Administered Protection as A Public Good

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Abstract

This paper examines the validity of the five fundamental theorems of international trade and some other issues in a general model of externality. The model allows the possibility of own-sector externality and cross-sector externality. This paper derives conditions under which some of these theorems are valid, and explains what the government may choose to correct the distortionary effects of externality. Conditions under which a economy with no optimality policies may gain from trade are also derived.

1 Introduction

Filing a petition for administered protection, such as antidumping duty and countervailing duty, can be seen as a provision of a public good. Namely, once a firm (or a group of firms) in an industry files a petition for administered protection, and protection is enforced, then the relief from import competition will be enjoyed by non-petitioning firms as well as the petitioning firms. Thus, similar to the political lobbying for protection, a petition for administered protection can have a free-rider problem pertaining to a collective action.

However, there is an important difference between political lobbying and a petition for administered protection. In lobbying, it is usually considered that the amount of resources spent on lobbying affects the level of protection. Thus, in lobbying the main decision problem of the industry is how much to spend for lobbying, as well as whether to lobby or not. On the other hand, in administered protection, the level of protection is quite independent of the resources spent on filing a petition: In the U.S., for example, whether the protection will be enforced, and how high the tariff will be imposed, are determined through investigation conducted by the Department of Commerce (DOC) and International Trade Commission (ITC), which are fairly free from political pressure. The cost of filing a petition is mainly for hiring a legal counsel, who prepare a set of documents that demonstrates the presence of "unfair" trade activity by foreign firms and material injury of the domestic industry. Although the petitioning firms may be able to obtain higher level of protection by spending more money and providing more convincing information in the petition, a dependence of the level of protection on the resources spent on asking for protection is much smaller in administered protection than in political lobbying. More or less, the decision problem of the industry in administered protection is simply whether to file a petition or not to file a petition. Thus, it is reasonable to consider that the public good provided by filing a petition for administered protection is discrete. In this paper, we study the decision of filing a petition for administered protection, by recognizing that it is a discrete public good. We are interested in when all firms participate in a petitioning group, and when some firms refrain from participating.

In the public finance literature, it has been shown that a binary public good is efficiently provided under perfect and complete information when the agents in the economy play the contribution game[1]. That is, there exists a set of Pareto-undominated Nash equilibria in which the public good is provided, if and only if the sum of the benefits of the public good is larger than the cost of providing it. For example, suppose that there are n identical agents in the economy, whose valuation of the public good is v, and that the cost of providing the public good is C. Then, each agent is contributing C/n is one of Nash equilibria if and only if $nv \geq C$.

If such a model of the contribution game is applied to filing decision of administered protection, we should observe that all firms in an industry are participating in filing a petition. However, it is quite rare that all firms in an industry are the petitioners. Usually, several firms form a petitioning group, and there are the other firms in the industry which do not participate in a petitioning group. Given these observation, we consider that simply using a contribution game is not appropriate to study the filing decision in administered protection. Typically, in a decision of filing a petition, no firm can be coerced to participate in the contribution game. Each firm has a freedom not to participate in filing a petition, and no firm can prevent such a non participant from enjoying a relief from import competition since protection is non-excludable public good. Thus, as pointed out by Dixit and Olson (2000), it is important to explicitly consider the noncooperative participation decision of the firms before analyzing the contribution game[2].

Thus, in this paper, we model the petitioning process as a two-stage game: in the first stage, the firms in an industry noncooperatively decide whether to participate in filing a petition. Then, in the second stage, the participating firms play a bargaining game to determine how to share the cost. We show that, if the probability of protection is independent of the number of petitioners, an equilibrium in which all firms in the industry are petitioners occurs only when each firm's benefit from protection is fairly small in the sense that no one is willing to file a petition alone. As the benefit-cost ratio gets bigger, there will be a free rider who do not participate in a petitioning group.

[1]See Nitzan and Romano (1990). In the context of oligopolistic entry deterrence, see Waldman (1987).

[2]Saijo and Yamato (1999) also studies a voluntary participation game of a non-excludable public good.

2 Literature Survey

The idea that a collective action has a public good property is not new: it can be traced back to at least as old as Olson (1965). However, the researches on the public good property of trade protection and free rider problem in lobbying are not abound, despite the huge body of the literature on private provision of a public good. In the empirical studies, there have not been found clear-cut evidence that an industry with high concentration (or an industry with small number of firms) is likely more successful in lobbying (Damania and Fredriksson (2000) names several empirical studies). In theoretical papers, too, the results are inconclusive: While Rodrick (1987) demonstrated that a negative relationship between the number of firms in an industry and the level of protection, Hillman (1991) showed that the relationship between high concentration of an industry and the level of protection the industry receives is ambiguous in general. A recent paper by Pecorino (1998) modeled a repeated game of lobbying and showed that the free rider problem is not important in lobbying for protection. In his paper, an industry can maintain jointly optimal level of lobbying by using a simple trigger strategy, even though the number of firms in an industry approaches to infinity. Damania and Fredriksson (2000) considers collusion on both lobbying and output in a repeated game setting, suggesting that the collusion in output is an important factor for an industry to maintain jointly optimal level of lobbying.

Those studies of political lobbying, however, may not be directly applicable to analyze the free-rider problem of a petition for administered protection. This is because, as mentioned in the introduction, the protection provided by the administered protection policy is not a continuous but a binary public good. In administered protection, what an industry decides is whether to file a petition or not, and typically the industry have little control over the size of the tariff when it files a petition. Rather, the size of the tariff is determined by the Department of Commerce, which investigates the market conditions prior to the petition. So, in administered protection policy, firms which want to have higher level of protection may have an incentive to alter its production or pricing decision in a period before protection enforcement so as to increase the size of the tariff. Notice that such distortions in quantity or price also has a public good property, since a benefit from an increase in the tariff is non-excludable. Therefore, to understand the collective action problem in petitioning for administered protection, it is important to study not only the petition-filing process but also the market behavior of firms prior to the petition. Thus, our study of the public-good property of administered protection is twofold. First, we considers a noncooperative decision of firms in an industry whether to file a petition. Second, we need to analyze the strategic behavior of firms to alter the size of the tariff in a period before the protection enforcement.

For the industrial decision of whether to file a petition, the relevant literature is of private provision of binary public good, such as Bagnoli and Lipman (1989) and Nitzan and Romano (1990). As Nitzan-Romano discusses, a binary public good is efficiently provided under perfect and complete information when the agents in the economy play the contribution game. That is, there exists a set of Pareto-undominated Nash equilibria in which the public good is provided, if and only if the sum of the benefits of the public good is larger than the cost of providing it. If such a model of the contribution game is applied to filing decision of administered protection, we should observe that all firms in an industry are participating in filing a petition. However, it is quite rare that all firms in an industry are the petitioners. Usually, several firms form a petitioning group, and there are the other firms in the industry which do not participate in a petitioning group. Given these observations, we consider that simply using a contribution game is not appropriate for the filing decision in administered protection. Typically, in a decision of filing a petition, no firm can be coerced to participate in the contribution game. Each firm has a freedom not to participate in filing a petition, and no firm can prevent such a non participant from enjoying a relief from import competition since protection is non-excludable. Thus, we model the petition process in line with the model by Dixit and Olson (2000), who explicitly consider the noncooperative participation decision of the economic agents before they play the contribution game.

For the analysis of strategic behavior of firms to alter the size of the tariff in future, the relevant literature is of so-called "endogenous protection". Endogenous determination of protection level is first examined by Bhagwati and Srinivasan (1976), in which a probability of quota enforcement in future depends on the current level of imports. The central result of their paper is that the exporting country reduces its exports when facing the future protection. Fischer (1992) studied endogenous probability of protection in an oligopolistic models, and derived the similar result that foreign firms strategically decrease the export in order to lower the level of protection in future. Reitzes (1993) presented a model where the antidumping duty depends on the price difference between the foreign market and the home market, and showed that the foreign firm decreases its export to the home market and the home firm increases its quantity. On the other hand, Anderson (1992, 1993) demonstrated that the possibility of protection may increase the exports by foreign firms. When the exporting firms are facing the prospect of voluntary export restraint, each firm will strategically increase its export in order to receive a larger share of export licences in future.

Although these papers provide the interesting results that the mere existence of protection policy, not an actual enforcement of protection, can affect the behavior of firms, they do not explicitly discuss the issue of externalities among the home firms or among foreign firms when they alter their production or pricing decision facing the prospect of protection. Fischer and Reitzes considers a duopoly model (one home firm and one foreign firm), while Anderson considers perfectly competitive exporters. An exception is a paper by Blonigen and Ohno (1998). In their model, two exporting firms compete in the third-county market, each facing a firm-specific tariff which depends not only on its export levels but also on the export levels of its rival. So, each firm's export has a negative externality on its rivals through the determination of the tariff. Contrary to theirs, in this paper, we consider two home firms facing one foreign exporting firm. Thus, the issue of an externality is between the home firms, and the external effect of each home firm altering its quantity decision is positive.

The positive externality of quantity distortion we study in this paper is closely related to the models of oligopolistic entry deterrence, such as Gilbert and Vives (1986), and Waldman (1987). The main result of their papers is that the entry is more likely deterred when there are several incumbent firms in an industry than when there is only one incumbent. That is, contrary to our intuition, they showed that positive externality of entry deterrence does not cause the underprovision of the public good (a barrier to the entry). We obtain the similar result that the two home firms are likely to produce more to increase the size of the tariff than one home firm.

3 Some observations in ADD and CVD petitions

In this section, we provide a couple of observations in antidumping and countervailing duty petitions relating to the results in this paper.

First, our claim that a firm with a larger market share is the one to file a petition, and a firm with a smaller share is the one to free ride, is fairly consistent with actual filing behavior. Although there are some exceptions, in which the largest firm in the industry is not a petitioner, these exception can be explained by our model if we relax the assumption of constant marginal cost. See section () for the detail.

Now, look at the table below, which summarizes the number of firms in an industry and the number of petitioning firms in each case[3].

Table (). The number of firms in the industry and the number of petitioning firms: 1990-2000

	the number of petitioning fims:		
# of the home firms in the industry	one firm	all firms	some firms
one firm (19 cases)	19 cases	-	-
two firms (16 cases)	11 cases	5 cases	-
three firms(17 cases)	14 cases	2 cases	1 case
four firms(11 cases)	8 cases	1 case	2 cases
five firms(12 cases)	6 cases	1 case	5 cases
six to ten firms (31 cases)	9 cases	0 case	22 cases
more than ten firms (40 cases)	4 cases	0 case	36 cases

From the inspection of the table, we see that when the number of firms is small, the petition is typically filed by one firm in the industry, while when the number of firms is large, the petition is filed jointly by several firms. Our model may be able to explain this. For the industry with small number of firms, the gain from protection one firm receives is large enough for one firm to cover the cost of petition, so that a joint petition is not likely to be an equilibrium. On the other hand, for the industry with large number of firms, the gain from protection each firm receives is not large enough for one firm to cover the petitioning cost, thus the firms jointly file a petition.

[3]The data are taken from the website of the Department of Commerce, and compiled by the authors.

Finally, an implication of the analysis of the first period is that there is no strong reason to believe that the industry with a single firm is more active in filing a petition than the industry with a few firms, because the noncooperative, oligopolistic home firms can be better at increasing the size of the tariff than the single home firm. The data shown in the table is not inconsistent with this result.

4 The Basic Model

We begin our analysis with a basic model with one period. There is a local market of a homogeneous product in an economy labeled home. The supply of the product comes from three sources: two local firms (firm 1 and firm 2) and a foreign firm (firm F). Denote the quantity supplied by firm i by q_i, $i = 1$, 2, F, and define the demand by $p = p(D)$, where p is the market price and D the demand. For simplicity, we consider a linear demand function: $p = a - bD$, where a, $b > 0$, and a is sufficiently large so that the market supports the three firms. The market equilibrium is described by

$$D = q_1 + q_2 + q_F. \tag{1}$$

Denote the marginal and fixed costs of firm i by c_i and f_i, respectively, where in this section c_i is assumed to be constant. With no demand in the foreign economy, the output of firm F is its export to home. The home government imposes a per unit tariff t on the good imported from firm F, where t may be zero (for free trade). In this one-period model, trade protection, if any, is known with certainty so that no lobbying or petitioning for protection is needed.

All firms take the policy parameter as given, and compete in a Cournot fashion. Taking the outputs of other firms as given and making use of condition (1), the profit maximization problem of home firm i is give by

$$\max_{q_i} \pi_i = (a - q_1 - q_2 - q_F - c_i)q_i + f_i, \tag{2}$$

where $i = 1, 2$. Similarly, the foreign firm chooses its quantity (its export to home) to maximize its profit:

$$\max_{q_F} \pi_F = (a - q_1 - q_2 - q_F - c_F - t)q_F + f_F. \tag{3}$$

It is easy to derive the Nash equilibrium quantities of the firms as a function of the tariff; they are equal to

$$\begin{cases} q_1^*(t) = \dfrac{a + c_2 + (c_F + t) - 3c_1}{4} \\ q_2^*(t) = \dfrac{a + c_1 + (c_F + t) - 3c_2}{4} \\ q_F^*(t) = \dfrac{a + c_1 + c_2 - 3(c_F + t)}{4} \end{cases}. \tag{4}$$

As mentioned, a is assumed to be sufficiently large so that all equilibrium quantities are positive. The corresponding profits of the firms are

$$\begin{cases} \pi_1^*(t) = \left(\dfrac{a + c_2 + (c_F + t) - 3c_1}{4}\right)^2 \\ \pi_2^*(t) = \left(\dfrac{a + c_1 + (c_F + t) - 3c_2}{4}\right)^2 \\ \pi_F^*(t) = \left(\dfrac{a + c_1 + c_2 - 3(c_F + t)}{4}\right)^2 \end{cases}. \tag{5}$$

Define $\pi_i^t \equiv \pi_i^*(t)$ and $\pi_i^0 \equiv \pi_i^*(0)$; π_i^0 is the equilibrium profit of firm i under free trade and π_i^t is its profit when a tariff t is imposed. In other words, for $t > 0$, the gains from protection enjoyed by the home firms are given by

$$\begin{cases} \Delta\pi_1 \equiv \pi_1^t - \pi_1^0 = \dfrac{t^2}{16} + \dfrac{(a + c_2 + c_F - 3c_1)t}{8} \\ \Delta\pi_2 \equiv \pi_2^t - \pi_2^0 = \dfrac{t^2}{16} + \dfrac{(a + c_1 + c_F - 3c_2)t}{8} \end{cases}. \tag{6}$$

It is clear from condition (6) that $\Delta\pi_i > 0$. The condition can be used to show the result given by the following lemma.

Lemma 1 *A home firm's gain from protection increases as (1) its marginal cost decreases, (2) the tariff increases, (3) the size of demand increases, and (4) the marginal costs of the rival firms increase.*

In the present case of constant marginal cost, a firm with a smaller marginal cost (thus a larger equilibrium quantity) have a larger gain from protection.

5 Petitioning for Protection

We now introduction petition for protection in the one-period model. Suppose that the government announces that it allows free trade unless one or both of the local firms file a petition for protection. If at least one of the local firms does file for protection, the government will impose with certainty a per unit tariff $t > 0$ on the good imported from the foreign firm.[4] Let the fixed cost of filing a petition be denoted by z. This cost is independent of the number of petitioning firms.

The period can be divided into two subperiods. In the first subperiod, both local firms decide whether to file a petition for protection. If a petition if filed by one or two local firms, the cost z is paid. If only one of them decides to file, the firm will pay the filing cost. If both of them file a petition together, they will share the filing cost. Let the amount firm i pays be z_i, where $z_1 + z_2 = z$. How they share the filing cost will be determined later. In the second subperiod, whether protection is imposed is known, and the firms, taking the government's decision as given and competing in a Cournot fashion, will choose their outputs. When the local firms decide whether to file a petition in the first subperiod, they will take into account how they compete with the foreign firm in the second subperiod.

The second subperiod has to be analyzed first, and is described in the previous section. As analyzed, firm i will receive a profit of π_i^j, for $i = 1, 2, F$, and $j = 0$ for free trade or $j = t > 0$ for a restricted trade with a tariff of t. Therefore this section focuses on the first subperiod. In this subperiod, what each of the local firms will choose can be described by a game, with the payoff of firm i, $i = 1, 2$, denoted by $\Delta\pi_i - x_i$, where x_i is the firm's share of filing cost: $x_i = z$ if it is the only firm to file, $x_i = z_i$ if both firms file and share the cost, and $x_i = 0$ if it does not file. Furthermore, $\Delta\pi_i = 0$ if none of the local files a petition.

Since each local firm always has the option of not filing a petition, therefore if the payoff of filing is negative, i.e., $\Delta\pi_i + x_i < 0$, the firm will choose not to file. On the other hand, if $\Delta\pi_i + x_i > 0$, the firm will have an incentive to file a petition.

The decisions of the local firms in terms of filing a petition depend on

[4]The assumption of protection with certainty in the presence of petition is not a strong assumption and qualitatively is not crucial for the results. Alternatively, we can assume that protection is imposed with a positive probability. As long as the probability is given exogenously, the analysis remains qualitatively the same.

what they may get from protection and the cost of filing. We consider the following cases.

5.1 Case (I): $\Delta\pi_1 + \Delta\pi_2 < z$

Since $\Delta\pi_i > 0$ for $i = 1, 2$, $\Delta\pi_1 + \Delta\pi_2 < z$ implies that $\Delta\pi_i < z$ in this case. This means that each of the two local firms will not get an increase in its profit big enough to cover the cost of filing. So neither of them will have an incentive to file a petition alone. Will they file a petition together? The answer is negative, as the condition for this case implies that no matter how the filing cost is shared between the two firms, at least one of them will be hurt, or $\Delta\pi_i + x_i < 0$, implying that the firm will block the sharing scheme and choose not to file a petition.

5.2 Case (II): $\Delta\pi_1 < z$, $\Delta\pi_2 < z$, and $\Delta\pi_1 + \Delta\pi_2 \geq z$

Second, consider $\Delta\pi_1 < z$, $\Delta\pi_2 < z$, and $\Delta\pi_1 + \Delta\pi_2 \geq z$. This case implies that each of the local firm will have no incentive to file a petition alone, as the payoff is negative. Will they file a petition jointly?

To answer this question, we first have to decide how they share the cost of filing if filing together. We assume that if they file a petition jointly, the sharing of the cost of filing is determined in a Nash bargaining process. In other words, z_1 is chosen to maximize

$$\max_{z_1}(\Delta\pi_1 - z_1)(\Delta\pi_2 - z + z_1), \tag{7}$$

where $z_2 = z - z_1$ has been used. The solution to the problem in (7) is

$$z_1 = \frac{\Delta\pi_1 - \Delta\pi_2 + z}{2}. \tag{8}$$

Condition (8) shows that the payoff of each firm is equal to $(\Delta\pi_1 + \Delta\pi_2 - z)/2$. Using this result, we can construct the payoff matrix of the filing game as follows:

Table 1: Case II

		Firm 2			
		F		NF	
Firm 1	F	$\frac{\Delta\pi_1 + \Delta\pi_2 - z}{2}$	$\frac{\Delta\pi_1 + \Delta\pi_2 - z}{2}$	$\Delta\pi_1 - z$	$\Delta\pi_2$
	NF	$\Delta\pi_1$	$\Delta\pi_2 - z$	0	0

where F = file a petition and NF = not file a petition. If both firms are filing a petition, they share the filing cost as described above. The payoff matrix indicates that the unique equilibrium is (F, F), with the first entry of the duplex representing the decision of firm 1, and the other entry that of firm 2, i.e., both firms file a petition jointly.

5.3 Case (III): $\Delta\pi_1 \geq z$, and $\Delta\pi_2 < z$

In this case, firm 1 is willing to file a petition if it is the only one to file, but firm 2 will have no incentive to file a petition alone. The question is, will the two firms file a petition jointly? To answer this question, we present the payoff matrix as follows. As explained earlier, x_i is what firm i pays for the filing cost, with $x_1 + x_2 = z$.

Table 2: Cases III and IV

		Firm 2			
		F		NF	
Firm 1	F	$\Delta\pi_1 - x_1$	$\Delta\pi_2 - x_2$	$\Delta\pi_1 - z$	$\Delta\pi_2$
	NF	$\Delta\pi_1$	$\Delta\pi_2 - z$	0	0

From the payoff matrix, we see that in order for firm 2 to be willing to file a petition jointly, it is required that $\Delta\pi_2 - x_2 > \Delta\pi_2$, i.e., $x_2 < 0$. This implies that $x_1 = z - x_2 > z$. As a result, the payoff of firm 1 when both firms file a petition jointly is less than what it can get when filing along. Then firm 1 will choose to file the petition alone. Thus the Nash equilibrium is (F, NF).

Using a similar argument, if $\Delta\pi_1 < z$ and $\Delta\pi_2 \geq z$, the Nash equilibrium is (NF, F), with firm 2 filing a petition alone.

5.4 Case (IV): $\Delta\pi_1 \geq z$ and $\Delta\pi_2 \geq z$

In this case, each of the two firms has an incentive to file a petition alone. We need to find out whether they want to file a petition jointly and what the Nash equilibrium is.

At first sight, it seems that the two firms will be willing to file a petition jointly and share the cost of filing. However, we want to argue that both firms filing a petition jointly is NOT a Nash equilibrium. To see why, refer back to Table 2. Suppose that (F, F) is a Nash equilibrium. For each of the firms to be willing to file jointly, we must have $\Delta\pi_i - x_i > \Delta\pi_i$. Adding them up, we have $\Delta\pi_1 + \Delta\pi_2 - (x_1 + x_2) > \Delta\pi_1 + \Delta\pi_2$, or $-(x_1 + x_2) > 0$, which is not true since $x_1 + x_2 = z > 0$. Thus we cannot have (F, F) as a Nash equilibrium.

In this case, what is the Nash equilibrium. This is given in the following proposition:

Proposition 1 *(F, NF) and (NF, F) are Nash equilibria.*

Proof. Nash bargaining gives that when both firms file a petition jointly, $0 < x_i < z$ for $i = 1, 2$; i.e., with both firms share part of the filing cost. Consider (F, NF). Taking the fact that firm 1 is going to file a petition, the best response of firm 2 is not to file, as $\Delta\pi_2 - x_2 < \Delta\pi_2$. On the other hand, when firm 2 is not filing, the best response of firm 1 is to file, as $\Delta\pi_1 - x_1 > \Delta\pi_1 - z$. So (F, NF) is a Nash equilibrium. Similarly, (NF, F) is also a Nash equilibrium. ■

The above proposition is not surprising, as it is in the heart of the literature of public goods. In the present case, since filing a petition is costly, while should a firm be interested in joining the other firm to file a petition if it is known that the other firm is going to file.

5.5 A Graphical Representation

In the above analysis, the Nash equilibria are derived in terms of the payoffs of the firms. From (4) and (6), we note that the equilibrium outputs and improvements in profits of the firms are directly related to firms' marginal costs. Thus we can make use of these two conditions to express the equilibria in terms of the marginal costs of the firms.

Figure 1 shows the (c_1, c_2) space. The line labeled β_1 represents $c_1 = c_2/3 + (a + c_F)/3$. From condition (4), we note that this line represents the locus of (c_1, c_2) that gives no output of firm 1 under free trade, i.e., $q_1^*(0) = 0$. Thus, to the right of this line, firm 1's equilibrium quantity is zero when the trade is free. Similarly, the line labeled β_2 is $c_2 = c_1/3 + (a + c_F)/3$, derived from the equality $q_2^*(0) = 0$. This means that points on and above line β_2 leads to zero equilibrium quantity of firm 2 under free trade. We restrict our attention to the parameter space inside of β_1 line and β_2 line, where both home firms produce positive outputs.

The line labeled α_1 represents the function $c_1 = c_2/3 + (a + c_F + t/2)/3 - 8z/3t$, which is derived from the equality $\Delta\pi_1 = z$. To the left of this line, $\Delta\pi_1 > z$. Similarly, the line labeled a_2 represents $c_2 = c_1/3 + (a + c_F + t/2)/3 - 8z/3t$, derived from the equality $\Delta\pi_2 = z$. Below this line, $\Delta\pi_2 > z$. The line labeled γ is $c_1 + c_2 = (a + c_F + t/2) - 4z/t$, derived from the equality $\Delta\pi_1 + \Delta\pi_2 = z$. Below this line, $\Delta\pi_1 + \Delta\pi_2 > z$.

First of all, the home firms do not file a petition if their marginal costs of production are too high, since the sum of the benefits from protection is smaller than the cost of filing a petition when the marginal costs are high. Second, two home firms filing a petition together is the equilibrium only when they have sufficiently high marginal costs of similar sizes. In such a case, the benefit from protection is not large enough for each firm to file a petition alone. That is, each firm is pivotal, or decisive for provision of the public good, thus two firms participate in filing a petition in the equilibrium. Third, if the unique equilibrium is that one firm is filing a petition alone, then the petitioner is a firm with smaller marginal cost. Note that the smaller marginal cost means the larger equilibrium quantity in the model of constant marginal cost. So, loosely speaking, a firm with a larger market share is the one to file a petition, and a firm with a smaller share is the one to free ride. This can be seen as an example of Olson's statement "the large is exploited by the small" (Olson, 1965). Finally, from the results of the model, one may argue that provision of public good here is efficient, in the sense that there are pure-strategy equilibria of filing a petition if and only if the sum of the benefits is larger than the cost of filing a petition. However, such an argument is not very convincing, because we have multiple pure-strategy equilibria ("firm 1 filling alone" and "firm 2 filing alone") when both home firms have sufficiently low marginal costs. Without a pre-play communication between the home firms, there is no way for the firms to know which equilibrium is played. Even if they can communicate, it is not very clear how they could reach to a consensus about which equilibrium to play. Thus, perhaps the best prediction will be a mixed-strategy equilibrium when both home firms have sufficiently low marginal costs. The inefficiency due to a free-rider problem then can be measured by the equilibrium probability with which the petition is not filed.

5.6 Comparative Statics

Now, let us mention the comparative statics for the net gain from protection. As long as the petition is filed in the equilibrium, and as long as the equilibrium outcome of the petition game does not change, it is readily seen that a home firm's net gain from protection is decreasing in the cost of production and the cost of filing a petition; increasing in the tariff, the size of demand, and the marginal costs of rival firms. These results are fairly conventional. However, if the equilibrium outcome of the petition-filing game is altered by a change in some parameter, the following unconventional results will happen: (1) a small increase in the marginal cost of a home firm can be beneficial to the firm; and (2) a small decrease in the tariff can benefit a home firm which files a petition alone and hurt the other home firm which free rides. The result (1) is illustrated as follows. Suppose that originally (c_1, c_2) is in the region where firm 1 files a petition, and that an increase in c_1 makes (c_1, c_2) move into the region where two firms file a petition together (as shown in the arrow in the graph). Although firm 1's benefit from protection falls, it now can share the cost of filing a petition with firm 2. If a change in the marginal cost is small enough, the latter effect dominates the former, so firm 1 will get better off (and firm 2 will get worse off). Similarly, the result (2) occurs in the following way. Again, suppose that originally (c_1, c_2) is in the region where firm 1 files a petition alone. When the tariff decreases, α_1 line shifts to the left, thus the equilibrium of the petition game is changed to two firms filing together. Intuitively, a decrease in the tariff lowers the firm 1's benefit from protection and makes firm 1 unable to file a petition alone. But if the decrease in the tariff is small enough, firm 1's net gain from protection increases because it can now share the cost of the petition with firm 2, which originally free rode.

5.7 Why does a large firm not file a petition sometimes?

One of the main results shown above is that a firm with a larger market share is more likely to be the one to file a petition, and a firm with a smaller share is more likely to be the one to free ride. This prediction of our model is fairly consistent with casual observation of data. However, there are several cases where a firm with smaller market share files a petition, and a firm with large market share refrains from filing a petition. For example, in the case of carbon steel butt-weld pipe fittings in 1994, the largest firm in the industry, Weldbend Corporation, did not join the petitioning firms. Another example is the case of collated roofing nails in 1996: Stanley-Bostitch, the largest U.S. producer, was not a petitioner. At first blush, these cases seem puzzling. Why does a large firm, which is likely to get a larger benefit from protection than marginal firms do, not file a petition? In this section, we provide one theory.

Here, we consider the general form of the inverse demand $p(q_1 + q_2 + q_F)$ with $p'(\cdot)$ and the cost function $C_i(q_i)$ with $C' > 0$ and $C'' > 0$. So, the profit function of the home firm is now given by

$$\pi_i = p(q_1 + q_2 + q_F)q_i - C(q_i),$$

where $i = 1, 2$, and that of the foreign firm is given by

$$\pi_F = p(q_1 + q_2 + q_F)q_F - C(q_F) - tq_F.$$

We assume that the demand curve is not too convex so that the profit function of each firm is concave in its own quantity, and that the marginal profit is decreasing in its rival's quantity. Then, the comparative statics results for the equilibrium quantity are calculated from the following system of equations

$$\begin{bmatrix} p''q_1 + 2p' - C_1'' & p''q_1 + p' & p''q_1 + p' \\ p''q_2 + p' & p''q_2 + 2p' - C_2'' & p''q_2 + p' \\ p''q_F + p' & p''q_F + p' & p''q_F + 2p' - C_F'' \end{bmatrix} \begin{bmatrix} \frac{dq_1}{dt} \\ \frac{dq_2}{dt} \\ \frac{dq_F}{dt} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}.$$

It is straightforward to show that $dq_1/dt > 0$, $dq_2/dt > 0$, and $dq_F/dt < 0$. The comparative statics results for the equilibrium profits of the home firms are given by

$$\begin{aligned} \frac{d\pi_1}{dt} &= p'q_1 \left(\frac{dq_2}{dt} + \frac{dq_F}{dt} \right) \\ \frac{d\pi_2}{dt} &= p'q_2 \left(\frac{dq_1}{dt} + \frac{dq_F}{dt} \right). \end{aligned}$$

Then, the benefit from protection, $\Delta\pi_i$ $(i = 1, 2)$ is expressed as

$$\Delta\pi_i = \int_0^t \frac{d\pi_i(s)}{ds} ds$$

So, a sufficient condition for $\Delta\pi_1 > \Delta\pi_2$ is that $d\pi_1/dt > d\pi_2/dt$ for all $t \geq 0$.

Here, we are interested in showing that $q_1 < q_2$ can imply $\Delta\pi_1 > \Delta\pi_2$. To show this, we first calculate $d\pi_1/dt - d\pi_2/dt$:

$$\begin{aligned} & \frac{d\pi_1}{dt} - \frac{d\pi_2}{dt} \\ = \; & \frac{p'}{D}\{(p'[2p' + p''(q_1 + q_2)] + C_1''C_2'')(q_1 - q_2) \\ & -q_1[C_1''p' + C_2''(2p' + p''q_1)] + q_2[C_2''p' + C_1''(2p' + p''q_2)]\}, \end{aligned}$$

where D is the determinant of the matrix given above. Now, suppose that $q_2 - q_1 > 0$, but the difference is vary small. Then, $d\pi_1/dt - d\pi_2/dt$ is approximately equal to $-p'q_1(p'+p''q_1)(C_2''-C_1'')/D$. Thus, $d\pi_1/dt - d\pi_2/dt > 0$ if $C_2'' > C_1''$. That is, if the slope of the marginal cost of firm 2 is larger than that of firm 1, it is possible that $\Delta\pi_1 > \Delta\pi_2$ even though $q_2 > q_1$. In words, when the marginal cost of firm 2 is more rapidly rising than that of firm 1, the benefit from protection is larger for firm 1 than for firm 2 even though firm 2's quantity is larger than firm 1's. Hence, $\Delta\pi_1 > z > \Delta\pi_2$ and $q_2 > q_1$ can simultaneously happen: when the marginal cost is increasing, the firm with a smaller market share may file a petition alone in the equilibrium.

6 Endogenous Tariff - A Two-Stage Game

So far we have been focusing on the strategies of the two local firms, under the assumption that the foreign firm takes the tariff to be imposed by the local government as given. In many cases, this is a strong assumption. Usuaully, it takes time for the local firms to file a petition and for the government to investigate the case and to declare a tariff rate. Furthermore, the government usually adopts some rules for picking the tariff rate; for example, the anti-dumping duty may be linked to the existing differential between the local price and the foreign price. Information about these rules is very likely in the public domain so that the foreign firm can anticipate the future tariff rates should the local firms file a petition. In such a case, the foreign firm will have time to respond to the local firms' petition. Similarly, the two local firms may also have time to act early in order to help their case in the near future when one or both of them file a petition.

To analyze how the firms may want to do prior to a petition is filed, we consider a two-period game. In the first period, all the three firms choose the optimal production. In the second period, the local firms choose whether to file a petition, and if at least one of them does, a tariff is imposed. The firms then choose the product levels, which may be different from what they choose in the first period. To ensure a subgame perfect equilibrium, in the first period the firms take into full account what they may do in the second period. In both periods, the firms compete in a Cournot fashion, as explained earlier.

The study of the oligopolistic firms' strategic behavior to affect the level of protection is not new. For example, Fischer (1992) analyzes the strategic interaction of the home firm and the foreign firm when they face the endogenous probability of future protection. A paper by Blonigen and Ohno (1998) considers the third market model where two exporting firms have an incentive to raise the tariff imposed on rival firms. Reitzes (1993) examines the effect of antidumping duty policy on the home firm's and the foreign firm's strategic interaction. Our analysis of the first period is based on the model of Reitzes: the size of the tariff is determined endogenously as a function of the price difference between the foreign market and the home market prior to the protection enforcement. The novel feature in our analysis is that we consider two home firms, taking into account the noncooperative behavior of the home firms to influence the size of the tariff in the second period. Thus, one of our interests in this section is to see how the equilibrium outcome of the first period is different when there are two home firms than when there is only one firm. We also ask how the strategic interaction among firms in the first period can affect the petition filing game in the second period.

Let us call the two periods period 1 and period 2. We analyze period 2 first. This period is just the same as what was described in the previous section. So there is no need to repeat it here. Let us turn to period 1. A superscript "1" is used to denote the variables in this period. Thus the demand for the good in the local market is given by

$$p^1 = a - (q_1^1 + q_2^1 + q_F^1).$$

In this period, the foreign market becomes important. So we have to specific its demand to be:

$$P^1 = A - Q^1,$$

where the upper-case letters represent the variables of the foreign market; for example, P^1 is the market price and Q^1 is the supply of the foreign firm to its own market. As explained, the foreign firm is a monopolist in its own market.[5]

To make the present analysis tractable, we make some additional assumptions: (a) The local firms are all symmetric, i.e., they have the same marginal cost, $c_1 = c_2 = c_H$. (b) There is no filing cost, i.e., $z = 0$. (c) If the government decides to restrict trade, it will choose the tariff rate given by $t = P^1 - p^1$.[6] (d) The two markets are segmented. Assumption (a) and (c) are made for simplicity, while assumption (b) will be relaxed later. A more general assumption about the tariff function is that the tariff rate in period 2 is a function of the gap between the prices in the two markets in period 1, but we believe that the function in assumption (c) will give us enough of insight. Given zero filing cost, the analysis in the previous section implies that the local firms will file a petition for protection. In this case, it does not matter which local firm files, or if both firms file. Assumption (d) is a common assumption in the theory of international trade under oligopoly. A justification is that no arbitrage is allowed, is discouraged due to factors such as high transport costs, between the two markets.[7]

We now derive the equilibrium outputs of the firms. Recall that in the one-period model, the profit of firm i is equal to $\pi_i = \pi_i(\tilde{t})$, $i = 1, 2, F$, where $\tilde{t} = P^1 - p^1$ is the tariff rate the government will choose to impose in the presence of a petition filed by local firms. Note that the first-period equilibrium price in the local market p^1 depends on the supplies of the good to the market by the firms, we can denote $\tilde{t}$ by $\tilde{t} = t(P, q_1 + q_2 + q_F) = P - p(q_1 + q_2 + q_F)$, where from now on, unless stated otherwise, we drop the

[5]In the previous analysis with only one period, we have not analyzed the foreign market. In the present section, generally the foreign market has to be examined in both periods. In the second period, because the firms have no strategies to play to affect future equilibrium, and because the markets are segmented and the firms have constant marginal costs, the two markets can then be analyzed separately. This means that the analysis for a one-period model given in the previous section applies here.

[6]We assume that the parameters are within the range so that in equilibrium $P^1 - p^1 \geq 0$.

[7]For a discussion of the assumption of no arbitrage and the implication of relaxing this assumption, see Wong (1995, Chapter 7).

superscript "1" for the variables in period 1; i.e., q_i is the first-period output chosen by firm i.

Our analysis focuses on the value of first-period outputs chosen by the firms, i.e., q_i. Let us first consider firm 1. Its problem is to choose q_1 to maximize the present value of its profits in the two periods, taking the outputs of all other firms as given, or

$$\max_{q_1} \Pi_1 = (a - q_1 - q_2 - q_F - c_H)q_1 + \delta\pi_1(\tilde{t}),$$

where $\delta \in (0,1)$ is a discount factor. Note that the tariff rate depends on q_1 as well, and that with segmented markets and constant marginal costs, there is a one-to-one correspondence between the foreign firm's supply to the foreign market and the foreign price. Taking the foreign firm's outputs as given means that the local firm takes the foreign prices as given. The reaction function of firm 1, $q_1 = q_1(q_2, q_F, P)$ is defined from the first-order condition:

$$a - 2q_1 - q_2 - q_F - c_H + \delta\pi_1'(\tilde{t}) = 0,$$

where $p' = -1$ has been used. The second order condition is satisfied because the second derivative of the objective function is $-2 + \delta\pi_1'' = -2 + \delta/8 < 0$. Since $\delta\pi_1'(\tilde{t}) > 0$, we have $a - 2q_1 - q_2 - q_F - c_H < 0$. By the concavity of the profit function, this inequality shows that the best reply of firm 1 is larger than when there is no intertemporal linkage. That is, to increase the tariff in the second period, firm 1 has an incentive to increase its first-period quantity above the standard Cournot best reply level. The reaction function of firm 2, $q_2(q_1, q_F, P)$ is derived in the same way, and symmetric to the reaction function of firm 1.

It is interesting to observe that the home firms' quantity distortion in the first period to increase the tariff in the second period has a public good property. When the tariff in the second period is increased as one home firm produces above the standard Cournot best reply, the other home firm can enjoy the benefit of the increase in the second-period tariff without changing its quantity. Namely, each home firm has an incentive to free ride on other firm's quantity distortion. A casual intuition suggests that, due to such a free riding incentive, the first-period quantity produced by the home firms would be less than jointly optimal quantity. However, this intuition is not correct. The proposition below shows that the home firms overproduce rather than underproduce.

Proposition 2 *Given the foreign firm's export and the foreign market price, the total quantity produced by the home firms is higher when they noncooperatively decide how much to produce than when they can collude in the first period (but not in the second period).*

Proof. Let q_1^{NC} and q_2^{NC} denote the optimal quantities produced by firm 1 and firm 2 when these two home firms noncooperatively chooses how much to produce. The corresponding tariff rate is $t^{NC} = P - p(q_1^{NC} + q_2^{NC} + q_F)$. Note that q_1^{NC} and q_2^{NC} satisfies each home firm's first order condition

$$\begin{aligned} a - 2q_1^{NC} - q_2^{NC} - q_F - c_H + \delta\pi_1'(t^{NC})) &= 0 \\ a - 2q_2^{NC} - q_1^{NC} - q_F - c_H + \delta\pi_2'(t^{NC}) &= 0. \end{aligned}$$

Summing these two first-order conditions, and using the symmetry, we have

$$2a - 3q_H^{NC} - 2q_F - 2c + \delta\pi_1'(t^{NC}) + \delta\pi_2'(t^{NC}) = 0,$$

where $q_H^{NC} = q_1^{NC} + q_2^{NC}$.

On the other hand, when two home firms can collude on the first-period quantity (but not on the second-period quantity), they maximize the joint profit

$$\max_{q_H}(a - q_H - q_F - c)q_H + \delta\pi_1(t(P, q_H + q_F)) + \delta\pi_2(t(P, q_H + q_F)).$$

The first-order condition defines the jointly optimal quantity, q_H^C (the superscript "C" for "colluding" or "cooperating"):

$$a - 2q_H^C - q_F - c + \delta\pi_1'(t(P, q_H^C + q_F)) + \delta\pi_2'(t(P, q_H^C + q_F)) = 0.$$

Suppose $q_H^{NC} \leq q_H^C$. Then, by the concavity of the intertemporal profit function,

$$\begin{aligned} 0 &\leq a - 2q_H^{NC} - q_F - c_1 + \delta\pi_1'(t^{NC}) + \delta\pi_2'(t^{NC}) \\ &< 2a - 3q_H^{NC} - 2q_F - 2c + \delta\pi_1'(t^{NC}) + \delta\pi_2'(t^{NC}) \\ &= 0. \end{aligned}$$

This is a contradiction. Thus, $q_H^{NC} > q_H^C$. ■

Notice that when the home firms noncooperatively decide how much to produce, there are two externalities. One is the public-good property of the protection policy in the second period: each firm fails to internalize the effect of its quantity on other firm's second period profit. Due to this positive externality, each firm tends to underproduce. The other externality is the effect of the first-period quantity on the first-period price. Each firm fails to internalize the effect of its quantity on other firm's first-period profit through a change in the price. This is a negative externality. The proposition above shows that, when these two externalities are internalized, the total quantity of the home firms is smaller, suggesting that the negative externality always dominates the positive externality. Thus, the free rider problem of the quantity distortion is not an significant factor. This result has the similar spirit to the oligopolistic entry deterrence problem studied by Gilbert and Vives (1986) and Waldman (1987). They showed that, under a certain setting, the free-rider problem is not an important issue in the entry deterrence with several incumbent firms.

The intuition behind the proposition is explained as follows. Suppose that firm 1 is going to decrease its quantity from q_1^* to $q_1^* - \varepsilon$. At the margin, this decrease in q_1^* has little impact on firm 1's profit since the first-order change is zero. The decrease in q_1^* lowers firm 2's second-period profit by $-\delta\pi_2'(t(P,\, q_1^* + q_2^* + q_F))\varepsilon$. However, the decrease in q_1^* raises the first period price by ε, causing an increase in the first-period profit of firm 2 by $q_2^*\varepsilon$. Without a change in its quantity, firm 2 is made better off by the decrease in q_1^*.

Finally, we note that the above proposition remains valid in more general cases: (i) The proof does not require linearity of the demand curve. (ii) The proposition holds not only for two home firms but also for n home firms.

Now, let us turn to the foreign firm's decision. It chooses the quantity to be supplied to the foreign market (or alternatively it chooses the price it charges in the foreign market) and the quantity it exports to the home market. So, its intertemporal profit maximization is

$$\max_{q_F, P} \Pi_F = (A - P)P + (a - q_1 - q_2 - q_F - c_F)q_F + \delta\pi_F(t(P,\, q_1 + q_2 + q_F)),$$

where for simplicity we assume that all firms have the same discount rate.

The first order conditions are

$$\left\{ \begin{array}{c} a - q_1 - q_2 - 2q_F - c_F + \delta \pi'_F(\tilde{t}) = 0 \\ A - 2P - c_F + \delta \pi'_F(\tilde{t}) = 0 \end{array} \right. .$$

These first-order conditions jointly define the foreign firm's reaction functions $q_F(q_1, q_2)$ and $P(q_1, q_2)$. Since $\delta \pi'_F(t) < 0$, it is seen that $a - q_1 - q_2 - 2q_F - c_F > 0$ and $A - 2P - c_F > 0$. That is, the best reply of the foreign firm's export is below the best-reply function of the standard Cournot game, and the price in the foreign market is below the monopoly price. We thus summarize the above results by the following proposition:

Proposition 3 *When the price difference of the first period affects the tariff in the second period, the home firms have incentives to increase their quantities to decrease the home-market price and thus widen the price difference, while the foreign firm has incentives to decrease its export and the foreign-market price to narrow the price differences. Therefore, in the equilibrium, the home firms' quantities are larger, the foreign firm's export is smaller, and the foreign-market price is lower than in the equilibrium of the static game.*

Consider now that the equilibrium quantities and prices are the function of the discount factor, δ: i.e., the equilibrium in the first period is represented by $\{q_1(\delta), q_2(\delta), q_F(\delta), P(\delta)\}$. Then, the equilibrium of the one-shot game is given by setting $\delta = 0$: i.e., $\{q_1(0), q_2(0), q_F(0), P(0)\}$. In order to see how the intertemporal linkage of the profit due to protection policy affects the firms' behavior in the first period, we take the derivatives of $q_1(\delta)$, $q_2(\delta)$, $q_F(\delta)$, and $P(\delta)$ with respect to δ and evaluate them at $\delta = 0$. Noticing that $\pi''_1(t) = \pi''_2(t) = \delta/8$ and $\pi''_F(t) = 9\delta/8$, the derivatives of the equilibrium quantities and the price with respect to δ are calculated from the following system of equations:

$$\begin{bmatrix} -2 + \frac{\delta}{8} & -1 + \frac{\delta}{8} & -1 + \frac{\delta}{8} & \frac{\delta}{8} \\ -1 + \frac{\delta}{8} & -2 + \frac{\delta}{8} & -1 + \frac{\delta}{8} & \frac{\delta}{8} \\ -1 + \frac{9\delta}{8} & -1 + \frac{9\delta}{8} & -2 + \frac{9\delta}{8} & \frac{9\delta}{8} \\ \frac{9\delta}{8} & \frac{9\delta}{8} & \frac{9\delta}{8} & -2 + \frac{9\delta}{8} \end{bmatrix} \begin{bmatrix} \frac{dq_1}{d\delta} \\ \frac{dq_2}{d\delta} \\ \frac{dq_F}{d\delta} \\ \frac{dP}{d\delta} \end{bmatrix} = \begin{bmatrix} -\pi'_1(t) \\ -\pi'_2(t) \\ -\pi'_F(t) \\ -\pi'_F(t) \end{bmatrix},$$

which yields

$$\begin{aligned}
\left.\frac{dq_1}{d\delta}\right|_{\delta=0} &= \left.\frac{3\pi'_1(t) - \pi'_2(t) - \pi'_F(t)}{4}\right|_{\delta=0} > 0, \\
\left.\frac{dq_2}{d\delta}\right|_{\delta=0} &= \left.\frac{3\pi'_2(t) - \pi'_1(t) - \pi'_F(t)}{4}\right|_{\delta=0} > 0, \\
\left.\frac{dq_F}{d\delta}\right|_{\delta=0} &= \left.\frac{3\pi'_F(t) - \pi'_1(t) - \pi'_2(t)}{4}\right|_{\delta=0} < 0, \\
\left.\frac{dP}{d\delta}\right|_{\delta=0} &= \left.\frac{\pi'_F(t)}{2}\right|_{\delta=0} < 0.
\end{aligned}$$

The signs of these derivatives are as expected. The home firms' equilibrium quantity is above, and the foreign firm's export and the foreign market price is below the equilibrium in the static game. However, it is ambiguous whether the equilibrium price in the home market increases or decreases. Also, it is ambiguous whether the price difference between the home and the foreign market increases or decreases. We see this below.

The effect of the protection policy on the home-market price in the first period is measured by

$$\begin{aligned}
\left.\frac{dp}{d\delta}\right|_{\delta=0} &= -\left(\left.\frac{dq_1}{d\delta}\right|_{\delta=0} + \left.\frac{dq_2}{d\delta}\right|_{\delta=0} + \left.\frac{dq_F}{d\delta}\right|_{\delta=0} \right) \\
&= -\left.\frac{\pi'_1(t) + \pi'_2(t) + \pi'_F(t)}{4}\right|_{\delta=0} \\
&= -\frac{1}{128}(22A - 15a - 62c_H + 11c_F).
\end{aligned}$$

The expression above is negative if the foreign firm's export is less than a quarter of the total quantity in the home market (when $t = P(\delta) - p(q_1(\delta) + q_2(\delta) + q_F(\delta))$ is evaluated at $\delta = 0$). In terms of the exogenous parameters, we can provide the following conditions. The home-market price is likely below the standard Cournot equilibrium if the size of the foreign market is sufficiently larger than that of the home market, and the marginal cost of the home firm is sufficiently smaller than that of the foreign firm, or the marginal cost of the home and the foreign firms are very small relative to the size of demand.

The effect of the protection policy on the price difference is given by

$$\left.\frac{d(P-p)}{d\delta}\right|_{\delta=0} = \left.\frac{\pi_1'(t)+\pi_2'(t)+3\pi_F'(t)}{4}\right|_{\delta=0}$$
$$= \frac{1}{128}(58A-57a-146c_H+29c_F).$$

Again, in terms of exogenous parameters, this expression is positive if the size of the foreign market is sufficiently larger than that of the home market, and the marginal cost of the home firm is sufficiently smaller than that of the foreign firm, or the marginal cost of the home and the foreign firms are very small relative to the size of demand.

With a casual intuition, one might consider that the foreign firm can more effectively affect the future tariff the home firms can do, since the foreign firm controls two variables, its export and the foreign market price, to lower the size of the tariff, while the home firms choose their quantities noncooperatively. However, contrary to this intuition, as proposition 1 showed, the free rider problem of quantity distortion between the home firms is not significant. Also, the comparative statics showed it is possible that the effect of the protection policy on the home firms' quantities is larger than the effect on the foreign firm's export, and as a result, the equilibrium price in the home market can be lower than the standard Cournot outcome. Now, we briefly consider the case where there is only one firm in the home market, and then compare the results of one home firm case with those of two home firm case. By doing so, we show that the size of the tariff is more likely above the equilibrium of the static game when there are two home firms than when there is only one firm.

6.1 Special Case: One Local Firm

To analyze the interactions between the local firms and the foreign firm, we now focus on a special case in which there is only one local firm. Let us index this firm by a subscript H. In the Cournot stage of the second period, the equilibrium quantities are given by $\hat{q}_H(t)=(a+c_F-c_H+t)/3$ and $\hat{q}_F(t)=(a+c_H-2c_F-2t)/3$; the equilibrium profits are $\hat{\pi}_H(t)=(a+c_F-c_H+t)^2/9$ and $\hat{\pi}_F(t)=(a+c_H-2c_F-2t)^2/9$ (a "hat" is used to stand for the variables in the case of one home firm). Assuming the cost of the petition to be zero (so that the home firm always file a petition), the intertemporal profit maximization problem of the home firm is

$$\max_{q_H}(a - q_H - q_F - c_H)q_H + \delta\hat{\pi}_H(t(P, q_H + q_F)),$$

which yields the first order condition

$$a - 2q_H - q_F - c_H + \delta\hat{\pi}'_H(t(P, q_H + q_F)) = 0. \tag{9}$$

The proposition below shows that the home's best reply in the first period is larger when there are two home firms than when there is only one home firm.

Proposition 4 *Given the foreign firm's export and the foreign market price, the total quantity produced by the home firms is higher when they noncooperatively decide how much to produce than when they can collude in the first period and in the second period.*

Proof. For given q_F and P, let q_H^B denote the home firm's optimal quantity when they can collude on quantity both in the first period and the second period. Note that q_H^B is equal to the optimal quantity when there is only one home firm. So it satisfies the first order condition (9). That is,

$$a - 2q_H^B - q_F - c_H + \delta\hat{\pi}'_H(t^B) = 0,$$

where $t^B = t(P, q_H^B + q_F)$. What we need to show here is $q_H^{NC} > q_H^B$. Since we have shown that $q_H^{NC} > q_H^C$ in proposition 1, it suffices to show that $q_H^C > q_H^B$. As seen in the proof of proposition (), q_H^C satisfies

$$a - 2q_H^C - q_F - c_H + \delta\pi'_1(t^C) + \delta\pi'_2(t^C) = 0,$$

where $t^C = t(P, q_H^C + q_F)$. Suppose that $q_H^C \leq q_H^B$. Then,

$$\begin{aligned}
0 &= a - 2q_H^B - q_F - c_H + \delta\hat{\pi}'_H(t^B) \\
&\leq a - 2q_H^C - q_F - c_H + \delta\hat{\pi}'_H(t^C) \\
&= \delta\hat{\pi}'_H(t^C) - \left[\delta\pi'_1(t^C) + \delta\pi'_2(t^C)\right] \\
&= \delta\left[\frac{2(a + c_F - 2c_H + t^C)}{9} - \frac{2(a + c_F - 2c_H + t^C)}{8}\right] \\
&< 0,
\end{aligned}$$

leading to a contradiction. The second inequality comes from the concavity of the intertemporal profit function, and the fourth equality comes from the symmetry of the home firms. ■

The key in the proof of proposition above is an observation that the sum of the second-period profit of the home firms when they act noncooperatively is more sensitive to a change in the tariff than the second-period profit of the home firms when they can collude is. In other words, the marginal benefit of quantity distortion in the first period is higher when two firms act noncooperatively in the second period than when they can collude in the second period.[8]

Now we look at the foreign firm's intertemporal profit maximization when it faces only one rival in the home country. The objective function is

$$\max_{q_F, P}(A - P)P + (a - q_H - q_F - c_F)q_H + \delta\hat{\pi}_F(t(P, q_H + q_F)),$$

where now $\tilde{t} = t(P, q_H + q_F)$. The first order conditions are

$$\begin{aligned} a - q_H - 2q_F - c_F + \delta\hat{\pi}'_F(\tilde{t}) &= 0, \\ A - 2P + \delta\hat{\pi}_F(\tilde{t}) &= 0. \end{aligned}$$

As in the case of two home firms, the effect of the second-period protection policy on the first period equilibrium is derived by differentiating the first order conditions with respect to δ and evaluating them at $\delta = 0$:

$$\begin{bmatrix} -2 + \dfrac{2\delta}{9} & -1 + \dfrac{2\delta}{9} & \dfrac{2\delta}{9} \\ -1 + \dfrac{8\delta}{9} & -2 + \dfrac{8\delta}{9} & \dfrac{8\delta}{9} \\ \frac{8\delta}{9} & \frac{8\delta}{9} & -2 + \frac{8\delta}{9} \end{bmatrix} \begin{bmatrix} \dfrac{d\hat{q}_H}{d\delta} \\ \dfrac{d\hat{q}_F}{d\delta} \\ \dfrac{d\hat{P}}{d\delta} \end{bmatrix} = \begin{bmatrix} -\hat{\pi}'_1(t) \\ -\hat{\pi}'_F(t) \\ -\hat{\pi}'_F(t) \end{bmatrix}.$$

[8] For symmetric home firms, this observation is true when the number of home firms is two, three or four. Thus, the proof of the proposition () is not valid when the home firms have different marginal cost or when the number of the home firms are more than four.

The solution to this system of equations is

$$
\begin{aligned}
\left.\frac{d\hat{q}_H}{d\delta}\right|_{\delta=0} &= \left.\frac{2\hat{\pi}'_H(t) - \hat{\pi}'_F(t)}{3}\right|_{\delta=0} > 0 \\
\left.\frac{d\hat{q}_F}{d\delta}\right|_{\delta=0} &= \left.\frac{2\hat{\pi}'_F(t) - \hat{\pi}'_H(t)}{3}\right|_{\delta=0} < 0 \\
\left.\frac{d\hat{P}}{d\delta}\right|_{\delta=0} &= \left.\frac{\hat{\pi}'_F(t)}{2}\right|_{\delta=0} < 0.
\end{aligned}
$$

The effect of the protection policy on the home-market price in the first period is measured by

$$
\begin{aligned}
\left.\frac{d\hat{p}}{d\delta}\right|_{\delta=0} &= -\left(\left.\frac{d\hat{q}_H}{d\delta}\right|_{\delta=0} + \left.\frac{dq_F}{d\delta}\right|_{\delta=0}\right) \\
&= -\left.\frac{\hat{\pi}'_H(t) + \hat{\pi}'_F(t)}{3}\right|_{\delta=0} \\
&= -\frac{1}{81}(15A - 16a - 34c_H + 5c_F).
\end{aligned}
$$

And the effect on the price difference is given by

$$
\begin{aligned}
\left.\frac{d(\hat{P} - \hat{p})}{d\delta}\right|_{\delta=0} &= -\left.\frac{2\hat{\pi}'_H(t) + 5\hat{\pi}'_F(t)}{6}\right|_{\delta=0} \\
&= \frac{1}{81}(33A - 46a - 64c_H + 11c_F).
\end{aligned}
$$

The following table summarizes the expressions of $dp/d\delta|_{\delta=0}$ and $d(P-p)/d\delta|_{\delta=0}$ in terms of the exogenous parameters.

	two home firms	one home firm
$\left.\frac{dp}{d\delta}\right\|_{\delta=0}$	$-\frac{1}{128}(22A - 15a - 62c_H + 11c_F)$	$-\frac{1}{81}(15A - 16a - 34c_H - 5c_F)$
$\left.\frac{d(P-p)}{d\delta}\right\|_{\delta=0}$	$\frac{1}{128}(58A - 57a - 146c_H + 29c_F)$	$\frac{1}{81}(33A - 46a - 64c_H + 11c_F)$

Suppose that the home market and the foreign market are equal in size $(A = a)$, and that the marginal cost of the foreign firm is equal to those of home firms ($c_H = c_F$). Then, when there are two home firms, it is possible that home market price is below and the price difference is above the standard Cournot outcome if the marginal cost is small enough. On the other hand, when there are only one home firm, home market price is always above and the price difference is always below the standard Cournot outcome. In other words, these results imply that the industry in the home country is more effectively influence the size of the tariff when there are two firms than when there is only one firm in the home country.

The intuition behind this result is the following. For the foreign firm, its second period profit is less sensitive to a change in the tariff when there are two home firms than when there is one home firm. Put it in another way, its marginal benefit of lowering the first-period export and the foreign market price is smaller when there are two home firms. Accordingly, the foreign firm distorts the export and the foreign market less when there are two home firms. On the other hand, the home firms tend to produce more when they act noncooperatively than when collude (or when there is only one home firm). This is because (1) the negative externality effect of noncooperative quantity decision on the first period profit always dominates the positive externality effect on the second period profit, and (2) the total second period profit is more sensitive to the tariff when they act noncooperatively than when they collude in the second period.

7 Concluding remarks

In this paper, we studied the home firms' noncooperative decision of filing a petition for administered protection, looking at the protection as a public good. We provided some interesting comparative statics results, such that an increase in the marginal cost of a home firm can benefit itself and hurt the other home firm, and an increase in the tariff can benefit one home firm and hurt the other. We also analyzed the effect of administered protection policy on the market outcome in a period before petition-filing decision, motivated by the fact that in the administered protection the size of the tariff depends on the market outcome prior to the protection enforcement. We pointed out that the home firms' quantity distortion to influence the future tariff also has a public good property, but the free-rider problem is not important there. Contrary to an intuition, the home firms tend to produce more to influence the future tariff when they act noncooperatively than when they collude on quantity. As a result, it is more likely that the size of dumping margin, and thus the size of the tariff, is above the myopic profit maximization level when the home firms act noncooperatively. An implication of this result is the following: an increase in the number of firms in the home market from one to two does not necessarily mean less possibility of petition filing. An industry with two home firms can be more active in filing a petition than an industry with one home firm, because two home firms are able to increase the size of the tariff than one home firm could do.

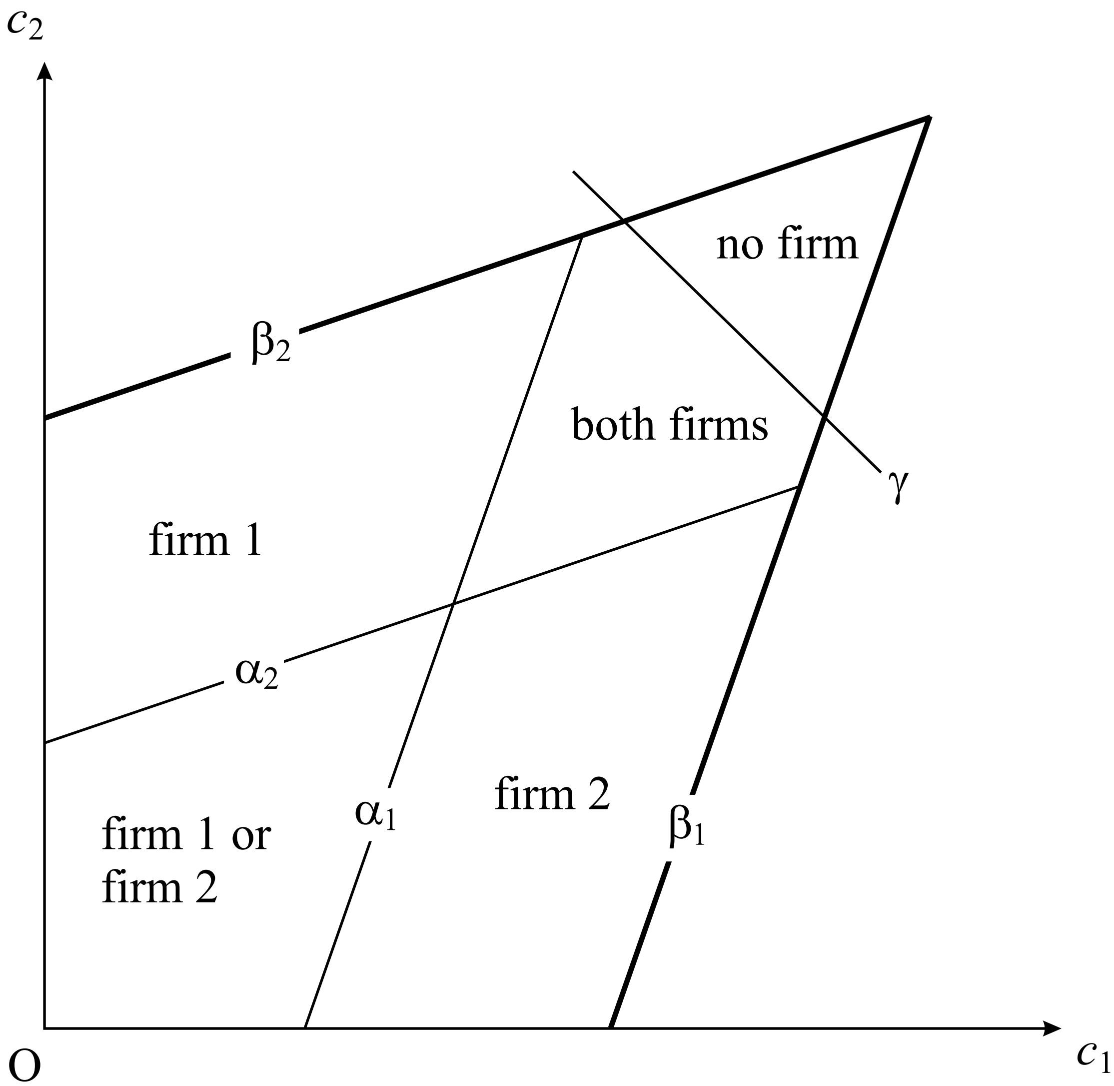

Figure 1

Decision to File A Petition

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