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DISTRIBUTING THE GAINS FROM TRADE WITH INCOMPLETE INFORMATION

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ABSTRACT

We argue that the *incomplete information* which the government has about domestic agents means that tariffs become an optimal instrument to protect them from import competition. We solve for the optimal government policies, subject to the political constraint of ensuring Pareto gains from trade, the incentive compatibility constraint, and the government's budget constraint. We find that the optimal policies take the form of nonlinear tariffs, so that both buyers and sellers of the import face an effective price which exceeds its world level. We find that the tariffs are never complete, in the sense of bringing prices for all individuals back to their initial level. Rather, it will always be possible to make some individuals strictly better off than at the initial prices, while ensuring that no persons are worse off.

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1. Introduction

When faced with lower prices because of import competition, industries often lobby for, and receive, protection. In the last decade, a formal analysis of lobbying pressure and the resulting protection has been the topic of much research in the political economy and trade literature. Early analyses often assumed that the method of protection was simply tariffs,[1] while later papers have explicitly compared tariffs, quotas, or other policy instruments.[2] In the context of a median voter model, Mayer and Riezman (1987) have argued that tariffs are inferior to a production tax/subsidy in that sense that *all* voters would prefer the latter. Thus, the question arises as to why tariffs or other forms of trade protection would be used at all. While there are a number of answers to this question,[3] in this paper we propose an explanation which we believe is new.

Specifically, we argue that the *incomplete information* which the government has about domestic agents means that tariffs become an optimal instrument to protect them from import competition. To see this argument, suppose that some individual is initially selling the amount x^0 of a product at the price p^0, and then the price drops to p^1. It is clear that if the government provided an income transfer of $(p^0-p^1)x^0$, then the individual could not be worse off from the price fall: even if she decided to sell the same amount x^0, then she would still receive total income of $p^1x^0 + (p^0-p^1)x^0 = p^0x^0$, which is the same as initially. More generally, if the individual *changed* her behavior in response to price change, while receiving this income transfer, then she would be better off. Thus, by providing income transfers of this type, the government can ensure that *all* individuals (whether they are buyers or sellers of the product) gain from the price fall.[4]

However, if the government does not actually observe the amount sold, then the income transfer $(p^0-p^1)x^0$ cannot be calculated: we refer to this as a situation of *incomplete information.* In practise, we could expect that it would be very difficult for the government to know the sales level of each firm in an industry, or the factor supply of each worker to that industry, so that compensating these individuals through income transfers becomes infeasible. This problem was recognized by Hufbauer and Rosen (1986, p. 77) in their proposal to compensate firms and workers for reductions in U.S. tariffs and quotas. They suggested that a complete list of workers, capital and farmland engaged in an industry could be made on an "inventory date," which would therefore determine who is eligible for compensation. In practise, we could imagine that such a scheme could be subject to various misrepresentation of the actual inputs employed at the "inventory date".

When the government does not observe the quantities x^0 sold or purchased, it is intuitive that a *tariff* becomes an informationally efficient form of compensating the sellers. For example, the tariff of (p^0-p^1) would fully compensate sellers for the price drop, and would also be financed by the same tariff applied to buyers of the import. The problem, of course, is that this tariff would lead to the same initial consumption and sales decisions, and therefore would not generate *gains* from trade (except for the possible tariff revenue, which could be redistributed). In deriving an *optimal* policy in the presence of incomplete information, the question is whether at least some individuals can strictly gain from the drop in the import prices, with no one being worse off. We find that such Pareto gains are indeed possible, and the optimal policy instrument is a (nonlinear) tariff.

In section 2 we outline our model. For simplicity, we ignore production and consider a *pure exchange* economy where individuals differ in their endowment of the importable good. Depending on their endowment, and the price, each person is then a buyer or seller of the importable. With a drop in the import price, we assume the government faces the political constraint of bringing each person back to their initial level of welfare, i.e. achieving Pareto gains from the increased trade. While we do not model the rational for this constraint, we could imagine that the government faces political pressure which would prevent trade from being increased unless most individuals gain.

In section 2 we also describe the type of policies the government can use, which we assume are a quite general combination of taxes and quantity of the import, both of which can differ across individuals. These policy options certainly include tariffs and simple income transfers as a special case, and more generally, allow for *nonlinear* tariffs which vary with the amount bought or sold. We also introduce the idea of "incentive compatible" policies: these policies make it optimal for agents to *truthfully reveal* their endowments of the importable good, but at the same time, constrain the actions of the government. Thus, the lack of information faced by the government is remedied by ensuring the individuals will voluntarily report their true sales or purchases of the import, but this behavior comes at the cost of adding an "incentive compatibility" constraint on the available policies.

In section 3 we solve for the optimal government policies, subject to the political constraint of ensuring Pareto gains from trade, the incentive compatibility constraint, and the government's budget constraint. We find that the optimal policies take the form of nonlinear tariffs, so that both buyers and sellers of the import face an effective price which exceeds its world level p^1. Thus, there is an implied tax on buyers and subsidy to sellers. We discuss various properties of the tariff schedule. In section 4 we argue that the tariffs are never complete, in the sense of bringing prices for all individuals back to their initial level p^0. Rather, it will always be possible to make some individuals strictly better off than at the initial prices, while ensuring that no persons are worse off. In this sense, *strict* gains from trade are obtained. Conclusions are given in section 5.

2. The Model

2.1 Assumptions and Notation

There are two goods in the economy , denoted by x and y, with y being the numeraire good. There is a continuum of individuals in the economy who are distinguished by the initial endowment of good x that they possess. All individuals have the same initial endowment y_0 of the good y. We shall let θ be the initial endowment of x, and assume that θ ranges in the interval $[\underline{\theta},\overline{\theta}]$. F(θ) represents the number of individuals with x-endowments less than or equal to θ. The density of individuals with endowment θ is given by $f(\theta) = F'(\theta)$, and we assume for simplicity that $\int f(\theta)d\theta = 1$. In what follows we will also assume that a standard hazard rate property is satisfied, $d/d\theta\,[F(\theta)/f(\theta)] > 0$.[5]

All individuals share the same quasi-linear utility function U(y,x,θ) given by:

$$U(x,y,\theta) = y_0 + y + \Phi(x + \theta), \tag{1}$$

where y and x represent the net purchases of the two goods. We assume that $\Phi' > 0$ and $\Phi'' < 0$.

For simplicity there is no domestic production. Initially the economy faces the price p^0 for good x, which may be either the autarky equilibrium price, or given exogenously by world markets. Each individual solves:

$$\max\ U(x,y,\theta) \quad \text{subject to} \quad p^0x + y = 0. \tag{2}$$

Let (y^0, x^0) be the unique solution to (2). Expressing x^0 as a function θ, it is easy to show that:

$$x^0(\theta) = \psi(p^0) - \theta, \tag{3}$$

where ψ is the inverse function of Φ', and $x^{0\prime}(\theta) = -1$. Note that the choice of x^0 varies inversely with the initial endowment θ. When $x < 0$ ($x > 0$) we say that the individual is a seller (buyer) of x. We will be supposing that x is the *import good*, with a zero or positive amount imported at the price p^0.

The utility for a type θ person in the initial equilibrium is given by:

$$U^0(\theta) = U(x^0, y^0, \theta).$$

Employing the Envelope Theorem, it is immediate that $U^{0\prime}(\theta) = \Phi'[x^0(\theta) + \theta] = p^0$. The utility schedule $U^0(\theta)$ corresponding to the initial equilibrium is shown in Figure 1. Since $x^{0\prime}(\theta) < 0$, there exists some $\hat{\theta} \varepsilon (\underline{\theta}, \overline{\theta})$ such that all individuals with initial endowments of x greater than $\hat{\theta}$ will be sellers in equilibrium, and all individuals with endowments less than $\hat{\theta}$ will be buyers of x in equilibrium. The boundary $\hat{\theta}$ type is also shown in Figure 1.

Now suppose that the price of imports x falls from p^0 to $p^1 < p^0$. For the moment assume that there are no import restrictions or tariffs, and that individuals still retain the same initial endowments of y and x. Then in the new free trade equilibrium, x and y will be chosen to:

$$\max U(x, y, \theta) \quad \text{subject to} \quad p^1 x + y. \tag{4}$$

Let (x^1, y^1) be the unique solution to (4), and denote by $U^1(\theta) = U(x^1, y^1, \theta)$ the corresponding utility as a function of θ. As before it is straightforward to show that $U^{1\prime}(\theta) = \Phi'[x^1(\theta) + \theta] = p^1$.

Looking at Figure 1 where $U^1(\theta)$ is compared with $U^0(\theta)$, one can see that all buyers and some marginal sellers of x would benefit from the chance to purchase less expensive imported goods. However the larger sellers, whose income would depend heavily on the sales revenues from x, would obviously be harmed by the less expensive imports. If the domestic government were informed as to the type of each individual (as characterized by their initial endowments) it could impose a suitable lump tax on those benefitting from imports, and distribute these revenues to those who were harmed, so as to make all individuals better off under free trade.[8] However, without this information such transfers are not possible. In this case the government may need to resort to second best policies, which are constrained by the private information that individuals possess about their initial endowments.

2.2 Informationally Constrained Policies

To examine informationally constrained policies, we make the following assumptions about the government's available policy options. First, we assume that while the initial endowments of a given individual are private knowledge, the government does have aggregate data on initial endowments in that the distribution of types $f(\theta)$ is known.

Second, we assume that the government is able to offer a menu of options which consist of pairs (T,x), where T is a fee which is paid by the individual in return for the right to buy or sell a specified quantity x at the going world price p^1. Notice, that T may be negative, in which case the individual receives a subsidy from the government. The individual's budget constraint becomes:

$$T + y + p^1 x = 0.$$

Substituting for y in terms of T and x from the budget constraint, we can rewrite utility in terms of T, x, and θ as:

$$U(T,x,\theta) = \Phi(x + \theta) + y_0 - p^1x - T.$$

Specifying a schedule of T's and x's allows the government to try to compensate the losers from import competition with funds that have been raised from the buyers of the imports. When the government announces a menu $\{T(\theta),x(\theta)\}$, it realizes that each individual will select the combination of taxes and imports which are optimal for them. In particular, an individual must find it in their interest to report a false value of θ. The government can limit this behavior, however, by choosing the schedule $\{T(\theta),x(\theta)\}$ which makes it in the best interest of each person to *truthfully* report their type. We model this requirement as the *incentive compatibility* constraint, which is formally written as:

$$U(\theta|\theta) \equiv U[T(\theta),x(\theta),\theta] \geq U[T(\theta'),x(\theta'),\theta] \equiv U(\theta'|\theta) \text{ for all } \theta,\theta'. \qquad [IC]$$

Define $U(\theta) \equiv U(\theta|\theta)$. Then a useful characterization of policies which satisfy the incentive compatibility constraint is given by:

Lemma 1 A policy $\{x(\theta),T(\theta)\}$ satisfies [IC] if and only if:

a) $U'(\theta) = \Phi'[x(\theta) + \theta]$;

b) $x(\theta)$ is nonincreasing.

The proof follows standard arguments presented in Guesnerie and Laffont (1984) and so is omitted.

Our third requirement on the government policies is that it must be politically acceptable. A strong form of political acceptability which we shall impose here is that no individual can be made worse off from the import competition. The political acceptability [PA] constraint is written as:

$$U(\theta) \geq U^0(\theta) \quad \text{for all } \theta. \qquad \text{[PA]}$$

Weaker forms of the [PA] constraint could be used by requiring that only a fraction (perhaps a majority) of individuals gain from the increase in trade, on the argument that if enough people gain than the action would be politically feasible.[7]

Finally, the government operates under a budget constraint, meaning that it has limited funds to implement the import policy. We model this budget constraint [BC] by requiring:

$$\int_{\underline{\theta}}^{\overline{\theta}} T(z)dF(z) + \overline{B} \geq 0, \qquad \text{[BC]}$$

where $\overline{B}$ is some fixed budget (possibly zero) which the government has to work with.

3. Analysis

We can now state the government's problem [GP] in trying to formulate an optimal import policy. We envision that government chooses a policy $\{x(\theta),T(\theta)\}$ to maximize the expected utility of all individuals in the economy plus the government budget surplus subject to the [IC], [PA], and [BC] constraints. Formally, we can represent the government's problem as:

$$\max_{\{x(\theta),T(\theta)\}} \quad H = \int_{\underline{\theta}}^{\overline{\theta}} \{\Phi(x(\theta)+\theta) + y_0 - p^1x(\theta) - T(\theta) + T(\theta) + \overline{B}$$

$$+ \lambda[T(\theta) + \overline{B}]$$

$$+ \mu(\theta)[U(\theta) - U^0(\theta)] \qquad \text{[GP]}$$

$$+ \rho(\theta)[\Phi(x(\theta)+\theta) + y_0 - p^1x(\theta) - T(\theta) - U(\theta)]$$

$$+ \gamma(\theta)\Phi'(x(\theta),\theta)\} \; dF(\theta).$$

The first line of the Hamiltonian H represents total expected surplus, inclusive of the budget surplus. The second line captures the [BC] constraint. The third line captures the [PA] constraint, where we are treating $U(\theta)$ as a state variable. Line four defines the state variable, and the final line represents the equation of motion for the state variable, which comes from part (a) of Lemma 1. We will verify that part (b) of Lemma 1 is satisfied once the characterization of the solution to [GP] is complete.

Maximizing H pointwise with respect to $x(\theta)$ and $T(\theta)$ we obtain the following conditions:

$$\partial H/\partial x(\theta) = [\Phi'-p^1](1+\rho) + \gamma\Phi'' = 0, \qquad (5a)$$

$$\partial H/\partial T(\theta) = \lambda-\rho = 0, \qquad (5b)$$

$$\partial H/\partial U(\theta) = (\mu-\rho)f(\theta) = -\partial[\gamma(\theta)f(\theta)]/\partial\theta, \qquad (5c)$$

$$\gamma(\underline{\theta})[U(\underline{\theta}) - U^0(\underline{\theta})] = \gamma(\overline{\theta})[U(\overline{\theta}) - U^0(\overline{\theta})] = 0. \qquad (5d)$$

(transversality conditions)

In what follows we assume that the [PA] constraint only binds at $\theta = \overline{\theta}$, meaning that all other individuals obtain utility strictly greater than $U^0(\theta)$. As we discuss below, this is the case when the government's budget constraint is not too stringent (see section 4). When [PA] in not binding this implies that the multiplier $\mu(\theta) = 0$. Also by assumption, $U(\underline{\theta}) - U^0(\underline{\theta}) > 0$ which implies $\gamma(\underline{\theta}) = 0$, from (5d). Substituting for ρ from (5b) and using (5c) we can express $\gamma(\theta)$ as:

$$\gamma(\theta) = \lambda F(\theta)/f(\theta).$$

Combining this with (5a) implies:

$$\Phi' - p^1 = -[\lambda/(1+\lambda)]\Phi'' [F(\theta)/f(\theta)]. \qquad (6)$$

The solution to [GP] is distinguished by whether the government budget constraint is binding or not binding. We now turn to these two cases.

3.1 Nonbinding Government Budget Constraint

According to (6), $x(\theta) = x^1(\theta)$ and there is *free trade* in the imported good x, whenever the government's budget constraint is not binding so that $\lambda = 0$. Otherwise if [BC] is binding so that $\lambda > 0$, (6) implies that consumption of the imported good will be inefficiently small. Therefore it is of interest to know when [BC] is binding. Arguing intuitively, [BC] will bind when the government must offer more compensation to individuals to insure the free trade policy is politically acceptable than the budget allows.

Figure 1 illustrates the utility obtained initially [$U^0(\theta)$] and after the fall in the import price [$U^1(\theta)$] by the various agents. Without government transfers, buyers of x (low θ types) tend to gain under free trade while sellers of x (high θ types) lose. If [BC] is not binding then the government must be compensating these individuals with lump sum transfers. However the identity of the sellers in not known to the government. so that all individuals can apply for this subsidy. As a consequence, all individuals receive the lump sum subsidy which is shown as L in Figure 1: enough to ensure that the highest θ type is no worse off from the import competition, while everyone else gains. Since we have assumed that the total number of individuals in the economy is unity, it follows that the total transfer paid by the government (the negative of taxes) also equals L, which we presume is positive as illustrated.[8]

Thus, if $\overline{B} = 0$ in [BC], then it is immediate that the government budget constraint is not met, so that free trade cannot be achieved. However, even if $\overline{B} > 0$, meaning that the government has some funds available to distribute, we can argue that [BC] will be violated if the *dispersion* of types is sufficiently large. To make this argument, consider a mean preserving variation of θ, where we define a new variable $\sigma(\lambda,\theta)$ which is given by:

$$\sigma(\alpha,\theta) = \theta + \alpha(\theta-\tilde{\theta}), \tag{7}$$

where $\alpha > 0$ and $\tilde{\theta}$ is the mean of θ. Then we have:

Proposition 1

[BC] is binding in the solution to [GP] if α is sufficiently large.

The proof of Proposition 1 proceeds by simply calculating how the transfer L depends on α. From Figure 1 we have $L = U^0(\overline{\theta}) - U^1(\overline{\theta})$, or after applying the mean preserving spread, $L = U^0(\overline{\sigma}) - U^1(\overline{\sigma})$. Then using Lemma 1 and (7) we calculate that:

$$dL/d\alpha = [U^{0\prime}(\bar{\sigma}) - U^{1\prime}(\bar{\sigma})](\bar{\theta} - \tilde{\theta})$$
$$= (p^0 - p^1)(\bar{\theta} - \tilde{\theta}) > 0.$$

Thus, for sufficiently high α we must have that payments L exceed the available revenue $\bar{B}$, so that [BC] is binding. We turn to an analysis of this case next.

3.2 Binding Government Budget Constraint

As we have shown, the budget constraint will be binding if there is sufficient heterogeneity among individuals in terms of their initial endowments of x (or if $\bar{B}$ is small). In this instance the solution to [GP] is characterized by the following:

Proposition 2

Assume [BC] is binding, and $\Phi''' \leq 0$. Then the solution to [GP] satisfies:

a) $\Phi' = p^1 + \tau(x)$;

b) $x^0(\theta) \leq x(\theta) \leq x^1(\theta)$ (with strict inequality for $\underline{\theta} < \theta < \bar{\theta}$);

c) $x'(\theta) < 0$;

d) $\tau(x) \geq 0$ (with strict inequality for $x < x^1(\underline{\theta})$),

$\tau'(x) < 0$;

e) $U(\theta) = U(\bar{\theta}) - \int_{\theta}^{\bar{\theta}} \Phi'[z + z(\theta)]dz.$

Proposition 2 is proved in the Appendix. As the reader might have expected, when the budget constraint is binding then it is not possible to achieve the efficient free trade solution. What results is a compromise policy which allows for some partial movement towards the free trade solution, as indicated by part (b).

Parts (a) and (c) imply that buyers of the good x are taxed on the margin at the rate $\tau(x)$. On the other hand, sellers of x receive a marginal subsidy equal to $\tau(x)$. We can think of $\tau(x)$ as a *nonlinear* tariff, which varies with the quantity imported. The result of this tariff is to lower consumption, raise domestic sales, and restrict imports into the economy.

The tariff is introduced because of the binding budget constraint. To balance the budget, the government must limit the rents which individuals earn from their private information. Figure 2 shows the utilities $U(\theta)$ of different θ types under the solution to [GP], in comparison to the initial level of utility $U^0(\theta)$. The gap between $U(\theta)$ and $U^0(\theta)$ represents the *information rent* earned by each individual. This rent is *increasing* as we move down the θ scale at the rate of $p^0 - \Phi'[x(\theta)+\theta]$. This rate can be reduced by inducing smaller levels of $x(\theta)$ since Φ is strictly concave. This is accomplished by introducing the noninear tariff $\tau(x)$.

According to part (c), $\tau(x)$ is decreasing with x. Thus, the tariff is decreasing in the amount sold, and the sales subsidies (for $x < 0$) *exceed* the consumption taxes (for $x > 0$). As we explained above, the tariff $\tau(x)$ is levied to encourage a reduction in x. This decreases the rate at which individuals earn higher rents from the private information about their endowments. Looking at Figure 2, we see that it is particularly important to limit the rents for the high θ types, since this also reduces the rents for all θ types below them. Consequently, the distortions become less for smaller θ types since it is not as important to limit their information rents. Thus, the tariff distortions are largest for the high θ types (sellers of x) and smallest for the low θ types (buyers of x).

To complete our characterization of the solution to [GP] let us analyze the tax function T. Recall that we can represent utility as:

$$U(T,x,\theta) = \Phi(x+\theta) + y_0 - p^1x - T .$$

Solving for T in terms of U, and using part (a) of Lemma 1 and (6), we can represent the tax function as:

$$T(\theta) = -U^0(\overline{\theta}) + \int_{\theta}^{\overline{\theta}} \Phi'[x(z)+z]dz + \Phi - p^1x + y_0 . \tag{8}$$

From part (c) of Proposition 2 we know that $x(\theta)$ is invertible, so we can represent θ as a function of x, say $\theta(x)$. Differentiating T with respect to x we obtain:

$$T'(x) = \Phi'[x+\theta(x)] - p^1 = \tau(x) > 0,$$

$$T''(x) = \tau'(x) < 0,$$

by part (d) of Proposition 2. This implies that the schedule {T,x} appears as in Figure 3 where T is an increasing, concave function of x.

When presented with this schedule individuals choose the point on the T(x) curve which maximizes their utility. Note that the marginal rate of transformation of T for x for individual θ is given by:

$$dT/dx\Big|_U = \Phi'[x(\theta) + \theta] - p^1 = \tau[x(\theta)],$$

so that different θ types locate at a tangency point along the T(x) schedule, as indicated in Figure 3. Since T(x) is strictly concave, it can be supported by a series of *linear schedules* $\{L(\theta),\tau(\theta)\}$, where L is a lump sum subsidy or tax, and τ is a per unit tax or subsidy placed on the consumption or sale of x. Two such linear schedules for θ_1 and θ_2 are illustrated in Figure 3. In theory then, the schedule {T,x} could be administered in a decentralized fashion by allowing individuals to choose from a series of two part tariffs $\{L(\theta),\tau(\theta)\}$ according to their type. This observation is formally stated in:

Proposition 3

The solution to [GP] can be implemented in a decentralized means by allowing individuals to choose from a schedule of two part tariffs $\{L(\theta),\tau(\theta)\}$.

Under this policy, an individual faces the tax (subsidy) of $\tau(\theta)$ on *all* units consumed (sold), where this tax rate does not vary with quantity. The tax rate differs across individuals, however, with each person choosing their preferred combination of the marginal tax $\tau(\theta)$ and lump sum subsidy $L(\theta)$.

4. Gains from Trade are Always Possible

In our discussion above we were assuming that the [PA] constraint was binding only at $\theta = \overline{\theta}$, while individuals with lower endowments of good x obtained strictly higher utility than initially. This situation was illustrated by the utility schedule $U(\theta)$ lying strictly above $U^0(\theta)$ in Figure 2 (except at $\overline{\theta}$). However, if the government budget constraint is too stringent ($\overline{B}$ is very low), it may not be possible to ensure these gains to all individuals.

In terms of our earlier analysis, suppose that λ - the multiplier on the budget constraint - rises. Then from (6) we see that Φ' would rise for any given value of $\Phi'' < 0$. Using Lemma 1, this means that utility declines at a faster rate for lower θ. However, in Figure 2 if utility declines too rapidly around $\overline{\theta}$ then the utility schedule $U(\theta)$ will fall below the schedule $U^0(\theta)$, which violates the [PA] constraint. Instead, the solution to [GP] would involve a utility level $U(\theta)$ just *equal* to $U^0(\theta)$ over some interval $[\theta^*,\overline{\theta}]$, with utility rising above its initial level for lower values of θ. This schedule is shown as

AB in Figure 2. The results of Proposition 2 would still apply, except that $x(\theta) = x^0(\theta)$ for $\theta \in [\theta', \overline{\theta}]$.

The question then arises as to whether some individuals can *always* gain from the lower import price, as along the utility schedule A'B' in Figure 2. That is, can we be sure that starting with non-negative government revenue, and zero or positive trade at the prices p^0, the government will be able to devise a policy which leaves some individuals strictly better off and none worse? The following result shows that this is indeed the case: gains from trade are always possible.

Proposition 4

Suppose that $\overline{B} \geq 0$, with zero or positive imports at the price p^0. Then with $p^1 < p^0$, there exists a schedule $\{\tilde{T}(\theta), \tilde{x}(\theta)\}$ satisfying [IC] and [BC] such that $U(\tilde{T}, \tilde{x}, \theta) \geq U^0(\theta)$ for all θ, with strict inequality for some θ.

In Figure 2 the range of individuals who gain from the government policy is shown by A'B', while all other persons obtain $U(\theta) = U^0(\theta)$. The idea behind the proof of Proposition 4 is that is is always possible to allow a small set of individuals to purchase the imports $x^1(\theta)$ rather than $x^0(\theta)$, but then apply higher taxes $T(\theta)$ on them reflecting their higher utility. For the person just indifferent between obtaining the greater imports at the higher taxes (that is, the individual at B'), the extra taxes which the government collects is exactly equal to their rise in utility from the extra imports. Since this extra utility is non-negligible, the government obtains higher revenue that if just applied a complete tariff of (p^0-p^1) and forced everyone to their initial consumption and utility level. Thus, allowing the set of individuals along A'B' to consume $x^1(\theta)$ imports yields higher utility for them, and greater revenue for the government.

5. Conclusions

In this paper we have argued that (nonlinear) tariffs can arise as the *optimal* instrument for protecting a domestic group from import competition, when the government is constrained by incomplete information. In this setting, the lump sum transfers which would be needed to compensate each seller for the price drop cannot be computed, since they depend on the initial quantity sold.[9] The (nonlinear) tariff becomes a method for compensating those who lose from the price drop, while raising the revenue for those who gain, and still securing strictly positive gains for some individuals.

It might be useful to contrast the role of information in our model with an alternative model presented by Magee, Brock and Young (1989). They have delightfully suggested that tariffs can arise under the heading of "Optimal obfuscation and the theory of the second worst." The idea is the government may rationally choose tariffs when voters are imperfectly informed, since the voters do not recognize this instrument as a consumption tax. Thus, in their model the government has more information about actual policies than voters. In contrast, we have argued that the government will likely have less information than voters, since it may not observe the exact losses faced by individuals due to import competition. In this case tariffs arise as an optimal policy, subject to the informational constraints.

Appendix

Propositions 1 and 3 are proved in the main text.

Proof of Proposition 2

Equation (6) in the text implicitly defines $x(\theta)$. Totally differentiating (6) with respect to (θ) we have:

$$x'(\theta) = -\left(\frac{\Phi'' + \tilde{\lambda}[d/d\theta(F/f)]\Phi'' + \tilde{\lambda}(F/f)\Phi'''}{\Phi'' + \tilde{\lambda}(F/f)\Phi'''}\right) < 0 \, , \tag{A1}$$

where $\tilde{\lambda} = \lambda/(1+\lambda)$. The sign of the above expression follows from $\Phi'' < 0$, $d/d\theta(F/f) > 0$, and $\Phi''' \leq 0$. This proves part (c) of the Proposition and verifies that part (b) of Lemma 1 is also satisfied.

Since x is monotone in θ, we can represent θ as a function of x, $\theta(x)$. Define $\tau \equiv \Phi' - p^1 = -\tilde{\lambda}\Phi''F(\theta(x))/f(\theta(x))$, using (6). Clearly $\tau \geq 0$, with strict inequality for $\theta > \underline{\theta}$. Differentiating τ with respect to θ we obtain $\tau'(x) = \Phi''(1 + \theta')$. Since $x'(\theta) < -1$ by inspection of (A1), we see that $-1 < \theta'(x) < 0$, and so $\tau'(x) < 0$. This proves parts (a) and (d) of the Proposition.

By assumption (PA) binds only at $\theta = \overline{\theta}$. This means that $U(\theta) > U^0(\theta)$ in a neighborhood of $\overline{\theta}$. Hence $\lim_{\theta \to \overline{\theta}} d/d\theta[U(\theta) - U^0(\theta)] = \Phi'[x(\overline{\theta}) + \overline{\theta}] - p^0 \leq 0$, implying that $x(\overline{\theta}) \geq x^0(\overline{\theta})$. But since $x'(\theta) < -1$ in (A1) and $\Phi'' < 0$ we obtain $\Phi'[x(\theta) + \theta] - p^0 < 0$ for all $\theta < \overline{\theta}$, implying that $x(\theta) > x^0(\theta)$ for all $\theta < \overline{\theta}$. Finally, since $\tau \geq 0$ with strict inequality for $\theta > \underline{\theta}$, we obtain $\Phi'[x(\theta) + \theta] - p^0 \geq 0$ and $x(\theta) \leq x^1(\theta)$ with strict inequality for $\theta > \underline{\theta}$. This completes the proof of part (b). Part (e) follows from the transversality condition $U(\overline{\theta}) = U^0(\overline{\theta})$, and part (a) of Lemma 1.

Proof of Proposition 4

At price p^0 the country is either in autarky or there are some imports of x. First consider the case where x is imported. Let $\tilde{T}(\theta) = (p^0-p^1)x(\theta)$. Then given $\tilde{T}(\theta)$ it is easy to verify that an individual of type θ will prefer $\tilde{T}(\theta)$, $x^0(\theta)$ to any other choice $\tilde{T}(\theta')$, $x^0(\theta')$, and that $U[\tilde{T}(\theta), x^0(\theta), \theta] = U^0(\theta)$. In this case the government's budget is:

$$\int_{\underline{\theta}}^{\overline{\theta}} \tilde{T}(\theta)dF\theta + \overline{B} = (p^0-p^1) \int_{\underline{\theta}}^{\overline{\theta}} x^0(\theta)dF(\theta) + \overline{B} > 0, \qquad [BC]$$

since $\int_{\underline{\theta}}^{\overline{\theta}} x^0(\theta)dF(\theta) > 0$ and $\overline{B} \geq 0$. But this implies that the government could make each person strictly better off than they were under the original price p^0 by giving a small poll subsidy, without violating [BC].

Now consider the case where the country is in autarky with price p^0 so that $\int_{\underline{\theta}}^{\overline{\theta}} x^0(\theta)dF(\theta) = 0$. Consider a program which induces individuals to choose $\tilde{x}(\theta)$ according to:

$$\begin{aligned} \tilde{x}(\theta) &= x^0(\theta), \quad \theta \in [\hat{\theta}, \overline{\theta}], \\ &= x^1(\theta), \quad \theta \in [\underline{\theta}, \hat{\theta}), \end{aligned} \qquad (A2)$$

where x^1 satisfies $\Phi'[x^1(\theta) + \theta] = p^1$. In order to induce $\tilde{x}(\theta)$ we must satisfy [IC] which requires that: (a) $U(\theta)$ is continuous; (b) $U'(\theta) = \Phi'[\tilde{x}(\theta) + \theta]$; and (c) $\tilde{x}(\theta)$ is nonincreasing. Assume for the moment that types $\theta \in (\hat{\theta}, \overline{\theta}]$ are induced to choose $\{\tilde{T}(\theta), x^0(\theta)\}$. Then to satisfy (a) and ensure the continuity of $U(\theta)$ at $\theta = \hat{\theta}$, we require that $\{T(\hat{\theta}), x^1(\hat{\theta})\}$ satisfy:

$$U(\hat{\theta}) = \Phi[x^1(\hat{\theta}) + \hat{\theta}] - p^1x^1(\hat{\theta}) - T(\hat{\theta})$$
$$= \Phi[x^0(\hat{\theta}) + \hat{\theta}] - p^1x^0(\hat{\theta}) - \tilde{T}(\hat{\theta}),$$

so that,

$$T(\hat{\theta}) = \Phi[x^1(\hat{\theta}) + \hat{\theta}] - \Phi[x^0(\hat{\theta}) + \hat{\theta}] + \tilde{T}(\hat{\theta}) - p^1[x^1(\hat{\theta}) - x^0(\hat{\theta})].$$

Using (A2), condition (b) implies that for $\theta \in [\underline{\theta}, \hat{\theta})$:

$$U'(\theta) = \Phi'(d\tilde{x}/d\theta + 1) - p^1dx/d\theta - T'(\theta) = \Phi' = p^1,$$

which implies $T'(\theta) = 0$, so that $T(\theta) = T(\hat{\theta})$. Finally notice that condition (c) is automatically satisfied by $x(\theta)$.

Thus, the choices (A2) are induced by the tax function:

$$T(\theta) = T(\hat{\theta}) \ , \ \theta \in [\underline{\theta}, \hat{\theta}),$$
$$= \tilde{T}(\theta) \ , \ \theta \in [\hat{\theta}, \overline{\theta}]. \tag{A3}$$

We need to check that [BC] is satisfied by (A3). Now we know that:

$$\int_{\underline{\theta}}^{\overline{\theta}} \tilde{T}(\theta)dF\theta + \overline{B} = (p^0-p^1)\int_{\underline{\theta}}^{\overline{\theta}} x^0(\theta)dF(\theta) + \overline{B} \geq 0 ,$$

since $\overline{B} \geq 0$ and $\int_{\underline{\theta}}^{\overline{\theta}} x^0(\theta)dF(\theta) = 0$. It follows that [BC] is satisfied if:

$$\int_{\underline{\theta}}^{\hat{\theta}} [T(\hat{\theta}) - \tilde{T}(\theta)]dF(\theta) \geq 0$$

$$\Rightarrow \int_{\underline{\theta}}^{\hat{\theta}} \Phi[x^1(\hat{\theta}) + \hat{\theta}] - \Phi[x^0(\hat{\theta}) + \hat{\theta}] - p^1[x^1(\hat{\theta})-x^0(\hat{\theta})]$$
$$+ (p^0-p^1)x^0(\hat{\theta}) - (p^0-p^1)x^0(\theta)\} \, dF(\theta) \geq 0, \text{ using (A3).}$$

The first three terms in the integrand represent the additional consumer surplus generated by allowing worker type $\hat{\theta}$ to expand his consumption of x from x^0 to x^1 at price p^1. Call this increase in consumer surplus $\Delta(\hat{\theta})$. Rewriting the expression above we have:

$$\Delta(\hat{\theta})F(\hat{\theta}) + (p^0-p^1)\int_{\underline{\theta}}^{\hat{\theta}} [x^0(\hat{\theta}) - x^0(\theta)]dF(\theta) \geq 0.$$

Now $x^0(\theta) + \theta$ is constant for $\theta \in [\underline{\theta},\hat{\theta})$, since $\Phi'[x^0(\theta) + \theta] = p^0$, so that $x^0(\theta) = x^0(\hat{\theta}) + (\hat{\theta}-\theta)$. Substituting this into the expression above we have:

$$\Delta(\hat{\theta})F(\hat{\theta}) + (p^0-p^1)\int_{\underline{\theta}}^{\hat{\theta}} [\hat{\theta}-\theta]dF(\theta) \geq 0$$

$$\Rightarrow \quad \Delta(\hat{\theta})F(\hat{\theta}) + (p^0-p^1)(\hat{\theta} - E_{\hat{\theta}}\theta)F(\hat{\theta}) \geq 0,$$

$$\Rightarrow \quad F(\hat{\theta})[\Delta(\hat{\theta}) + (p^0-p^1)(\hat{\theta} - E_{\hat{\theta}}\theta)] \geq 0,$$

where $E_{\hat{\theta}}\theta$ is the mean of θ conditioned on $\theta \in [\underline{\theta},\hat{\theta})$. Notice that $\hat{\theta} - E_{\hat{\theta}}\theta$ approaches zero as $\hat{\theta}$ approaches $\underline{\theta}$. However, the consumer surplus term $\Delta(\hat{\theta})$ approaches $\Delta(\underline{\theta}) > 0$ as $\theta \rightarrow \underline{\theta}$. It follows that there exits a $\hat{\theta}$ sufficiently close to $\underline{\theta}$ such that the above inequality is satisfied, so that the induced allocation satisfies [BC].

Finally it remains for us to show that under this allocation some persons are strictly better off than they were in the original equilibrium. It is easy to verify that $U[T(\theta),x(\theta),\theta] = U^0(\theta)$ for $\theta \in [\hat{\theta},\overline{\theta}]$. For $\theta \in [\underline{\theta},\hat{\theta})$ we have:

$$U(\theta) = U^0(\hat{\theta}) - \int_{\theta}^{\hat{\theta}} U'(z)dz$$

$$= U^0(\hat{\theta}) - \int_{\theta}^{\hat{\theta}} \Phi'[x^1(z) + z]dz$$

$$> U^0(\hat{\theta}) - \int_{\theta}^{\hat{\theta}} \Phi'[x^0(z) + z]dz$$

$$= U^0(\theta),$$

thus completing our proof.

Footnotes

[1] For example, tariffs are assumed in the models of Brock and Magee (1978), Feenstra and Bhagwati (1982), Findlay and Wellisz (1982), Mayer (1984) and Wilson and Wellisz (1982).

[2] See Dinopoulos (1983), Cassing and Hillman (1985) and Hillman and Ursprung (1988) who compare tariffs and quotas, and Feenstra and Lewis (1988) who allow for tariff-rate quotas.

[3] Mayer and Riezman (1989) consider a model where voters differ in multiple dimensions, in which case tariffs can arise as a Pareto-optimal outcome of a voting process.

[4] It can be argued that transfers of this type are also feasible for the government, i.e. the revenue collected from the buyers of imports by imposing a lump-sum tax of $(p^0-p^1)x^0$ exceeds the lump-sum transfer providing to sellers.

[5] This property is invoked to eliminate the possibility of pooling equilibria from arising, which would unduly complicate our analysis.

[6] That is, it could give the lump sum transfers $(p^0-p^1)x^0(\theta) > 0$ to sellers, and $(p^0-p^1)x^0(\theta) < 0$ to buyers of the import good x.

[7] This form of the [PA] constraint is considered in our earlier paper, Lewis, Feenstra and Ware (1989), which examines the compensation to firms from a drop in the import price.

[8] If the price drop is very large, then it is possible that all sellers of x will become consumers, and everyone can gain from the lower import price. In this case there is no need for any government intervention (L = 0).

[9] See footnote 6.

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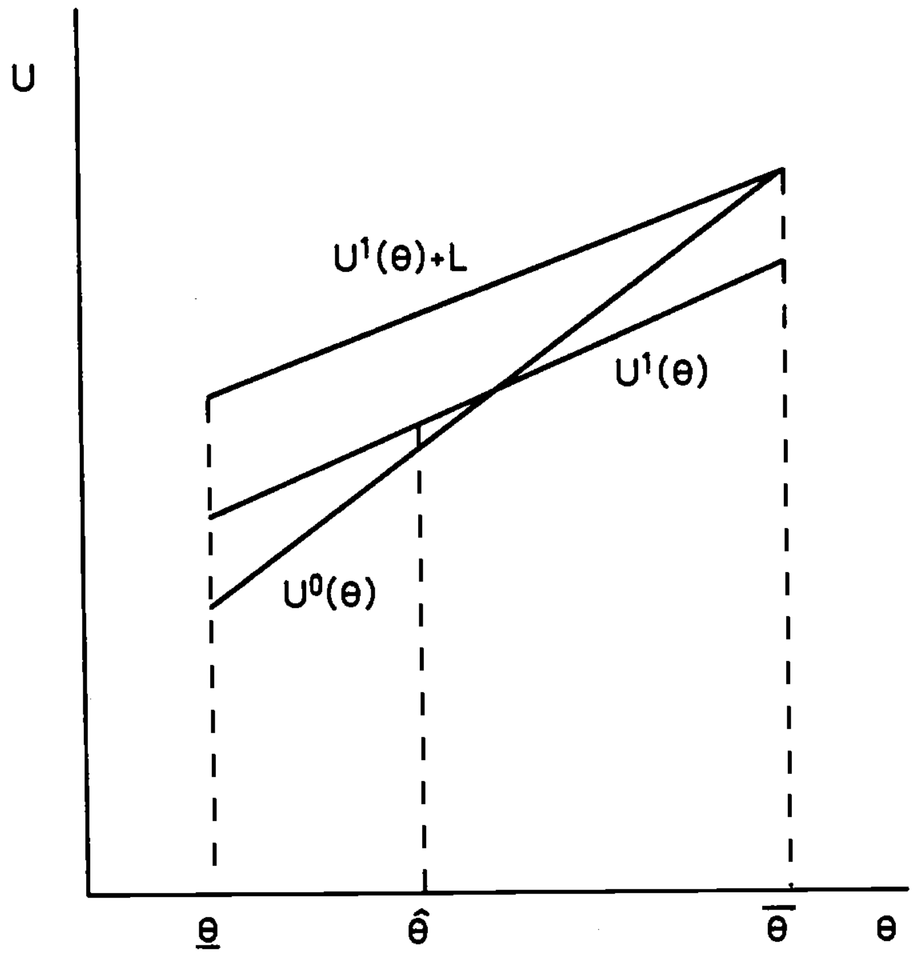

Figure 1

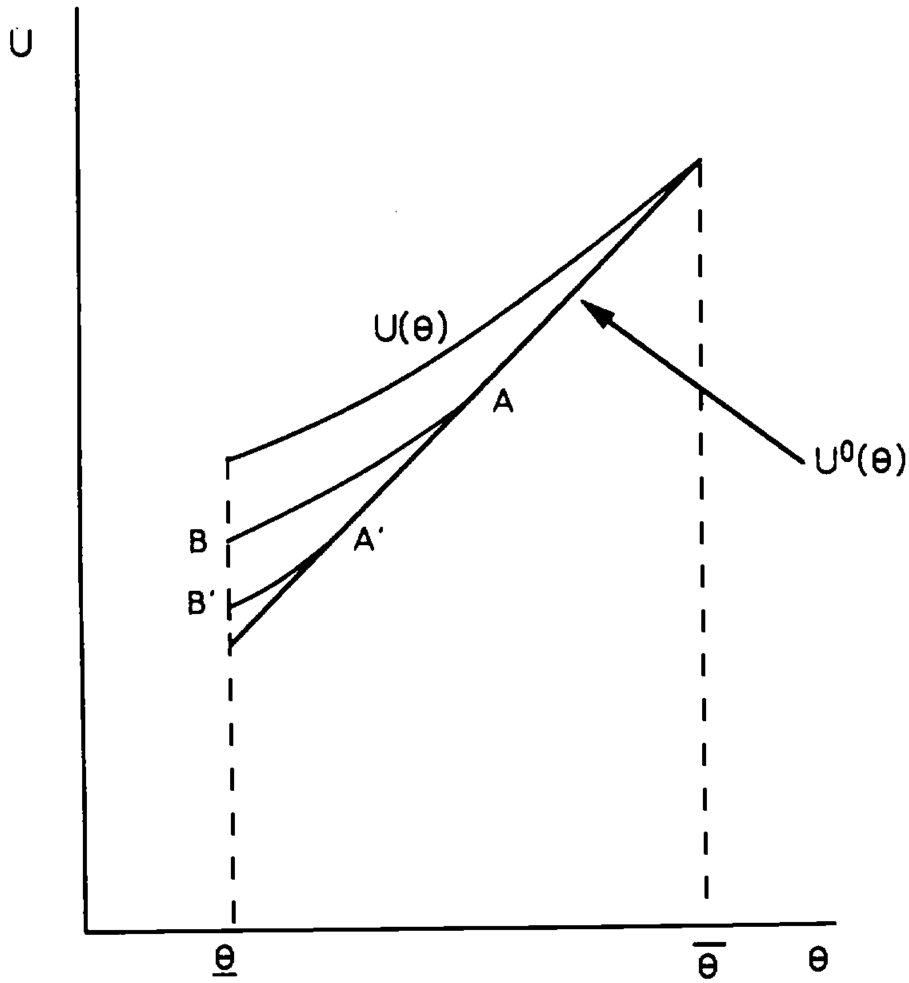

Figure 2

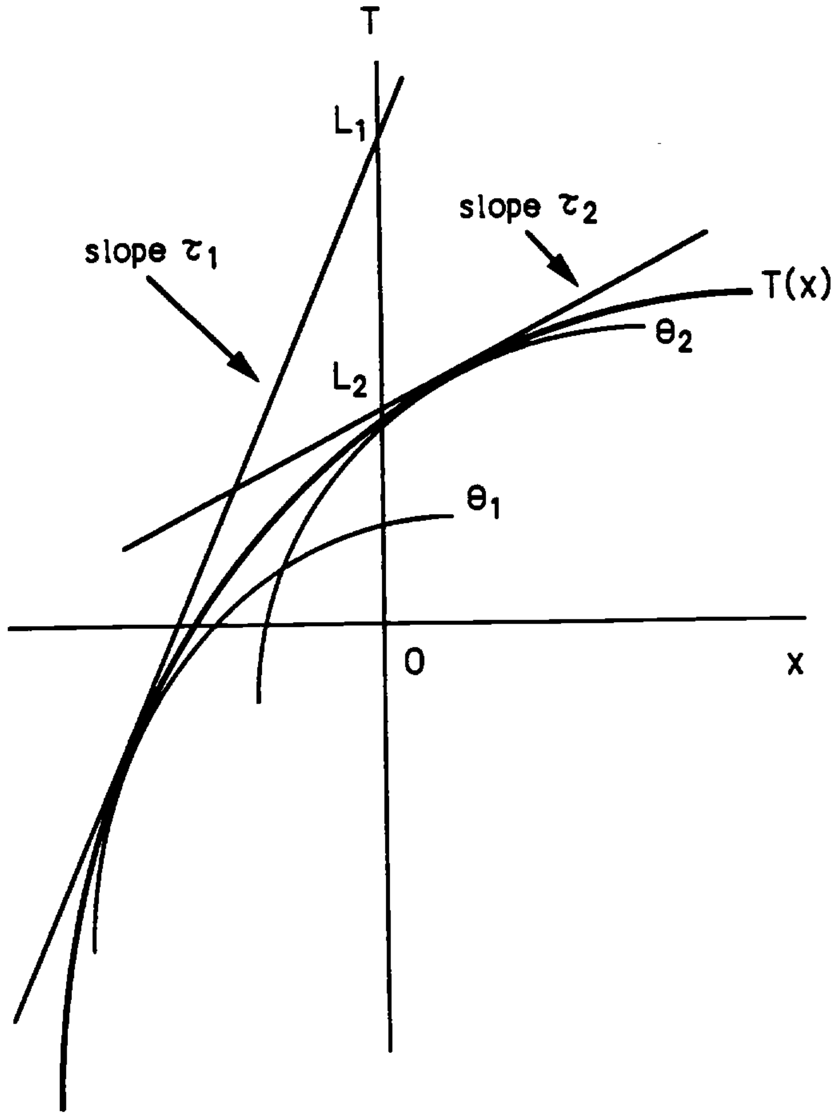

Figure 3