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Design of an Antidumping Rule with Incomplete Information about Material Injury

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Abstract

This paper deals with the inability of an administering authority to directly observe the level of material injury in antidumping petitions. We focus on the use, by the domestic firm, of private information about injury in order to obtain higher protection. By using an incentive framework, we show that asymmetric information about the level of injury can be resolved by using a mix of lump-sum compensation, domestic unit taxes and antidumping duties rather than just import duties. Surprisingly, the lump-sum transfer decreases and the domestic unit tax increases with the level of material injury. This efficient antidumping rule will induce the domestic firm to tell the truth about the level of material injury. (JEL Classification: F13, L50)

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I. Introduction

This paper develops incentive compatible contracts to deal with the inability of an administering authority to directly observe the level of material injury in antidumping petitions. We analyze the problem in an incentive framework and show that problems arising from asymmetric information about material injury can be resolved by using a mix of lump-sum compensation, unit taxes, and antidumping duties. An efficient antidumping rule will induce the domestic firm to truthfully report its level of material injury and thus prevents the use of antidumping procedures as a strategic device against foreign competitors.

Identifying efficient antidumping procedures is of crucial importance. Antidumping measures have become the most frequently used tools in trade policy over the last twenty years. This procedure has been enshrined in the GATT system since its inception and will continue to play a role in the international trading system overseen by the World Trade Organization. Antidumping procedures world-wide have been designed to allow duties to be placed on goods that are imported at "less-than-fair" value and have caused "material injury" to domestic firms competing with imports.

Most economists have long argued that antidumping procedures enshrined in national laws have little economic justification and result in unnecessary and unjustified increases in consumer prices. ⟨See Baldwin, [1985]⟩. For example, the conditions for successful predatory pricing by foreign firms (*e.g.* high barriers to entry) do not frequently hold. Moreover, domestic firms need not demonstrate that these preconditions for predatory pricing exist in the formal legal framework of antidumping procedures. More generally, Dixit [1988] uses a Cournot duopoly framework to show that no normative reasons are found to impose duties to protect domestic firms from foreign competition.

Besides an increase in consumer prices, the existence of antidumping laws may cause other perverse effects. Many recent contributions have shown that domestic firms might use antidumping laws strategically to limit foreign competition. Staiger and Wolak [1991] show how domestic firms use antidumping laws against foreign competing firms to enforce tacit collusion. Prusa [1992] points out that domestic firms have incentives to file antidumping suits

against foreign competing firms without concern for the petition's outcome. Fisher [1992] emphasizes that the domestic firms can manipulate the law with the aim to endogenously protect themselves from foreign competition.

Further difficulties arise in the practical implementation of antidumping laws. Moore [1992b] examines the outcomes when politically-motivated legislators use budgets to influence the administering authority in a repeated game context. Even if one assumes that the administering authority is immune to outside political pressure, the authority must rely on accurate information about economic conditions in order make proper decision about the merit of an individual antidumping petition.

The most problematic information needed for the administering authority relates to the degree of injury suffered by the domestic firm facing allegedly unfair competition. All imports create "injury" from competition; the challenge for the authority is to determine whether the imports cause injury beyond some critical level. The difficulty arises since the authority must rely on data provided by domestic firms themselves which clearly have an incentive to overstate the degree of injury.[1]

The optimal policy is to suppress all kinds of antidumping regulation, given the negative impact of higher prices on consumers and the possibility of strategic manipulation of the system by domestic firms. However, the political reality is that these policies do and will continue to exist. Consequently, the overriding issue before us is how to design a "second-best" antidumping rule that minimizes the losses to consumers and reduces the attractiveness of strategic behavior by domestic firms seeking to limit competition from abroad.

In this paper, we ignore the strategic interactions among foreign firms and domestic firms and focus instead on the relationship between the domestic government and domestic firms and the determination of material injury. Because the administering authority must use private information elicited from the domestic firm about its economic condition to set trade policy, an asymmetric information problem regarding the true level of injury arises. We find that it can be solved using a mix of duties and a compensa-

1. See Moore [1992a] and Eyemann and Schuhknecht [1996] for empirical studies of US and EC material injury decisions, respectively.

tion transfer which consists of a lump-sum sum transfer ***and*** a domestic unit tax. This mix of policies will dominate a system based on duties alone.

We also show that tariffs alone result in a Pareto inefficient solution wherein the domestic firm has an incentive to mislead the authority about its true level of injury. In contrast, a duty-cum-transfer mix, while it does create another type of loss to consumers, yields a Pareto superior solution in that the firm has a self-interest in revealing its actual production costs and hence eliminates the incentive to strategically manipulate the antidumping process. In addition, the lump-sum compensation part of the contract is *decreasing* in the amount of the material injury, while the domestic tax increases with the amount of the material injury and with the tariff.

The rest of the paper is organized as follows. In Section II, we study the issue of the antidumping policy based solely on tariffs in the case of complete about material injury. We show that, in the case of complete and symmetric information about material injury, a simple domestic tariff is optimal. In Section III, we analyze the case of incomplete information about material injury. We set up the asymmetric information framework in order to analyze the principal-agent relationship between the domestic firm and the domestic authority and show that the simple domestic tariff is not optimal. In that framework, the domestic firm will always have incentives to lie about the extent of injury in order to obtain the protection from the authority if the antidumping policy is a duty alone. In Section IV, we can develop an optimal solution to the problem of adverse selection concerning the provision of protection to domestic firms from the authority. Concluding remarks are contained in a final section.

II. A Tariff-Based Antidumping Rule with Complete Information

Suppose there exists two commodities in a small economy, money and a consumption good. Consumer preferences for the consumption good are described by a continuously differentiable aggregate domestic demand function, $Q(\cdot)$. This demand arises from a quasi-linear utility function which allows us to ignore income effects in the analysis. The associated inverse demand function is denoted by $P(\cdot)$.

The consumption good is produced by two firms: a single domestic firm

and a single foreign supplier. The total quantity supplied on the domestic market is composed of the foreign supply $q_f(P)$ and of the domestic supply $q_h(P)$. The market clearing condition imposes $Q(P) = q_h(P) + q_f(P)$. We make the assumption that the domestic firm's technology has a fixed sunk cost and increasing marginal cost so that $\partial q_h(P)/\partial P > 0$. The economy demand for imports is $q_f(P)$. It is obtained by subtracting the domestic supply $q_h(P)$ from the domestic demand $Q(P)$. Hence $\partial q_f(P)/\partial P = \partial(Q(P) - q_h(P))/\partial P < 0$ because $\partial Q(P)/\partial P < 0$ and $\partial q_h(P)/\partial P > 0$. Moreover, we assume that, after dumping has occurred, the home market price is implicitly determined by the administering authority as it sets the tariff imposed on the domestic market. In this context, both firms are price takers, *i.e.*, $\partial P(Q)/\partial q_i = 0$, $(i = h, f)$.

We assume that the domestic firm may limit competition with the foreign supplier by the use of an administrative protection process. Under this system, the domestic firm may petition a domestic authority to impose a dumping duty on the imports of the foreign firm. Hence, the domestic firm charges the foreign firm with selling imports below the cost of production.[2] Duties may be placed on the imports if the domestic authority finds that the imports are unfairly priced and are causing injury to the domestic firm.

The "dumping margin" is the difference between the "fair value" and the price charged for imports in the domestic market. Because we focus on the domestic firm's manipulation of information about material injury, manipulation which consists of lying about its minimum average cost (MAC) in order to obtain higher protection, we assume that a positive dumping margin has already been "proved" by the domestic authority using technical criteria so that duties will be placed if material injury can be found.[3]

Before duties may be placed on the imports, the domestic authority must

2. Dumping based on simple price discrimination is ignored here. We do not take into account the dumping motives of the foreign firm because in our model we focus on the relationship between the domestic firm and the domestic authority. We assume that the foreign firm behavior only consists of setting a dumping price which is very low. For strategic behavior of firms in an antidumping setting, see Prusa [1992] and [1994].
3. In fact, dumping margins are almost always found, in large part because of biases in the procedures of calculating margins. For example, in the United States, over 90% of all petitions result in a positive dumping margin while only about 60% of material injury decisions are positive. (See Baldwin and Moore [1991].)

determine whether the allegedly dumped imports cause "material" injury to the domestic firm. We define material injury as negative profit so that the domestic firms will win its petition if the domestic price falls below the domestic MAC. Hence the level of injury is homothetic to the difference between the dumping price and the MAC and is contingent on a domestic cost parameter. This parameter, denoted by θ, has the property that $dC(\cdot)/d\theta > 0$.

The domestic firm knows θ but the authority does not. Consequently, the actual level of injury caused by imports is unobservable by the domestic authority but known with certainty by the domestic firm. The authority must rely therefore on information provided to it by the domestic firm which obviously has a vested interest in overstating the degree of injury.

The duty actually imposed is that which will eliminate the material injury to the domestic firm.[4] Thus, the dumping duty will be a function of the domestic production technology as summarized by the domestic cost parameter θ.

We assume that the authority sets antidumping protection by following the spirit of the GATT article VI. This article stipulates that foreign unfair trade practices on a domestic market can be repressed if it causes injury to domestic firms. The presence of this condition means that the GATT considers low import price as a benefit for domestic consumers. If we interpret the word "injury" as negative profit, then dumping is prohibited from the GATT point of view when the dumping price falls below the home minimum average cost of production. Thus, the imposition of the antidumping duty is a way to restore a minimum "fair price" that eliminates home firm injury, *i.e.*, the negative profit, while insuring that not all foreign competition is subject to the tariff.

We model the authority's decisions as a constrained optimization problem based on the maximization of home consumer welfare subject to the preservation of the domestic firm's non-negative profits.[5] Thus, the authority

4. This consistent with the European Union's administration of antidumping law wherein the duty is bounded from above by the level needed to eliminate the material injury. In the United States, the duty is based strictly on the difference between the "fair value" and the import price.
5. Once again, this mirrors European practice where the Council of Ministers must consider "Community interest" before setting duties. In sharp contrast, the U.S. International Trade Commission is prohibited from explicitly considering consumer interest when adjudicating antidumping petitions.

keeps overall consumer welfare in mind but with the institutional constraint of maintaining positive domestic production.

Formally, the authority's objective function is the value of the net consumer surplus $W(Q)$. With complete information, the authority observes $q_f(P_d)$, the quantity supplied by the foreign firm, θ the cost parameter of the domestic firm, $q_h(P_d)$ the quantity supplied by the domestic firm on the domestic market, P_d the price charged by the foreign firm in the domestic market. We assume that P_d is fixed.[6] After observing these values, the authority implements an antidumping rule. That rule sets the domestic market price (and, implicitly, the tariff) in view of the parameters of domestic demand $Q(P)$.

Let $t(\theta)$ be the antidumping tariff, $P(\theta) = P_d + t(\theta)$ the market price, $\Pi(q_h(P), \theta)$ the domestic firm profit, and $P_d \cdot q_f(P_d + t(\theta))$ the revenue of the foreign firm. Domestic production costs of type θ firm is $C(q_h(P), \theta)$. We assume the domestic firm technology is based on increasing marginal costs, *i.e.*, $d^2C(q_h(P),\theta)/dq_h^2 > 0$.

We let the gross surplus of the domestic consumers for market supply equal $S(Q)$ and the expenditure of domestic consumers, $E(Q) = P(Q) \cdot Q$. Thus, the net surplus of the domestic consumer and domestic profits are, respectively:

$$W(Q) = S(Q) - P(Q) \cdot Q \tag{1}$$

$$\Pi(q_h(P), \theta) = P(Q) \cdot q_h - C(q_h, \theta) \tag{2}$$

Suppose the domestic authority is considering the imposition of a tariff to protect a domestic firm. With complete information about domestic costs, the objective of the authority will be to solve the following program :

$$\text{(P1)} \begin{cases} \underset{q_h}{Max}\, W(Q) \\ s.t.\ \Pi(q_h(P), \theta) \geq 0 \end{cases}$$

The solution of that program straightforward (see appendix 1 for details). It allows us to see that with complete information, the optimal market price equals the minimum of the average cost of domestic production. Thus, the

6. We assume that the foreign firm behavior on the domestic market consists only of setting a price P_d which is very low.

tariff $t(\theta)$ must be equal to the difference between the foreign price P_d and the minimum of the average cost of domestic production:

$$t^{CI}(\theta) = \min_{q_h}\left(AC(q_h, \theta)\right) - P_d \tag{3}$$

Under this rule, the profit of domestic producers equals zero. This rule will allow domestic firms to remain in the market while minimizing the consumer costs of increased prices.

III. A Pure Tariff Antidumping Rule With Incomplete Information

We turn now to the study of a tariff based antidumping rule with asymmetric information about domestic costs. If we assume that domestic cost observability is very costly, the regulator cannot check the announcements made by the domestic firm. An informational problem arises which can be resolved by using a contract theory approach in which the authority reaches its objective by offering a contract to the domestic firm. That contract specifies the modalities of the antidumping protection according to the domestic firm type.

With incomplete information, the authority cannot observe θ, so we assume that it forms its expectations by using a prior cumulative distribution function G, $(G(\theta^-) = 0, G(\theta^+) = 1)$, with differentiable density $g(\theta)$ such that $g(\theta) > 0$ for all θ in $\Theta = [\theta^-, \theta^+]$. $G(\theta)/g(\theta)$ has the monotone hazard rate property, *i.e.*, G/g is non decreasing in θ. The distribution function G is common knowledge to all agents.

This antidumping rule must satisfy two conditions: 1) a rule of economic efficiency (Pareto criterion) and 2) an institutional rule (price not less than the minimum of the average cost of the domestic production). Following the *Revelation Principle* ⟨Myerson [1979]⟩, we can restrict attention, without loss of generality, to *truthful direct mechanisms* by which the authority elicits direct truthful answers about θ.

The protection mechanism must be studied in the light of its implementability and of its optimality. The implementability conditions of the mechanism consists of choosing from the set of the firm's announced strategies the subset of truthful announcements. These strategies are incentive compatible. After the authority determines the set of these strategies, the

authority determines its own strategy in the first stage wherein it maximizes its objective function.

The interaction between the authority and the domestic firm is modeled as an incomplete information game. That game has a Nash-Bayes equilibrium in which the domestic firm maximizes its profit by revealing its true type and the authority maximizes its objective by inducing the firm to announce its actual costs. The solution of that problem is a second best solution; there will always be a social cost of inducing the firm to reveal its true costs. However, the contract can be designed so that this social cost is no greater than that when the firm lies about its true production costs and obtains an excessively high tariff.

The timing of the relationship between the domestic firm and the administrator is the following:

The domestic firm files an antidumping suit against a foreign competitor. The authority observes the dumping price P_d. A cost parameter θ is drawn from the distribution $G(\cdot)$. After the domestic firms learns its cost type and announces the alleged level of material injury, the authority proposes a contract (the antidumping rule) to the domestic firm. This contract specifies a protection decision as a function of the alleged material injury level. The antidumping rule consists of inducing the domestic firm to choose the optimal level of domestic production on the domestic market $q_h(\theta)$ through the choice of the optimal price $P(\theta)$ (and the tariff $t(\theta)$).

We solve the problem by backward induction so that we will study first the strategies of the domestic firm. Then we will turn to see how these strategies are taken into account by the authority and its optimization problem.

Since the true production costs are private information, the firm has an incentive to overstate its costs and receive higher protection. The authority unfortunately cannot directly punish this mendacity. It can hope instead to identify situations where the domestic firm has a self-interest in revealing its true type. The set of strategies such that profits are at least as high as by revealing its true costs as by lying is given by the incentive compatibility constraint (I.C.):

$$\Pi\left(q_h(\theta),\theta\right) \geq \Pi\left(q_h(\tilde{\theta}),\theta\right) \qquad \forall(\tilde{\theta},\theta) \in \Theta^2 \qquad \text{(I.C.)} \qquad (4)$$

where θ is the true cost parameter and $\tilde{\theta}$ is any alternative announced parameter.

The authority must also consider a second constraint, namely that the domestic firm's profit must be non-negative. Whatever the domestic firm strategy, its profit must be non negative, otherwise there will be no reason for the firm to accept the contract. In other words, the domestic firm will participate in the mechanism only if the individual rationality constraint (I.R.) holds:

$$\Pi(\theta) \geq 0 \quad \forall \theta \in \Theta \qquad \text{(I.R.)} \tag{5}$$

A protection mechanism which satisfies the I.C. and I.R. constraints is called *feasible*. The authority's goal consists of choosing in the set of feasible mechanisms which will maximize its objective.

The authority sets the domestic market price in order to reach its objective of maximizing the expected surplus of domestic consumers subject to the implementation constraints (incentive compatibility and individual rationality) of the protection mechanism. Formally, the program of the authority will be:

$$\text{(P2)}\begin{cases} \underset{q_h(\theta)}{Max} \int_{\theta-}^{\theta+} W(Q(P(\theta))) \cdot g(\theta) \cdot d\theta \\ s.t. \\ \Pi\left(q_h(\theta),\theta\right) \geq \Pi\left(q_h(\tilde{\theta}),\theta\right) \quad \forall(\tilde{\theta},\theta) \in \Theta^2 \quad \text{(I.C.)} \\ \Pi\left(q_h(\theta),\theta\right) \geq 0 \qquad \forall \theta \in \Theta \qquad \text{(I.R.)}. \end{cases}$$

The authority will only consider implementable contracts. Consequently, we will first study the two constraints and afterwards we will incorporate them in the authority's objective in order to find the optimal solution of the program (P2).

Consider first the I.C. constraint. Following the *Revelation Principle*, we restrict ourselves to the subset of direct truthful announcements concerning the cost parameter.

The profit of the domestic firm of type θ that reports its type as $\tilde{\theta}$ is:

$$\Pi(\tilde{\theta},\theta) = \Pi(\tilde{\theta}) + C(q_h(\tilde{\theta}),\tilde{\theta}) - C(q_h(\tilde{\theta}),\theta) \tag{6}$$

By using a useful trick of Mirrlees [1971], (I.C.) becomes:

$$\text{(I.C.)} : \Pi(\theta) = \underset{\tilde{\theta}}{Max}\left[\Pi(\tilde{\theta}), \theta)\right] \tag{7}$$

where $\tilde{\theta}$ is the strategy chosen by the firm of type θ.

By applying the envelope theorem to the solution of (7), we have the first order condition for the mechanism to be incentive compatible (which ensures that the truth telling condition is satisfied *locally*):

$$\frac{d\Pi(\theta)}{d(\theta)} = -C_\theta\left(q_h(\theta), \theta\right) \quad \text{(I.C.1)} \tag{8}$$

Thus, the IC constraint imposes the domestic firm profit to be a decreasing function of the announced material injury by the domestic firm. (Recall that the material injury is an increasing function of the cost type.)

The incentive compatibility constraint and the fact that costs increase in θ allows us to show that:

$$\Pi(\theta^+) < \Pi(\theta^-) \tag{9}$$

This means that the first incentive compatibility condition for implementable protection requires that the authority offer a higher profit to a low cost domestic firm than a high cost firm.

By integrating (8), we get the expression of the firm's profit:

$$\Pi(\theta) = -\int_{\theta}^{\theta+} d\Pi(\theta) + \Pi(\theta^+) \tag{7'}$$

Taking into account this result, we can bind the individual rationality constraint by setting $\Pi(\theta^+) = 0$ and $\Pi(\theta) > 0$ for all $\theta \neq \theta^+$. In other words, if the domestic firm has high costs it will receive no extranormal profits from protection.

The second order condition for the mechanism to be incentive compatible (which ensures that the truthtelling condition is satisfied *globally*) is: (see appendix 2a for details)

$$C\left(q_h(\theta), \tilde{\theta}\right) - C\left(q_h(\theta), \theta\right) \geq C\left(q_h(\tilde{\theta}), \tilde{\theta}\right) - C\left(q_h(\tilde{\theta}), \theta\right)$$
$$\forall(\tilde{\theta}, \theta) \in [\theta^-, \theta^+] \times [\theta^-, \theta^+] \tag{10}$$

In order to obtain a more tractable expression of condition (10), assume that $C(q_h(a), b) = b \cdot C(q_h(a))$. Then condition (10) requires that $(\tilde{\theta} - \theta) \cdot C(q_h(\theta)) \geq (\tilde{\theta} - \theta) \cdot C(q_h(\tilde{\theta}))$ when $\tilde{\theta} \geq \theta$. Thus, $q_h(\theta)$ has to be a non increasing function of θ because $C(\cdot)$ is increasing in q_h. A type θ firm which chooses a $q_h(\theta + d\theta)$ level of output must incur a cost $C(q_h(\theta))$ which is not inferi-

or to the "lying" cost $C(q_h(\theta + d\theta))$. This implies that the firm will not increase its supply by exaggerating its reported cost type. Formally, the second order condition for incentive compatibility is then defined by:

$$dq_h(\theta)/d\theta \leq 0 \quad \text{(I.C. 2)} \tag{8'}$$

In order to keep the problem tractable, we will solve the program (P2) and check afterwards that the solution verifies (IC2), the second order condition for global incentive compatibility.

The solution of program (P2) yields the optimal price function on the domestic market (see appendix 2b for details):

$$P(\theta) = \frac{\partial C(q_h(\theta),\theta)}{\partial q_h(\theta)} + \frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)} \cdot \frac{G(\theta)}{g(\theta)} \tag{11}$$

The optimal antidumping tariff with incomplete information is therefore:

$$t^{AI}(\theta) = \frac{\partial C(q_h(\theta),\theta)}{\partial q_h(\theta)} - P_d + \frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)} \cdot \frac{G(\theta)}{g(\theta)} \tag{12}$$

The difference between the tariff with complete information and incomplete information equals:

$$t^{AI}(\theta) - t^{CI}(\theta) = \frac{\partial C(q_h(\theta),\theta)}{\partial q_h(\theta)} - \min_{q_h(\theta)} AC + \frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)} \cdot \frac{G(\theta)}{g(\theta)} \tag{13}$$

As long as the marginal cost of production under asymmetric information is greater than or equal to the minimum AC, then the tariff under incomplete information is higher than with complete information. We can see that the first order condition for incentive compatibility is not sufficient and the second order condition for incentive compatibility of the tariff based protection mechanism is not satisfied.

This yields the following proposition

Proposition 1: *With positive domestic production, the antidumping tariff with incomplete information will always be higher than the antidumping tariff with complete information.*

The tariff under incomplete information is an increasing function of the domestic cost parameter θ. Since we have assumed that the domestic firm

has complete information about the objective function of the domestic authority, it has complete information about the domestic authority's decision rule. Thus, it knows that the tariff will be selected so that the domestic price is based on the authority's "guess" of domestic production costs. However, since the true production costs are private information, the firm has an incentive to overstate its costs and receive higher protection. The term $(\partial C(q_h(\theta),\theta)/\partial q_h(\theta))\cdot(G(\theta)/g(\theta))$ thus allows the firm to obtain an informational rent of:

$$\Gamma(\bar{\theta},\theta)=\int_{\theta}^{\bar{\theta}} C_{\theta}(q_h(\theta),\theta)d\theta \tag{14}$$

where θ is the true cost parameter and $\bar{\theta}$ is the announced cost parameter.

The function $\Gamma(\bar{\theta}, \theta)$ is decreasing in the true cost parameter θ of the domestic firm but it is also an increasing function of the amplitude of the lie $\bar{\theta} - \theta$. The informational rent arising from antidumping protection is thus a decreasing function of the domestic firm's type. Hence, protection allows the domestic firm to earn extra profit. The rational strategy of the firm is to lie when the antidumping tariff is variable. A constant duty will resolve the asymmetric information problem by making the domestic firm unable to lie. However a constant duty will also make a high cost firm risk going out of business if the duty is not high enough. The IR constraint, which implies that any domestic firm incurring foreign dumping has to be protected if it incurs losses, allows the more efficient firm to benefit from an informational rent by mimicking an inefficient firm.

This allows us to offer the following proposition:

Proposition 2: *An antidumping rule with incomplete information which consists only of a variable tariff based protection is not optimal because it always induces the domestic firm to lie about its production costs.*

IV. An Optimal Antidumping Rule with Incomplete Information about Material Injury.

A tariff based antidumping rule with incomplete information encourages a domestic firm to behave in a strategic manner so that an *adverse selection*

problem arises. This fact points out the existence of a Principal – Agent relationship between the regulator and the domestic firm. Taking into account these results, the regulator can try to implement an antidumping rule by compensating the domestic firm so it will reveal its true type. Because the game between the firm and the authority is not a zero sum game, this game can contain another equilibrium in which the two parties share the gain from lowering protection. The idea is to propose a menu of couples (tariff, compensation) to the injured domestic firm in which the firm selects the optimal couple designed for it.

This optimal antidumping rule consists of a modified protection mechanism q_h, K: $\theta \in \Theta \rightarrow \{q_h(\theta), K(\theta)\}$ where $K(\theta)$ is a compensation scheme offered by the authority to the type θ domestic firm.

The compensation $K(\theta)$ is added to the firm's profit and is subtracted from the consumer's net surplus. Formally, the program of the authority, (P3), will be:

$$(\text{P3})\begin{cases} \underset{q_h(\theta),K(\theta)}{Max} \int_{\theta-}^{\theta+} W^K(Q(P(\theta)),K(\theta),\theta)\cdot g(\theta)\cdot d\theta \\ s.t. \\ \Pi^K(q_h(\theta),\theta) \geq 0 & \forall\theta\in\Theta & \text{(I.R.)} \\ \Pi^K(q_h(\theta),\theta) \geq \Pi^K(q_h(\tilde{\theta}),\theta) & \forall(\tilde{\theta},\theta)\in\Theta^2 & \text{(I.C.)} \end{cases}$$

With:

$$W^K\big(Q(P(\theta)),K(\theta),\theta\big) = S(Q) - P(Q)\cdot Q - K(\theta) \tag{15}$$

$$\Pi^K\big(q_h(\theta),\theta\big) = \Pi(\theta,\theta) = P(\theta)\cdot q_h(\theta) + K(\theta) - C(q_h(\theta),\theta) \tag{16}$$

And:

$$K(\theta) = -\int_{\theta}^{\theta+} d\Pi(q_h(\theta),\theta) - P(\theta)\cdot q_h(\theta) + C(q_h(\theta),\theta) \tag{17}$$

The treatment of the (I.R.) and (I.C.) constraints is identical to program P2. By replacing (I.C.) with its formal representations (I.C.1) and (I.C.2), we can rewrite the program (P3) to obtain (P3b):

$$
\text{(P3b)}\begin{cases}
\underset{q(\theta),K(\theta)}{Max}\int_{\theta-}^{\theta+} W^K(Q(P(\theta)),K(\theta),\theta)\cdot g(\theta)\cdot d\theta \\
s.t. \\
\Pi^K(q_h(\theta^+),\theta^+)=0 & \text{(I.R.)} \\
\dfrac{d\Pi^K(q_h(\theta),\theta)}{d\theta}=-C_\theta(q_h(\theta),\theta) & \text{(I.C.1)} \\
\dfrac{dq_h(\theta)}{d\theta}\leq 0 & \text{(I.C.2)}
\end{cases}
$$

The solution is obtained by substituting K from the constraints into the objective function and by maximizing W with respect to $q_h(\theta)$ for all θ. After solving the program (P3b), we obtain the optimal protection tariff with asymmetric information (see Appendix 3 for details):

$$
t^K(\theta)=\frac{\partial C(q_h(\theta),\theta)}{\partial q_h(\theta)}-P_d+\frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)}\cdot\frac{G(\theta)}{g(\theta)} \tag{18}
$$

Substituting this expression into (17) yields the following for the compensation K:

$$
K(\theta)=-\int_\theta^{\theta+} d\Pi(q_h(\theta),\theta)-\left(\frac{\partial C(q_h(\theta),\theta)}{\partial q_h(\theta)}+\frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)}\cdot\frac{G(\theta)}{g(\theta)}\right)\cdot q_h(\theta)+C(q_h(\theta),\theta) \tag{17'}
$$

Equation (18) can also be rewritten as:

$$
P(\theta)-\frac{\partial C(q_h(\theta),\theta)}{\partial q_h(\theta)}=\frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)}\cdot\frac{G(\theta)}{g(\theta)} \tag{18'}
$$

so that the price-cost markup is positive under incomplete information.

And the complete information optimum is reached if the firm sets its supply in order to equal its minimum average cost to the market price, *i.e.* :

$$
P(\theta)=\underset{q_h}{min}\,AC(Q_h(\theta),\theta) \tag{19}
$$

Thus, the difference between the tariff with complete information and the tariff with incomplete information reflects the social cost of the mechanism. Recalling the value of the complete information tariff, t^{CI} above, we can write:

$$t^K(\theta) - t^{CI}(\theta) = \frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)} \cdot \frac{G(\theta)}{g(\theta)} \tag{20}$$

This difference is positive, given that marginal cost is increasing as increases. In this case, the compensation is:

$$K(\theta) = -\int_\theta^{\theta+} d\Pi(q_h(\theta),\theta) - \frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)} \cdot \frac{G(\theta)}{g(\theta)} \cdot q_h(\theta) \tag{21}$$

Thus, the compensating transfer consists of two components:

– A positive informational rent: $-\int_\theta^{\theta+} d\Pi(q_h(\theta),\theta)\left(= \int_\theta^{\theta+} C_\theta(q_h(\theta),\theta) \cdot d\theta\right)$

which depends on the actual cost structure of the firm

– And the subtraction of a tax: $\frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)} \cdot \frac{G(\theta)}{g(\theta)} \cdot q_h(\theta)$.

This leads us to see that the solution satisfies (IC2), the second order condition for incentive compatibility. In order to negate the incentive to lie, the domestic firm must not reap any direct benefits from the price increase on the domestic market by increasing its output level when an antidumping tariff is applied, *i.e.*, type θ firm will incur a *tax* $T(\theta)$ equal to the price-cost markup:

$$T(\theta) = \frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)} \cdot \frac{G(\theta)}{g(\theta)} \tag{22}$$

While the first order condition for incentive compatibility locally ensures that the domestic firm truthfully announces its costs (at the Nash-Bayes equilibrium of the game), this does not imply that this condition is satisfied globally (that the equilibrium is unique). In order to be sure that the domestic firm does not get its profit by lying about its costs, the compensation scheme must induce the firm to obtain its "informational" profit through a lump sum transfer rather than through price effects of an antidumping tariff resulting from overstating its costs. Thus, the condition (IC2) for the mechanism to be globally implementable is satisfied because the firm, by being taxed, cannot benefit from the full rise in the domestic price after the application of the antidumping tariff and therefore will choose to get its "informational" profit through the lump sum transfer.

Clearly, the net effect of the tariff therefore depends on the privately-known cost structure of the firm. In particular, for a firm of type $\theta = \theta^+$, the

informational rent part of the compensating transfer equals zero; the firm cannot gain from "lying" about its costs. But the domestic price with incomplete information is higher than the price with complete information. However, a firm of type $\theta = \theta^-$ receives the maximum rent since it must receive a high payment to induce an announcement of this truth.

These two facts mean that this protection scheme gives a positive profit to any firm of type $\theta < \theta^+$. In addition, the lump-sum transfer is a *decreasing* function of the domestic firm's announcement of its cost type, and the tax per unit of domestic product is an *increasing* function of the domestic firm's announcement of its cost type.

The optimal antidumping rule is characterized in proposition 3:

Proposition 3: *The optimal protection mechanism consists of a vector function:*

$$q_h, K : \theta \in \Theta \rightarrow \{q_h(\theta), K(\theta)\}$$

where :

$$K(\theta) = \int_{\theta}^{\theta+} C_\theta(q_h(\theta), \theta) \cdot d\theta - T(\theta) \cdot q_h(\theta)$$

and

$$T(\theta) = \frac{\partial C_\theta(q_h(\theta), \theta)}{\partial q_h(\theta)} \cdot \frac{G(\theta)}{g(\theta)}$$

$$q_h(\theta) = Z(P_d + t^K(\theta)) = Z(P(\theta))$$

$$t^K(\theta) = \frac{\partial C(q_h(\theta), \theta)}{\partial q_h(\theta)} + \frac{\partial C_\theta(q_h(\theta), \theta)}{\partial q_h(\theta)} \cdot \frac{G(\theta)}{g(\theta)} - P_d = t^{CI}(\theta) + T(\theta)$$

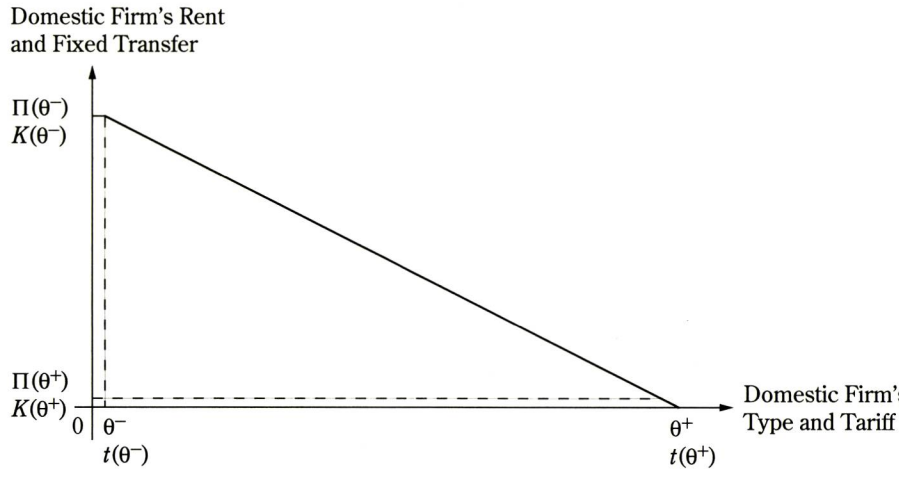
$$\text{and } Z(P(\theta)) = MC^{-1}\left(P(\theta) - \frac{\partial C_\theta(q_h(\theta), \theta)}{\partial q_h(\theta)} \cdot \frac{G(\theta)}{g(\theta)} \right)$$

Z is the supply function of the domestic firm and MC^{-1} is the inverse marginal cost curve of the domestic firm.

We can see that the optimal protection mechanism: q_h, K: $\theta \in \Theta \rightarrow \{q_h(\theta), K(\theta)\}$ satisfies the first incentive compatibility and the individual rationality constraints (*i.e.*, $\Pi(\theta^+) < \Pi(\theta^-)$) and the second order incentive compatibility condition, $dq_h(\theta)/d\theta \leq 0$ which is equivalent to $dt^K(\theta)/d\theta > 0$ and $dT(\theta)/d\theta > 0$).

The tariff, $t^K(\theta)$ and the domestic tax $T(\theta)$ are increasing functions of the type θ of the domestic firm. As the announced cost parameter increases, the tariff rate is increased, as is the domestic price. The optimal protection mechanism can be seen on Figure 1. The domestic firm cannot incur losses when that mechanism is applied, because the domestic price will always be as high as its minimum average cost of production.

Figure 1
Domestic Firm's Rent and Fixed Transfer



In this framework, the profit of the domestic firm will become:

$$\Pi^K(q_h(\theta),\theta) = \Pi(\theta,\theta) = P(\theta)\cdot q_h(\theta) + K(\theta) - C(q_h(\theta),\theta) \tag{23}$$

$$\Pi^K(q_h(\theta),\theta) = \int_{\theta}^{\theta+} C_\theta(q_h(\theta),\theta)\cdot d\theta \tag{24}$$

The net welfare effect (given by the net change of the consumer surplus) of the compensation scheme is : (see appendix 4 for details)

$$dW = \int_{p(\theta^+)}^{p(\theta)} Q(v)\cdot dv - \int_{\theta}^{\theta+} C_\theta(q_h(\theta),\theta)\cdot d\theta + T(\theta)\cdot q_h(\theta) \tag{25}$$

The tax is subtracted to the domestic firm profit and is returned to the consumer. We can see that the welfare cost of inducing the firm to reveal its type is given by the informational rent ($\int_{\theta}^{\theta+} C_\theta(q_h(\theta),\theta)\cdot d\theta$). The complete information solution is reached by paying this rent to the firm.

The net welfare effect is positive for any price $P(\theta)$ such that $P(\theta) \leq P(\theta^+)$.

The welfare level with compensation scheme under incomplete information is however obviously inferior to the welfare level with antidumping protection under complete information. Nevertheless, it is superior to the welfare level under incomplete information without incentive scheme. That is to say that the incomplete information antidumping protection with incentive scheme is a second best solution.

Without an incentive compatible scheme, the firm would announce a cost of θ^+. In this scenario, the authority would choose $t^{AI}(\theta^+)$ so that the firm reached its minimum average cost associated with that cost structure. The rent reduction is however costly for domestic consumers because it results in an increase of domestic price. To see this more explicitly, recall that $C(q_h(\theta), \theta) = \theta \cdot C(q_h(\theta))$ so that the informational rent can be rewritten as:

$$\Pi^K(q_h(\theta), \theta) = \int_{\theta}^{\theta+} C(q_h(\theta)) \cdot d\theta \tag{26}$$

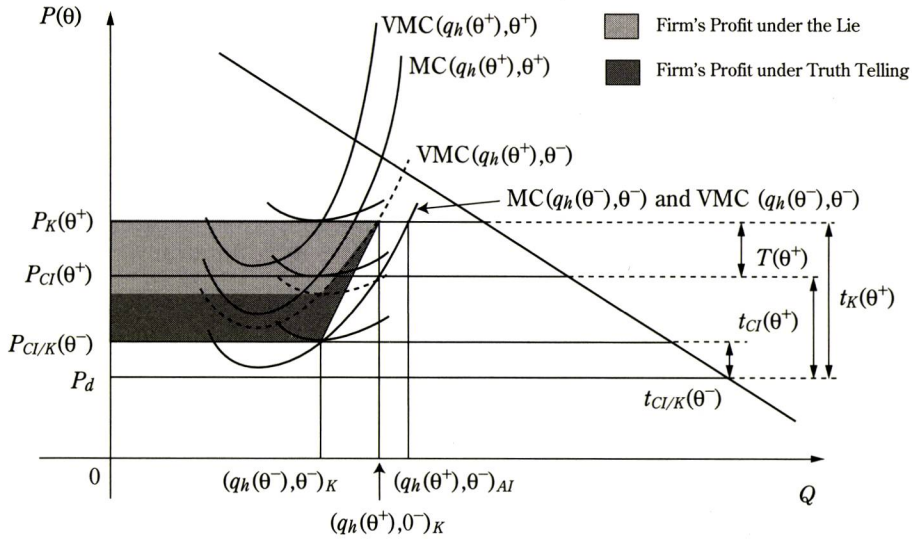
Low quantities reduces the influence of variations in cost on the firm's rent. Thus a rise in the domestic price through a rise of the tariff will not increase the firm's rent only if the firm cannot substitute its production to the foreign production on the domestic market. This is possible only if the virtual supply curve (VMC) of the domestic firm is displaced above its real supply curve (MC).[7] Hence, the domestic firm must be taxed in order to deny it to benefit from the price increase. This effect can be seen on Figure 2.[8]

The authority has to find a trade-off between increasing the tariff (increasing the domestic tax and the price and diminishing the lump sum part of the compensation scheme) in order to appropriate the informational rent of the domestic firm and lowering the tariff (lowering the price and the tariff and increasing the lump sum part of the compensating scheme) in order to increase the domestic consumer surplus.

---

7. Here we can see that is not in the foreign firm's interest to set a higher price after it has set P_d because under the optimal protection mechanism because by doing so the foreign quantities supplied on the domestic market will diminish. Hence the foreign firm behavior can be summarized as only setting a low P_d at the beginning of the game.
8. To draw Figure 2, we assume that the domestic firms technology is based on a fixed sunk cost and an increasing marginal cost.

Figure 2



V. Conclusion

In this paper, we have analyzed the effects of domestic firm possession of private information about material injury in the antidumping process. We found that a domestic authority had two potential strategies to limit the consumer effects of the antidumping process. Whatever the choice, the presence of asymmetric information means that the firm's profit will remain non negative because of the presence of protection.

On one hand, the authority can use a pure tariff. The disadvantage to this strategy is that a firm will have an incentive to lie about its true costs so that the tariff imposed will always be higher than the full-information duty. This will allow the firm to capture "informational rents" since the duty will be too high, *i.e.*, at a level above that which will keep the domestic firm in operation.

The domestic authority, however, can use a combination of a compensating scheme (which consists of a lump-sum compensation and a domestic unit tax) and tariffs to induce the truthful announcement of the firm's true costs. Unfortunately, the overall profit level can only be reduced by the authority at the expense of domestic consumers since the announcement of the true level of costs will occur only at the cost of a higher monetary transfer.

However, in terms of consumer welfare, the authority's strategy of tariff reduction combined with increased in lump-sum transfer dominates the strategy of accepting the higher tariff with less (or no) monetary transfer. This is because consumer surplus will be higher with the smaller price distortion and one-for-one transfer to the domestic firm. The firm simply obtains a positive profit, albeit by a different route.

This solution of tariff-compensation scheme does present an odd version of protectionism. The domestic firm obtains a non negative profit via a fixed subsidy (the lump sum transfer) but not via the introduction of a tariff. In addition, the firm may still choose to lie about its true production costs but this strategy is dominated by sincerity because of the presence of a domestic tax which is increasing with the tariff.

While perhaps dangerous to draw many policy implications from such a formal model, this approach does point to a number of important issues.

On one side, we find once again that lump-sum transfers have important advantages apart from their traditional benefits of not distorting production or consumption decisions. In particular, in this context transfers help induce firms not to try to strategically manipulate the administrative protection process. In addition, this framework has focused on the difficulty brought about through the information requirements associated with the antidumping process – any ways to lessen the reliance on proprietary information provided by domestic firms with a vested interest will bring about important benefits. Firms simply will be able to extract more protection with private information about their costs the more that administering authorities must rely exclusively upon such information.

On the other hand, the optimal antidumping rule has limited practicality from an institutional point of view. For example, two part monetary transfers do not currently exist in the antidumping process of any nation. It may be very difficult politically to convince political leaders that such a system would dominate a pure tariff system. The tariff-cum-transfer scheme identified here would not only add to the complexity of an already costly antidumping structure, but would also entail taxing industries who have obtained an affirmative decision by the administering authorities. It is hard to imagine that politicians would be willing to tax away the profits from a domestic firm which has suffered "material injury" at the hands of a preda-

tory foreign firm, regardless of the potential. real benefits that might arise out of firms not over-stating their production costs.

Another problem is that if efficient firms know that they will earn informational rents by filling antidumping petitions they may tend to "overfile" antidumping petitions, not as a harassment strategy to intimidate foreign competitor, but instead to elicit a direct transfer of funds from the domestic government. This might mean that the contract mechanism derived in this paper would be more likely to lead to frivolous suits than would a pure tariff procedure. The only restraining factor would that the certain legal costs of filing would have to be compared to the uncertain benefits of the antidumping process since success is not guaranteed. While not strictly part of this research, this phenomenon would be interesting to analyze, perhaps within an audit model in the spirit of the paper of Baron and Besanko [1984].

In sum, this model has highlighted the critical importance of information in the administration of antidumping processes. It also points to ways in which the costs to consumers might be lessened through careful consideration of non-tariff based methods, in particular transfers which might elicit truthful reporting of domestic costs in a material injury case.

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Appendix 1

Recall program (1):

$$(P1)\begin{cases} \underset{q_h}{Max}\, W(Q) \\ s.t. \Pi(q_h(P),\theta) \geq 0 \end{cases}$$

The welfare function is as follows:

$$W(Q) = S(Q) - P(Q)\cdot Q = S(Q) - P(Q)\cdot(q_h + q_f)$$

And the profit of the domestic firm is:

$$\Pi(q_h(P),\theta) = P(Q)\cdot q_h - C(q_h,\theta)$$

We assume that the constraint is binding (*i.e.*, $\Pi(\cdot) = 0$) since otherwise it would be possible to increase imports and raise welfare (W) without violating the constraint. By substituting the firm revenue into the objective function we get:

$$W(Q) = S(Q) - P(Q) \cdot (Q - q_h) - C(q_h, \theta)$$

The first order condition implies:

$$\frac{\partial W(Q)}{\partial q_h} = P\frac{\partial Q}{\partial q_h} - \frac{\partial P(Q)}{\partial q_h} \cdot (Q - q_h) - P(Q) \cdot \left(\frac{\partial Q}{\partial q_h} - 1\right) - \frac{\partial C(q_h, \theta)}{\partial q_h} = 0$$

This yields $P(\theta) = \partial C(q_h, \theta)/\partial q_h$ because we have assumed that $\partial P(Q)/\partial q_h = 0$. Hence the optimal the price function is:

$$P(\theta) = \min_{q_h} AC(q_h, \theta) = \frac{\partial C(q_h, \theta)}{\partial q_h}$$

The second order condition for that solution to be a maximum is that $\partial^2 C(q_h, \theta)/\partial q_h^2 > 0$ which is satisfied since we have assumed increasing marginal costs.

Appendix 2a

Suppose that any type θ firm lies about its cost by announcing $\tilde{\theta}$ (and assume that $\tilde{\theta} > \theta$). In this case, the output of type θ firm, which is a function of its cost report $\tilde{\theta}$ (θ), is given by:

$$\tilde{\theta}(\theta) \rightarrow q_h(\tilde{\theta})$$

The effect of the lie on the level of output gives the value of the informational profit and is given by using (6):

$$\Pi(\tilde{\theta}, \theta) - \Pi(\tilde{\theta}) = C(q_h(\tilde{\theta}), \tilde{\theta}) - C(q_h(\tilde{\theta}), \theta)$$

Now, suppose that the firm cannot increase its informational profit by increasing its cost report $\tilde{\theta}$ that is, the lie as no effect on the level of output. Thus the output of type θ firm is given by:

$$\tilde{\theta}(\theta) \rightarrow q_h(\theta)$$

In this case, the informational profit of the lying firm is given by the difference:

$$C(q_h(\theta),\tilde{\theta})-C(q_h(\theta),\theta)$$

Thus, truth telling for all $\theta \in \Theta$ needs that the following condition is satisfied (condition (10) in the text):

$$C(q_h(\theta),\tilde{\theta})-C(q_h(\theta),\theta)>C(q_h(\tilde{\theta}),\tilde{\theta})-C(q_h(\tilde{\theta}),\theta) \qquad \forall(\theta,\theta)\in\Theta^2$$

Appendix 2b

The objective of the authority is to solve the program (P2)

$$(\text{P2})\begin{cases} \underset{q_h(\theta)}{\text{Max}} \int_{\theta}^{\theta+} W\big(Q(P(\theta))\big)\cdot g(\theta)\cdot d\theta \\ \text{s.t.} \\ \Pi(q_h(\theta),\theta)\geq \Pi(q_h(\tilde{\theta}),\theta) \quad \forall(\tilde{\theta},\theta)\in\Theta^2 \quad \text{(I.C.)} \\ \Pi(q_h(P(\theta)),\theta)\geq 0 \qquad \forall\theta\in\Theta \qquad \text{(I.R.)}. \end{cases}$$

Using the Envelope Theorem and substituting the (IC) constraint into the objective function yields:

$$\int_{\theta-}^{\theta+} W\big(Q(P(\theta))\big)\cdot g(\theta)\cdot d\theta$$
$$=\int_{\theta-}^{\theta+}\left[S(Q)-P(Q)\cdot(Q-q_h(\theta))+C(q_h(\theta),\theta)+C_\theta(q_h(\theta),\theta)\cdot\frac{G(\theta)}{g(\theta)}\right]\cdot g(\theta)\cdot d\theta$$

By deriving this expression for all θ, using the assumption $\partial P(Q)/\partial q_h=0$, and equating the expression to zero yields:

$$p(\theta)=\frac{\partial C(q_h(\theta),\theta)}{\partial q_h(\theta)}+\frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)}\cdot\frac{G(\theta)}{g(\theta)}$$

Appendix 3

The optimal protection mechanism is determined by solving the program (P3b)

$$
\text{(P3b)}\begin{cases}
\underset{q(\theta),K(\theta)}{\text{Max}} \int_{\theta-}^{\theta+} W^K\big(Q(P(\theta)),K(\theta),\theta\big)\cdot g(\theta)\cdot d\theta \\
s.t. \\
\Pi^K(q_h(\theta^+),\theta^+)=0 \quad (IR) \\
\dfrac{d\Pi^K(q_h(\theta),\theta)}{d\theta}=-C_\theta(q_h(\theta),\theta) \quad (IC1) \\
\dfrac{dq_h(\theta)}{d\theta}\le 0 \qquad\qquad\qquad\qquad (IC2)
\end{cases}
$$

The net compensating transfer $K(\theta)$ (*i.e.*, inclusive of all taxes and tariffs) is added to the firm's profit and subtracted from the consumer surplus. We ignore the local second order condition and check ex post that it is satisfied by the solution to the relaxed program. The resolution of that relaxed program is the same than the resolution of program (P2):

$$P(\theta)=\frac{\partial C(q_h(\theta),\theta)}{\partial q_h(\theta)}+\frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)}\cdot\frac{G(\theta)}{g(\theta)}$$

The firm will choose a level of output where the marginal cost that it faces at is just equal to the market price that it faces:

$$\frac{\partial C(q_h(\theta),\theta)}{\partial q_h(\theta)}=P(\theta)-\frac{\partial C_\theta(q_h(\theta),\theta)}{\partial q_h(\theta)}\cdot\frac{G(\theta)}{g(\theta)}$$

We can check that $q_h(\theta)$ is non increasing in θ if $G(\theta)/g(\theta)$ is not decreasing in θ. Thus, the second order condition for incentive compatibility $dq_h(\theta)/d\theta\le 0$ is satisfied.

Appendix 4

The informational rent of firm of type θ is:

$$\Pi(\theta)=\int_\theta^{\theta+} C_\theta(q_h(\theta),\theta)d\theta+\Pi(\theta^+)$$

But that rent is compensated by the monetary transfer:

$$K(\theta)=-\int_\theta^{\theta+} d\Pi(q_h(\theta),\theta)-P(\theta)\cdot q_h(\theta)+C(q_h(\theta),\theta)$$

And the net surplus of the domestic consumer will be:

$$S(Q) - P(\theta)\cdot Q(\theta) + \int_{\theta}^{\theta+} d\Pi(q_h(\theta),\theta) + P(\theta)\cdot q_h(\theta) - C(q_h(\theta),\theta)$$

Without $K(\theta)$ the surplus would have been:

$$S(Q(\theta^+)) - P(\theta^+)\cdot Q(\theta^+)$$

Let $SN(\cdot)$ denote the net consumer surplus. The welfare effect dW is:

$$dW = SN(P(\theta)) - SN(P(\theta^+)) - \int_{\theta}^{\theta+} C_\theta(q_h(\theta),\theta)\cdot d\theta + P(\theta)\cdot q_h(\theta) - C(q_h(\theta),\theta)$$

$$= \int_{p(\theta^+)}^{p(\theta)} Q(v)\cdot dv - \int_{\theta}^{\theta+} C_\theta(q_h(\theta),\theta)\cdot d\theta + (P_d + t^{AI})\cdot q_h(\theta) - C(q_h(\theta),\theta)$$

$$= \int_{p(\theta^+)}^{p(\theta)} Q(v)\cdot dv - \int_{\theta}^{\theta+} C_\theta(q_h(\theta),\theta)\cdot d\theta + (P_d + t^{CI} + T)\cdot q_h(\theta)$$

And the firm chooses the price P such that:

$$(P_d + t^{CI})\cdot q_h(\theta) = C(q_h(\theta),\theta)$$

It yields:

$$dW = \int_{p(\theta^+)}^{p(\theta)} Q(v)\cdot dv - \int_{\theta}^{\theta^+} C_\theta(q_h(\theta),\theta)\cdot d\theta + T\cdot q_h(\theta)$$

dW is always non negative because $\int_{\theta}^{\theta+} C_\theta(q_h(\theta),\theta)\cdot d$ cannot exceed $\int_{p(\theta^+)}^{p(\theta)} Q(v)\cdot dv + T\cdot q_h(\theta)$