The capacity decisions and profits of the firms are given as $k_i = D(p_i, p_{-i})$ and $\pi_i = (p_i - c - c_0)k_i$, $i = 1,2$.

Case 2: Moderately flexible firms – $\theta_V > \theta_1 > \theta_2 > \theta_S$

When both firms have moderately large export costs, the game admits multi-equilibria. As shown in Appendix B.2, the game has three possible (asymmetric) subgame perfect equilibria in this case. The equilibrium price pairs are given by the intersection of the subgame reaction functions $r^1(p_2; c+\theta_1)$ and $r^2(p_1; c+\theta_2)$ and the intersection of

[14] There are more intermediate cases. I left those out since they do not offer any different interesting implications in the comparative-statics exercise than the three cases do. Also, for some cases, the results are ambiguous unless stronger assumptions are made.

$r^i(p_{-i};c+\theta_i)$ and $S^{-i}(p_i;c+c_0)$, $i=1,2$. The capacity decisions and profits of the firms are given as $k_i = D(p_i, p_{-i})$ and $\pi_i = (p_i - c - c_0)k_i$, $i=1,2$.

The outcome of the game is determined by the capacity choices of the firms. Let type i equilibrium be given by the intersection of $S^i(p_{-i};c+c_0)$ and $r^{-i}(p_i;c+\theta_{-i})$ $i=1,2$. Type 3 equilibrium is given by the intersection of $r^1(p_2;c+\theta_1)$ and $r^2(p_1;c+\theta_2)$. Also, let $k_i^{\ j}$ be the equilibrium capacity level for firm i at type j equilibrium. Then, $k_1^{\ 1} > k_1^{\ 3} > k_1^{\ 2}$ and $k_2^{\ 2} > k_2^{\ 3} > k_2^{\ 1}$.[15]

Case 3: Inflexible firms – $\theta_1 > \theta_2 > \theta_C$

When both firms have high export costs, they limit production and raise prices, and Bertrand outcome can no longer be sustained as an equilibrium. As shown in Appendix B.3, the unique subgame perfect equilibrium in this case is given by the Cournot price pair $((p^c(c+c_0), p^c(c+c_0))$. The capacity decisions and profits of the firms are given as $k_i = D(p^c, p^c)$ and $\pi_i = (p^c - c - c_0)k_i$, $i=1,2$.

5. Government Intervention

Suppose that the subsidiaries successfully lobby for AD protection on each other's parents and the home country's government imposes (equal) specific tariffs on both

[15] Each firm has an isoprofit function that passes through the equilibrium point since the firms produce at their capacities in equilibrium. Also, given its rival's price, each firm's price choice on its isoquantity curve depends negatively on its capacity choice. The closed form expression for $\Phi_i(p_{-i}; k_i)$ is $(a+ b_2 p_{-i} – k_i)/ b_1$.

MNCs.[16] Although both subsidiaries choose to produce at capacity in equilibrium and there are no exports by the parent plants, the imposition of a tariff has an impact on the equilibrium structure of the game.[17] The tariff affects the short-run marginal cost function of the firms, thus, it affects the subgame reaction functions, altering the optimal prices chosen by the firms in the second stage.

Throughout this section, I assume that the changes in θ_1 and θ_2 due to tariff imposition are small relative to their initial levels. I analyze the impact of the changes in θ_1 and θ_2 on the equilibria of the game within each interval for the parameters, that is, both parameters stay within the original interval after the tariff imposition. For the cases in which multi-equilibria exist, I study the effects of the tariff for each equilibrium type. The next proposition describes how symmetric firms will be affected by a common tariff imposition on both goods.

Proposition 1: For symmetric firms, when $\theta < \theta_C$ holds, a small common specific tariff increases the profits for both firms. For regions of θ where there are multi-equilibria ($\theta_S < \theta < \theta_V$), this result holds for each equilibrium. When θ is sufficiently high (for $\theta \geq \theta_C$,) the profits are not affected by tariff imposition.

Proposition 1 establishes that unless the export costs are initially very high, symmetric firms would favor the common tariff. When θ is high, the capacity constraints are very

[16] Equal tariff assumption makes it more convenient to keep track of each equilibrium. The model could easily be extended to differentiate between the tariff amounts.
[17] Although the structures of the models are quite different, this can be similar to Krishna (1989)'s finding that a VER has a considerable impact on the equilibrium although it is set at the free trade level of imports.

strong (firms are inflexible), and the equilibrium is given by the Cournot price pair as shown in Appendix A. Since the Cournot price $p^c(c+c_0)$ does not depend on the value of θ, firms would not be affected by the tariff. In this model, the capacity choice is made by the firms in the first stage as a commitment to limit production and charge higher prices in the second stage. The export costs determine how effective this commitment is. In other words, initial levels of export costs determine to what extent these firms could respond to each other's decisions to raise prices and limit capacities. When export costs are high, the firms are initially able to reach a favorable outcome and tariff imposition does not provide an additional incentive to limit production Therefore, the outcome is not influenced by the government intervention. For low values of export costs, this commitment is not very effective and each firm can supply above the capacity limit relatively more easily. The tariff imposition raises the marginal cost of providing an extra unit from the parent plants of each firm and triggers them to raise their prices together, and keep production at low quantities. In other words, the tariff generates extra commitment for both firms and helps them achieve a more profitable outcome.

It might also be interesting to note that for high values of θ, although a tariff imposition is redundant, a policy targeting the production (capacity) costs such as an output (capacity) tax will change the equilibrium prices and capacities. The reason is that an output (capacity) tax will change c (c_0) and alter the equilibrium, which is given by Cournot price $p^c(c+c_0)$ for high values of θ. The next proposition establishes whether asymmetric firms would favor tariff or not when the export costs are low.

Proposition 2: For $\theta_S > \theta_1 > \theta_2$, a small common specific tariff improves the profits of both firms provided that θ_1 stays sufficiently below θ_S after the tariff imposition, that is, $\theta_1 < \theta_S - \Delta$, where Δ is small and positive. If $\theta_1 \approx \theta_S - \Delta$, then a further increase in θ_1 accompanied by an increase in θ_2 results in a decline in firm 1's profits while still improving firm 2's profits.

Proposition 2 suggests that when both firms are flexible enough, a small common tariff will raise their profits for a wide range of θ_1 and θ_2. The intuition is similar to the one in the symmetric case. However, when θ_1 becomes high enough, then the tariff will still be beneficial to the low-θ firm while worsening the profits of the high-θ firm. Although this is true for a very small range, it is important in that it indicates that as the cost of exporting increases, the common tariff starts becoming a conflict of interest. This conflict is more noticeable in the next case.

Proposition 3: For $\theta_V > \theta_1 > \theta_2 > \theta_S$, a small common specific tariff improves the profits of both firms if there is a certain degree of divergence between the capacities of the firms, that is, one firm builds a small capacity while the other one chooses to build a large capacity. If the capacities built by the two firms are somewhat similar in size, then the result is ambiguous and depends on the relative sizes of θ_1 and θ_2. If θ_1 is sufficiently larger than θ_2, then only the low-θ firm benefits from the tariff imposition, or vice versa.

The case in which one firm builds a small capacity and the other one builds a larger capacity corresponds to type 1 and type 2 equilibria (the intersection of $S^i(p_{-i};c+c_0)$ and $r^{-i}(p_i;c+\theta_{-i})$ $i=1,2$.) defined earlier in section 4. In type 3 equilibrium (the intersection of $r^1(p_2;c+\theta_1)$ and $r^2(p_1;c+\theta_2)$), the result is ambiguous and depends on the divergence between the export costs. As shown in the Appendix B.6, for type 1 and type 2 equilibria, only the change in export costs of the low-capacity firm has an impact on the equilibrium outcome for that specific equilibrium type. Thus, the tariff imposition on the high-capacity firm does not influence the profits of either firm for these two types of equilibria.

As stated in proposition 3, with larger export costs in comparison to the previous flexible case, capacity levels play a more significant role in determining the outcome. For equilibrium type 2, for example, the tariff imposition affects only θ_1. This triggers a reaction by firm 2 to also raise its price. Firm 2 clearly benefits from the increase in its rival's marginal cost and price. Surprisingly, firm 1 also benefits from the tariff. It is important to note that firm 1 can avoid the whole tariff by strategically adjusting its capacity in the first stage. Even if this was not the case and firm 1 could not avoid the tariff fully by adjusting its capacity, the increase in its marginal cost due to tariff applies to its output at the margin while the price increase applies to all of its output. The opposite holds for the first type of equilibrium. Therefore, for both of these cases, the tariff brings in additional commitment ability to the low-capacity firm and improves both firms' profits.

When both these firms tend to build relatively similar capacities initially (equilibrium type 3), the tariff imposition creates a conflict of interest between them. In this case, the tariff raises both θ_1 and θ_2. Although both firms benefited from the similar effect on export costs in the former flexible case, the outcome is ambiguous in this case. At this Bertrand equilibrium price pair, firms are more aggressive (higher prices, lower capacities) than they were in the flexible case. Thus, for each firm, raising its own price after tariff imposition may or may not trigger a favorable price increase from the rival firm. If, for example, firm 1's initial export cost θ_1 is considerably high compared to firm 2's export cost θ_2, then, firm 1 has losses from the tariff imposition since it is more sensitive to quantity reduction than firm 2.

It might be interesting to note that for this type of equilibrium where firms build relatively similar capacities, a capacity policy would be redundant while an output policy is perfectly substitutable with a policy targeting export costs. The next proposition describes how the tariff imposition would affect inflexible asymmetric firms.

Proposition 4: For $\theta_1 > \theta_2 > \theta_C$, a small common tariff imposition has no impact on the equilibrium structure of the game. Thus, the profits of both firms remain unchanged.

The intuition is similar as to the one in the symmetric case. When exporting is very costly (capacity constraints are very important), the equilibrium is given by the Cournot price pair $(p^c(c+c_0), p^c(c+c_0))$, which would not be affected by the tariff.

6. Conclusion

This paper addresses the question why some subsidiaries file protection from their own parents or do nothing to prevent other firms' efforts to pursue protection. The possibility that these firms might potentially be abusing AD legislation by lobbying for ADs on themselves through their subsidiaries in order to gain competitiveness in the foreign markets is investigated in a duopoly model.

The multinational firm behavior is modeled as a two-stage capacity-constrained price game in which firms could serve a foreign market via FDI and exports simultaneously. The firms decide on the level of FDI in the first stage (capacities of the subsidiaries) and compete in prices in the second stage. While the capacity decisions are binding for local production, the firms are capable of exporting from their domestic plants, if necessary. Thus, the export costs represent the flexibility level of the firms.

When the export costs are the same, that is, the firms are equally flexible; they would favor a common AD imposition on themselves. They are indifferent if the export costs are too high. The imposition of ADs deters the MNCs from exporting, thus, acts as a commitment device to reduce competition in the foreign market. If the export costs are originally very high, a further increase in them does not provide extra commitment for the firms to limit production. If one of the firms has a proximity advantage, thus, incurs lower export costs, the outcome is not always clear cut. When the export costs are very low or very high, the findings of the symmetric case still hold. When the firms are moderately flexible, the outcome depends on the capacity decisions of the firms as well as the relative sizes of the export costs. If the capacities of the subsidiaries differ to a certain extent, both firms benefit from the tariff. If, on the other hand, the firms have similar volumes of production in their subsidiaries, the tariff becomes a conflict of interests between the firms.

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APPENDIX A

Symmetric firms - Equilibria of the full game

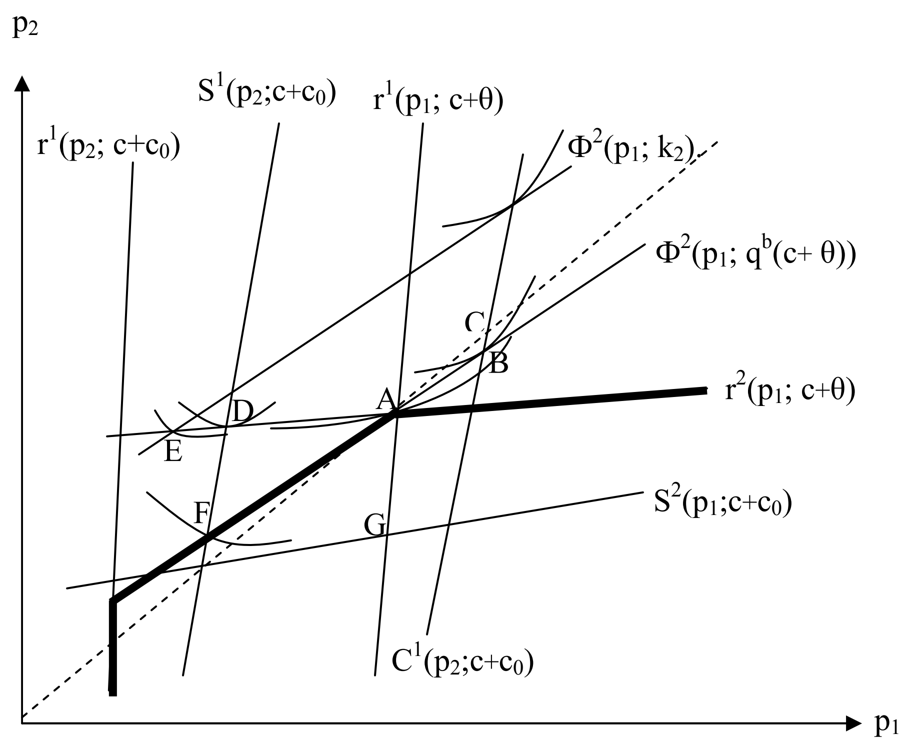
The proof consists of two cases: $\theta < \theta_C$ and $\theta \geq \theta_C$. For $\theta < \theta_C$, the proof is shown only for the upper part of 45º line. $(p_1 \geq p_2)$ Since the firms are symmetric, the same arguments apply also for the region $p_1 \geq p_2$.

Case 1: $\theta < \theta_C$

Assume firm 2 chooses its capacity as $q^b(c+\theta)$. Then, the Bertrand price pair $(p^b(c+\theta), p^b(c+\theta))$ lies on the isoquantity curve $\Phi^2(p_1; q^b(c+\theta))$. (point A in graph 1) The price reaction function of firm 2 is shown in bold lines in graph 1. Since $\theta < \theta_C$, the Cournot price, shown as point C, is higher than the Bertrand price. Firm 1 has an isoprofit curve that is tangent to $r^2(p_1; c+\theta)$ at point D, and another one that is tangent to $\Phi^2(p_1; q^b(c+\theta))$ at point B, by definitions of $S^1(p_2; c+c_0)$ and $C^1(p_2; c+c_0)$, respectively. Firm 1 may increase its profits by moving left on $r^2(p_1; c+\theta)$ and choose a price pair that is still within the required band $(r^1(p_2; c+c_0), r^1(p_2; c+\theta))$. However, the price pair will no longer be on the price reaction function of firm 2, which is kinked at point A. Since firms are symmetric, with similar arguments, it can easily be shown that firm 2 also cannot deviate from point A. Thus, point A is a symmetric equilibrium point. Moreover, the same methodology above can be used to show that all points on the segment DA are candidate equilibrium points. However, any point outside this range such as point E cannot be an equilibrium point.

This can easily be shown with contradiction:

Assume E is an equilibrium point. Then, firm 2 has to choose a capacity level k_2 such that $\Phi^2(p_1;k_2)$ passes through point E. Firm 1 can increase its profits by deviating from point E towards point D and can still be on the price reaction function of firm 2 and within the required band $(r^1(p_2;c+c_0), r^1(p_2;c+\theta))$. This contradicts with the assumption that E is an equilibrium point.



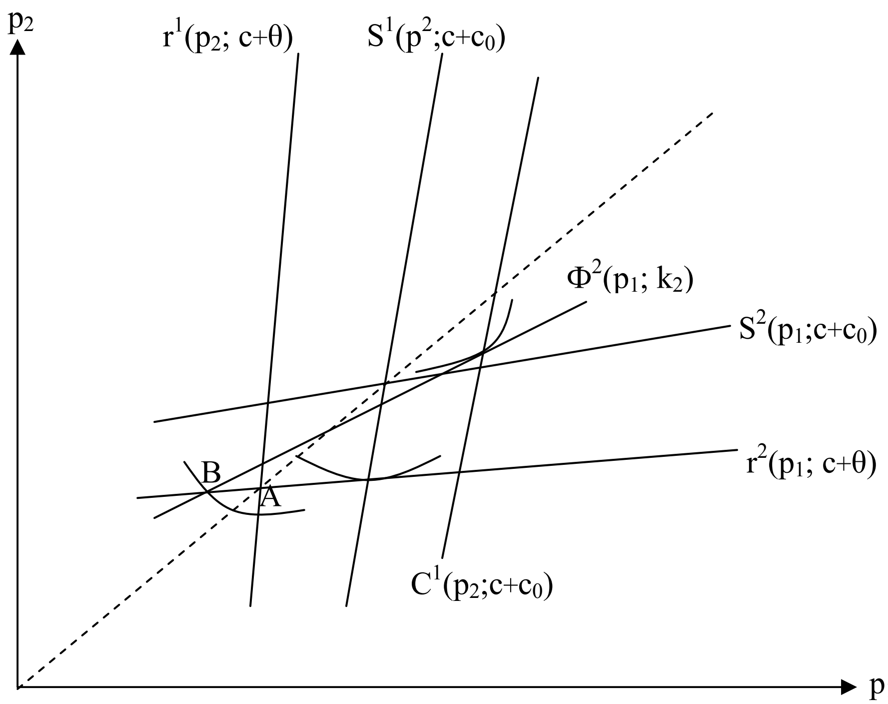
Graph 1

Moreover, an equilibrium price pair has to satisfy $p_2 = r^2(p_1;c+\theta)$. Together with the band constraint $r^1(p_2;c+c_0) \le p_1 \le r^1(p_2;c+\theta)$, this indicates that all the candidate equilibrium points should lie only on the segment DA. For instance, at point F, the condition above is clearly violated, and firm 1 has an incentive to deviate by moving upwards on $\Phi^2(p_1;k_2)$ and increase its profits. Since firms are symmetric, this last condition can be written as $p_1 = r^1(p_2;c+\theta)$ for the region $p_2 \le p_1$. Together with the required band $r^2(p_1;c+c_0) \le p_2 \le r^2(p_1;c+\theta)$, the segment AG also consists of candidate equilibrium points. Maggi (1996) shows that most of these asymmetric equilibria, however, are not robust. All asymmetric equilibrium points but D and G turn out to be not robust when marginal cost function is approximated by a smooth function. Intuitively, this result is due to the presence of a kink in firm 2's price reaction function. This reaction function becomes smooth and the equilibrium breaks down when $R^2(p_1;k_2)$ approximated by a smooth function.

To sum up, the candidate robust equilibrium points are D, A, and G. One final restriction remains necessary to determine the set of robust equilibria. For D and G to be in the robust equilibrium set, the condition $\theta_S < \theta \le \theta_V$ should be satisfied. ($\theta_S < \theta_V < \theta_C$, by definition)

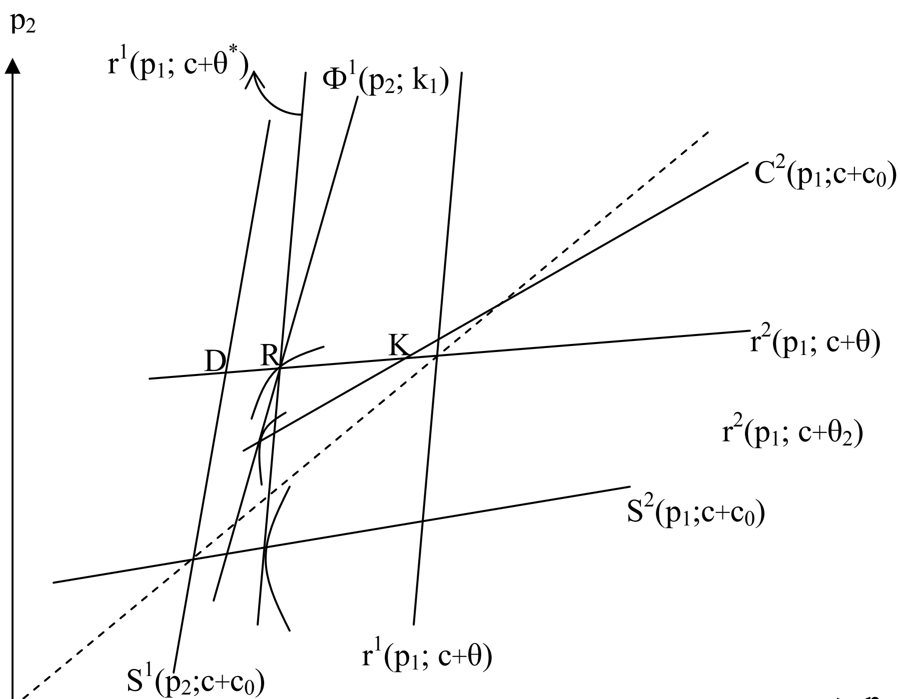
Proof:

Recall from section 3.2 that when $\theta < \theta_S$, the intersection point of $S^1(p_2;c+c_0)$ and $S^2(p_1;c+c_0)$ on the diagonal is higher than the Bertrand price $p^b(c+\theta)$. As seen in graph 2 below, at point B, firm 1 has an incentive to deviate towards point A in order to increase its profit without violating any of the constraints mentioned previously. At point A, however, firm 1 can no longer deviate in that it the price pair it chooses should be within the required band $(r^1(p_2;c+c_0), r^1(p_2;c+\theta))$. Thus, for $\theta < \theta_S$, the only equilibrium point is the Bertrand price $(p^b(c+\theta), p^b(c+\theta))$.



Graph 2

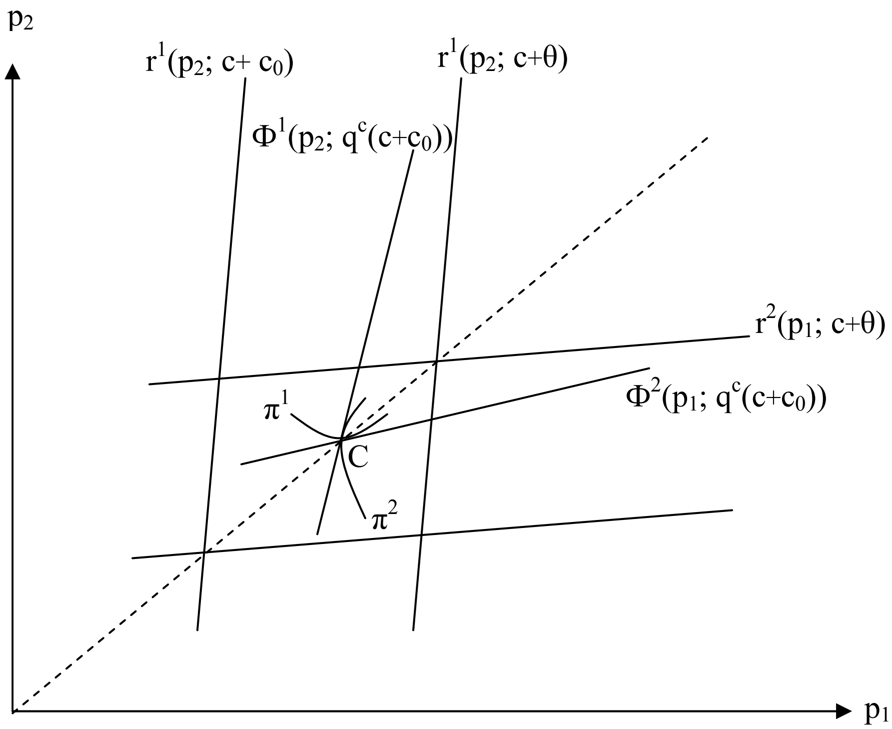
Recall from section 3.2 that when $\theta > \theta_V$, $C^2(p_1;c+c_0)$ intersects $S^1(p_2;c+c_0)$ at a lower point than $r^2(p_1;c+\theta)$ does. Assume $\theta > \theta_V$ and consider the asymmetric price pair R in graph 3, which is on $r^2(p_1;c+\theta)$ and to the left of the K. It is easy to see in graph 3 that $p_2 > C^2(p_1;c+c_0)$ at point R. Firm 2 has an incentive to deviate by going down on $\Phi^1(p_2;k_1)$. Therefore, point R cannot be an equilibrium point although it is located between $S^1(p_2;c+c_0)$ and $r^1(p_2;c+\theta)$. This implies that a necessary condition for a price pair (p_1, p_2) to be an equilibrium point is $p_2 \leq C^2(p_1; c + c_0)$. For $\theta > \theta_V$, it is obvious that this condition does not hold for point D. (Since firms are symmetric, the equivalent condition for the region $p_1 \geq p_2$ is $p_1 \leq C^1(p_2; c + c_0)$.



Graph 3

Case 1: $\theta \geq \theta_C$

Assume firm 2 chooses its capacity at $q^c(c + c_0)$. As seen in graph 4, the Cournot price pair (point C) lies on the isoquantity curve $\Phi^2(p_1; q^c(c + c_0))$. This price pair is the one that maximizes firm 1's profits. The capacity level k_1 that implements this price pair is given by $D(p^c(c + c_0), p^c(c + c_0))$, which is the Cournot quantity $q^c(c + c_0)$. For the given capacity decision of firm 1, firm 2 is also maximizing its profits at the Cournot price pair, by the definition of the Cournot price. Thus, the Cournot price pair is the unique (by definition of the Cournot equilibrium) equilibrium of the full game and the capacity pair that implements this equilibrium is $(q^c(c+c_0), q^c(c+c_0))$.

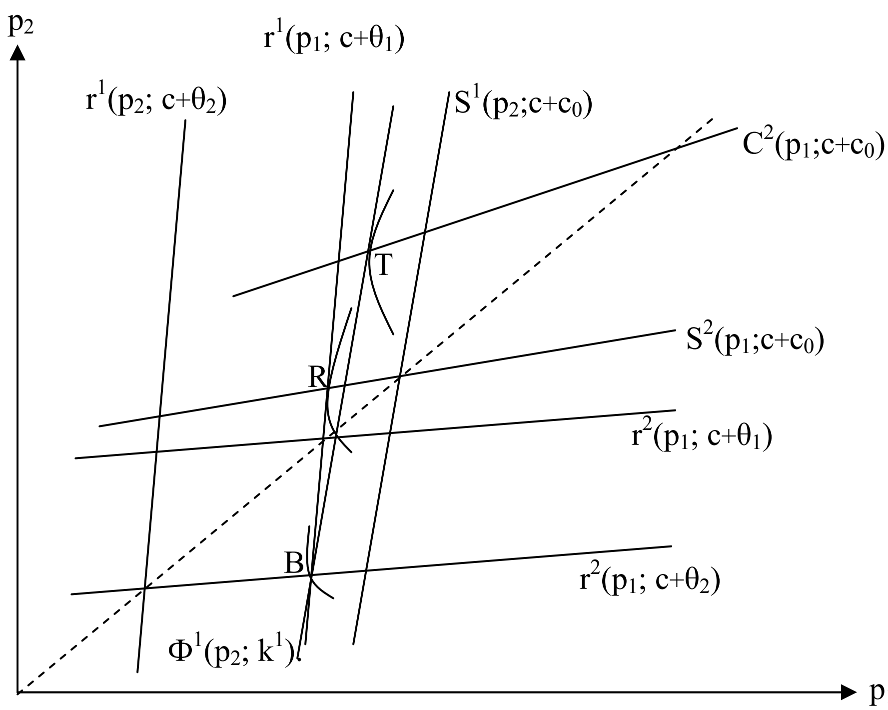


Graph 4

Appendix B

B.1. Flexible firms – $\theta_S > \theta_1 > \theta_2$

If point B in graph 5 is an equilibrium point, then firm 1 has to choose a capacity level k_1 such that $\Phi^1(p_2;k_1)$ passes through point B. Since $\theta_2 < \theta_S$, $r^2(p_1;c+\theta_2)$ is located below $S^2(p_1;c+c_0)$. On $r^1(p^2; c+\theta_1)$, the price pair that maximizes firm 2's profits is at point R. Firm 2 has another isoprofit at point T, which is tangent to $\Phi^1(p^2; k^1)$ above point B, by definition of $C^2(p_1;c+c_0)$. These two isoprofit functions imply that firm 2's isoprofit at point B is flatter than $r^1(p_2;c+\theta_1)$, as seen in the graph 5.

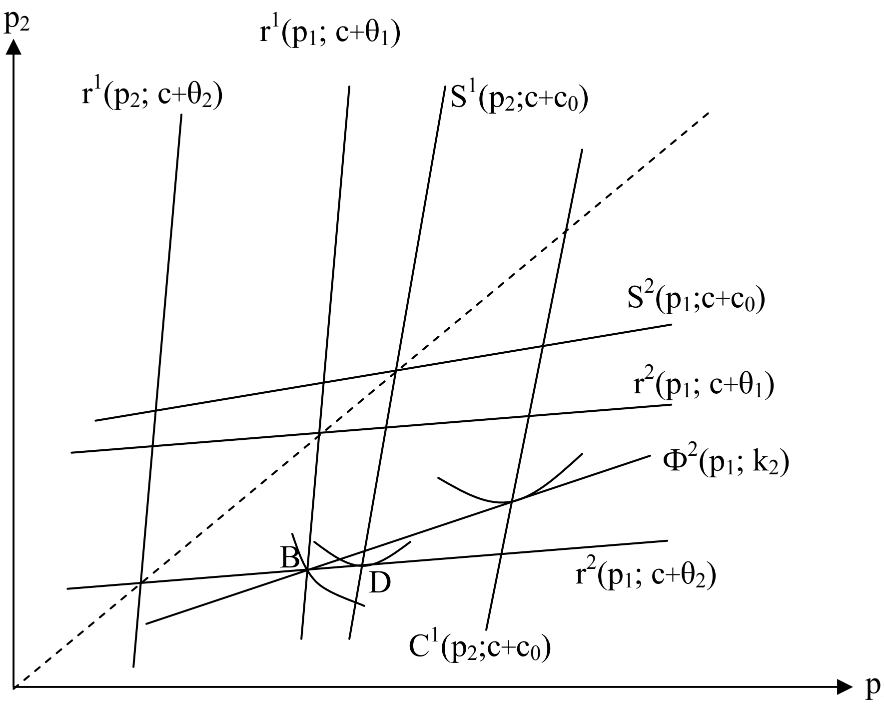


Graph 5

Firm 2 can increase its profits by moving up on $r^1(p_2;c+\theta_1)$ (also on $\Phi^1(p_2;k_1)$) or to the right on $r^2(p_1;c+\theta_2)$. However, the first one would violate the band constraint $r^2(p_1;c+c_0) \le p_2 \le r^2(p_1;c+\theta_2)$. If instead it chooses a price pair to the right of point B on $r^2(p_1;c+\theta_2)$, this new price pair will not be on the price reaction function $R^1(p_2;k_1)$ of firm 1, which is kinked at point B. Thus, firm 2 does not have any incentive to deviate from point B.

For B to be an equilibrium point, firm 2's isoquantity $\Phi^2(p_1;k_2)$ for the capacity level k_2 it chooses in equilibrium also has to pass through point B. (see graph 6) Since $\theta_1 < \theta_S$, $S^1(p_2;c+c_0)$ is located to the right of $r^1(p_2;c+\theta_1)$. The price pair that maximizes firm 1's profits on $r^2(p_1;c+\theta_2)$ is given by point D. By definition of $C^1(p_2;c+c_0)$, firm 1 has another isoprofit that is tangent to $\Phi^2(p_1;k_2)$ above point B. Thus, firm 1's isoprofit at point B is flatter than $r^2(p_1;c+\theta_2)$. Firm 1 wants to increase its profits by moving towards point D while staying on the price reaction function $R^2(p_1;k_2)$ of firm 2. However, it can't do so in that the price pair it chooses would violate the constraint $p_1 \le r^1(p_2;c+\theta_1)$. Since neither of the firms has an incentive to deviate, B is an equilibrium point.

Furthermore, no other point on $r^1(p_2;c+\theta_1)$ below point B or on $r^2(p_1;c+\theta_2)$ to the left of point B can be an equilibrium point. At a point on $r^1(p_2;c+\theta_1)$ below point B, firm 2 can move up on $r^1(p_2;c+\theta_1)$ and increase its profits while staying on the price reaction function of firm 1 (kinked at B) and satisfying the constraint $p_1 \le r^1(p_2;c+\theta_1)$. Similarly, at a point on $r^2(p_1;c+\theta_2)$ to the left of point B, it is firm 1 which can improve its profits by choosing a price pair closer to point B without violating any of the constraints. Therefore, point B is the unique equilibrium point of the full game.



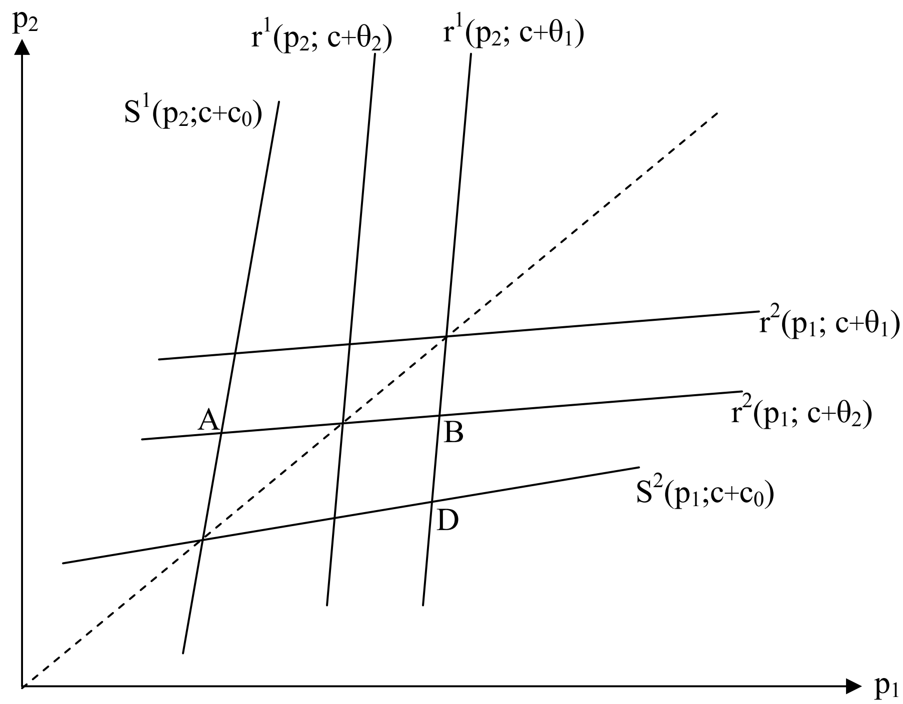
Graph 6

B.2. Moderately flexible firms – $\theta_V > \theta_1 > \theta_2 > \theta_S$

The same methodology applied in the previous proofs can easily be used to show that the robust equilibrium prices are given as points A, B, and D in graph 7. Therefore, I present a sketch of the proof only.

Since both θ's are smaller than θ_V, the necessary conditions $p_1 \le C^1(p_2; c + c_0)$ and $p_2 \le C^2(p_1; c + c_0)$ hold for all three points. Also, since both θ_1 and θ_2 are greater than θ_S, all candidate equilibrium points lie on the segments AB and BD. As in the symmetric case, the intermediate points on these segments, however, are not robust when the marginal cost function is approximated by a smooth function. The intersection points

A, B, and D in graph 7 are the only robust equilibrium points, which survive this perturbation.



Graph 7

B.3. Inflexible firms – $\theta_1 > \theta_2 > \theta_C$

Since both θ_1 and θ_2 are greater than the critical value θ_C, the Cournot price pair lies on the diagonal at a lower point than the Bertrand price pairs $(p^b(c+\theta_2), p^b(c+\theta_2))$ and $(p^b(c+\theta_1), p^b(c+\theta_1))$. At the Cournot point, both firms maximize their profits given the capacity choices. The proof is identical to the one in the symmetric case where $\theta > \theta_C$. (see section A of the Appendix)

In the symmetric case, since $\theta_S < \theta_C < \theta$, $C^i(p_{-i};c+c_0)$ lies between $r^i(p_{-i};c)$ and $S^i(p_{-i};c+c_0)$, $i=1,2$. Therefore, the two robust candidate asymmetric equilibria, namely points D and G in graph 1, violate either of the following necessary conditions: $p_1 \le C^1(p_2;c+c_0)$ and $p_2 \le C^2(p_1;c+c_0)$. The symmetric point A violates both of these constraints. In the asymmetric case, the two robust candidate asymmetric equilibrium points still violate either one of the constraints mentioned above. The only difference is that the Bertrand reaction functions $r^1(p_2;c+\theta_1)$ and $r^2(p_1;c+\theta_2)$ might intersect below $C^2(p_1;c+c_0)$ if θ_2 is small enough. However, even if that's the case, this point will still not satisfy the constraint $p_1 \le C^1(p_2;c+c_0)$, thus it cannot be an equilibrium point.

B.4. Proof of Proposition 1

Recall from Appendix A that for $\theta < \theta_C$, the unique symmetric equilibrium is given by the Bertrand price pair $(p^b(c+\theta), p^b(c+\theta))$. There are also two other (asymmetric) equilibria, which are given by the intersection of $r^i(p_{-i};c+\theta)$ and $S^{-i}(p_i;c+c_0)$, $i=1,2$. I discuss the latter two asymmetric equilibria for asymmetric firms as type 1 equilibrium and type 3 equilibrium in the proof for proposition 3. The same arguments follow for this specific case. Both firms will be positively affected by a change in θ for each type of asymmetric equilibrium.

Assume that after the local government imposes a small common tariff on exports from both firms. At the symmetric equilibrium, the profits for each firm are given by

$$\blacksquare\ \pi_i = \left(a - b_1 p_i(c+\theta) + b_2 p_{-i}(c+\theta)\right) \bullet \left(p_i(c+\theta) - c - c_0\right) \text{ for } i = 1,2 \qquad (1)$$

To see the impact of the tariff on profits for either firm, it would be sufficient to look at the sign of $\frac{\partial \pi_1}{\partial \theta}$.

$$\frac{\partial \pi_1}{\partial \theta} = \frac{\partial\left((a - b_1 p_1(c+\theta) + b_2 p_2(c+\theta)) \bullet (p_1(c+\theta) - c - c_0)\right)}{\partial \theta}$$

Replacing $p_1(c+\theta)$ and $p_1(c+\theta)$ with $p^b(c+\theta)$ in equation (1) yields

$$\frac{\partial \pi_1}{\partial \theta} = \frac{2b_1(b_2 - b_1)p^b(c+\theta) + ab_1 - (b_2 - b_1)(c + c_0)b_1}{2b_1 - b_2}$$

$$\frac{\partial \pi_1}{\partial \theta} < 0 \Rightarrow p^b(c+\theta) > \frac{(b_2 - b_1)(c + c_0)b_1 - ab_1}{2b_1(b_2 - b_1)} \Rightarrow \frac{a + b_1 c + \theta b_1}{2b_1 - b_2} > \frac{(b_2 - b_1)(c + c_0)b_1 - ab_1}{2b_1(b_2 - b_1)}$$

Solving the inequality above for θ yields

$$\blacksquare\ \theta > \frac{2b_1 - b_2}{b_1}\left(\frac{(b_2 - b_1)(c + c_0)b_1 - ab_1}{2b_1(b_2 - b_1)} - \frac{a + b_1 c}{2b_1 - b_2}\right) \qquad (2)$$

If θ is greater than the threshold given in equation (2), a tariff imposition lowers the profits of both firms. Let this lower bound be θ_W. The next step is to compare θ_W with the critical value θ_C, for which the Bertrand price equals the Cournot price, that is, $p^b(c+\theta_C) = p^c(c+c_0)$.

$$\blacksquare\ p^b(c+\theta_C) = p^c(c+c_0) \Rightarrow \frac{a+b_1c+\theta_C b_1}{2b_1-b_2} = \frac{a+b_1}{(b_1-b_2)(2b_1+b_2)} + \frac{(b_1+b_2)(c+c_0)}{(2b_1+b_2)} \qquad (3)$$

Solving for θ_C gives

$$\blacksquare\ \theta_C = \frac{2b_1-b_2}{b_1}\left(\frac{ab_1}{(b_1-b_2)(2b_1+b_2)} + \frac{(b_1+b_2)(c+c_0)}{(2b_1+b_2)} - \frac{a+b_1c}{(2b_1-b_2)}\right) \qquad (4)$$

As found earlier, a tariff imposition hurts both firms if $\theta > \theta_W$. Also, when $\theta > \theta_C$, the equilibrium is given by the Cournot price $p^c(c+c_0)$, that is, a change in θ for this region has no impact on the equilibrium. Therefore, if $\theta_W > \theta_C$, for our region of interest ($\theta < \theta_C$), firm 1's profits go up as θ increases. They keep increasing further for a certain region above $\theta_C (\theta_C < \theta < \theta_W)$, however, this is irrelevant for our purposes in that for that interval, the unique equilibrium is given by the Cournot price. Thus, we need to check if

$\theta_W > \theta_C$ ($\theta_W > \theta_C \Rightarrow b_1 - b_2 < \frac{a}{c+c_0}$)

The inequality above is equivalent to the assumption that ensures both Bertrand and Cournot quantities are positive. Therefore, we can conclude that both firms benefit from a small tariff imposition when $\theta < \theta_C$.

B.5. Proof of Proposition 2

As seen in graph 5, firm 2's profits will increase if it chooses a higher price pair on $r^1(p_2;c+\theta_1)$. So, it will benefit from an increase in θ_2. As firm 2's isoprofit shifts up on $r^1(p_2;c+\theta_1)$, it will intersect $r^2(p_1;c+\theta_2)$ to the right of point B. Thus, an increase in θ_1 alone also makes firm 2 better off. Firm 1's isoprofit on $r^2(p_1;c+\theta_2)$ is steeper at point B than it's at point D since it's tangent to $r^2(p_1;c+\theta_2)$ at point D. (see graph 6) For this reason, as θ_2 gets higher, firm 1's isoprofit of $r^1(p_2;c+\theta_1)$ is going to be above the isoprofit at point B. Thus, firm 1's profits also go up on $r^1(p_2;c+\theta_1)$ as θ_2 goes up. Also, since firm 1's profits are maximized on $r^2(p_1;c+\theta_2)$ at point D, an increase in θ_1 will improve firm 1's profits by bringing the equilibrium point closer to D. Therefore, for the given parameter range, $\theta_S > \theta_1 > \theta_2$, simultaneous increases in θ_1 and θ_2 will improve the profits of both firms. As θ_1 gets sufficiently close to θ_S, however, this result will not hold. When $\theta_1 \approx \theta_S - \Delta$ (Δ is small and positive), $r^1(p_2;c+\theta_1)$ intersects $r^2(p_1;c+\theta_2)$ at point D. $(\partial r^1(p_2;c+\theta_1)/\partial\theta_2) < \partial S^1(p_2;c+c_0)/\partial\theta_2$, that is, $r^1(p_2;c+\theta_1)$ is steeper than $S^1(p_2;c+c_0)$. At point D, firm 1's profits are maximized by definition of $S^1(p_2;c+c_0)$. Thus, a further increase in θ_1 worsens the profits of firm 1. This is true for a very small range, though.

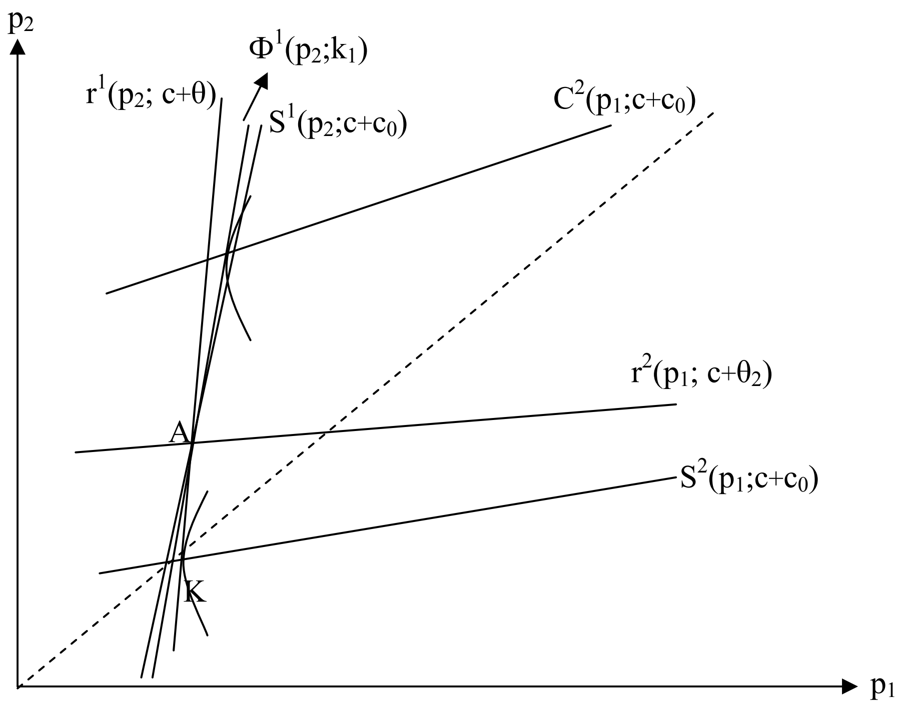
B.6. Proof of Proposition 3

Since there are multiple equilibria in this case, I analyze the impact of changes in the θ's for each equilibrium type. Let type i equilibrium be given by the intersection of $S^i(p_{-i};c+c_0)$ and $r^{-i}(p_i;c+\theta_{-i})$, $i=1,2$. Type 3 equilibrium is given by the intersection of $r^1(p_2;c+\theta_1)$ and $r^2(p_1;c+\theta_2)$.

<u>Type 1 equilibrium:</u>

As θ_2 increases towards θ_V, the equilibrium point goes up on $S^1(p_2;c+c_0)$. A change in θ_1, however, has no effect on this type equilibrium. In graph 8, point A is the initial equilibrium point. By definition, $r^1(p_2;c+\theta)$ (for $\theta<\theta_2$) is steeper than both $\Phi^1(p_2;k_1)$ and $S^1(p_2;c+c_0)$. Since $\theta<\theta_V$, $C^1(p_2;c+c_0)$ intersects firm 2's isoquantity curve $\Phi^1(p_2;k_1)$, which is given by its optimal capacity k_1 for this type of equilibrium at a higher point than point A. The isoprofit at this point yields lower profits than the one at point K, which is tangent to $r^1(p_2;c+\theta)$ by definition of $S^2(p_1;c+c_0)$. Therefore, the slope of firm 2's isoprofit at point A should be between the slopes of these two isoprofits. An increase in θ_2 will shift up the equilibrium point on $S^1(p_2;c+c_0)$, and a higher point on $S^1(p_2;c+c_0)$ (also on $\Phi^1(p_2;k_1)$) yields higher profits for firm 2.

By definition of $S^1(p_2;c+c_0)$, it is straightforward to see that a higher point on $S^1(p_2;c+c_0)$ means higher profits also for firm 1. Thus, a simultaneous increase in θ_1 and θ_2 will (an increase in θ_1 only is redundant) make both firms better off.

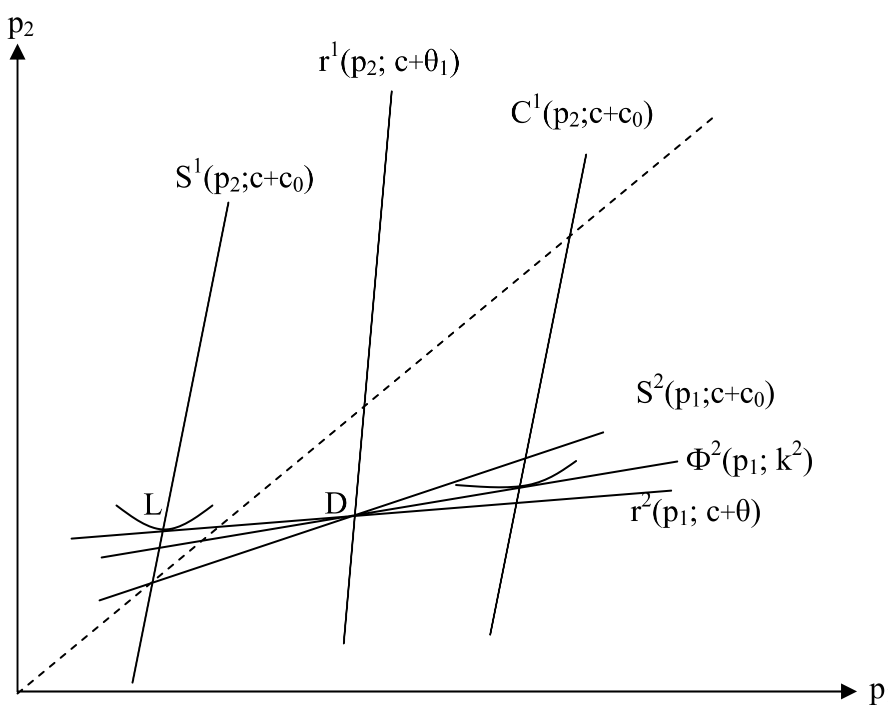


Graph 8

Type 2 equilibrium:

As θ_1 increases towards θ_V, the equilibrium point moves to the right on $S^2(p_1;c+c_0)$. A change in θ_2 has no effect on this type equilibrium. In graph 9, the initial equilibrium point is given by point D. This type of equilibrium is the region $p_2 \leq p_1$ equivalent of the type 1 equilibrium. Thus, $S^2(p_1;c+c_0)$ is now the steepest curve while $r^2(p_1;c+\theta)(\theta < \theta_2)$ has the smallest slope. Since $\theta < \theta_V$, $C^2(p_1;c+c_0)$ intersects firm 1's isoprofit curve $\Phi^2(p_1;k_2)$ at a higher point than point D. The isoprofit at this point yields lower profits than the one at point L, which is tangent to $r^2(p_1;c+\theta)$ by definition of $S^1(p_2;c+c_0)$. Therefore, the slope of firm 1's isoprofit at point K is between the slopes of these two isoprofits. An increase in θ_1 will move the equilibrium point on $S^2(p_1;c+c_0)$ to the right. As seen in the graph below, a higher point on $S^2(p_1;c+c_0)$ (also on $\Phi^2(p_1;k_2)$) yields higher profits for firm 1.

By definition of $S^2(p_1;c+c_0)$, as the intersection point between $r^1(p_2;c+\theta_1)$ and $S^2(p_1;c+c_0)$ moves to the right, firm 2's profits will also increase. Thus, a simultaneous increase in θ_1 and θ_2 will (an increase in θ_2 only is redundant) make both firms better off.



Graph 9

Type 3 equilibrium:

As θ_1 increases towards θ_V, the equilibrium point moves to the right on $r^2(p_1;c+\theta_2)$. In graph 7, at the initial equilibrium point B, firm 1's isoprofit is steeper than $r^2(p_1;c+\theta_2)$.

Thus, it is clear that an increase in θ_1 decreases the profits of firm 1. A higher isoprofit of firm 1 will intersect $r^1(p_2;c+\theta_1)$ at a higher point than point B. Therefore, firm 1 will benefit from an increase in θ_2, which moves the equilibrium point up on $r^1(p_2;c+\theta_1)$. Firm 2, however, will be affected differently by the changes in θ_1 and θ_2. Since firm 2's isoprofit at point B is less steep than $r^1(p_2;c+\theta_1)$, an increase in θ_2 will decrease firm 2's profits by moving the equilibrium point away from point B. An increase in θ_1, however, will have a positive impact on firm 2's profits by moving the equilibrium point to the right on $r^2(p_1;c+\theta_2)$. Since changes in either θ_1 or θ_2 alone affect firms' profits in opposite directions, it seems ambiguous at first glance as to which of the firms will benefit from a simultaneous increase in θ_1 or θ_2. To address that question, one needs to calculate firms' profits before and after a small equal change in θ_1 or θ_2.

Let the price pairs $\{p_1, p_2\}$ and $\{p_{*1}, p_{*2}\}$ represent the equilibrium price pairs before and after the tariff imposition, respectively. The price pair $\{p_1, p_2\}$ is can be found by solving the following two Bertrand price equations together:

■ $p_1 = r^1(p_2;c+\theta_1) = \dfrac{a+b_2p_2}{2b_1} + \dfrac{c+\theta_1}{2}$ (5)

■ $p_2 = r^2(p_1;c+\theta_2) = \dfrac{a+b_2p_1}{2b_1} + \dfrac{c+\theta_2}{2}$ (6)

Solving (3) and (4) together yields:

$$\blacksquare\ p_1 = \frac{a + b_1 c}{2b_1 - b_2} + \frac{b_1 b_2 \theta_2}{4b_1^2 - b_2^2} + \frac{2b_1^2 \theta_1}{4b_1^2 - b_2^2} \tag{7}$$

$$\blacksquare\ p_2 = \frac{a + b_1 c}{2b_1 - b_2} + \frac{b_1 b_2 \theta_1}{4b_1^2 - b_2^2} + \frac{2b_1^2 \theta_2}{4b_1^2 - b_2^2} \tag{8}$$

A common small tariff of size t will raise both θ_1 and θ_2 by the size of the tariff. It is clear from equations (5) and (6) that both prices will increase by the same amount due to tariff imposition. More specifically, changes in p_1 and p_2 will be given as

$$\blacksquare\ \Delta p_1 = \Delta p_2 = \frac{t(b_1 b_2 + 2b_1^2)}{4b_1^2 - b_2^2} \tag{9}$$

Let $\frac{t(b_1 b_2 + 2b_1^2)}{4b_1^2 - b_2^2}$ be denoted by k. The assumption $b_1 > b_2$ implies $\frac{(b_1 b_2 + 2b_1^2)}{4b_1^2 - b_2^2} < 1$, which in turn implies $k < t$. The equilibrium price pair $\{p_{*1}, p_{*2}\}$ can be written as $\{p_1 + k, p_2 + k\}$. Let π_i and π_{*i} represent firm i's profits before and after the tariff imposition, respectively. (i = 1, 2). The profit functions π_i and π_{*i} can be written as:

$$\blacksquare\ \pi_i = (a - b_1 p_i + b_2 p_{-i}) \bullet (p_i - c - c_0) \tag{10}$$

$$\blacksquare\ \pi_{*i} = (a - b_1(p_i + k) + b_2(p_{-i} + k)) \bullet (p_i + k - c - c_0) \tag{11}$$

To figure out whether firm 1 is better off or not after the tariff imposition, we need to look at the change in its profits:

$$\blacksquare\ \pi_1 - \pi_{*1} = -ka + k(b_1 - b_2)(k - c - c_0) + k(p_1(2b_1 - b_2) - b_2 p_2) \qquad (12)$$

The first term on the right-hand side of equation (7) is clearly negative. Since the tariff amount is small relative to the cost parameters and $k < t$, the second term is also negative. Therefore, the condition $\pi_1 > \pi_{*1}$ can hold only when the last term is sufficiently large and positive. Since the equilibrium point lies below the 45 degree line, p_1 exceeds p_2. Also, the coefficient of p_1 $(2b_1 - b_2)$ is larger than the coefficient of p_2 (b_2), thus, the last term is positive. For the right-hand side of equation (7) to be positive, p_1 should be sufficiently larger than p_2, which is equivalent to saying that there should be a certain degree of divergence between θ_1 and θ_2. Therefore, when p_1 is sufficiently larger than p_2, a tariff imposition brings firm 1's profits down. The same methodology can be used for firm 2. The change in firm 2's profits is given by equation below.

$$\blacksquare\ \pi_2 - \pi_{*2} = -ka + k(b_1 - b_2)(k - c - c_0) + k(p_2(2b_1 - b_2) - b_2 p_1) \qquad (13)$$

The first two terms on the right-hand side of equation (8) are negative. When p_1 is sufficiently larger than p_2, the last term will also be negative. Therefore, when p_1 exceeds p_2 by a sufficient amount, a tariff imposition has a positive impact on firm 2's profit while worsening the profits for firm 1.

B.7. Proof of Proposition 4

Similar to the symmetric case (see proof of proposition 1), once θ_1 and θ_2 are high enough, the equilibrium is given by the Cournot price, which is not affected by the tariff.

Chapter 2: Strategic Trade Policy toward Multinational Firms

1. Introduction

Strategic trade policy is commonly defined as the trade policy that changes the strategic interactions between firms. As Brander (1995) notes "…the key point is that the strategic relationships between firms introduce additional motives for trade policy, over and above terms of trade and other effects that arise in all market structures." The profit-shifting motive has been the hallmark of strategic trade policy literature. Strategic trade theory has shown that government intervention can affect the strategic interactions between firms and potentially boost the welfare of a country by mainly shifting profits from foreign firms to domestic firms.[18]

An established result in the strategic import policy literature is that when there is a domestic rival to a foreign monopolist, a specific tariff imposition is more likely to improve domestic welfare at the expense of the foreign firm than if there were no domestic firm, suggesting that the profit-shifting effect of the tariff (together with the tariff revenue) dominates the loss in the consumer surplus caused by an increase in

[18] The influential work of Brander and Spencer (1985) envisions two exporting firms selling to a third country, which does not produce the product. This set-up (commonly referred to as "third market model") is convenient in that it allows the authors to focus their attention on the firm competition and leaves aside the question of how interventionist trade policies affect domestic consumers. The authors show that although an export subsidy worsens terms of trade for a country, it shifts oligopoly profits from the foreign firm to the domestic firm, leading to a net welfare gain. Other early contributions to strategic trade policy include Krugman (1984), Dixit (1984), and Eaton and Grossman (1986).

prices.[19] In these standard models of strategic import policy, exporting is the sole means of supplying the domestic market for the foreign firms, thus, a tax on their exports is usually an unavoidable increase in their marginal costs.[20] It is widely known that multinational corporations ("MNC"s) are much more complex, yet flexible, organizations that seek economic gains and efficiencies through increasing their scope of operations forming wide networks of subsidiaries, acquisitions, etc. The presence of these alternative ways of operating in the international markets besides exporting may possibly have different implications than what the standard strategic import policy models predict. This paper fills a gap in the literature by studying the welfare implications of a strategic import policy tool (specific tariff) for the domestic country in the presence of a flexible foreign MNC. It is important to note that this motivation is not fully encompassed in the tariff-jumping argument of Blonigen and Ohno (1998) although they consider strategic trade policy against MNCs. In their analysis, a multinational firm chooses to build a subsidiary firm in the targeted market if the import tax is too high (tariff-jumping), or else it chooses to export only. Thus, the common observation that many MNCs produce locally as well as export from their parent plants is not addressed in their paper.

The competition takes place in two stages. In the first stage, a domestic firm and a foreign multinational firm decide how much to invest in the domestic market, that is, they choose the capacities of their plants. In the second stage, after the capacity decisions are

[19] See Helman and Krugman (1989, pp. 117-131) for an extensive analysis of strategic import policy.

[20] Lai (1999) studies a strategic trade policy model with spillovers in which a domestic firm and a multinational firm both produce in the domestic market and compete in Cournot form. In this study, the multinational firm produces only in the domestic country, thus, a production tax on the multinational firm's output is like an import tax on a foreign firm's exports. The possibility that the multinational firm can also export besides engaging in foreign direct investment is not addressed.

revealed to both firms, they simultaneously choose prices and produce to satisfy demand. As opposed to the traditional models of capacity-constrained price competition, I follow Maggi (1996) and model capacity as a flexible constraint.[21,22] The multinational firm produces at its local plant (subsidiary firm) and can increase production through exports if it decides to supply beyond capacity. This additional cost of providing in excess of capacity includes mainly the transportation costs and is referred as trade costs throughout the paper. Similarly, the domestic firm's production can exceed its capacity at a higher marginal cost, which is determined by factors such as the cost of over time work, degree of unionization of the industry, etc.[23]

I show that a welfare-maximizing domestic government's decision to intervene or not depends on several factors. If exporting is initially cheap, a tariff imposition on the foreign multinational firm's exports acts as a "facilitating practice" rather than as a profit-shifting device, that is, the tariff helps the firms to reach an outcome they could otherwise not and raises the profits for both firms.[24] The national welfare is diminished in this case. When exporting is more costly, only the domestic firm benefits from the tariff imposition at the expense of the foreign firm and domestic consumers. The increase in the domestic firm's profits can outweigh the loss in the consumer surplus only when the goods are

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[21] Maggi (1996) considers a "third market" model in which oligopolistic firms in a home country and a foreign country export goods to a third country while the home country's government is trying to decide on the single-rate best policy (output or capacity subsidy/tax).

[22] Jean Tirole (1988, pp.217) suggests "In most cases, firms do not face rigid capacity constraints, as we noted earlier. The cost function induced by the investment choice does not have the (inverted) L shape. That is, there is generally no capacity level that gives meaning to the quantity variable in the Cournot profit functions."

[23] The results are robust if the domestic firm's out-of-capacity cost is set to be arbitrarily high.

[24] The term "facilitating practice" was first used in Krishna (1989). Krishna (1989) shows that under price competition, a voluntary export restraint on the foreign firm improves the profits of both the domestic firm and the foreign firm, helping the firms to achieve a favorable outcome they would otherwise not be able to.

close enough substitutes. Thus, the implications of the tariff for the total welfare depend on the initial costs of exporting as well as the degree of differentiation of the products.[25]

The remainder of the paper is structured as follows. Section 2 extends the two-stage capacity-constrained price competition model developed in Maggi (1996) to allow for asymmetric firms and discusses the equilibrium structure of the full game. The consumer model is developed in this section as well. Section 3 discusses the welfare implications of a specific tariff for both the domestic country and the foreign firm. Section 4 concludes.

2. The Model

2.1. Firms

Consider a market that consists of an imperfectly competitive sector served by two firms and a competitive sector. A domestic firm and a foreign multinational firm operate in the imperfectly competitive sector by producing two (symmetrically) differentiated products. The multinational firm has a subsidiary firm in the domestic country and is able to support its local production through exports. Both firms can produce at a constant short-run marginal cost up to the capacity level and can produce beyond capacity at a higher marginal cost. The domestic firm's ability to produce beyond capacity is determined by such factors as the cost of over time work, degree of unionization of the industry, etc. The

[25] Using a duopoly strategic trade policy model, Kohler and Moore (2002) show that under Bertrand competition, strategic export tax by the foreign government has ambiguous effects on domestic welfare. They find that the degree of product differentiation and cross-price elasticity of demand between domestic and foreign goods are essential in determining the sign of the welfare change.

multinational firm's flexibility is due to its capability to export, thus, the major factor that influences its ability to increase production above the capacity limit is trade costs. It is important to note that the central characteristic of the model is the multinational firm's more flexible production set-up due to its capability to serve the domestic market through exports and local production. I start with the assumption that both firms can produce beyond capacity at viable (within the range of key parameters in the model) level of costs although it is always less expensive for the multinational firm to do so. Later on, I show that setting the domestic firm's out-of-capacity costs arbitrarily high leaves the main results unaffected.

The demand side of the model is identical to that of Maggi (1996). The demand is linear for each product:

$$q_i = D(p_i, p_{-i}) = a - b_1 p_i + b_2 p_{-i},\ i = 1,2 \text{ and } b_1 > b_2 > 0.^{26} \tag{1}$$

Each firm produces at a constant marginal cost c. The marginal cost of building a unit of capacity (k) is given by c_0. Thus, the long-run marginal cost of production per unit is $c + c_0$. Each firm is capable of producing in excess of capacity at an additional marginal cost θ_i for $i = 1,2$ where $\theta_1 > \theta_2$. Thus, it is more expensive for firm 1 (domestic firm) to provide an additional unit beyond capacity than firm 2 (multinational firm).[27] The standard assumption $c_0 < \theta_i$ ($i = 1,2$) guarantees that each firm has an incentive to build

[26] This condition indicates that the goods are substitutes and strategic complements.
[27] Maggi (1996) considers the symmetric case ($\theta_1 = \theta_2$). I follow the same approach of the symmetric case to find out the equilibria of the subgame and the full game, which are needed for analyzing the implications of government intervention.

capacity. The short-run marginal cost of each unit sold in the domestic market beyond capacity is given by $c+\theta_i$ for $i=1,2$.[28] Thus, the short-run total cost for firm i ($i=1,2$) is given as follows:

$$TC_i = \begin{cases} cq_i & \text{for } q_i \le k_i \\ cq_i + \theta_i(q_i - k_i) & \text{for } q_i > k_i \end{cases} \tag{2}$$

The game has two stages. In the first stage, the firms simultaneously choose capacities. In the second stage, after the capacity decisions are revealed to both firms, they simultaneously choose prices. The game can be solved with backward induction.

2.1.1. The Second Stage: The Price Subgame

Taking the capacities as given, each firm chooses its optimal price, thus, the equilibria of the price subgame are given by the intersection of the subgame reaction functions. The key functions used to derive the subgame reaction functions are the Bertrand reaction function and the isoquantity curve. Bertrand reaction function for firm i is the solution to $\arg\max_p (p-x)D(p,p_{-i})$ given constant marginal cost x and is denoted by $r^i(p_{-i};x)$. The price combinations such that the demand for firm i is constant at k_i are represented by $p_i=\Phi^i(p_{-i};k_i)$, that is, $\Phi^i(p_{-i};k_i)$ is an isoquantity curve. The bold line in figure 1 shows the reaction function $R^i(p_{-i};k_i)$ in the price subgame for firm i. This can be

[28] The implicit assumption is that the multinational firm is not constrained by capacity at its domestic plant and can produce at a constant marginal cost c.

explained as follows. When its rival's price is low, firm i can either produce at capacity and choose a price on its isoquantity curve $\Phi^i(p_{-i};k_i)$ or it can produce less than its capacity and choose a price on its Bertrand reaction curve $r^i(p_{-i};c)$. In figure 2, which demonstrates the short run marginal cost and the residual marginal revenue curve ($MR_i^r(q_i, p_{-i})$) for firm i, the capacities in these two scenarios correspond to k_i^B and k_i^A, respectively. Producing at capacity and charging a price on its isoquantity curve is not optimal for firm i in this case because, given the low price of its rival firm, firm i has an incentive to raise its price and not fully utilize its capacity. The best response of firm i in this case is given by its Bertrand price (lower bold segment in figure 1.) Similarly, when its rival is charging a high price, firm i benefits from cutting its price and produce more than its capacity level. Thus, the upper bold segment in figure 1 is part of the best response function for firm i and the corresponding capacity choice is k_i^C. When rival's price is at an intermediate level, firm i's residual marginal revenue curve intersects its marginal cost at the vertical segment in figure 2 and the firm chooses to produce at capacity. This is true for a range of its rival's prices and firm i is more aggressive compared to the other two scenarios (i.e., the isoquantity curve has a smaller slope than the Bertrand reaction functions). For any pair of capacities, the two subgame reaction functions intersect only once, thus, the pure-strategy equilibrium of the subgame is unique. The profit functions are continuous and quasi-concave.[29]

[29] In Krishna (1989), the game does not admit pure-strategy equilibrium in the presence of a voluntary export restraint. The voluntary export restraint acts like a capacity constraint on the foreign firm. This leads

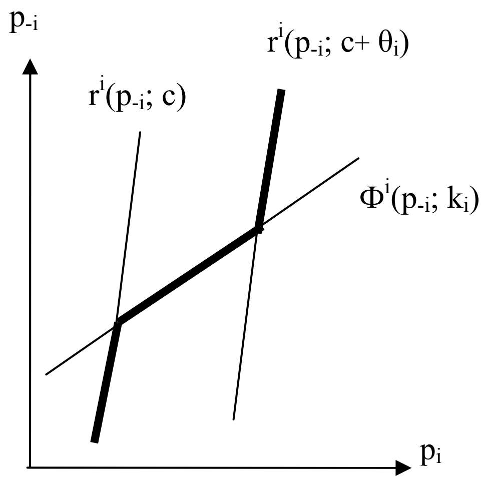

Figure 1
Subgame reaction function

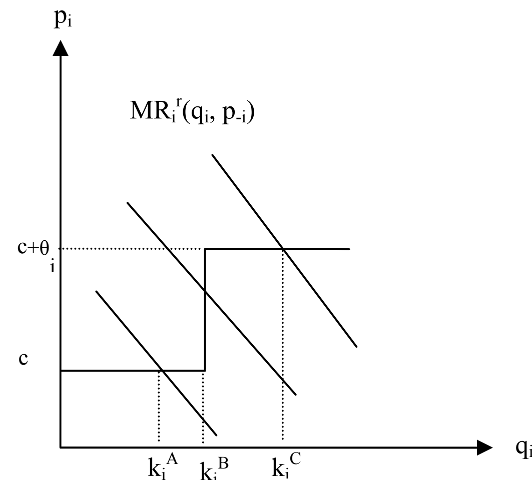

Figure 2

2.1.2. The First Stage

In equilibrium, each firm produces builds its capacity to satisfy the demand, that is, $k_i = D(p_i^*, p_{-i}^*)$ for $i = 1,2$ where (p_i^*, p_{-i}^*) is the optimal price pair chosen in the second stage. Thus, the equilibrium price pair lies on the segment of the isoquantity curve of firm i between the two Bertrand reaction functions. (the middle branch in figure 1) This result can be explained by figure 2. The initial capacity level is denoted by k_i^B. If firm i's residual marginal revenue curve intersects its marginal cost curve at the lowest horizontal segment ($MC = c$), then the capacity is not fully utilized. This case corresponds to the lower bold segment in the subgame reaction function in figure 1 where firm i's price given by the Bertrand reaction function $r^i(p_{-i};c)$ is higher than its price

to rationing of the foreign firm's product and discontinuity in the home firm's reaction function. With the assumptions of differentiated goods and rigid capacities, Friedman (1988) shows that if the degree of product differentiation dominates the size of the demand spillover caused by rationing consumers, the quasi-concavity of profit functions is preserved, thus, the price game may admit pure-strategy equilibria.

when it produces at capacity. Firm i can reduce its capacity level to k_i^A without affecting the equilibrium prices and incur lower costs. Similarly, the case in which firm i produces above the capacity limit ($MC = c + \theta_i$) corresponds to the upper bold segment in the subgame reaction function in figure 1. In this case, firm i can increase its capacity level to k_i^C and save costs since producing within capacity is less expensive than exporting.

2.1.3. The Equilibria of the Full Game

Maggi (1996) constructs two curves ($C^i(p_{-i};c+c_0)$, $S^i(p_{-i};c+c_0)$) and identifies three critical values for θ in the symmetric case. I adopt these definitions in order to study the asymmetric equilibria in the present case.

Connecting the tangency points between firm i's ($i = 1,2$) highest isoprofit curve and its rival's isoquantity curve $\Phi^{-i}(p_i;k_{-i})$ as k_{-i} changes trace the curve $C^i(p_{-i};c+c_0)$ in the price space. The points of tangencies between firm i's highest isoprofit curve and the Bertrand reaction function of its rival firm ($r^{-i}(p_i;c+\theta)$) as θ changes trace the curve $S^i(p_{-i};c+c_0)$ in the price space. The curves $C^1(p_2;c+c_0)$ and $S^1(p_2;c+c_0)$ are shown in figure 3.

The value of θ for which $r^i(p_{-i};c+\theta)$ crosses the diagonal at the same point as $S^i(p_{-i};c+c_0)$ does is denoted by θ_S, $i = 1,2$. In figure 4, $S^1(.)$ and $S^2(.)$ intersect at point D, which is lower on the diagonal than the Bertrand price pair at point B, thus, $\theta > \theta_S$ in this particular case.

Finally, θ_V is the value of θ for which $C^i(p_{-i};c+c_0)$ passes through the point of intersection between $S^{-i}(p_i;c+c_0)$ and $r^i(p_{-i};c+\theta)$, $i=1,2$. In figure 4, for instance, $C^1(p_2;c+c_0)$ intersects $S^2(p_1;c+c_0)$ to the left of point K, thus, θ is greater than θ_V.

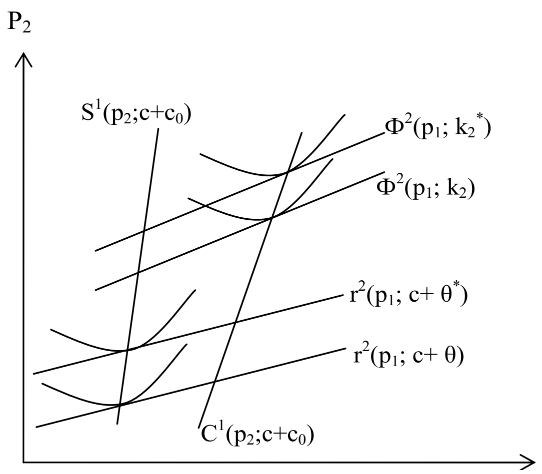

Figure 3
The curves C^1(.)and S^1(.)

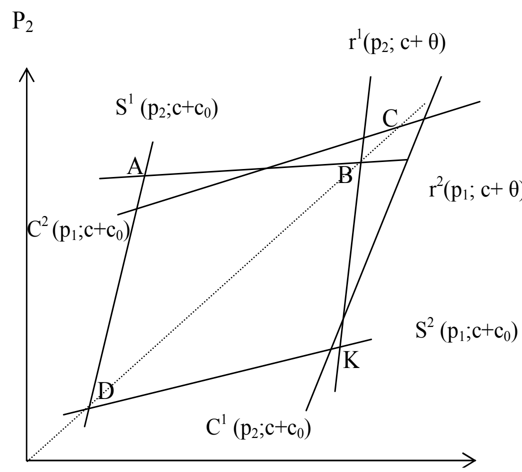

Figure 4
Critical values of θ

I start constructing the equilibria of the full game with the case for which both the multinational firm and the domestic firm have low out-of-capacity costs. ($\theta_S > \theta_1 > \theta_2$) Firm i chooses its optimal price to maximize its profits subject to two constraints. ($i=1,2$) First, the optimal price pair it chooses must lie on the price reaction function of the rival firm. Second, the price pair should lie on the middle branch between $r^i(p_{-i};c)$ and $r^i(p_{-i};c+\theta_i)$ in figure 1 since it produces at its capacity level. These can be seen as the incentive compatibility (IC) constraints.

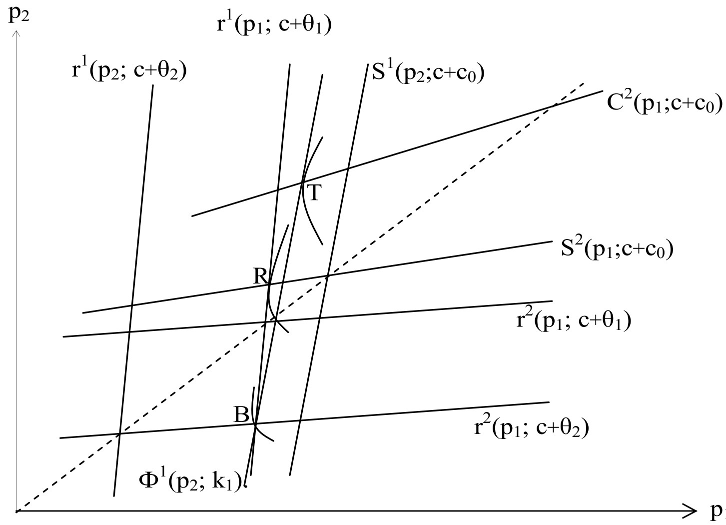

Figure 5

If the intersection of the Bertrand reaction functions $r^1(p_2;c+\theta_1)$ and $r^2(p_1;c+\theta_2)$ constitutes an equilibrium price pair (point B in figure 5), then firm 1 has to choose a capacity level k_1 such that $\Phi^1(p_2;k_1)$ passes through point B. Since $\theta_2 < \theta_S$, $r^2(p_1;c+\theta_2)$ is located below $S^2(p_1;c+c_0)$. On $r^1(p_2;c+\theta_1)$, the price pair that maximizes firm 2's profits is given by point R by definition of $S^2(p_1;c+c_0)$. Firm 2 has another isoprofit curve at point T, which is tangent to $\Phi^1(p_2;k_1)$ by definition of $C^2(p_1;c+c_0)$. These two isoprofit curves imply that firm 2's isoprofit curve at point B is flatter than $r^1(p_2;c+\theta_1)$. Firm 2 can increase its profits by moving up on $r^1(p_2;c+\theta_1)$ or to the right on $r^2(p_1;c+\theta_2)$. However, the first one would violate the second IC constraint ($p_2 \le r^2(p_1;c+\theta_2)$). If instead it chooses a price pair to the right of point B on $r^2(p_1;c+\theta_2)$, this new price pair will not be on the price reaction function $R^1(p_2;k_1)$ of firm 1, which is kinked at point B. Thus, firm 2 does not have any incentive to deviate from point B.

For B to be an equilibrium point, firm 2's isoquantity $\Phi^2(p_1;k_2)$ for a given capacity level k_2 it chooses in equilibrium also has to pass through point B. (see figure 6) Since $\theta_1 < \theta_S$, $S^1(p_2;c+c_0)$ is located to the right of $r^1(p_2;c+\theta_1)$. The price pair that maximizes firm 1's profits on $r^2(p_1;c+\theta_2)$ is given by point D by definition of $S^1(p_2;c+c_0)$. By definition of $C^1(p_2;c+c_0)$, firm 1 has another isoprofit that is tangent to $\Phi^2(p_1;k_2)$ above point B. Thus, firm 1's isoprofit at point B is flatter than $r^2(p_1;c+\theta_2)$. Firm 1 wants to increase its profits by moving towards point D while staying on the price reaction function $R^2(p_1;k_2)$ of firm 2. However, it can't do so in that the price pair it chooses would violate the constraint $p_1 \le r^1(p_2;c+\theta_1)$. Since neither of the firms has an incentive to deviate, B is an equilibrium point. Furthermore, no other point on $r^1(p_2;c+\theta_1)$ below point B or on $r^2(p_1;c+\theta_2)$ to the left of point B can be an equilibrium point. At a point below point B on $r^1(p_2;c+\theta_1)$, firm 2 can move up on $r^1(p_2;c+\theta_1)$ and increase its profits while staying on the price reaction function of firm 1 and satisfying the constraint $p_1 \le r^1(p_2;c+\theta_1)$. Similarly, at a point on $r^2(p_1;c+\theta_2)$ to the left of point B, it is firm 1 which can improve its profits by choosing a price pair closer to point B without violating any of the IC constraints. Therefore, for $\theta_S > \theta_1 > \theta_2$, point B is the unique equilibrium point of the full game. I consider two other cases: $\theta_C > \theta_1 > \theta_2 > \theta_V$ and $\theta_1 > \theta_C > \theta_V > \theta_2$.[30] The equilibria for these cases are constructed in Appendix A.

For $\theta_C > \theta_1 > \theta_2 > \theta_V$, the unique equilibrium of the game is given by the intersection of the Bertrand reaction functions $r^1(p_2;c+\theta_1)$ and $r^2(p_1;c+\theta_2)$. For $\theta_1 > \theta_C > \theta_V > \theta_2$, the equilibrium is unique as in the previous cases and is given by the intersection of $r^2(p_1;c+\theta_2)$ and $S^1(p_2;c+c_0)$.

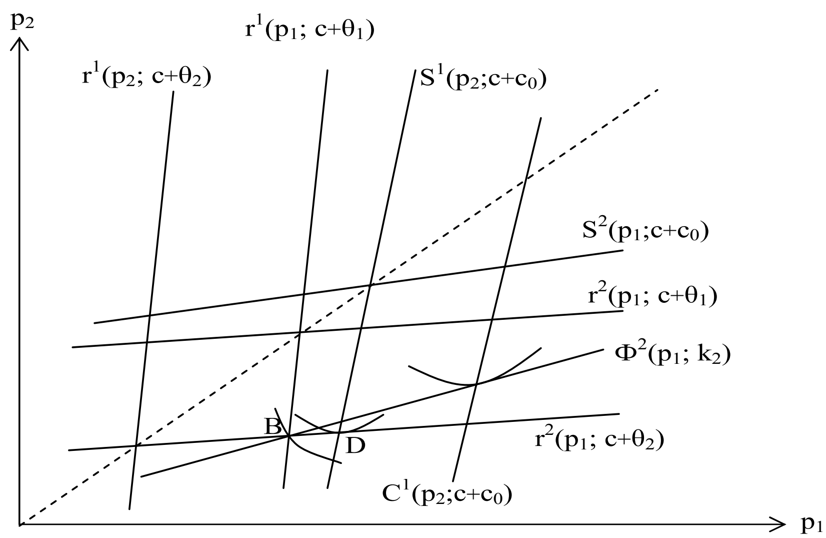

Figure 6

An obvious observation is that the equilibrium price pair in this final case does not depend on the Bertrand reaction function $r^1(p_2;c+\theta_1)$ of the domestic firm, thus, the value of θ_1 does not affect the equilibrium price. It is shown in Appendix A.4. that at this equilibrium price, both firms charge lower prices and install larger capacities than they

[30] There are other possible cases that are left out because they do not offer any unique implications in the comparative statics exercise of the next section.

would at the Bertrand price pair given by the intersection of $r^1(p_2;c+\theta_1)$ and $r^2(p_1;c+\theta_2)$. Thus, when θ_1 is very high, the Bertrand prices are also very high and the Bertrand outcome cannot be sustained as an equilibrium since firms have an incentive to expand their capacities and charge lower prices. Appendix A.4. also shows that as θ_2 becomes large enough, none of these previously mentioned equilibria stay robust anymore. In that case, the unique equilibrium is given by the Cournot price pair. (the point of intersection of curves $C^1(p_2;c+c_0)$ and $C^1(p_2;c+c_0)$ at which each firm's isoprofit curve is tangent to its isoquantity curve by definition) Therefore, the outcomes may resemble Bertrand or Cournot outcomes depending on the values of out-of-capacity costs of the firms in the present model.

2.2. Consumers

Three different goods are consumed in the domestic country. Two of them are the differentiated (symmetrically) products produced by the subsidiary firm and the domestic firm. The third product is the numeraire good, which is produced domestically in the competitive sector. Domestic consumers are of the same type and the representative consumer has a separable utility function that is linear in the numeraire good. Thus, there are no income effects on the consumers' consumption of the differentiated goods. The representative consumer's maximization problem can be written as:

$$Max_{q_1,q_2}\{U(q_1,q_2)-p_1q_1-p_2q_2\}$$

where q_1 and q_2 denote the consumption of differentiated products produced by the subsidiary firm and the domestic firm, respectively, and p_1 and p_2 are their prices.

As in Singh and Vives (1984), $U(q_1, q_2)$ is assumed to be quadratic and strictly concave and is given by the following functional form:

$$U(q_1, q_2) = \alpha_1 q_1 + \alpha_2 q_2 - \frac{1}{2}(\beta_1 q_1^{\ 2} + 2\gamma q_1 q_2 + \beta_2 q_2^{\ 2}) \tag{3}$$

In order to match the direct demands given in the previous section, I assume that $\alpha_1 = \alpha_2 = \alpha$ and $\beta_1 = \beta_2 = \beta$. Thus, the consumer surplus can be written as

$$CS(q_1, q_2, p_1, p_2) = \alpha(q_1 + q_2) - \frac{1}{2}(\beta q_1^{\ 2} + 2\gamma q_1 q_2 + \beta q_2^{\ 2}) - p_1 q_1 - p_2 q_2 \tag{4}$$

Following the consumer maximization problem, the linear direct demands are given as

$$q_i(.) = \frac{\alpha}{\beta + \gamma} - \frac{\beta}{\beta^2 - \gamma^2} p_i(.) + \frac{\gamma}{\beta^2 - \gamma^2} p_{-i}(.) \qquad \text{for } i = 1, 2. \tag{5}$$

Matching the demand form above with $q_i(.) = a - b_1 p_i(.) + b_2 p_{-i}(.)$ suggests

$$a = \frac{\alpha}{\beta + \gamma}, \quad b_1 = \frac{\beta}{\beta^2 - \gamma^2} \quad \text{and} \quad b_2 = \frac{\gamma}{\beta^2 - \gamma^2} \tag{6}$$

The assumption $b_1 > b_2 > 0$ indicates $\beta > \gamma > 0$. The ratio γ/β expresses the degree of differentiation between the two products. As this ratio approaches to zero, the goods become more independent (differentiated) and as it gets close to one, the market becomes almost homogenous.

3. Government Intervention

Suppose the domestic government is considering implementing an import policy with an objective of maximizing the national welfare.[31] The policy tool is a specific tariff. A tariff imposition has an impact on the equilibrium structure of the game even though in equilibrium, the multinational firm chooses not to export to the domestic market and produces at capacity.[32] On the other hand, an import quota (strictly positive) would be redundant in this model. This distinction can be explained as follows. The tariff affects the short-run marginal cost function of the multinational firm (figure 2), thus, it affects the subgame reaction function of the multinational firm, altering the optimal prices chosen by the firms in the second stage. A strictly positive quantity restriction does not lead to the same conclusion in that the marginal cost curve is not affected and the multinational firm's residual marginal curve intersects the marginal cost curve still at the vertical segment in figure 2 under a quantity restriction. It might be interesting to compare this result to Krishna (1989)'s main finding of non-equivalence of quantity and price restrictions under strategic trade policy. The main result of the paper is that under

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[31] The approach taken here is normative in the sense that the model does not encompass any political economy motivations such as strategic interactions between firms and government (e.g. lobbying) and the government is assumed to maximize national welfare exogenously.

[32] This structure facilitates the welfare analysis in that there is no tariff revenue. Yet, the insights of the model carry over to situations in which the multinational firm may choose to export due to an uncertainty in costs, demand, etc.

price competition, while a voluntary export restraint ("VER") set at the free trade level of imports improves the profits of the foreign firm and the domestic firm, a tariff imposition acts as a profit-shifting device, harming the foreign firm. In her model, a VER acts like a capacity constraint on the foreign firm and restricts its ability to compete effectively in the domestic market. This changes the strategic interactions between firms and helps them to sustain higher prices than they would with a tariff.

In the present model, the capacities are assumed to be flexible and a quantity restriction (unless it is an extreme restriction of no imports) on imports does not impose any additional constraints for the foreign firm. On the other hand, the tariff plays this role by making it more difficult for the multinational firm to export and induces changes in its capacity in the first stage.

3.1. Implications of Tariff for Firms

The tariff raises θ_2, thus, shifts the Bertrand reaction function of the multinational firm ($r^2(p_1;c+\theta_2)$), changing the equilibrium prices. I analyze the impact of the changes in θ_2 on the equilibria of the game for three different regions: $\theta_S > \theta_1 > \theta_2$, $\theta_C > \theta_1 > \theta_2 > \theta_V$, and $\theta_1 > \theta_C > \theta_V > \theta_2$. Throughout this section, I assume that θ_2 stays within the original region after the tariff imposition.[33] Recall from section 2.1.3 that for $\theta_S > \theta_1 > \theta_2$ and $\theta_C > \theta_1 > \theta_2 > \theta_V$, the equilibrium is unique and is given by the

[33] This prevents equilibrium from breaking down as well as additional equilibria from occurring, thus, facilitates comparison between different cases.

intersection of the Bertrand reaction functions $r^1(p_2;c+\theta_1)$ and $r^2(p_1;c+\theta_2)$. The next proposition describes how the domestic and the multinational firm will be affected by a tariff imposition on the multinational firm's exports for different initial levels of trade costs that lead to a unique equilibrium.

Proposition 1*: For $\theta_S > \theta_1 > \theta_2$, the tariff increases the profits for both firms. When θ_2* is *initially large $(\theta_C > \theta_1 > \theta_2 > \theta_V)$, only the domestic firm benefits from the tariff while the multinational firm loses.*

In the model, firms set their capacities in the first stage as a commitment to limit production and charge higher prices. The additional marginal cost of producing beyond capacity (trade costs for the multinational firm) determines how effective this commitment is.[34] For both ranges of θ_1 and θ_2, taxing the multinational firm's exports increases θ_2 and shifts its Bertrand reaction function $r^2(p_1;c+\theta_2)$ upwards. Since the price reaction functions of the subgame are upward sloping (prices are strategic complements), the optimal response of the domestic firm is also to raise its price. (It is shown in the next section that MNC's price increases by more than the domestic firm's price) These changes feed back into the capacity decisions of the firms in the first stage. Anticipating the price increases, the multinational firm would reduce its capacity in the first stage to avoid capacity idleness and the domestic firm's optimal response would be

[34] These results are conditional on θ_2 being low or high, thus, the flexibility of the multinational firm, which is the only firm directly affected by the tariff is the essential factor. Considering the case $\theta_2<\theta_S<\theta_1$, for example, leads to the same conclusion of proposition 1. This point will be emphasized again in proposition 2.

an expansion of its capacity since capacities are strategic substitutes.[35] Thus, the tariff provides a further commitment for the multinational firm to limit its production. When the capacity commitment is initially weak (for the range $\theta_S > \theta_1 > \theta_2$), it is shown in Appendix A.5. that the capacities of both firms are larger and the prices are lower compared to their levels in the strong commitment $(\theta_C > \theta_1 > \theta_2 > \theta_V)$ scenario. As explained in section 2.3.1, for both ranges of θ_1 and θ_2, the outcome resembles Bertrand outcome and the equilibrium prices depend positively on the marginal costs θ_1 and θ_2 although these marginal costs do not actually play any role in production. Thus, an increase in either of these costs raises the equilibrium prices. Intuitively, this result might be explained as follows. If a firm is the only producer of a good in the market, a low out-of-capacity cost lowers the penalty of producing beyond capacity if such a need arises due to unexpected changes in demand, etc. and the firm may want to build a small capacity initially. However, in this model, a low out-of-capacity cost is a signal for weak commitment to capacity to the rival firm, that is, the rival firm realizes that its competitor may expand its production beyond capacity easily and gain a competitive advantage by reducing its price. This triggers each firm to build large capacities to strategically respond to each other's actions. On the other hand, when the out-of-capacity cost is high, a firm is restricted by its capacity more strongly. Since the rival firm is aware of this situation, both firms strategically decide to limit production and charge higher prices. When the multinational firm's capacity is larger initially (low θ_2), it is more likely to benefit from a

[35] It is shown in Appendix B that the decrease in multinational firm's output outweighs the increase in domestic firm's output since own price effects dominate cross price effects in the demand equation.

tariff imposition. Because, the multinational firm loses some of its revenue due to decrease in its production (contraction in its capacity), but gains from the price increase for the remaining output that it sells. Moreover, the multinational firm can avoid the whole tariff by strategically adjusting its capacity in the first stage. Even if this was not the case and the multinational firm could not avoid the tariff fully by adjusting its capacity, the increase in its marginal cost applies to its output at the margin while the price increase applies to all of its output. A price elasticity argument would conclude that the gains are more likely to offset the losses if the initial production level is high. Therefore, the tariff has a positive impact on profits of the multinational firm when the initial trade costs are low enough. Although the favorable and adverse effects of the tariff seem to depend on θ_2, one might question to what extent these results are affected by the out-of-capacity cost θ_1 of the domestic firm since θ_1 and θ_2 lie in the same interval in both cases. This question is addressed in the following proposition by setting the domestic firm's out-of-capacity cost θ_1 at an arbitrarily high level.

Proposition 2: *For $\theta_1 > \theta_C > \theta_V > \theta_2$, the tariff increases the profits for both firms.*

As it was the case for $\theta_S > \theta_1 > \theta_2$, the multinational firm benefits from the tariff when θ_2 is low regardless of the value of θ_1, thus, the key factor in determining whether the multinational firm benefits from the tariff or not depends on the initial trade costs.

It can also be shown with a similar approach that the equilibrium structure and the implications of tariff for the multinational firm remain the same for certain ranges of out-of-capacity costs if firms were assumed to be symmetric, that is, $\theta_1 = \theta_2 = \theta$. More specifically, for both $\theta < \theta_S$ and $\theta_V < \theta < \theta_C$, the unique equilibrium is given by the Bertrand reaction functions $r^1(p_2; c+\theta)$ and $r^2(p_1; c+\theta)$. Also, both firms gain from the tariff for $\theta < \theta_S$, and only the domestic firm benefits from the tariff for $\theta_V < \theta < \theta_C$. This result is particularly useful for the purposes of the next section.

3.2. Implications of Tariff for Consumers

Recall from section 3.1 that for $\theta < \theta_S$ and $\theta_V < \theta < \theta_C$, the unique equilibrium is the symmetric Bertrand price. In order to facilitate comparison and for algebraic convenience, I focus only on this symmetric equilibrium to study the welfare effects of a tariff imposition by the domestic country's government. The results are robust for identical scenarios (one firm gains vs. both firms gain) for the asymmetric equilibria as well. At the symmetric equilibrium, both firms could be better off or only the domestic firm could gain (depending on the value of θ) due to government intervention. The implications of these different scenarios for the consumers and total welfare will be studied for different regions of θ. All the calculations and proofs for this section are presented in Appendix B.

Bertrand prices are obtained by solving the reaction functions $r^1(p_2; c+\theta)$ and $r^2(p_1; c+\theta)$ together and replacing (a, b_1, b_2) with $(\frac{\alpha}{\beta+\gamma}, \frac{\beta}{\beta^2-\gamma^2}, \frac{\gamma}{\beta^2-\gamma^2})$:

$$p_1 = p_2 = p_b(c+\theta) = (2\beta-\gamma)^{-1}(c\beta+\theta\beta+\alpha\beta-\alpha\gamma) \tag{7}$$

Plugging these prices in the demand function $q_i(.) = a - b_1 p_i(.) + b_2 p_{-i}(.)$ for either firm yields

$$q_1 = q_2 = q_b(c+\theta) = (\beta+\gamma)^{-1}(2\beta-\gamma)^{-1}(\alpha-c-\theta)\beta \tag{8}$$

At the symmetric equilibrium, the Bertrand price is positive since $\beta > \gamma > 0$. A necessary assumption for the Bertrand quantity to be positive is $\alpha > c+\theta$. The initial consumer surplus is calculated by plugging in the Bertrand prices and quantities in equation (1):

$$CS_{initial} = (\gamma-2\beta)^{-2}(\beta+\gamma)^{-1}(\alpha-c-\theta)^2\beta^2 \tag{9}$$

Trying different values γ/β of demonstrates that the initial consumer surplus is lower when goods are more differentiated, that is, when the ratio γ/β is smaller. Also, the consumer surplus decreases in θ, consistent with the observation that a higher θ means lower quantities and higher prices.

A tariff imposition (t) by the domestic government on the multinational firm's exports increases the marginal cost of supplying a unit beyond capacity by t, thus shifts the Bertrand reaction function $r^2(p_1; c+\theta)$ to the right. Since both reaction functions have positive slopes, the tariff will raise the prices of both goods. However, this increase is not equally proportional to the tariff amount in that the subsidiary firm's product becomes relatively more expensive since the slope of the domestic firm's Bertrand reaction function $r^1(p_2;c+\theta)$ is less than one. More specifically, the changes in prices are:

$$\Delta p_2 = (2\beta+\gamma)^{-1}(2\beta-\gamma)^{-1}(2t\beta^2) > \Delta p_1 = (2\beta+\gamma)^{-1}(2\beta-\gamma)^{-1}(t\gamma\beta) \qquad (10)$$

As a result, the amount of the subsidiary firm's product (q_2) decreases while consumers increase their consumption of the domestic firm's product. Thus, although both products become more expensive, there is more demand for the domestic firm's product, which is relatively cheaper. An intuitive result is that as goods become closer substitutes (γ/β goes up), the changes in both q_1 and q_2 (in absolute value) increase, that is, the consumers find it easier to shift their consumption to the relatively cheaper good. The change in the consumer surplus has the following functional form:

$$\Delta CS = f(\alpha,\gamma,\beta,c,\theta,t)$$

For different degrees of differentiation ($0<\gamma/\beta<1$), this form reduces to

$$\Delta CS = \frac{1}{\beta}t\big(A(c+\theta-\alpha)+Kt\big) \text{ where } 0<A<K \text{ for } 0<\gamma/\beta<1 \qquad (11)$$

Since both prices increase due to tariff, ΔCS is unambiguously negative. $\partial\Delta CS/\partial\theta$ is positive for all values of γ/β. Thus, an equal amount of tariff reduces the consumer surplus more when θ is small. This is consistent with the finding that both firms gain from the tariff imposition when θ is small while only the domestic firm is better off when θ is large. Therefore, the adverse effects of the tariff are borne both by consumers and the subsidiary firm when θ is large. Another observation is that $\partial \Delta CS / \partial t$ is negative for all values of γ/β and increases in absolute value as γ/β goes down. Therefore, the consumers are hurt more by the tariff as goods become more differentiated. This result is also intuitive in the sense that if goods are closer substitutes, consumers can shift their consumption towards the domestic firm's product more easily.

3.3. Implications of Tariff for Total Welfare

The change in the total domestic welfare is given by the sum of the change in consumer surplus and the net increase in domestic firm's profits: $\Delta TW = \Delta CS + \Delta \pi_1$. If the net increase in the domestic firm's profits can compensate for the loss in consumer surplus, then the tariff will improve the national welfare. The profits of the domestic firm can be written as follows:

$$\pi_1 = \left(\frac{\alpha}{\beta + \gamma} - \frac{\beta}{\beta^2 - \gamma^2} p_1 + \frac{\gamma}{\beta^2 - \gamma^2} p_2 \right) \bullet \left(p_1 - c - c_0 \right) \tag{12}$$

Using the pre- and post-tariff prices, $\Delta \pi_1$ $(\pi_{*1} - \pi_1)$ can be written as a function of the parameters $(\alpha, \gamma, \beta, c, c_0, \theta, t)$. For different degrees of differentiation ($0 < \gamma/\beta < 1$), this function reduces to

$$\Delta \pi_1 = \frac{1}{\beta} t \left(S(\alpha - c - c_0) + W(\theta - c_0) + R\alpha + Yt \right) \tag{13}$$

where S, W, R and Y are all positive as well as $(\theta - c_0)$ and $(\alpha - c - c_0)$.[36]

A few observations can be made about the factors that affect the profits of the domestic firm. $\partial \Delta\pi_1 / \partial\theta$ is positive for all values of γ/β. Thus, an equal amount of tariff increases the profits of the domestic firm more when θ is large. Recall from section 3.2. that when θ is small, the loss in the consumer surplus is larger than in the high θ case. The previous result implicitly indicates that the domestic firm's gain from profit-shifting for high θ dominates the difference between its gain of share of consumer surplus for high and low values of θ. Combining this result with the previous finding that an equal amount of tariff reduces the consumer surplus less when θ is large indicates that under government intervention, the change in welfare is more likely to be positive when θ is large. Also, $\partial \Delta\pi_1 / \partial t$ is positive for all values of γ/β but decreases as γ/β goes down. Thus, while the domestic firm benefits from the tariff for any given value of θ, the increase in its profits gets smaller as goods become more differentiated. This intuition is the same as before. As consumers find it more difficult to shift their consumption towards the domestic firm's product due to a low differentiation degree, the profits of the domestic firm are unfavorably affected. Combining this result with the previous finding that consumers lose more from the tariff when goods are more differentiated suggests that the total domestic welfare is more likely to fall as the degree of differentiation decreases. Adding ΔCS and $\Delta\pi_1$ yields the following functional form:

[36] The former is due to the presence of incentive for either firm to build capacity, and the latter is due to the non-negativity assumption for the Bertrand quantity ($\alpha - c - \theta > 0$) plus the former assumption.

$$\Delta TW = Z(\alpha, \gamma, \beta, c, c_0, \theta, t)$$

For different degrees of differentiation ($0 < \gamma/\beta < 1$), this function reduces to

$$\Delta TW = \frac{1}{\beta} t\left(D(\theta - c_0) - E(\alpha - c - \theta) + F(c + \theta) + Lt\right) \quad (14)$$

where D, E, F and L are all positive as well as $(\theta - c_0)$ and $(\alpha - c - \theta)$.

For $\theta < \theta_S$, the change in the total welfare turns out to be negative regardless of the differentiation level of the products. This is not a surprising result in the sense that when θ is low enough, both the domestic firm and the subsidiary firm benefit from the tariff imposition at the expense of consumers while the tariff revenue is zero since there are no exports in equilibrium. Therefore, the domestic country's welfare is reduced by the tariff. For $\theta_V < \theta < \theta_C$, the result is ambiguous and depends on the differentiation level of the products. Replacing θ with θ_V (the smallest possible value in this interval) suggests that the net change in welfare is positive as long as $\gamma/\beta > 0.35$. If goods become more differentiated (γ/β falls below the threshold level), a higher θ is required to keep the welfare change positive.

4. Conclusion

One of the most robust findings in the strategic import policy literature is that a domestic government's tariff imposition on exports of a foreign firm benefits the domestic firm at the expense of the foreign firm. This result is intuitive in that tariff increases the marginal cost of supplying the host market for the foreign firm, giving the domestic firm a strategic advantage in the competition. However, if the foreign firm is a flexible MNC which does not solely depend on either exports or local production as opposed to the case in the standard models, it may potentially avoid some (or all) of the burden resulting from the tariff.

The purpose of this paper is to examine how this flexibility factor affects a domestic government's decision on the optimal trade policy. More specifically, I consider a duopoly model in which a domestic firm and a foreign MNC compete in the domestic market. Besides local production, the MNC can also export to the domestic market from its parent plant. It is shown that a specific tariff imposition on the MNC's exports successfully helps out the domestic firm as one would normally expect. A more interesting result is that when initial trade costs are low enough, the MNC also benefits from the tariff imposition. Thus, the effects of the tariff on the total domestic welfare are ambiguous and depend on the level of trade costs as well as the degree of differentiation between firms' products. The tariff seems to enhance the total welfare when trade costs are high enough provided that the products of the rival firms are not very differentiated.

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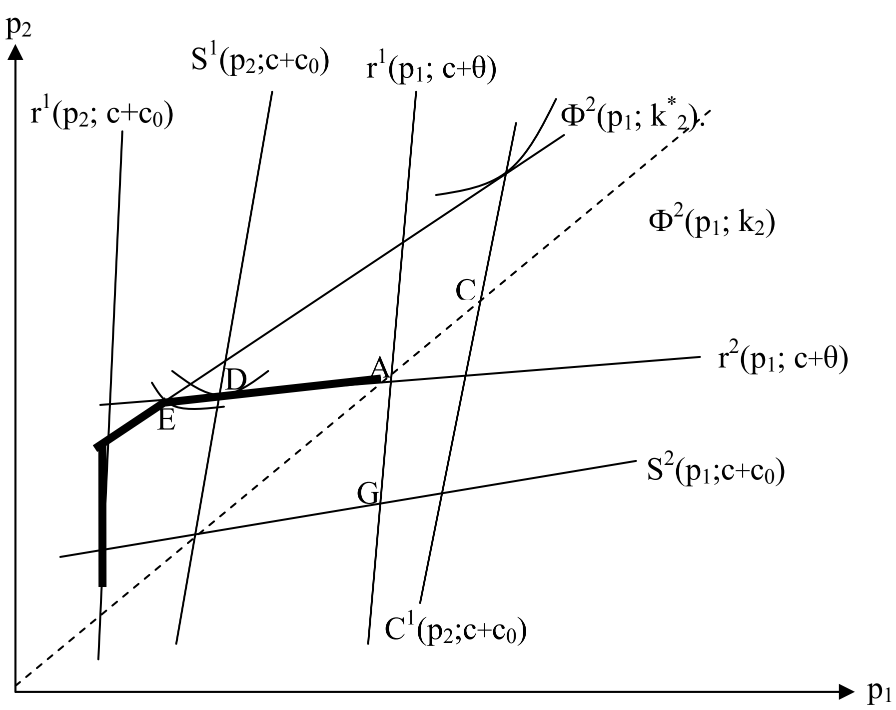
Appendix A

A.1. Equilibria of the full game : $\theta_S < \theta < \theta_V < \theta_C$

It is graphically easier to illustrate the candidate equilibrium points for a symmetric case ($\theta_S < \theta < \theta_V < \theta_C$). The same analysis follows for the two asymmetric cases, which will be discussed later. (The role of θ_S was shown for the asymmetric case ($\theta_2 < \theta_1 < \theta_S$) in section 2.1.3.)

It can be shown by contradiction that no point to the left of point D can be an equilibrium point:

Assume E is an equilibrium point. Then, firm 2 has to choose a capacity level k_2^* such that $\Phi^2(p_1;k_2^*)$ passes through point E.

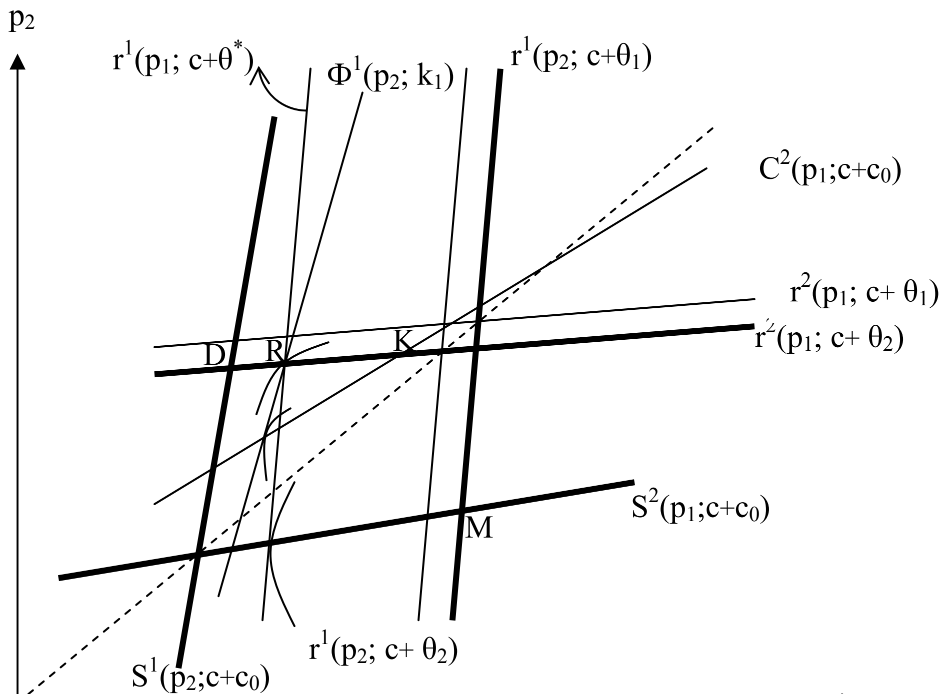


Graph 1

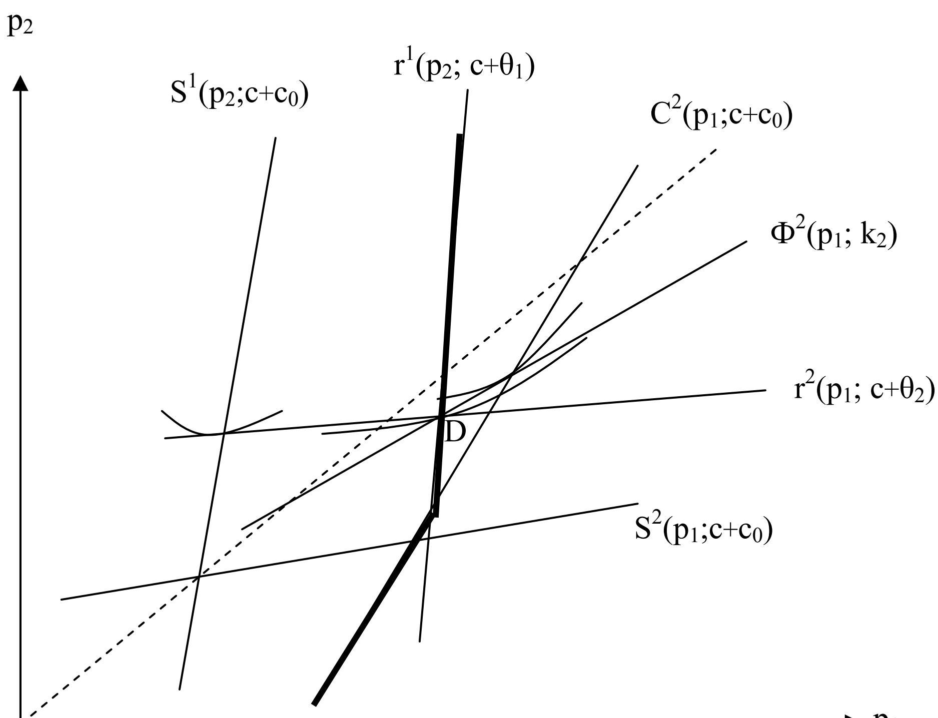
Firm 1 can increase its profits by deviating from point E towards point D and can still be on the price reaction function of firm 2 (bold line) and within the required band $(r^1(p_2;c+c_0), r^1(p_2;c+\theta))$. This contradicts with the assumption that E is an equilibrium point. Since firms are symmetric, no point below point G can be an equilibrium point as well. Together with the IC band constraint presented in section 2.3.1, the set of candidate equilibria points reduces to the band DG and AG. Maggi (1996) shows that the only robust asymmetric equilibrium price candidates on the segments DA and AG are given by the intersection of the Bertrand reaction functions and S(.) curves. (point D and G) when marginal cost function is approximated by a smooth function. Intuitively, this result is due to the presence of a kink in firm 2's price reaction function. This reaction function becomes smooth and the equilibrium breaks down when $R^2(p_1;k_2)$ is approximated by a smooth function.

A.2. Equilibria of the full game : $\theta_C > \theta_1 > \theta_2 > \theta_V$

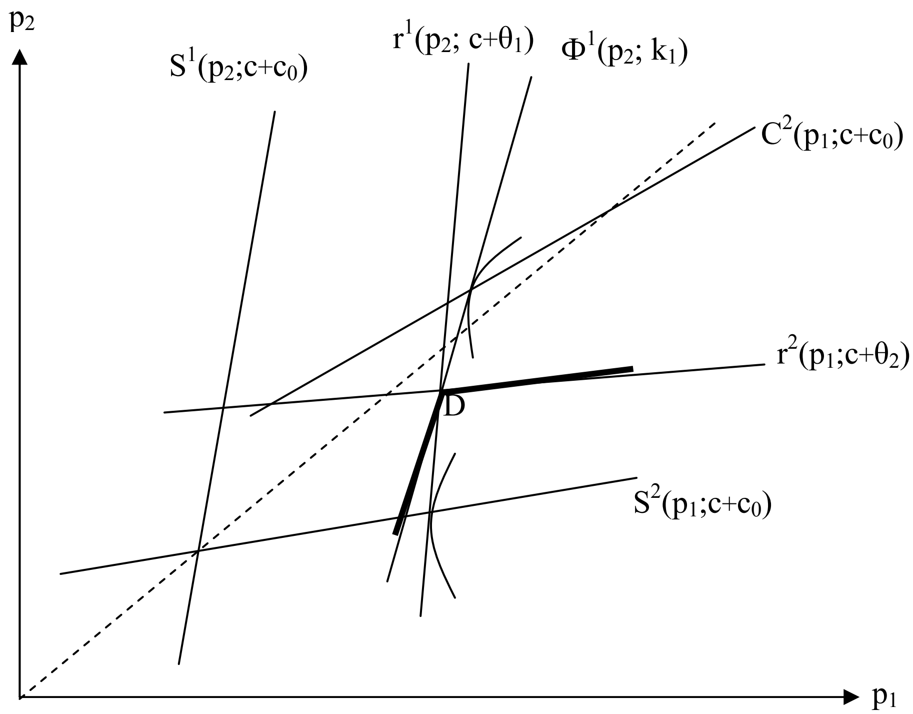
Recall from section 2.1.3 that when $\theta > \theta_V$, $C^i(p_{-i};c+c_0)$ intersects $S^{-i}(p_i;c+c_0)$ at a lower point than $r^i(p_{-i};c+\theta)$ does, $i=1,2$. Thus, $C^2(p_1;c+c_0)$ intersects $r^2(p_1;c+\theta_2)$ to the right of point D. (point K in graph 3) Consider the asymmetric price pair R which is on $r^2(p_1;c+\theta)$ and to the left of the K. If R is an equilibrium point, then, Firm 1 should build its capacity (k_1) in such a way that its isoquantity curve $\Phi^1(p_2;k_1)$ passes through point R. Also, for a specific value of $\theta(\theta^*)$, there is a Bertrand reaction function for Firm 1 $(r^1(p_2;c+\theta^*))$ which passes through point R. (by definition, the slopes $m(.)$ of curves $r^i(.)$, $S^i(.)$, and $\Phi^i(.)$ are ordered as follows: $m(r^i) > m(\Phi^i) > m(S^i)$) As seen from the isoprofit curves in graph 3, at point R, firm 2 has an incentive to deviate by going down on $\Phi^1(p_2;k_1)$ and still be on the subgame reaction function of firm 1. Therefore, point R cannot be an equilibrium point although it is located between $S^1(p_2;c+c_0)$ and $r^1(p_2;c+\theta)$. This implies that a necessary condition for a price pair (p_1,p_2) to be an equilibrium point is $p_2 \leq C^2(p_1;c+c_0)$. For $\theta > \theta_V$, it is obvious that this condition does not hold for the robust equilibrium candidate point D. With a similar analysis, it can be shown that the same result holds for point M since $\theta_1 > \theta_V$. The remaining candidate robust equilibrium price pair is given by the intersection of the Bertrand reaction functions. (point D in graph 3) Firm 2's isoprofit function's slope should be in between the slope of $r^1(p_2;c+\theta_1)$ and $\Phi^1(p_2;k_1)$. At point D, firm 2 wants to deviate and go to the right on $r^2(p_1;c+\theta_2)$. While doing that, it can still stay on the subgame reaction function of firm 1 (bold line), however, it will no longer satisfy the band constraint $p_1 \leq r^1(p_2;c+\theta_1)$. Therefore, firm 2 does not have any incentive to deviate from point D. As seen in graph 4, firm 1 has an isoprofit curve whose slope at point D is in between the slopes of $r^2(p_1;c+\theta_2)$ and $\Phi^2(p_1;k_2)$. Firm 1 can increase its profits by moving up on $r^1(p_2;c+\theta_1)$ or moving to the left on $r^2(p_1;c+\theta_2)$. However, it can't deviate from point in either way. The first move would violate the band constraint $p_2 \leq r^2(p_1;c+\theta_2)$. The second one would result in a price that is not on the subgame reaction function (bold line) of firm 2. Therefore, point D is the unique equilibrium price pair of the game.



Graph 2



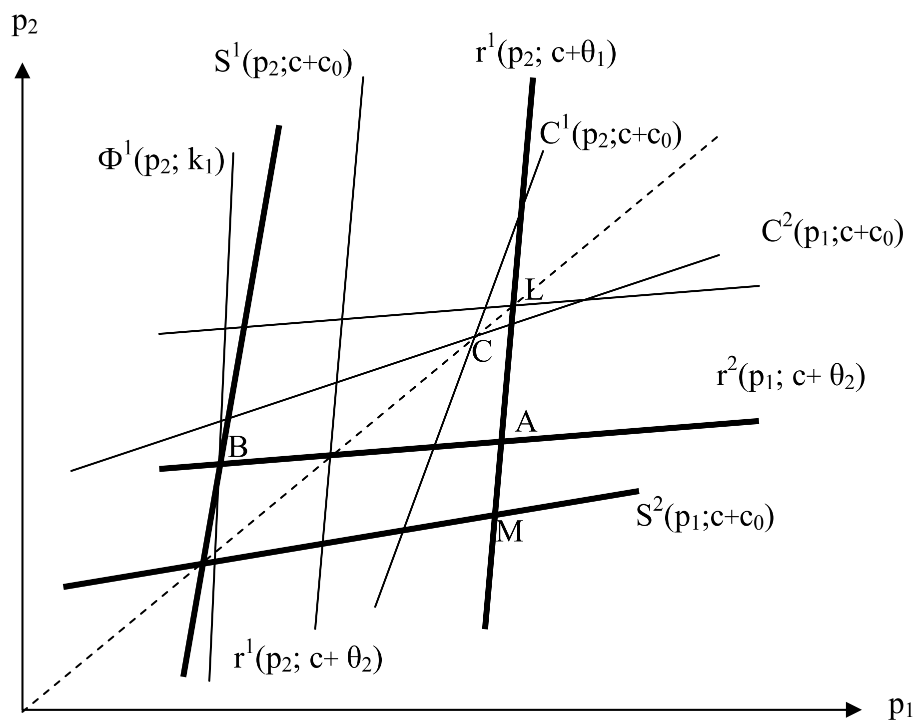
Graph 3



Graph 4

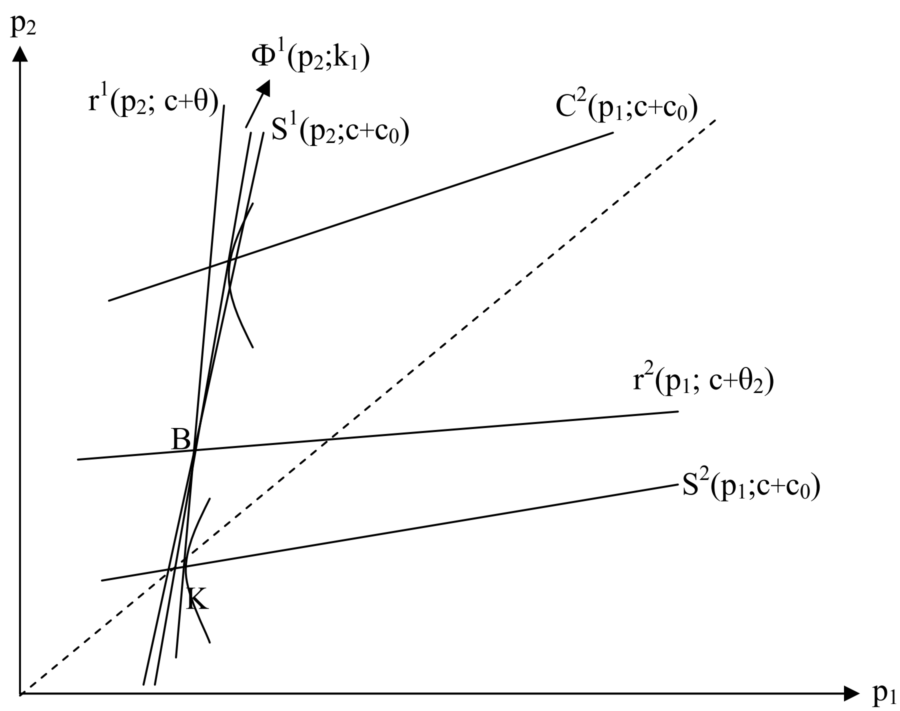
A.3. Equilibria of the full game : $\theta_1 > \theta_C > \theta_V > \theta_2$

As seen in graph 5, since $\theta_1 > \theta_C$, the Bertrand price pair ($p^b(c+\theta_1)$, $p^b(c+\theta_1)$) lies at point L, which is above the Cournot price pair. (point C). Thus, both of the candidate equilibrium points (points A and M) are to the right of $C^1(p_2;c+c_0)$, violating the necessary equilibrium constraint $p_1 \le C^1(p_2;c+c_0)$. Given $\theta_V > \theta_2$, point B is a candidate equilibrium point. Graph 6 studies this candidate equilibrium in detail. By definition, $r^1(p_2;c+\theta)$ (for $\theta < \theta_2$) is steeper than both $\Phi^1(p_2;k_1)$ and $S^1(p_2;c+c_0)$. Since $\theta < \theta_2 < \theta_V$, $C^1(p_2;c+c_0)$ intersects firm 2's isoquantity curve $\Phi^1(p_2;k_1)$, which is given by its optimal capacity k_1 for this type of equilibrium at a higher point than point B. The isoprofit at this point yields lower profits than the one at point K, which is tangent to $r^1(p_2;c+\theta)$ by definition of $S^2(p_1;c+c_0)$. Therefore, the slope of firm 2's isoprofit at point A should be between the slopes of these two isoprofits.



Graph 5

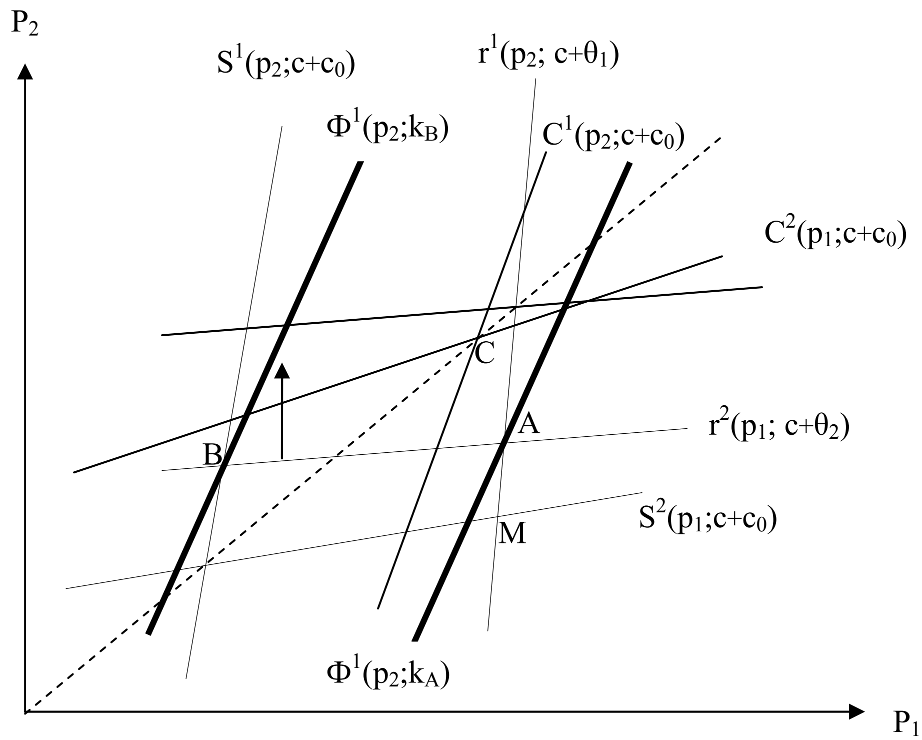
The slope of the isoprofit curve at point B is lower than the slopes of $S^1(p_2;c+c_0)$ and $\Phi^1(p_2;k_1)$. (firm 2's isoprofit curve that is tangent on $\Phi^1(p_2;k_1)$ at the intersection of $C^2(p_1;c+c_0)$ and $\Phi^1(p_2;k_1)$ is not demonstrated on the graph) Similar analysis as before can be used to show that firm 2 cannot deviate from point B because this potentially profitable deviation (moving up on $S^1(p_2;c+c_0)$ or down on $r^1(p_2;c+\theta)$) would violate either the band constraint $p_2 \le r^2(p_1;c+\theta_2)$ or the new price pair would not be on the subgame reaction function of firm 1, which is kinked at point B. It is trivial to see that firm 1 also dos not have any incentive to deviate from point B. Because its isoprofit curve that is tangent to $r^2(p_1;c+\theta_2)$ at point B by definition of $S^1(p_2;c+c_0)$ is already a profit-maximizing price pair for firm 1.



Graph 6

A.4. Cournot and Bertrand Outcomes

Graph 7 demonstrates the equilibrium structure for $\theta_1 > \theta_C > \theta_V > \theta_2$. As shown before, the unique equilibrium is given by point B. However, as θ_2 increases above θ_V, then, the new candidate robust equilibrium price will be above point B on $S^1(p_2;c+c_0)$. In that case, $C^1(p_2;c+c_0)$ intersects $S^1(p_2;c+c_0)$ above below this candidate equilibrium price and the equilibrium constraint $p_2 \le C^2(p_1;c+c_0)$ is no longer satisfied. The other candidate equilibrium price pairs (point A and M) are not affected by these changes and still lie outside the equilibrium range. Thus, with high levels of θ_1 and θ_2, the only equilibrium price is given by point C (the Cournot price pair) at which neither firm has an incentive to deviate because by definition of curves $C^1(p_2;c+c_0)$ and $C^2(p_2;c+c_0)$, each firm's isoprofit curve is tangent to its isoquantity curve.



Graph 7

Recall from section 2.1.1 that the price combinations such that the demand for firm i is constant at k_i are represented by $p_i = \Phi^i(p_{-i};k_i)$, that is, $\Phi^i(p_{-i};k_i)$ is an isoquantity curve. Formally, the isoquantity curve for firm 1 can be written as follows:

$$\blacksquare\, k_1 = D(p_i, p_{-i}) = a - b_1 p_1 + b_2 p_2 \qquad (1)$$

Solving the equation above for p_1 yields:

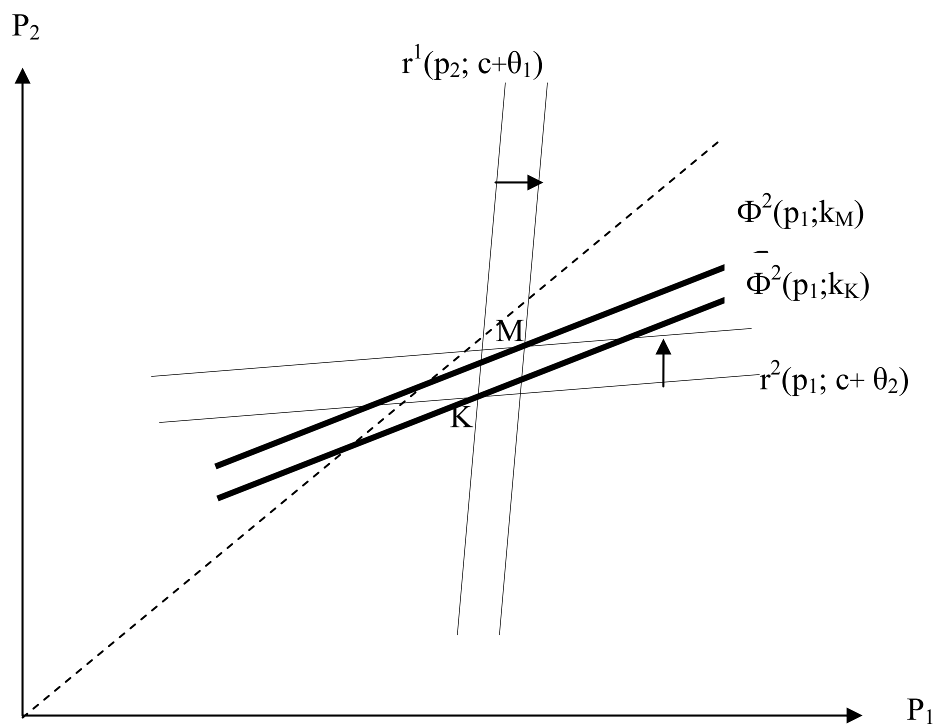
$$\blacksquare\ p_1 = \Phi^1(p_2;k_1) = \frac{a + b_2 p_2 - k_1}{b_1} \tag{2}$$

Therefore, given the rival's price, a firm's price on its isoquantity curve is inversely proportional to its capacity. Since firm 1's price is higher on $\Phi^1(p_2;k_B)$ than on $\Phi^1(p_2;k_A)$ given p_2, we can conclude that firm 1's capacity level at point B (k_B) is greater than its capacity level at point A. (k_A) A similar analysis could be done to show that firm 2 also chooses a lower capacity level at point B. Comparing the prices at point A and B is an easier task. Since the Bertrand reaction function is upward sloping, both firms charge lower prices at point B than at point A.

A.5. Proposition 1

Once the equilibria and profit curves are constructed, the implications of the tariff for the firms could be identified by a comparative-statics exercise on the equilibria of the game. Recall from figure 5 in section 2.1.3 that for $\theta_S > \theta_1 > \theta_2$, the unique equilibrium is given by the intersection of Bertrand reaction functions. (point B) A tariff imposition on the exports of the multinational firm raises θ_2, thus, shifts the Bertrand reaction function $r^2(p_1;c+\theta_2)$ upwards. The new equilibrium price gets closer to the profit-maximizing price pair on $r^1(p_2;c+\theta_1)$ (point R), thus, the multinational firm benefits from the tariff. Similarly, as seen in figure in section 2.1.3, a price pair on $r^1(p_2;c+\theta_1)$ above the initial equilibrium point B indicates higher profits for firm 1 as well. It can be seen in Graph 3 in section A.2 that firm 1 can achieve higher profits if it moves up on $r^1(p_2;c+\theta_1)$. Thus, a tariff imposition is beneficial to firm 1. However, the two isoprofit curves in graph 4 indicate that firm 4's isoprofit curve at point D has to lie in between $r^1(p_2;c+\theta_1)$ and $\Phi^1(p_2;k_1)$. Thus, firm 2 can increase its profits only by choosing a price pair to the right of point D on $r^2(p_1;c+\theta_2)$ or below point D on $r^1(p_2;c+\theta_1)$. Therefore, the multinational firm loses from the tariff in this case.

As seen in graph 8, the equilibrium point for low levels of θ_2 and θ_1. At point M, the prices are higher. Also, remembering from Appendix section A.5. that firm 2's price on its isoquantity curve is inversely proportional with its capacity level given firm 1's price, we can conclude that $k_M < k_K$. Note that fixing the level of θ_1 and changing only θ_2 does not affect this result. A similar exercise could be done to prove that firm 1's capacity is also higher at point M than at point K.



Graph 8

A.6. Proposition 2

The two isoprofit curves in graph 6 indicate that the multinational firm's isoprofit curve at point B lies in between $r^1(p_2; c+\theta)$ and $\Phi^1(p_2; k_1)$. The multinational firm can increase its profits only by choosing a price pair above point B on $S^1(p_2; c+c_0)$ or below point B on $r^1(p_2;c+\theta)$. Since a tariff imposition raises θ_2, and moves up the equilibrium point on $S^1(p_2;c+c_0)$ by shifting up $r^2(p_1;c+\theta_2)$, the multinational firm benefits from the tariff for this case. By definition, $S^1(p_2;c+c_0)$ consists of the tangency points between the domestic firm's profits and $r^2(p_1;c+\theta_2)$. As θ_2 increases, the new equilibrium point corresponds to a higher isoprofit curve, which indicates that the domestic firm also benefits from the tariff.

Appendix B

B.1. Consumer surplus under free trade

For $\theta < \theta_C$, as shown in the previous section, the symmetric equilibrium is given by the Bertrand price and quantity pair $\{p^b(c+\theta), q^b(c+\theta)\}$ for each firm. The Bertrand prices can be obtained by solving the reaction functions $r^1(p_2;c+\theta)$ and $r^2(p_1;c+\theta)$ together.

$$p_1 = r^1(p_2;c+\theta) = \frac{a+b_2 p_2}{2b_1} + \frac{c+\theta}{2} \qquad \text{(i)}$$

$$p_2 = r^2(p_1;c+\theta) = \frac{a+b_2 p_1}{2b_1} + \frac{c+\theta}{2} \qquad \text{(ii)}$$

Solving (i) and (ii) yields

$$\blacksquare\ p_1 = p_2 = p_b(c+\theta) = \frac{a+b_1 c+\theta b_1}{2b_1 - b_2} \qquad (3)$$

Plugging the Bertrand price pair in the demand function $q_i(.) = a - b_1 p_i(.) + b_2 p_{-i}(.)$ for either firm gives the Bertrand quantity.

$$\blacksquare\, q_b(c+\theta) = a + (b_2 - b_1)(\frac{a + b_1 c + \theta b_1}{2b_1 - b_2}) = \frac{(a - cb_1 + cb_2 - \theta b_1 + \theta b_2)b_1}{2b_1 - b_2} \qquad (4)$$

Replacing (a, b_1, b_2) with $(\frac{\alpha}{\beta+\gamma}, \frac{\beta}{\beta^2-\gamma^2}, \frac{\gamma}{\beta^2-\gamma^2})$ in both the Bertrand price and quantity gives the following expressions:

$$p_1 = p_2 = p_b(c+\theta) = \frac{(\frac{\alpha}{\beta+\gamma}) + (\frac{\beta}{\beta^2-\gamma^2})c + \theta(\frac{\beta}{\beta^2-\gamma^2})}{2(\frac{\beta}{\beta^2-\gamma^2}) - (\frac{\gamma}{\beta^2-\gamma^2})}$$

$$\blacksquare\, p_b(c+\theta) = (2\beta - \gamma)^{-1}(c\beta + \theta\beta + \alpha\beta - \alpha\gamma) \qquad (5)$$

$$q_1 = q_2 = q_b(c+\theta) = \frac{\left(\frac{\alpha}{\beta+\gamma} - c(\frac{\beta}{\beta^2-\gamma^2}) + c(\frac{\gamma}{\beta^2-\gamma^2}) - \theta(\frac{\beta}{\beta^2-\gamma^2}) + \theta(\frac{\gamma}{\beta^2-\gamma^2})\right)(\frac{\beta}{\beta^2-\gamma^2})}{2(\frac{\beta}{\beta^2-\gamma^2}) - (\frac{\gamma}{\beta^2-\gamma^2})}$$

$$\blacksquare\, q_b(c+\theta) = (\beta+\gamma)^{-1}(2\beta-\gamma)^{-1}(\alpha - c - \theta)\beta \qquad (6)$$

Given the initial Bertrand prices and quantities, the consumer surplus can be calculated as follows:

$$CS_{initial} = 2\alpha q^b(c+\theta) - (\beta+\gamma)(q^b(c+\theta))^2 - 2p^b(c+\theta)q^b(c+\theta)$$

$$= q^b(c+\theta)\left(2\alpha - (\beta+\gamma)q^b(c+\theta) - 2p^b(c+\theta)\right)$$

$$=\left((\beta+\gamma)^{-1}(2\beta-\gamma)^{-1}(\alpha-c-\theta)\beta\right)\begin{pmatrix}2\alpha-(\beta+\gamma)((\beta+\gamma)^{-1}(2\beta-\gamma)^{-1}(\alpha-c-\theta)\beta)\\ -2(2\beta-\gamma)^{-1}(c\beta+\theta\beta+\alpha\beta-\alpha\gamma)\end{pmatrix}$$

$$\blacksquare\ CS_{initial} = (\gamma-2\beta)^{-2}(\beta+\gamma)^{-1}(\alpha-c-\theta)^2\beta^2 \qquad (7)$$

B.2. Consumer surplus with government intervention

The tariff t increases the additional marginal cost of producing beyond capacity for the subsidiary firm by making exporting more expensive. The domestic firm's Bertrand reaction function remains unchanged.

$$\blacksquare\ p_2 = r^2(p_1; c+\theta) = \frac{a+b_2p_1}{2b_1} + \frac{c+\theta+t}{2} \qquad (8)$$

$$\blacksquare\ p_1 = r^1(p_2; c+\theta) = \frac{a+b_2p_2}{2b_1} + \frac{c+\theta}{2} \qquad (9)$$

Solving the equations above together yields

$$\blacksquare\ p_{*2} = p_b(c+\theta) + \frac{2tb_1^{\,2}}{4b_1^{\,2}-b_2^{\,2}} \qquad p_{*1} = p_b(c+\theta) + \frac{tb_1b_2}{4b_1^{\,2}-b_2^{\,2}} \qquad (10)$$

Replacing (b_1, b_2) with $(\frac{\beta}{\beta^2-\gamma^2}, \frac{\gamma}{\beta^2-\gamma^2})$ yields

$$\blacksquare\ \Delta p_2 = \frac{2tb_1^{\,2}}{4b_1^{\,2}-b_2^{\,2}} = \frac{2t(\frac{\beta}{\beta^2-\gamma^2})^2}{4(\frac{\beta}{\beta^2-\gamma^2})^2-(\frac{\gamma}{\beta^2-\gamma^2})^2} = \frac{2t\beta^2}{(2\beta+\gamma)(2\beta-\gamma)} \qquad (11)$$

$$\blacksquare\ \Delta p_1 = \frac{t(\frac{\beta}{\beta^2-\gamma^2})(\frac{\gamma}{\beta^2-\gamma^2})}{4(\frac{\beta}{\beta^2-\gamma^2})^2 - (\frac{\gamma}{\beta^2-\gamma^2})^2} = \frac{t\gamma\beta}{(2\beta+\gamma)(2\beta-\gamma)} \quad (12)$$

$\blacksquare\ \Delta p_2 > \Delta p_1$ since $2(t\beta^2) > t\gamma\beta \Rightarrow 2\beta > \gamma$ which holds for all values of β and γ.

The new equilibrium quantities are obtained as follows:

$$q_{*2} = (\frac{\alpha}{\beta+\gamma}) - (\frac{\beta}{\beta^2-\gamma^2})p_{*2} + (\frac{\gamma}{\beta^2-\gamma^2})p_{*1}$$

$$q_{*2} = (\frac{\alpha}{\beta+\gamma}) - (\frac{\beta}{\beta^2-\gamma^2})\left(p_b(c+\theta) + \frac{2t\beta^2}{(2\beta+\gamma)(2\beta-\gamma)}\right) + (\frac{\gamma}{\beta^2-\gamma^2})\left(p_b(c+\theta) + \frac{t\gamma\beta}{(2\beta+\gamma)(2\beta-\gamma)}\right)$$

$$\blacksquare\ q_{*2} = q_b(c+\theta) + \Delta q_2 \Rightarrow \Delta q_2 = \frac{t(\frac{\beta}{\beta^2-\gamma^2})(\frac{\gamma}{\beta^2-\gamma^2})^2 - 2t(\frac{\beta}{\beta^2-\gamma^2})^3}{4(\frac{\beta}{\beta^2-\gamma^2})^2 - (\frac{\gamma}{\beta^2-\gamma^2})^2} \quad (13)$$

$$\blacksquare\ \Delta q_2 = (\beta+\gamma)^{-1}(2\beta+\gamma)^{-1}(\gamma-2\beta)^{-1}(\gamma-\beta)^{-1}(\gamma^2-2\beta^2)\beta t < 0 \quad \text{since } \gamma < \beta \quad (14)$$

Similarly, the change in q_1 can be found as

$$\blacksquare\ \Delta q_1 = (\beta+\gamma)^{-1}(2\beta+\gamma)^{-1}(\gamma-2\beta)^{-1}(\gamma-\beta)^{-1}(t\gamma\beta^2) > 0 \quad (15)$$

$\blacksquare\ |\Delta q_2| > |\Delta q_1| \Rightarrow (2\beta^2-\gamma^2)\beta t > t\gamma\beta^2 \Rightarrow 2\beta^2-\gamma^2-\beta\gamma > 0$ which holds since $\beta > \gamma$.

The new consumer surplus can be calculated by plugging the new equilibrium prices and quantities in the consumer surplus equation.

$$\blacksquare\, CS_{final} = \alpha(q_{*1} + q_{*2}) - \frac{1}{2}(\beta q_{*1}{}^{2} + 2\gamma q_{*1} q_{*2} + \beta q_{*1}{}^{2}) - p_{*1} q_{*1} - p_{*2} q_{*2} \qquad (16)$$

CS_{final} is a rather lengthy expression and is a function of the parameters $(\alpha, \gamma, \beta, c, \theta, t)$. Subtracting $CS_{initial}$ from CS_{final} gives the change in the consumer surplus ΔCS as follows:

$$\blacksquare\, \Delta CS = \frac{(8c\beta^3 - 2c\gamma^3 + 8\theta\beta^3 - 2\theta\gamma^3 - 8\alpha\beta^3 + 2\alpha\gamma^3 + 4\beta^3 t - 6c\beta\gamma^2 - 6\theta\beta\gamma^2 + 6\alpha\beta\gamma^2 - 3\beta\gamma^2 t)(\beta^2 t)}{-2(\beta+\gamma)(2\beta+\gamma)^2(\gamma-2\beta)^2(\gamma-\beta)} \qquad (17)$$

Replacing γ with $\beta \times j$ for different values of $j \in (0,1)$ in the ΔCS equation above yields the following functional form for the change in the consumer surplus:

$$\blacksquare\, \Delta CS = \frac{1}{\beta} t\big(A(c + \theta - \alpha) + Kt\big) \text{ where } 0 < A < K \qquad (18)$$

B.3. Total welfare with government intervention

Change in total welfare is given as

$$\blacksquare\, \Delta TW = \Delta CS + \Delta\pi_1 \qquad (19)$$

where $\pi_1 = (a - b_1 p_1 + b_2 p_2) \bullet (p_1 - c - c_0)$ and $\Delta\pi_1 = \pi_{*1} - \pi_1$

Using the pre-tariff and post-tariff price pairs $((p_1, p_2), (p_{*1}, p_{*2}))$ and replacing (a, b_1, b_2) with $(\frac{\alpha}{\beta+\gamma}, \frac{\beta}{\beta^2-\gamma^2}, \frac{\gamma}{\beta^2-\gamma^2})$, the net increase in π_1 can be written as follows:

$$\blacksquare \; \Delta\pi_1 = \frac{(2\theta\beta^3 - 2c\beta^3 + 2\alpha\beta^3 - \alpha\gamma^3 + c\beta\gamma^2 + c\beta^2\gamma - 4\beta^3 c_0 + \theta\beta^2\gamma - 2\alpha\beta\gamma^2 + \alpha\beta^2\gamma - \beta^2\gamma t + \beta\gamma^2 c_0)(\beta t)}{(\beta+\gamma)(2\beta+\gamma)^2(\gamma-2\beta)(\gamma-\beta)} \tag{20}$$

Replacing γ with $\beta \times j$ for different values of $j \in (0,1)$ in the ΔCS equation above yields the following functional form for the change in the consumer surplus:

$$\blacksquare \; \Delta\pi_1 = \frac{1}{\beta} t\left(S(\alpha - c - c_0) + W(\theta - c_0) + R\alpha + Yt\right) \tag{21}$$

where S, W, R and Y are all positive as well as $(\alpha - c - c_0)$ and $(\theta - c_0)$. The table below provides the values for S, W, R and Y for some random values of j where $\gamma = \beta \times j$.

$\gamma = \beta \times j$	$j = 0.90$	$j = 0.50$	$j = 0.30$	$j = 0.10$
S	0.165	0.178	0.197	0.228
W	1.65	0.356	0.281	0.253
R	0.149	0.09	0.06	0.023
Y	0.512	0.071	0.037	0.012

Adding $\Delta\pi_1$ with ΔCS from the previous section gives the net change in total welfare as follows:

$$\blacksquare \; \Delta TW = \left((\beta+\gamma)(2\beta+\gamma)^2(\gamma-2\beta)(\gamma-\beta)\right)^{-1}(\beta t)\begin{pmatrix}(\beta^4(16\theta+4t-16c_0) - \beta^2\gamma^2(4c+8\theta+4\alpha+5t-4c_0) + \\ \beta^3(8c\gamma+4\gamma t+8\gamma c_0) - \gamma^3(4c\beta+2\theta\beta-2\alpha\beta-2\beta) + 2\alpha\gamma^4\end{pmatrix} \tag{22}$$

Replacing γ with $\beta \times j$ for different values of $j \in (0,1)$ in the ΔTW equation above yields the following functional form for the change in the total welfare:

$$\blacksquare\ \Delta TW = \frac{1}{\beta} t\big(D(\theta - c_0) - E(\alpha - c - \theta) + F(c + \theta) + Lt\big) \tag{23}$$

The table below provides the values for D, E, F and L for some random values of j where $\gamma = \beta \times j$.

$\gamma = \beta \times j$	$j = 0.90$	$j = 0.70$	$j = 0.50$	$j = 0.30$
D	1.8	0.73	0.53	0.48
E	0.12	0.063	0.0296	0.01
F	0.15	0.12	0.09	0.06
L	0.92	0.35	0.23	0.06

As seen in the previous table, all the positive terms diminish as goods become more differentiated. The single negative term also gets smaller. For $\theta_V < \theta \le \theta_C$, only the domestic firm benefits from the tariff imposition at the expense of the domestic consumers and the foreign firm. We need the following condition for the total welfare to increase:

$$\blacksquare\ \Delta TW > 0 \Rightarrow (\alpha - c - \theta) < \frac{D(\theta - c_0) + F(c + \theta) + Lt}{E} \tag{24}$$

A good candidate for the interval of interest is the lower bound θ_V. Recall from section 4.1.1 that θ_V is the value of θ for which $C^i(p_{-i}; c + c_0)$ passes through the intersection points of $S^{-i}(p_i; c + c_0)$ and $r^i(p_{-i}; c + \theta)$, $i = 1,2$. The long-term expressions for the curves $S^{-i}(p_i; c + c_0)$ and $C^i(p_{-i}; c + c_0)$ are as follows:

$$\blacksquare\ S^{-i}(p_i; c + c_0) = \frac{2b_1 b_2 p_i}{4b_1^2 - b_2^2} + ab_1 + \frac{(c + c_0)(2b_1^2 - b_2^2)}{2} \tag{25}$$

$$\blacksquare\, C^i(p_{-i}; c+c_0) = \frac{b_1 b_2 p_{-i} + ab_1 + (c+c_0)(b_1^{\,2} - b_2^{\,2})}{2b_1^{\,2} - b_2^{\,2}} \tag{26}$$

The first step is to solve $r^i(p_{-i}; c+\theta)$ and $S^{-i}(p_i; c+c_0)$ together for p_i and p_{-i}. Then, these prices can be plugged in the $C^i(p_{-i}; c+c_0)$ equation above and we can solve for θ in order to get θ_V. Following these steps, θ_V can be found as a function of the parameters (a, b_1, b_2, c, c_0). (The calculations and long expressions are omitted here)

Next, (a, b_1, b_2) are replaced with $(\frac{\alpha}{\beta+\gamma}, \frac{\beta}{\beta^2-\gamma^2}, \frac{\gamma}{\beta^2-\gamma^2})$, respectively and this new expression for θ_V is plugged for θ in the ΔTW equation. Finally, replacing γ with $\beta \times j$ for different values of $j \in (0,1)$ in the new ΔTW equation yields

$$\blacksquare\, \Delta TW = \frac{1}{\beta} t\left(Mc - Yc_0 - G(\alpha - c - c_0) + Zt\right) \tag{27}$$

where M, Y, G and Z are positive and $Y > G$.

Similar to the methodology applied in the previous section, one needs to look at the non-negativity constraint of the Bertrand quantity to determine the sign of the above expression. This constraint is given as

$$\blacksquare\, (\alpha - c - \theta) > t \frac{2\beta^2 - \gamma^2}{2\beta^2 - \gamma^2 - \beta\gamma} \tag{28}$$

Replacing θ with θ_V (a function of $(\alpha, \beta, \gamma, c, c_0)$) and trying different values of γ/β simultaneously with the ΔTW equation above suggests that as long as the tariff is small enough with respect to unit costs (both $t < c$ and $t < c_0$ hold), ΔTW is positive unless the goods are very differentiated. More specifically, the tariff reduces total welfare if $\gamma/\beta > 0.35$. Since θ has a positive coefficient, one would expect this threshold value to go down for higher values of θ. ($\theta > \theta_V$)

By doing a similar exercise with θ_S (recall from section 4.1.1 that θ_S is the value of θ for which $S^i(p_{-i};c+c_0)$ and $S^{-i}(p_i;c+c_0)$ intersect at the Bertrand price pair $\{p_b(c+\theta), p_b(c+\theta)\}$), it can be proven that the net change in welfare is negative unambiguously for all values of γ/β.

Chapter 3: Do Indian Firms Learn from Exporting?: Evidence with Matching

1. Introduction

Traditionally, economists have argued that 'openness to trade' increases productivity and stimulates growth. Thus, participation in export markets has been viewed as a prerequisite for economic growth in developing countries. However, neither the theoretical studies nor the empirical cross-country analyses have reached a consensus on the role of openness on economic growth.[37]

Starting during the early 1990s, a number of studies have empirically examined the relationship between exporting and economic performance using firm-level panel data. The common robust finding to all empirical studies addressing this issue is that exporting firms are more productive than non-exporting firms. The direction of causality (whether only more productive firms can export or exporting makes firms more productive) in this relationship has remained as the center of the debate. The two alternative but not mutually exclusive hypotheses that attempt to disentangle these effects are self-selection ("SS") and learning-by-exporting ("LE"). According to the former argument, only more productive firms that can afford paying for the high entry costs associated with export markets such as networking, adapting to new quality standards,

[37] Edwards (2003) reviews the most important studies published until the early 1990s. Some of more recent studies include Irwin and Terviö (2002), Dollar and Kraay (2003), Alcala and Ciccone (2004) and Noguer and Siscart (2005).

etc. are able to engage in exporting. It is unclear if these successful firms experience any additional efficiency gains from exporting per se. The learning hypothesis mainly suggests that increased competition in foreign markets, interaction with foreign customers who demand higher product quality and better service force exporting firms to become more efficient, increase innovation, and enhance their productivity. As reported in various studies such as Kessing (1983), Kessing and Lall (1992), Westphal et al. (1979, 1984), Aw and Batra (1998), etc., the foreign customers may suggest ways to improve the manufacturing process, new product designs, and help the exporting firms to increase the quality of their products.[38] Thus, by engaging in foreign competition, firms may experience further productivity increases.[39]

In this paper, I test these two main hypotheses by using a firm-level panel data set from India. The first part of the analysis focuses on the differences in characteristics between exporting firms and non-exporting firms, and presents a formal test for the self-selection hypothesis. The results confirm the robust findings in this literature. Firms that engage in foreign competition perform better than their domestic competitors years before they enter export markets. There is very weak evidence as to whether these exporting firms prepare themselves consciously for the international markets. The changes in characteristics of exporting firms before they start exporting are not statistically different than those of the firms that serve only the domestic markets. The second part of the analysis attempts to address the more challenging issue of learning-by-

[38] Lopez, A. Ricardo (2005) summarizes the evidence (from World Bank and other research institutes) on the various forms of benefits that the foreign customers have provided to exporting firms.
[39] An increase in productivity with exporting may also be consistent with the existence of economies of scale. There is, however, little empirical support for this channel (e.g. Tybout and Westbrook, 1995).

exporting. An initial comparison of the changes in characteristics of exporters and non-exporters during the post-entry period suggests that the exporting firms seem to benefit from the export markets. A major criticism to this approach is the use of all non-exporting firms as a comparison group for exporting firms. If the exporting firms have already the better performance characteristics before entering export markets, this might potentially bias the post-entry comparison measures. To address this issue, I employ standard matching techniques. The results of this analysis undermine the previous findings, suggesting that exporting firms experience productivity gains only during the first year after entry, if at all. The exporting firms experience greater growth in capital accumulation and sales relative to the domestic firms. However, this could merely be the result of an expansion in the customer base. Therefore, I have found very weak evidence for learning effects of exporting for Indian manufacturing firms.

The paper is organized as follows. Section 2 gives a brief summary of the previous findings in similar studies in the related literature. Section 3 describes the data set and the total factor productivity estimation. Section 4 presents the differences between exporters and non-exporters. Self-selection and learning-by-exporting hypotheses are addressed in section 5 and section 6, respectively. Section 7 concludes.

2. Micro Evidence on Self-Selection and Learning-by-Exporting

The proliferation of plant-level data during the 1990s opened up a new channel of research that has shed light on the relationship between exporting and productivity. Scholars have started using large panel data sets at the plant/firm level to test whether export participation increases productivity (LE) or exporting firms initially have the desired characteristics to enter export markets (SS), or both.

The robust finding of all these studies is that firms self-select into export markets. On the other hand, empirical support for LE hypothesis is moderate. Kraay (1999) finds evidence of LE for established exporters for Chinese firms whereas Delgado et al. (2002) finds that young Spanish firms experience some learning after they start exporting. Girma et al. (2002) and Hahn (2004) find similar evidence during the first few years of exporting for firms in the UK and Korea, respectively. Other studies that find evidence for learning include Bigsten et al. (2000 – some African countries), Yasar and Nelson (2003 - Turkey), Baldwin and Gu (2003 - Canada) and Alvarez and Lopez (2004 - Chile). Table 1 summarizes the micro-level empirical evidence concerning SS and LE.

Study	Country	Results
Clerides et al. (1998)	Colombia, Mexico, and Morocco	SS; LE in some Moroccan industries
Bernard and Jensen (1995, 1999a, 2004)	USA	SS
Kraay (1999)	China	LE in established exporters (no test for SS)
Aw et al. (2000)	Korea, Taiwan	SS;LE in some Taiwanese industries
Bigsten et al. (2000)	Cameroon, Ghana, Kenya, and Zimbabwe	SS;LE
Isgut (2001)	Colombia	SS
Delgado et al. (2002)	Spain	SS;LE in young exporters
Castellani (2002)	Italy	SS;LE in plants with high export orientation
Wagner (2002)	Germany	Absence of LE (no test for SS)
Girma et al. (2002)	UK	SS;LE in first 2 years of exporting
Baldwin and Gu (2003)	Canada	SS;LE
Yasar and Nelson (2003)	Turkey	SS;LE
Alvarez and Lopez (2004)	Chile	SS;LE in entrants
Hahn (2004)	Korea	SS;LE in first years of exporting
Arnold and Hussinger (2004)	Germany	SS
Van Biesebroeck (2005)	Nine Sub-Saharan African countries	SS;LE
Fernandes and Isgut (2005)	Colombia	SS;LE in young exporters
De Loecker (2007)	Slovenia	SS
Tekin (2007)	Chile	SS
Serti and Tomasi (2007)	Italy	SS;LE

Table 1: Micro-level evidence on Self-Selection (SS) and Learning-by-Exporting (LE)

3. Data, Descriptive Statistics and Productivity Estimation

3.1. Data Description

For the purposes of this study, I use the Center for Monitoring the Indian Economy's (CMIE) Prowess database. This database is an Indian firm-level panel dataset of balance sheets and income statements spanning 19 years (1988-2006) with information on nearly 10,000 companies. Since the main firm-level productivity measure used in the estimations is the total factor productivity (TFP), which is typically not an appropriate measure of productivity for non-manufacturing firms since these firms have a different structure of production than manufacturing firms, I conduct the analysis using only manufacturing firms. The dataset contains about 5500 manufacturing companies, which are categorized by industry according to the 4-digit 1998 NIC code. The largest manufacturing sectors, measured by the number of companies, are food products, textiles, chemicals, basic metals and machinery.

Year	Number of Firms	Exporters (%)	Entrants (%)	Quitters (%)
1988	351	56.7%	.	.
1989	1005	56.2%	2.9%	1.1%
1990	1201	59.2%	7.2%	3.1%
1991	2010	55.8%	5.3%	2.6%
1992	2112	57.4%	7.8%	2.6%
1993	2166	55.7%	5.8%	2.5%
1994	2796	54.0%	6.8%	2.3%
1995	3367	53.6%	7.8%	2.5%
1996	3538	55.1%	7.2%	3.6%
1997	3512	55.4%	5.8%	5.2%
1998	3522	56.0%	4.6%	4.1%
1999	3797	53.8%	4.2%	4.4%
2000	4007	52.3%	4.5%	5.2%
2001	3944	52.8%	5.6%	4.7%
2002	4000	52.3%	4.5%	4.4%
2003	4136	53.2%	4.4%	3.7%
2004	3980	56.3%	5.1%	3.5%
2005	3438	57.3%	4.2%	4.0%
2006	2684	61.4%	3.7%	2.9%

Table 2: Export behaviour of manufacturing firms

The export data and the income statement items are not available for a considerable number of firms during periods 1988-1990 and 2005-2006, which makes it difficult to observe continuous export behavior and use the productivity estimates for the analysis. Thus, I focus on the period 1991-2004 throughout the analysis.

Table 2 shows some useful statistics. The percentage of exporters in total firms is on average 55 % across time. The firms that change their export status from "non-export" to "export" (entrant) and from "export" to "non-export" (quitter) constitute on average 5.5 % and 3.5 % of all firms, respectively across time.[40]

As presented in table 3, exporting firms have on average larger sales, income and capital. They spend more on raw materials, power and fuel expenses, and pay more wages. The age variable indicates that non-exporting firms tend to be younger than exporting firms. The TFP index is also on average larger for exporters although the difference does not appear to be very significant.[41]

However, the unbalanced nature of the sample, frequency of entry and exit behavior of firms, and missing observations make it difficult to interpret these results. A more formal and systematic analysis that takes into account the consistency of firms in terms of export behavior is required for a reliable comparison of exporters and non-exporters. The export premia measurement will address this issue in section 4.

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[40] Export-starters and non-exporters will be defined differently in section 5. Here, the definitions of entrants and quitters are merely based on the firms' exporting behavior in two consecutive years. For example, 4.4 % of all firms that did not export in 2002 exported in 2003.

[41] The TFP index (explained in detail in section 3.2.) is a productivity measure estimated by using firms' TFP levels in each industry to account for different industry characteristics.

Variables (exporters)	Number of observations	Mean	Std. Dev.	Min	Max
Sales	28,857	315.97	2,685.43	0	159,984.40
Total Income	28,857	323.46	2,736.81	-7.40	162,755.20
Raw material expenses	28,857	116.80	971.51	-6.77	55,826.18
Power and Fuel Expenses	28,857	13.78	72.22	0	3,389.74
Salaries and wages	28,857	19.87	113.45	0	5,176.53
Capital	28,857	218.61	1,686.69	0	90,204.68
Company age	30,134	28.82	75.14	0	181.00
TFP index	26,207	0.24	0.69	-5.27	8.84
Variables (non-exporters)	**Number of observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
Sales	23,437	54.61	349.64	0	26,966.30
Total Income	23,437	56.28	359.79	-18.76	27,388.14
Raw material expenses	23,437	23.81	198.32	-5.95	19,645.06
Power and Fuel Expenses	23,437	3.80	23.49	0	1,551.34
Salaries and wages	23,437	4.61	38.58	0.06	1,625.04
Capital	23,437	59.31	558.95	0	46,231.60
Company age	24,667	24.90	94.87	0	172.00
TFPindex	16,642	0.22	0.73	-4.99	7.79

Table 3: Basic data characteristics of Exporters and Non-exporters

3.2. Total Factor Productivity (TFP) Estimation

The ordinary least squares estimation of TFP as the difference between actual and predicted output leads to omitted variables bias since the firm's choice of inputs is likely to be correlated with any unobserved firm-specific productivity shocks. Adding firm fixed effects into the estimation could solve the simultaneity problem if productivity is assumed to be time-invariant (Harrison (1994), Blakrishnan et al. (2000); however, this strategy is not appropriate since we are interested in changes in firm-level productivity.

The consistent firm-level measure of TFP used in this paper is constructed based on the two-stage methodology of Levinsohn and Petrin (2003). Assuming a Cobb Douglas production function, this methodology uses firm's raw material inputs to correct for the simultaneity in the firm's production function.

$$y_{i,t} = \alpha + \beta_l l_{i,t} + \beta_p e_{i,t} + \beta_m m_{i,t} + \beta_k k_{i,t} + w_{i,t} + \varepsilon_{i,t} \quad (1)$$

where y denotes output, l denotes labor, e denotes electricity consumption, m denotes raw material inputs, k denotes capital, and w denotes the unobservable part of the productivity shock that is correlated with the firm's inputs. All variables are expressed in natural logarithm. [42] We rewrite (1) as:

$$y_{i,t} = \beta_l l_{i,t} + \beta_m m_{i,t} + \phi(k_{i,t}, e_{i,t}) + \varepsilon_{i,t} \quad (2)$$

where $\phi(k_{i,t}, e_{i,t})$ is partially linear (linear in variable inputs and non-linear in electricity and capital) as follows:

$$\phi(k_{i,t}, e_{i,t}) = \alpha + \beta_k k_{i,t} + w_{i,t}(k_{i,t}, e_{i,t}) \quad (3)$$

We estimate equation (1) in the first stage, following the general approach for semi-parametric estimation given in Robinson (1988). The goal is to obtain the estimates on the coefficients of inputs that enter (2) linearly. (i.e. β_l, β_m) In the second stage, we define $V_{i,t} = y_{i,t-} \hat{\beta}_l l_{i,t} - \hat{\beta}_m m_{i,t}$ and estimate the following equation:

[42] All variables that enter into TFP estimation are deflated using appropriate deflators from India's National Account Statistics. Value of output is deflated using the corresponding industry deflators. Energy and fuel expenses are deflated by a fuel and energy deflator. Salaries and wages as well as material expenses are deflated by the wholesale price index. Finally, gross fixed assets are converted to real terms by a capital goods deflator. Energy and fuel consumption is used as the intermediate input as a proxy for unobserved productivity shocks.

$$V_{i,t} = \beta_k k_{i,t} + g(\phi_{t-1} - \beta_k k_{i,t-1}) + \mu_{i,t} + e_{i,t} \quad (4)$$

where $g(.)$ is an unknown functions of lagged values of ϕ and k. This function is approximated by a high-order polynomial expression in ϕ_{t-1} and k_{t-1}. The estimation is done by using 2-digit National Industrial Classification industry codes (due to small number of companies in some of the 4-digit level industries) and over two time periods: a period of high-growth (before 1996) and a period of low-growth (after 1996). Having obtained consistent coefficients on the production inputs, we can easily estimate the TFP using the initial production function.

Finally, after obtaining the unbiased TFP measures, a TFP index is created in order to make the estimated TFP comparable across industries. [43] The resulting TFP index serves as the dependent variable in all the regressions.

4. Export Premia – Relative Performance of Exporters

The descriptive statistics presented in the previous section suggest that exporting firms are different than non-exporting firms in terms of plant attributes, all of which favor exporting firms. To document the differences between exporting and non-exporting firms more systematically, I estimate the export premia (ceteris paribus percentage differences in firm characteristics between exporters and non-exporters) for each year in the sample

[43] The productivity index is calculated as the logarithmic deviation of a firm in a particular industry from a reference firm's productivity in that same industry in a base year. The productivity of the reference firms in each industry is calculated from the respective industry's TFP regression, using the mean log output and mean log input level in 1988-89.

during 1991-2004. The main firm characteristics of interest are productivity measure (TFP), capital, sales, and unit labor cost, which is obtained by dividing total labor cost (salaries and wages) by the value of real output.

Following Bernard and Jensen (1999), I estimate the export premia for each firm i in each year by regressing the firm characteristics on an export dummy and a set of control variables. More specifically, the export premia is estimated from a regression of the following form:

$$\ln X_i = \alpha + \beta Export_i + \gamma Industry_i + \delta Control_i + \varepsilon_i \qquad (5)$$

where $Export_i$ is a dummy for the current export status (1 if firm i is an exporter, 0 otherwise), X_i represents the firm characteristics of interest, and $Control_i$ is a vector of firm-specific controls (in logs except for size dummy), which include different combinations of firm characteristics such as firm size dummy, firm age and capital. Following Topalova (2004), each firm is classified into large, medium or small in size depending on its average sales over the span of the data. The top 1 percent of firms are classified as large, firms with sales above the 50^{th} percentile but excluding the top 1 percent are medium, and the bottom 1 percent of firms are categorized as small.[44] $Industry_i$ dummy includes the 2-digit NIC codes. The results of the export premia regressions are presented in table 4.

[44] The standard measure in the literature for firm size is the employment level. Unfortunately, the number of employees data is not available in the data set.

The scale of operations is the most significant difference between exporters and non-exporters. Exporters produce on average 375 % more than non-exporters. After controlling for capital endowment, this average difference drops down to 90 %. Exporters also employ more capital and have lower unit labor cost than non-exporters. Even after controlling for firm size, exporters employ on average 97 % more capital than exporters. These differences in sales and capital endowment become more noticeable after 1997. With an identical model specification, the average unit labor cost is 12.4 % lower for exporters. Controlling for capital endowment in addition to firm size leads to a slightly larger average gap (-13.4 %) for the unit labor cost. Although these results are an important proof of superior performance of exporters, the crucial statistic of interest is the productivity measure. The export premia results indicate that even after adjusting for industry and size effects and using a TFP index, which is constructed on firm specific inputs including capital, the exporters have higher level of productivity throughout the whole sample. Exporters are on average 14.8 % (9.3 %) more productive than non-exporters during 1991-1997 (1998-2004).

If capital is included in the controls, the differences become even more significant. The regression results reported so far confirm the previous robust findings in the literature. For every single year in the sample, exporters have significantly different characteristics and exhibit superior performance in terms of productivity, sales, capital endowment and unit labor cost. These cross-section results are silent about the direction of causality. I tackle this issue in the following sections.

Variables	1991		1992		1993		1994		1995		1996		1997	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
logTFPindex	18.6 % (0.000)	22.4 % (0.000)	16.5 % (0.000)	19.6 % (0.000)	16.8 % (0.000)	21.3 % (0.000)	15.5 % (0.000)	22.7 % (0.000)	15.7 % (0.000)	22.5 % (0.000)	11.1 % (0.000)	24.0 % (0.000)	9.5 % (0.000)	23.5 % (0.000)
Logcapital	125.3% (0.000)	73.1% (0.000)	111.8 % (0.000)	52.6 % (0.000)	154.2 % (0.000)	76.3 % (0.000)	186.1 % (0.000)	97.2 % (0.000)	192.5 % (0.000)	88.7 % (0.000)	198.7 % (0.000)	86.7 % (0.000)	217.9 % (0.000)	95.5 % (0.000)
Logsales	173.4 % (0.000)	54.0 % (0.000)	173.5 % (0.000)	51.9 % (0.000)	206.6 % (0.000)	56.7 % (0.000)	242.2 % (0.000)	63.4 % (0.000)	305.6 % (0.000)	86.5 % (0.000)	282.7 % (0.000)	64.5 % (0.000)	321.9 % (0.000)	69.3 % (0.000)
LogUnitLaborCost	(-)6.8 % (0.127)	(-)7.0 % (0.123)	(-)5.5 % (0.214)	(-)5.6 % (0.209)	(-)9.4 % (0.027)	(-)9.2 % (0.03)	(-)19.0 % (0.000)	(-)19.3 % (0.000)	(-)18.7 % (0.000)	(-)18.4 % (0.000)	(-)15.9 % (0.000)	(-)14.8 % (0.000)	(-)12.8 % (0.000)	(-)12.1 % (0.001)
Number of Observations (Max)	1,986	1,986	2,050	2,050	2,110	2,110	2,724	2,724	3,285	3,285	3,478	3,478	3,459	3,459

Variables	1998		1999		2000		2001		2002		2003		2004	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
logTFPindex	5.9 % (0.031)	19.6 % (0.000)	7.8 % (0.003)	21.7 % (0.000)	12.9 % (0.000)	27.2 % (0.000)	11.5 % (0.000)	26.7 % (0.000)	9.0 % (0.003)	25.1 % (0.000)	8.8 % (0.003)	25.6 % (0.000)	9.0 % (0.003)	26.1 % (0.000)
Logcapital	245.5 % (0.000)	105.5 % (0.000)	252.5 % (0.000)	103.6 % (0.000)	255.7 % (0.000)	97.4 % (0.000)	280.7 % (0.000)	107.1 % (0.000)	322.1 % (0.000)	118.2 % (0.000)	308.5 % (0.000)	113.5 % (0.000)	339.6 % (0.000)	136.3 % (0.000)
Logsales	338 % (0.000)	67.0 % (0.000)	416.3 % (0.000)	95.3 % (0.000)	463.2 % (0.000)	116.9 % (0.000)	518 % (0.000)	122.2 % (0.000)	612 % (0.000)	128.4 % (0.000)	580 % (0.000)	139.2 % (0.000)	621.5 % (0.000)	139.2 % (0.000)
LogUnitLaborCost	(-)7.6 % (0.041)	8.6 % (0.022)	(-)10.6 % (0.003)	(-)11.6 % (0.002)	(-)12.3 % (0.001)	(-)14.5 % (0.000)	(-)13.7 % (0.000)	(-)16.6 % (0.000)	(-)7.6 % (0.046)	(-)10.2 % (0.008)	(-)14.6 % (0.000)	(-)18.3 % (0.000)	(-)19.0 % (0.000)	(-)22.2 % (0.000)
Number of Observations (Max)	3,465	3,465	3,728	3,728	3,946	3,946	3,902	3,902	3,949	3,949	4,058	4,058	3,864	3,864

All regressions include industry dummies and company age (in log). For the TFP regressions, column (a) includes a firm size dummy and column (b) controls for capital stock in addition to firm size. For the capital regressions, column (b) controls for firm size. For the sales regressions, column (b) controls for capital stock. (Firm size dummy is left out since it is constructed based on sales) Finally, for the unit labor cost regressions, column (a) controls for firm size and column (b) includes both a firm size dummy and capital. Note: The reported export premia estimates are the exact percentage differentials given by (e^β-1)*100 where β is the export dummy coefficient from regression equation (2). P-values are reported in parentheses below the estimates.

Table 4: Export Premia: OLS regression of log values of firm characteristics on export status and firm-specific controls (in logs)

5. Self-Selection – Do Better Firms Export?

The cross-section analysis of the previous section documents the different characteristics of exporters and non-exporters. However, this experiment is not sufficient to identify if the firms with desirable characteristics self-select into export markets. To address this issue, one should compare the performance of export-starters with non-exporters several years before entry.

Similar studies have defined export-starters in several different ways in the literature. An export-starter is defined in Bernard and Wagner (1997) as a plant that exports for the first time after at least three years in the sample. Accordingly, the subsample includes only plants that have at least four consecutive annual observations and do not export in any of their first three annual observations. Bernard and Jensen (1999) follows a similar approach. Serti and Tomasi (2007) defines export-starters as firms that do not export at least for two years and continue to export subsequent to their entry. Undoubtedly, these definitions above as well as others not mentioned here are influenced by data restrictions. Serti and Tomasi (2007)'s approach has the clear advantage of identifying continuous export behavior. Defining a firm as an export-starter based on whether the firm exports for the first time after a few years might be unsatisfactory in that the firm in question could stop exporting after one year or so. If the export behavior is not consistent and continuous over time for the export-starters, these firms would not be exposed to the benefits of participating in the international markets, if any, to a measurable extent. Thus, it would be problematic to draw a sound conclusion from this type of analysis.

In order to have consistent export behavior data and a reasonable number of observations in the analysis, I divide the sample into two sub-periods: 1991-1997 and 1998-2004. The export-starters for the first (second) period are defined as the firms that do not export for the first three years in the sample, and start exporting for the first time in 1994 (2001). These firms continue exporting until the last year of the selected period (1997 and 2004, respectively).[45] The non-exporters for each sample period are defined as firms that did not export in any of the years in the selected sample periods.

Following Bernard and Jensen (1999), I measure the systematic differences of plant characteristics between export-starters and non-exporters by estimating the following regression:

$$\ln X_{it} = \alpha + \beta Export_{iT} + \gamma Industry_i + \delta Control_{it} + \varepsilon_i \qquad (6)$$

where $Export_{iT}$ is a dummy for the export-entry status (1 if firm i is an export-starter in year T (1994 or 2001), 0 if it is a non-exporter), X_{it} represents the firm characteristic of interest in year t of the sample ($t < T$). $Control_{it}$ is a vector of firm-specific controls (in

[45] Surely, the ideal analysis will include only the firms that will export until the last year in the entire sample period (2004). Unfortunately, this is not feasible due to data restrictions. To enhance the quality of the analysis, I included as export-starters only the firms that did not export at least 65 % of the time before 1991 (1998 for the second period) and exported at least 60 % of the time after 1997 (50 % for the second period after 2004). During 1991-1997 (1998-2004), there are 110 (93) export-starters and 248 (499) non-exporters. 620 (1014) firms export continuously during the first (second) sample period.

logs) including a firm size dummy, firm age and capital in year t. $Industry_i$ dummy includes the 2-digit NIC codes.

Table 5 displays the differences between plant characteristics of export-starters and non-exporters n years before (n = 1, 2 or 3) the entry for both sample periods. The results are unambiguous and even stronger for the productivity measure than the results of the previous cross-section analysis. After controlling for firm size, the export-starters are more productive than non-exporters years before they participate in the international markets. More specifically, the export-starters' TFP is on average 30 % higher than non-exporters' TFP during 1991-1993. The productivity gap is in favor of export-starters (33.4 %) also during 1998-2000. This gap enlarges when capital is included as a control variable and the results are significant at 1 % confidence interval level in this case. The main difference between these two sample periods is that the productivity differential between exporters and non-exporters increases continuously (both have U-shape with capital as a control) before entry during 1991-1993 and decreases during 1998-2000.

Similarly, the export-starters already have the other desirable characteristics before entry. On average, export-starters employ more capital (79 % - controlling for firm size), sell 80 % more (controlling for capital), and have 41 % lower unit labor cost (controlling for firm size and capital) than non-exporters during the pre-entry years. The export premia for these characteristics show different patterns before entry. While firms invest continuously more in capital before entry, sales and unit labor cost do not follow a consistent pattern during the two sample periods.

Variables	1991 Premia		1992 Premia		1993 Premia		1998 Premia		1999 Premia		2000 Premia	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
logTFPindex	27.8 % (0.012)	36.8 % (0.003)	28.9 % (0.017)	42.1 % (0.005)	32.2 % (0.007)	41.5 % (0.001)	34.0 % (0.013)	49.0% (0.000)	33.5 % (0.021)	55.2 % (0.000)	32.6 % (0.039)	49.9 % (0.002)
Logcapital	147.6% (0.004)	62.2 % (0.082)	168.6 % (0.001)	80.8 % (0.018)	180.9 % (0.000)	84.2 % (0.016)	159.5 % (0.003)	43.3 % (0.160)	241.0 % (0.000)	91.0 % (0.014)	276.0 % (0.000)	112.7 % (0.004)
Logsales	323.2 % (0.000)	86.9 % (0.005)	255.2 % (0.000)	55.3 % (0.004)	249.3 % (0.000)	56.3 % (0.023)	291.0 % (0.000)	79.0 % (0.049)	402.7 % (0.000)	73.4 % (0.077)	556.5 % (0.000)	127.1 % (0.013)
LogUnitLaborCost	(-)48.8 % (0.000)	(-)43.8 % (0.001)	(-)37.3 % (0.002)	(-)36.5 % (0.002)	(-)38.2 % (0.001)	(-)37.4 % (0.001)	(-)40.9 % (0.039)	(-)42.4 % (0.027)	(-)34.6 % (0.072)	(-)34.3 % (0.074)	(-)50.8 % (0.005)	(-)50.7 % (0.007)
Number of Observations (Max)	350	350	350	350	352	352	576	576	580	580	582	582

All regressions include industry dummies and company age (in log). For the TFP regressions, column (a) includes a firm size dummy and column (b) controls for capital stock as well in addition to firm size. For the capital regressions, column (b) controls for firm size. For the sales regressions, column (b) controls for capital stock. (Firm size dummy is left out since it is constructed based on sales) Finally, for the unit labor cost regressions, column (a) controls for firm size and column (b) includes both a firm size dummy and capital. Note: The reported export premia estimates are the exact percentage differentials given by $(e^\beta-1)*100$ where β is the export dummy coefficient from regression equation (3). P-values are reported in parentheses below the estimates.

Table 5: Ex-ante differences between export-starters and non-exporters

These findings imply that good firms self-select into export markets. An interesting idea recently proposed by Lopez (2004) is that this self-selection process may be a conscious decision by which firms prepare for the international markets by increasing their productivity with the explicit purpose of becoming exporters. In order to gain more insight about the dynamics of the changes that export-starters go through relative to non-exporters, I measure the export premia for the growth rates of the relevant firm characteristics. Following Bernard and Jensen (1999), I estimate the following model:

$$\%\Delta X_{T-1} = \frac{\ln X_{iT-1} - \ln X_{i0}}{T-1} = \alpha + \beta Export_{iT} + \gamma Industry_i + \delta Control_{i0} + \varepsilon_i \qquad (7)$$

where $Export_{iT}$, X_{it} and $Industry_i$ are defined the same way as before. $Control_{i0}$ is a vector of firm-specific controls (in logs) in the base year (1991 or 1998) including a firm size dummy, firm age and capital. Thus, this equation estimates the growth rate premia of export-starters for certain firm characteristics during 1991-1993 and 1998-2000 based on their initial firm characteristics.

The results are displayed in table 6. During 1991-1993, the growth rate premia for TFP, sales and capital are all positive, but statistically insignificant. Surprisingly, unit labor cost coefficient also has a positive sign; however, it is not significant. Thus, during the initial pre-entry period, there is no evidence that exporter-starters build upon their already-superior characteristics. During 1988-2000, exporters accumulate around 11-12 % more capital than non-exporters. This is accompanied by a sales growth differential of 33 %. In spite of this increase in capital stock, exporters' productivity growth is not statistically different than non-exporters' productivity growth. The unit labor cost has the expected sign in this period although it is insignificant. To sum up, the export-starters already have the competitive advantage over non-exporters before they enter export markets. However, they do not experience any major productivity improvements compared to non-exporters during the pre-entry periods. Only during 1998-2000, the capital stock appears to grow more for export-starters, possibly due to positive sales growth during this period.

Variables	1991-1993 Growth Rate		1998-2000 Growth Rate	
	(a)	(b)	(a)	(b)
logTFPindex	1.82 % (0.526)	1.13 % (0.702)	0.43 % (0.934)	0.32 % (0.956)
LogCapital	6.24 % (0.329)	5.85 % (0.374)	12.70 % (0.004)	11.44 % (0.009)
LogSales	3.01 % (0.712)	9.04 % (0.286)	33.18 % (0.006)	33.42 % (0.005)
LogUnitLaborCost	7.17 % (0.228)	1.80 % (0.741)	(-)9.44 % (0.315)	(-)9.73 % (0.281)
Number of Observations (Max)	350	350	574	574

All regressions include industry dummies and company age (in log). For the TFP regressions, column (a) includes a firm size dummy and column (b) controls for capital stock as well in addition to firm size. For the capital regressions, column (b) controls for firm size. For the sales regressions, column (b) controls for capital stock. (Firm size dummy is left out since it is constructed based on sales) Finally, for the unit labor cost regressions, column (a) controls for firm size and column (b) includes both a firm size dummy and capital. Note: The reported export premia estimates are the exact percentage differentials given by (e^β-1)*100 where β is the export dummy coefficient from regression equation (4). P-values are reported in parentheses below the estimates.

Table 6: Pre-entry export premia of growth rates

6. Learning by Exporting - Does Exporting Improve Productivity?

6.1. Post-Entry Effects of Exporting

The previous sections provided clear evidence for self-selection of better firms into export markets. Arguably, assessing the causality in the other direction would be a more interesting and challenging task. Thus, the main question of interest in this section is whether the exporting firms experience productivity gains after they start exporting.

As a first step, I measure the post-entry growth rate premia for export-starters to demonstrate how export-starters have performed compared to non-exporters after they started exporting. Estimating an equation similar to equation 4:

$$\%\Delta X_{iT} = \frac{\ln X_{iT} - \ln X_{i0}}{T} = \alpha + \beta Export_{i0} + \gamma Industry_i + \delta Control_{i0} + \varepsilon_{iT} \qquad (8)$$

where X_{it} and $Industry_i$ are defined the same way as before. $Export_{i0}$ and $Control_{i0}$ are a dummy for the export-entry status and a vector of firm-specific controls (in logs) including a firm size dummy, firm age and capital in the base year (1994 or 2001), respectively. Thus, this equation estimates the growth rate premia of export-starters for certain firm characteristics during 1994-1997 and 2001-2004 based on their initial firm characteristics.[46] The results are presented in table 7.

During 1994-1996, the TFP growth is 0.7 % higher (controlling for firm size) for export-starters than non-exporters. This difference is still positive but not significant over three-year period during 1994-1997. The results for the TFP measure are higher (1.38 %) and significant for over the three-year period during 2001-2004. The export-starters also experience superior growth rates in terms of capital and sales. The export-starters' capital accumulation rate is 9-16 % faster (controlling for firm size) than non-exporters while their sales growth (controlling for capital) is 8-15 % higher during the short run and long run following entry. ULC has the predicted sign for all years; however, it is significant only during the first year (two years) after entry during 1991-1997 (1998-2004). For these periods, the export-starters' ULC growth rate is 3.83 % (6.65 %) lower than non-exporters' ULC growth. On balance, these results might suggest exporting leads to better performance.

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[46] Since the definition of export-starter requires the firms to have continuous exporting status, this estimation is not biased by the transitions (switching export-status) in the export markets. For example, if the initial export status of a firm is "non-exporter" at time 0 and "exporter" at time T, then its status is also "exporter" during (0,T-1].

Variables	1994-1995 Growth Rate		1994-1996 Growth Rate		1994-1997 Growth Rate		2001-2002 Growth Rate		2001-2003 Growth Rate		2001-2004 Growth Rate	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
logTFPindex	1.12 % (0.004)	0.94 % (0.018)	0.70 % (0.082)	0.65 % (0.092)	0.84 % (0.240)	0.73 % (0.351)	2.15 % (0.015)	1.57 % (0.042)	1.86 % (0.033)	1.69 % (0.047)	1.38 % (0.074)	1.12 % (0.095)
Logcapital	12.54 % (0.000)	9.57 % (0.002)	11.41 % (0.021)	9.62 % (0.034)	10.26 % (0.045)	9.45 % (0.065)	18.62 % (0.000)	16.33 % (0.000)	15.11 % (0.009)	14.21 % (0.016)	14.92 % (0.003)	12.56 % (0.034)
Logsales	7.52 % (0.000)	8.96 % (0.003)	13.69 % (0.021)	15.12 % (0.003)	12.73 % (0.059)	14.84 % (0.044)	9.38 % (0.000)	10.23 % (0.000)	9.47 % (0.004)	12.42 % (0.017)	7.73 % (0.023)	8.50 % (0.011)
LogUnitLaborCost	(-)3.83 % (0.024)	(-)4.58 % (0.053)	(-)1.35 % (0.257)	(-)1.65 % (0.279)	(-)1.27 % (0.151)	(-)1.43 % (0.217)	(-)5.92 % (0.002)	(-)6.81 % (0.029)	(-)6.65 % (0.001)	(-)4.33 % (0.018)	(-)3.64 % (0.148)	(-)4.16 % (0.235)
Number of Observations (Max)	354	354	352	352	348	348	579	579	575	575	574	574

All regressions include industry dummies and company age (in log). For the TFP regressions, column (a) includes a firm size dummy and column (b) controls for capital stock as well in addition to firm size. For the capital regressions, column (b) controls for firm size. For the sales regressions, column (b) controls for capital stock. (Firm size dummy is left out since it is constructed based on sales) Finally, for the unit labor cost regressions, column (a) controls for firm size and column (b) includes both a firm size dummy and capital. Note: The reported export premia estimates are the exact percentage differentials given by $(e^{\beta}-1)*100$ where β is the export dummy coefficient from regression equation (5). P-values are reported in parentheses below the estimates.

Table 7: Post-entry export premia of growth rates - Non-matched samples

The implicit assumption behind this measurement is, however, problematic. Determining the benefits of exporting on export-starters in the most reliable way requires information on what would have happened to an export-starter if it had not entered the export markets, which is not observable. By comparing export-starters with all non-exporters, Bernard and Jensen (1999) assume that all these non-exporting firms are capable of providing this counterfactual. An objection to this assumption is the heterogeneous nature of productivity between exporters and non-exporters, an issue raised by Melitz (2003), Helpman, Melitz and Yeaple (2004), Head and Reis (2003), etc. The most recent innovation in the measurement of learning-by-exporting hypothesis to tackle this heterogeneity issue is the use of matching methods. These methods provide more precise control for differences between the comparison groups, i.e. exporters and non-exporters. A brief theoretical foundation for the matching technique and the results of its application are discussed in the following section.

6.2. Propensity Score Matching and Learning Effects

Formally, if Δy represents the change in TFP (or another firm characteristic) and $Expdummy_{it} \in \{0,1\}$ is an indicator of whether firm i exported for the first time at time t, then $\Delta y^{1}_{i,t+s}$ is the change in TFP at time $t+s$ ($s \geq 0$) following entry. A systematic measurement of effects of entry into export markets requires a counterfactual. Hence, the causal effect of export entry on firm i at time $t+s$ can be written as $\Delta y^{1}_{i,t+s}$ - $\Delta y^{0}_{i,t+s}$ where $\Delta y^{0}_{i,t+s}$ denotes the outcome for export-starters had they never entered export markets. The main problem is that this outcome is not observable. Following Heckman et al. (1997), I define the average effect of exporting on export-starters as:

$$E\{\Delta y^{1}_{i,t+s} - \Delta y^{0}_{i,t+s} | Expdummy_{it} = 1\} = E\{\Delta y^{1}_{i,t+s} | Expdummy_{it} = 1\} - E\{\Delta y^{0}_{i,t+s} | Expdummy_{it} = 1\}$$

The quality of this measurement will depend on appropriately identifying a counterfactual for the last term in the equality above. I estimate this counterfactual by the corresponding average value of a control group of firms, assuming that all the differences between export-starters and firms in this control group can be captured by a vector of observable firm characteristics. A common choice in the related literature for this control group is non-exporters, which perform similarly to export-starters before the entry, thus, the appropriate counterfactual is $E\{\Delta y^{0}_{i,t+s} | Expdummy_{it} = 0\}$. In other words, the main target of this matching process is to identify a group of non-exporting firms for which the distribution of the variables affecting the export decision is as similar as possible to the corresponding distribution of the export-starters. Since matching non-exporters with export-starters on an n-dimensional vector of characteristics is generally unfeasible, I adopt the propensity score (estimated probability of a firm to export given its characteristics) matching method of Rosenbaum and Rubin (1983). This method facilitates comparison between firms and makes matching feasible by summarizing pre-treatment characteristics of each subject into a single index variable, namely, propensity score. As the first step, I find the propensity score for all export-starters and non-exporters for 1991-1997 and 1998-2004 using a probit specification for each period as follows:[47]

$$P(Expdummy_{i,t} = 1) = F(TFP_{i,t-1}, Control_{i,t-1}) \quad (9)$$

where $F(.)$ is the normal cumulative distribution function. The control variables include sales, capital, ULC, company age, company age squared, and industry dummies. Let $P_{i,t}$ denote the probability of exporting at time t for firm i, which is an export-starter. A non-exporting firm j, which is closest in terms of its propensity score to firm i, is selected as

47 I have used several different combinations of controls and earlier periods (t-2 and t-3) in the F(.) function. The resulting specification in equation (6) is the outcome of the Becker and Ichino (2002)'s algorithm described below.

a match. More formally, this nearest-neighbor matching method requires that at each point in time, a non-exporting firm j is chosen based on the following criteria:[48]

$$\left|p_{i,t} - p_{j,t}\right| = \min_{j \in \{Expdummy_{j,t}=0\}} (p_{i,t} - p_{j,t})$$

I follow Becker and Ichino (2002)'s algorithm to confirm that the probit specification is valid and that the optimal number of groups of firms in which the propensity scores and the means of company characteristics do not differ for the treated (export-starter) and the control (non-exporter) units.[49] Initially, the nearest neighbor matching method eliminates substantially different non-exporting firms, and matches 98 (91) non-exporting firms to 110 (93) export-starters during 1991-1997 (1998-2004).

The second step is to divide these updated samples into equally spaced intervals such that within each interval, the average propensity scores of the treatment and control group do not differ statistically.[50] In both periods, splitting the sample into two intervals satisfies this condition. Subsequently, I run a simple t-test of difference of means for the pre-entry period $t-1$ to see if the mean characteristics of firms in all these four groups do not differ statistically between the treated and control units, i.e., I test the samples for

[48] The results from the radius matching method are almost identical. With radius matching, each treated unit is matched only with the control units whose propensity scores fall in a predefined neighborhood (the radius determines the length of the neighborhood) of the treated unit's propensity score. Therefore, unlike the nearest neighborhood matching, the radius matching can potentially result in unmatched treated units. In the present case, several choices of reasonably small radii did not leave any unmatched treated units.

[49] The Stata codes (Pscore and attnd) for these applications are provided in Becker and Ichino (2002).

[50] Before the second step, after identifying the appropriate matches, I estimated the probit specification again with only the matched sample to update the propensity scores of the remaining control and treated units. This resulted in very similar scores for both groups. The first group during 1991-1997 (1998-2004) includes 54 (47) export-starters and 50 (45) non-exporters. The second group during 1991-1997 (1998-2004) includes 56 (46) export-starters and 48 (46) non-exporters.

balancing hypothesis. The results in table 8 indicate that this constraint is satisfied and the identified two groups for each period consist of appropriately matched firms. All the P-values are greater than 0.1, thus, the hypothesis that the means of these variables are equal for export-starters and non-exporters is not rejected at any confidence level.

Having assured that the subgroups of firms include very similar control and treatment units, the final step is to estimate the differences in changes of firm characteristics in these four groups during the post-treatment period, i.e. export market entry. That is, I estimate regression equation (5) for these matched samples. Table 9 presents the results for these four different groups. Matching leads to substantially different post-entry results especially in terms of TFP growth premia from those in section 6.1 with non-matched samples.

Matched sample (1991-1997) - group 1			**Matched sample (1991-1997) - group 2**		
Variable	**Difference in Means**	**P-values**	**Variable**	**Difference in Means**	**P-values**
TFP	0.013	0.54	TFP	0.025	0.42
Capital	0.022	0.78	Capital	0.138	0.25
Sales	0.125	0.33	Sales	0.117	0.72
ULC	(-)0.241	0.15	ULC	(-)0.003	0.22
Matched sample (1998-2004) - group 1			**Matched sample (1998-2004) - group 2**		
Variable	**Difference in Means**	**P-values**	**Variable**	**Difference in Means**	**P-values**
Non-exporters					
TFP	0.106	0.55	TFP	0.041	0.64
Capital	0.056	0.18	Capital	0.232	0.61
Sales	0.129	0.29	Sales	0.223	0.33
ULC	(-)0.247	0.18	ULC	(-)0.095	0.15
The differences of means are calculated by subtracting the means of the relevant variables of non-exporters from the means of the corresponding variables of exporter-starters. P-values refer to the t-tests performed for the equality of means, for which the null hypothesis is that the selected groups do not differ in pupulation means					

Table 8: Basic data characteristics of non-exporters and exporters in the matched samples

In all four groups, export-starters' sales are boosted up relative to their domestic rivals. The sales grow on average 11.14 % faster for export-starters during the three-year period after entry. Capital growth premia displays similar characteristics although it is not as strong as sales. During 1991-1997, export-starters experience faster capital accumulation in both groups during the second year after entry and the growth is continuous (3-4 %) in the long run. During 1998-2004, the export-starters grow in capital significantly (7 %) right after entry. However, this growth premia prevails for only the first two years.

Variables	Group 1 (1991-1997)						Group 3 (1998-2004)					
	1994-1995 Growth Rate		1994-1996 Growth Rate		1994-1997 Growth Rate		2001-2002 Growth Rate		2001-2003 Growth Rate		2001-2004 Growth Rate	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
logTFPindex	0.72 % (0.163)	0.53 % (0.182)	0.84 % (0.122)	0.66 % (0.561)	0.33 % (0.293)	0.21 % (0.446)	1.03 % (0.017)	0.89 % (0.043)	1.27 % (0.246)	1.09 % (0.295)	0.85 % (0.192)	0.72 % (0.207)
Logcapital	6.53 % (0.123)	4.59 % (0.187)	7.27 % (0.030)	6.64 % (0.039)	4.15 % (0.078)	3.57 % (0.082)	7.87 % (0.002)	7.21 % (0.008)	7.56 % (0.015)	7.08 % (0.022)	5.59 % (0.120)	4.90 % (0.148)
Logsales	7.04 % (0.055)	7.91 % (0.063)	9.85 % (0.017)	12.36 % (0.020)	11.19 % (0.007)	12.87 % (0.014)	8.84 % (0.002)	7.82 % (0.007)	8.55 % (0.004)	8.03 % (0.011)	10.14 % (0.024)	9.71 % (0.035)
LogUnitLaborCost	(-)1.33 % (0.230)	(-)2.57 % (0.304)	(-)1.08% (0.512)	(-)0.96 % (0.653)	0.38 % (0.281)	0.04 % (0.324)	(-)1.54 % (0.033)	(-)1.38 % (0.047)	(-)1.22% (0.245)	(-)1.18 % (0.292)	(-)0.94 % (0.385)	(-)0.87 % (0.410)
Number of Observations (Max)	104	104	102	102	102	102	92	92	92	92	92	92
	Group 2 (1991-1997)						Group 4 (1998-2004)					
Variables	1994-1995 Growth		1994-1996 Growth		1994-1997 Growth		2001-2002 Growth		2001-2003 Growth		2001-2004 Growth	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
logTFPindex	0.60 % (0.238)	0.54 % (0.337)	1.16 % (0.390)	0.93 % (0.449)	0.12 % (0.259)	(-)0.13 % (0.732)	1.34 % (0.068)	1.24 % (0.075)	1.08 % (0.126)	1.09 % (0.281)	0.95 % (0.230)	0.88 % (0.258)
Logcapital	7.02 % (0.159)	6.79 % (0.174)	5.39 % (0.023)	5.05 % (0.047)	3.22 % (0.004)	3.18 % (0.019)	6.88 % (0.015)	6.19 % (0.021)	7.31% (0.018)	6.95 % (0.027)	6.04 % (0.240)	5.55 % (0.297)
Logsales	7.45 % (0.002)	8.03 % (0.014)	9.22% (0.011)	11.49 % (0.018)	10.98% (0.013)	13.02 % (0.021)	7.62 % (0.006)	7.34 % (0.012)	8.08 % (0.001)	7.99 % (0.009)	9.23 % (0.038)	9.10 % (0.044)
LogUnitLaborCost	(-)1.72 % (0.348)	(-)2.02 % (0.491)	(-)0.99 % (0.454)	(-)0.83 % (0.571)	(-)0.57 % (0.532)	(-)0.48 % (0.598)	(-)1.17 % (0.025)	(-)0.98 % (0.031)	(-)1.37% (0.158)	(-)1.26 % (0.172)	(-)1.05 % (0.293)	(-)0.94 % (0.304)
Number of Observations (Max)	102	102	102	102	100	100	92	92	90	90	92	92

All regressions include industry dummies and company age (in log). For the TFP regressions, column (a) includes a firm size dummy and column (b) controls for capital stock as well in addition to firm size. For the capital regressions, column (b) controls for firm size. For the sales regressions, column (b) controls for capital stock. (Firm size dummy is left out since it is constructed based on sales) Finally, for the unit labor cost regressions, column (a) controls for firm size and column (b) includes both a firm size dummy and capital. Note: The reported export premia estimates are the exact percentage differentials given by (e^β-1)*100 where β is the export dummy coefficient from regression equation (5). P-values are reported in parentheses below the estimates.

Table 9: Post-entry export premia of growth rates - Matched samples

The ULC premia has the expected sign (-) except for the 3-year growth premia in group 1; however, it is mostly insignificant. Only during the period 1998-2004, export-starters experience a statistically significant reduction (1.54 % and 1.17 %) in their ULC relative to non-exporters during the first year after entry. The TFP growth premia is positive but insignificant for both groups during 1991-1997. During 1998-2004, export-starters experience productivity gains (1.03 % and 1.34 %) only during the first year after entry.

Thus, overall, the evidence for learning due to exposure to international markets appears to be very weak for Indian firms. The ability to sell abroad as well as the domestic market led to a surge in sales, which seemed to be accompanied by extra capital use; however, the export-starters did not experience any significant productivity gains in the long run compared to the non-exporters.

7. Conclusion

This study builds on the recent empirical literature about the relationship between productivity and exporting at the firm level. By using firm-level panel data from Indian manufacturing firms for the period 1991-2004, I test the two main hypotheses (self-selection and learning-by-exporting) that address the direction of causality between exporting and productivity. The results confirm that good plants are more likely to become exporters, i.e., more successful firms self-select into export markets. I do not find any empirical support for the idea that exporting firms might prepare for the export markets by consciously improving themselves before they enter export markets.

To address the hypothesis that exporting leads to success, I apply matching techniques. Matching methods have been used recently to enhance the quality of the more traditional post-entry comparison analyses of exporting and non-exporting firms. These methods help reduce the selection bias by identifying a group of non-exporting firms that perform similarly to exporting firms before entry. As a result, I find very weak evidence in favor of learning-by-exporting. There is some benefit to exporting firms in terms of sales and capital; however, these firms do not experience any major productivity boost after they start exporting. There are some productivity gains for two matched groups out of four; however, these gains are brief and disappear within one year of exporting.

If openness of an economy is linked solely to productivity growth at the firm level, these results might indicate that encouraging export policies (e.g. export subsidy, etc.) that target the less efficient domestic firms may not have the desired impact on the economy overall. However, there are a few issues that need more scrutiny before reaching such a conclusion. First, as it was supported by empirical evidence, exporting can potentially provide other benefits. The expansion in the customer base might lead to a decrease in the unemployment rate, higher firm survival rates, better allocation of resources through efficiency gains, etc. Secondly, this study does not take into account the export destinations of Indian manufacturing firms. If learning takes place through the exchange of knowledge, adaptation to high quality standards, etc., exporting to more advanced countries might induce stronger learning opportunities for firms. This issue is left as a topic for future research.

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