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The Optimal Tariff, Production Lags, and Time Consistency

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Abstract

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The Optimal Tariff, Production Lags, and Time Consistency

By HARVEY E. LAPAN*

The optimal tariff for a large country equals the reciprocal of the foreign export elasticity of supply. However, if production decisions occur before consumption decisions, the ex ante optimal tariff is not time consistent because the ex post elasticity is less than the ex ante elasticity. We show all countries are worse off if the large country cannot precommit to its ex ante optimal tariff, and that all countries can gain if the large country taxes domestic production of importables.

It is well known that a large country can increase domestic welfare through trade restrictions. In particular, the optimal *ad valorem* tariff rate on imports equals the reciprocal of the foreign export price elasticity of supply. The operational problems with this formula are that the relevant elasticity is not a constant (as it varies along the offer curve) and it will, in general, depend upon the appropriate time perspective.

For example, assume a time lag between production and trade decisions, and that the home country is "large." From an *ex ante* perspective, the elasticity of foreign export supply depends upon both foreign supply and demand elasticities, whereas the *ex post* (given production choices) foreign export supply elasticity depends only upon preferences, and hence will be less elastic than the *ex ante* export supply schedule. Accordingly, domestic policymakers, attempting to capitalize on the home economy's greater market power, will have an incentive to set *ex post* tariffs at a higher level than they would if they could irrevocably precommit themselves to an *ex ante* tariff.

Foreign and domestic producers, aware of the tariff rule used (without precommitment) will adjust their production decisions accordingly. Consequently, both countries will be worse off in the situation, where tariffs are set *ex post*, in accord with the short-run

export supply elasticity, than they would be if tariffs were set *ex ante*. This dilemma is akin to the now familiar issue of time consistency in macro models: the inability of the government to (believably) precommit itself to a known policy can lead to a suboptimal outcome. Recent papers by Jonathan Eaton and Gene Grossman (1985) and by Robert Staiger and Guido Tabellini (1987) address the issue of time consistency in models in which tariffs are used as second-best policy instruments.¹

The political reasons why the (current) government does not, or cannot, precommit itself (or *future* governments) to a predetermined tariff is not the main focus of this paper. Nevertheless, it should be clear that, in any dynamic setting, a large country will always have an *ex post* incentive to increase tariffs above the *ex ante* optimal level. Thus, unless legislation or treaties can be implemented that prohibit (future) governments from changing tariffs, the optimal *ex ante* tariff is not a credible, time-consistent solution.²

¹Both papers focus on the ability of tariffs to redistribute income and both assume incomplete (insurance) markets. Eaton and Grossman report, based on numerical methods, that the optimal and time-consistent solutions are similar. The Staiger-Tabellini model indicates that the time-consistent solution leads to (more) protection.

²Reputational considerations may cause the *ex post* tariff to be set closer to the *ex ante* optimal level as the large country government attempts to persuade foreign producers that it will *not* exploit the inelasticity of the *ex post* offer curve. However, if reputation is not transferable between governments, these reputational consid-

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The plan of our paper is as follows. In Section I we present the basic model, derive the time-consistent tariff, and compare it with the optimal tariff. In Section II we show that, due to the second-best nature of the time-consistent tariff, a production tax on importables in the large country can benefit all countries. We also compare the time-consistent tariff/tax equilibrium with the optimal and time-consistent solutions from Section I. The Appendix contains proofs of these propositions.

I. The Optimal and the Time-Consistent Tariff

Our analysis utilizes the standard two-good (M, F) trade model, with well-behaved preferences and technology. There are a large number of small, identical foreign countries that pursue free trade policies. The domestic economy is large, and would, under free trade, export M (the numeraire). All private agents act as price takers, but the domestic government utilizes commercial policy to increase domestic welfare.

The distinguishing characteristic of our model is its focus on the timing of economic decisions, which are made in the following sequence: (i) the domestic government announces the tariff rate on imports (of F); (ii) domestic and foreign production decisions are made based upon producer prices expected to prevail when trade/consumption decisions are made; (iii) the government may revise its announced tariff prior to trade decisions; and (iv) finally, trade (and consumption) decisions are made and carried out, given the predetermined production levels and tariff rate.

Given our assumption of full information, the key assumption is not merely the production lag, but more importantly the ability of the government to revise tariffs once pro-

duction decisions are made (step (iii)). If, in step (i), the government could credibly precommit to a tariff (thereby abolishing step (iii)) then, despite the production "lag," our model, and results, would reduce to those of the standard optimal tariff literature. However, if the government can change tariffs after production decisions are made, step (i) is essentially irrelevant, and the standard optimal tariff will not be time consistent. This time inconsistency of the optimal tariff arises not only in the presence of production lags (as for agricultural markets, with spring plantings and fall harvest), but also in a dynamic model in which *ex ante* and *ex post* supply elasticities differ. In essence, precommitment means that the current government can set tariff rates for all time, and can *preclude* future governments from ever changing these rates. If the current government cannot exercise such authority, then the (dynamic) optimal tariff will not be time consistent.³

We now turn to our formal model. Let \bar{p} and p , respectively, denote the foreign, and domestic, relative (consumer) price of F . Similarly, \bar{p}^a and p_s^a denote the relative price foreign, and domestic, producers of F expect (to receive for their output) when production decisions are made. In a perfect foresight equilibrium, $\bar{p}^a = \bar{p}$ and $p_s^a = p$ (if no domestic production tax/subsidies are used).

The (aggregate) foreign supply and demand curves have their usual properties, with the exception that supply depends upon price expectations, whereas demand depends upon realized income and realized price. Foreign income (\bar{y}) is given by

$$(1) \quad \bar{y}(\bar{p}, \bar{p}^a) = \bar{S}_m(\bar{p}^a) + \bar{p}\bar{S}_f(\bar{p}^a),$$

erations will be unimportant. Also, under uncertainty, if state-contingent tariffs were not feasible, precommitting to a fixed *ex ante* tariff would not be optimal. Thus, if production lags are present, and if additional information is available once production decisions are made, the choice between *ex ante* and *ex post* tariffs involves ranking second-best policies.

³I emphasize the implausibility of precommitting to the optimal tariff because several readers of an earlier version of this paper thought it important to explain why precommitment did not occur. While this would be an interesting exercise in political economy, my main point is that precommitment would matter. Moreover, since I know of no case in which a government is *irrevocably* committed to an announced tariff (or any other economic) policy, the time-consistency issue seems germane.

where \bar{S}_i denotes the foreign supply schedule for good i . Given foreign demand for F ($\bar{F}(\bar{y}, \bar{p})$), the foreign export supply curve is

$$(2) \quad \bar{X}(\bar{p}, \bar{p}^a) \equiv \bar{S}_f(\bar{p}^a) - \bar{F}(\bar{y}, \bar{p}).$$

The slope of the *ex ante* foreign export supply curve (denoted \bar{X}') is derived assuming $d\bar{p} = d\bar{p}^a$ (and $\bar{p} \equiv \bar{p}^a$), whereas the slope of the *ex post* export supply curve (denoted $\partial \bar{X} / \partial \bar{p}$) assumes foreign production is fixed ($d\bar{p}^a = 0$):

$$(3) \quad (\partial \bar{X} / \partial \bar{p}) = - [\bar{F}_p + \bar{F}_y \bar{S}'_f(\bar{p}^a)] \\ = (\bar{X}' - \bar{S}'_f) \quad \text{at } \bar{p}^a = \bar{p},$$

where \bar{F}_p, \bar{F}_y denote partial differentiation of demand, and $\bar{S}'_f (> 0)$ is the slope of the foreign supply curve.

Turning to the domestic economy, domestic production (denoted $S_i(p_s^a)$) depends on anticipated producer prices, while domestic demand depends upon the consumer price and realized income. Domestic income is

$$(4) \quad y = S_m(p_s^a) + pS_f(p_s^a) \\ + (p - \bar{p})\{F(y, p) - S_f(p_s^a)\},$$

where $F(y, p)$ denotes domestic demand for F , and the tariff revenue (the latter term in (4)) is rebated in a lump-sum fashion to households. Using the standard representative agent assumption, we let $V(y, p)$ denote the indirect utility function for domestic agents; domestic demand is derived from this using Roy's identity.

The equilibrium trade condition is given by

$$(5) \quad F(y, p) - S_f(p_s^a) = \bar{X}(\bar{p}, \bar{p}^a).$$

The standard optimal tariff formula is derived by maximizing $V(y, p)$, using (1)–(5) and assuming $\bar{p}^a \equiv \bar{p}, p_s^a \equiv p$ (i.e., assuming perfect foresight, no production subsidies, and that tariffs are set before production decisions are made). Performing this optimi-

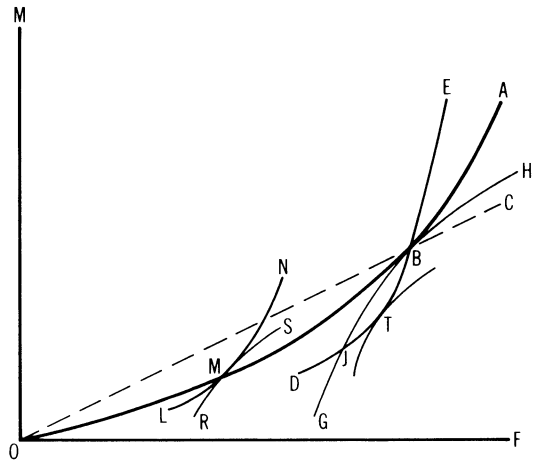


FIGURE 1. THE OPTIMAL TARIFF AND THE TIME-CONSISTENT TARIFF

zation yields the familiar result⁴

$$(6) \quad \{dV(y, p) / d\bar{p}\} = V_y [-\bar{X} + t\bar{X}'] = 0; \\ t \equiv (p - \bar{p}).$$

Denote this optimal *ex ante* solution by (p^0, \bar{p}^0) . As noted earlier, this solution is not time consistent if tariff rates may be changed once production decisions are made since the *ex post* foreign offer curve is less elastic than the *ex ante* curve. This time inconsistency is shown in Figure 1, where $OMBA$ represents the *ex ante* foreign offer curve, and $GJBH$ the domestic economy's (*ex ante*) trade indifference curve. The point B denotes the optimal trade point, with world price (\bar{p}^0) given by the slope of ray OBC , and domestic price (p^0) given by the slope of the common tangent (not shown) at B .

⁴Formally, we use foreign price, not the tariff, as the choice variable. If there is a unique equilibrium for each tariff, the two instruments are equivalent. However, if there are multiple equilibria for some tariffs (as may happen if the foreign offer curve is bending backward), then there is no guarantee that the "optimal" tariff will cause the "correct" equilibrium to emerge. For this case, setting world price is a superior instrument. Sufficient second-order conditions to (6) are convex domestic preferences, concave domestic technology, and a concave (*ex ante*) foreign offer curve.

Given foreign production decisions (based on \bar{p}^0), the *ex post* foreign offer curve is less elastic, as shown by the curve *DJTBE*. While the trade point *B* is still obtainable, it is not optimal from the domestic perspective. Given foreign production, the *ex post* optimum occurs at a point like *T*, with lower foreign price (higher tariff) than at *B*.⁵ While *T* seemingly results in higher domestic welfare than *B*, it is not a time-consistent solution since foreign producers' price expectations are incorrect. Unless the domestic government can irrevocably precommit to its *ex ante* optimal tariff, the *ex ante* optimum (*B*) is not obtainable.

The time-consistent solution requires that producers' price expectations be correct and that the *ex post* price (tariff) set by the home government be optimal, given the *ex post* offer curve. Graphically, this time-consistent equilibrium is represented in Figure 1 by point *M*, where (i) the *ex post* foreign offer curve (*LMN*) is tangent to the (relevant) domestic trade indifference curve (*RMS*), and (ii) the equilibrium occurs along the *ex ante* foreign offer curve. This time-consistent solution results in lower world price, lower foreign welfare, and lower domestic welfare.

Formally, the time-consistent, no precommitment solution is derived as follows. Using (1)–(3), equations (4) and (5) determine domestic income (*y*) and price (*p*) as functions of foreign price (\bar{p}), and predetermined output levels (i.e., price expectations). For subsequent analysis, we totally differentiate (4) and (5):

$$(7) \quad dy = \left[\{ F_p b_1 + (F + tF_p) b_2 \} / \beta \right];$$

$$t \equiv (p - \bar{p}),$$

$$(8) \quad dp = \left[\{ -F_y(b_1) + (1 - tF_y) b_2 \} / \beta \right];$$

$$\beta \equiv [F_p + FF_y] < 0,$$

⁵If domestic production decisions are also made *ex ante* (based upon price expectations of p^0), the *ex post* trade indifference curve will not be *GJBH*. However, it will be tangent to *GJBH* at *B*, so the essential argument is unaltered.

where β is the slope of the domestic compensated demand for importables, and we define

$$(9) \quad b_1 \equiv \left[-\bar{X} \cdot d\bar{p} + 0 \cdot dp^{-a} \right. \\ \left. + (\bar{p} - p_s^a) S_f' dp_s^a \right],$$

$$(10) \quad b_2 \equiv \left[(\partial \bar{X} / \partial \bar{p}) \cdot d\bar{p} \right. \\ \left. + (\bar{S}_f' \cdot dp^{-a}) + (S_f' \cdot dp_s^a) \right].$$

Optimizing domestic utility ($V(y, p)$), over \bar{p} , given output levels (price expectations) yields

$$(11) \quad \frac{\partial V}{\partial \bar{p}} = \left(V_y \frac{\partial y}{\partial \bar{p}} + V_p \cdot \frac{\partial p}{\partial \bar{p}} \right) \\ = V_y \left[-\bar{X}(\bar{p}, \bar{p}^a) + t \cdot \frac{\partial \bar{X}}{\partial \bar{p}} \right] = 0.$$

Equations (4), (5), and (11) determine the optimal foreign and domestic prices as functions of price expectations; the model is closed by assuming rational expectations and no production subsidies ($\bar{p}^a = \bar{p}$, $p_s^a = p$). Denote this time-consistent solution by (\bar{p}^c, p^c) .

PROPOSITION I: *The inability to precommit to the ex ante optimal tariff results in a lower world price and a higher domestic price of importables. It also leads to lower welfare in both countries.*

PROOF:

Evaluating (11) at the *ex ante* optimum (\bar{p}^0, p^0) yields

$$(12) \quad \partial V / \partial \bar{p} = V_y \left[t^0 \left(\frac{\partial \bar{X}}{\partial \bar{p}} - \bar{X}' \right) \right] \\ = -t^0 V_y \bar{S}_f'; \quad t^0 \equiv (p^0 - \bar{p}^0).$$

Thus, assuming $\bar{S}_f' > 0$, $\partial V / \partial \bar{p} < 0$ at $(\bar{p}^0,$

p^0), implying $\bar{p}^c < \bar{p}^0$.⁶ From (8), with $d\bar{p}^a = d\bar{p}$, $dp_s^a = dp$ (and $p_s^a = p$):

$$(13) \quad (dp/d\bar{p}) = \left\{ \left[\bar{X}' - t\bar{S}'_y F_y \right] / (\beta - S'_y) \right\} < 0$$

assuming no goods are inferior. Thus, $\bar{p}^c < \bar{p}^0$ implies $p^c > p^0$. Foreign welfare declines as \bar{p} falls, whereas domestic welfare must decline as the *ex ante* tariff yields the global optimum.

Since *ex post* price changes have only demand effects, it is apparent from (3) that the *ex post* foreign export supply curve will be everywhere negatively sloped if the foreign compensated price elasticity of demand is zero (no substitutability between goods). Hence, for this case, the only time-consistent solution is *autarky*! Intuitively, the time-consistent, no precommitment solution will be close to the *ex ante* optimum when the price elasticity of foreign supply is low and the demand elasticity large, whereas the equilibria will be "far apart" when foreign supply is very elastic and (compensated) demand inelastic.

Thus, the inability of the large country to irrevocably precommit to its optimal tariff leads to a decline in welfare in *both* countries. This occurs because foreign (domestic) producers, correctly anticipating a tariff above the *ex ante* optimum, respond by decreasing (increasing) production of F , thereby reducing world trade and specialization. Naturally, if the large country government could impose some cost (or treaty) on itself (or future governments) that effectively limited its ability to alter tariffs, this time-inconsistency problem could be reduced, or eliminated.

⁶We assume a unique *ex ante* optimum tariff, and a unique, consistent solution for the *ex post* tariff. In general, satisfaction of the *SOC* for the *ex post* tariff is neither necessary, nor sufficient, to guarantee uniqueness. Sufficient conditions for uniqueness, and the *SOC*, are: (i) convex preferences; (ii) concave technology; (iii) concave *ex post* foreign offer curve; and (iv) no inferior goods. Details are in the Appendix and an earlier version of this paper.

Failing this, it will be in the interests of the domestic government to induce foreign producers to expand output by precommitting itself to other policies that will have the net impact of raising world prices. One such policy is to limit (tax) domestic production of importables.

II. Domestic Production Taxes and the Time-Consistent Tariff

It is well known that (with precommitment) the optimal policy for a large country entails trade restrictions, but no production taxes ($MRS = DRT = FRT$). However, the time-consistent solution described in Section I results in an equilibrium in which: $MRS = DRT > ex\ ante\ FRT$. Intuitively, then, a policy that restricted (taxed) domestic production of importables—thereby encouraging foreign production—could increase welfare in both countries.

The timing of economic decisions, as detailed in Section I, is modified as follows: First, the government announces a price (or tax/subsidy) it will pay domestic producers, as well as a tariff rate. Next, domestic (and foreign) production decisions are made, on the basis of producer price expectations. Then, the government—assuming precommitment is not feasible—can revise the tariff rate (or production tax/subsidy). Finally, trade and consumption decisions are made. Note that time-consistency issues do *not* arise with respect to revision of the producer price (or tax) in step (iii) since, given the level of domestic production, such *ex post* changes merely redistribute domestic income, but cannot change output (or domestic "welfare").⁷

The *ex ante* optimal domestic producer price is determined as follows.⁸ Equations

⁷If all agents are alike, revisions in the tax—given output—have no effect. If agents differ, and other forms of lump-sum transfers are not feasible, a social welfare function would be required to determine the time-consistent production tax (and tariff).

⁸The *ex ante* choice of domestic output, the production tax, or the producer price are equivalent instruments.

(4), (5), and (11), in conjunction with perfect foresight ($\bar{p}^a = \bar{p}$), determine the (time-consistent) world and domestic prices, and domestic income, as functions of the predetermined domestic output level (or producer price, p_s^a). Totally differentiating $V(y, p)$ with respect to p_s^a , using (7)–(11) yields—after some simplification

$$(14) \quad dV/dp_s^a = V_y [\delta S_f' + t\bar{S}_f'(d\bar{p}/dp_s^a)] = 0; \quad \delta \equiv (p - p_s^a).$$

In (14), δ represents the (implicit) tax on domestic production of importables. Since the world price (\bar{p}) will be inversely related to the domestic producer price, p_s^a (positively related to the production tax), it is apparent from (14) that some production tax on importables will be desirable. Denote the optimal production tax by δ^* , and the resulting domestic and foreign prices by (p^*, p_s^*, \bar{p}^*) . Then:

PROPOSITION II: *Assume the large country cannot precommit to its optimal tariff, but it can control (tax or subsidize) domestic production. Then, assuming all goods are normal and the ex post foreign offer curve is concave (increasing FRT):*

(i) An optimal policy entails a tax on domestic production of importables that is less than the ex post tariff ($t^* \equiv [p^* - \bar{p}^*] > \delta^* > 0$).

(ii) The resulting production tax, tariff equilibrium is characterized by

$$\{ \text{ex post FRT} = p^* \equiv MRS > p_s^* \\ \equiv DRT > \text{ex ante FRT} > \bar{p}^* \}.$$

(iii) Foreign nations, as well as the domestic country, gain from the production tax.

(iv) Nevertheless, the resulting equilibrium is Pareto inferior to the ex ante optimal tariff, with higher domestic (consumer) prices of importables, and lower world prices ($p^* > p^c > p^0$; $\bar{p}^c < \bar{p}^* < \bar{p}^0$).

PROOF:

See the Appendix.

Note that this implies that a large country which exports agricultural goods (for which production lags exist) could gain by subsidizing production of exportables, assuming tariff precommitment is not feasible.⁹

III. Conclusions

We have shown that if production lags are present and tariff precommitment is not feasible, then the time-consistent tariff equilibrium is Pareto inferior to the precommitment equilibrium, and the second-best solution will include a production tax on importables. Clearly, these conclusions extend to any dynamic framework in which some inputs are committed before trade decisions are made.

An interesting extension would be to incorporate uncertainty into the model. Assuming state-contingent policies (tariffs) are not feasible, then both ex ante and ex post tariffs would be second-best instruments, as the ex ante tariff is set under imperfect information, whereas the ex post tariffs involve time-consistency problems. The relative advantage of flexibility (deferring tariff decisions) should depend upon the degree of uncertainty and the elasticity of foreign supply.

APPENDIX: PROOF OF PROPOSITION II

Using (4)–(5), the FOC for the ex post tariff (11) defines

$$(A1) \quad J[\bar{p}, \bar{p}^a, p_s^a] = V_y \left[-\bar{X} + t \frac{\partial \bar{X}}{\partial \bar{p}} \right] = 0.$$

The SOC, given (\bar{p}^a, p_s^a) , requires

$$(A2) \quad \partial J/\partial \bar{p} = (1/\beta) \left[(\bar{X}' - \bar{S}_f')^2 - \beta \Delta \right] < 0;$$

$$\Delta \equiv \left[2(\bar{X}' - \bar{S}_f') - t(\bar{X}'' - \bar{S}_f'' + \bar{F}_y \bar{S}_f') \right],$$

⁹Since using a production tax and a tariff is equivalent to using a production tax/subsidy and a consumption tax, Proposition II implies that the second-best policy entails a production subsidy (on importables) that is less than the consumption tax. It should also be clear that, in this model, the time inconsistency of the optimal tariff arises because of the “consumption-tax component” of the tariff. I am indebted to an anonymous referee for suggesting this observation.

where β (slope of domestic compensated demand for importables) is negative, and $\Delta > 0$, if and only if the *ex post* foreign offer curve is concave (i.e., increasing *FRT*, given output). Uniqueness of the time-consistent solution (given p_s^a) requires

$$(A3) \quad \left[\frac{\partial J}{\partial \bar{p}} + \frac{\partial J}{\partial \bar{p}^a} \right] = (-W/\beta) < 0;$$

$$W \equiv [\beta \cdot K - (\bar{X}' - \bar{S}'_f)(\bar{X}' - tF_y \bar{S}'_f)];$$

$$(A4) \quad K \equiv [\Delta + \bar{S}'_f(1 + t\bar{F}_y)].$$

$K > 0$ implies the *ex post FRT* increases as one moves up the *ex ante* offer curve. Assuming normality, the *SOC* implies uniqueness. Comparative static results are derived from (4)–(5) and (A1)–(A4):

$$(A5) \quad [d\bar{p}/dp_s^a] = [(1 - \delta F_y) S'_f (\bar{X}' - \bar{S}'_f) / W] < 0;$$

$$\delta \equiv (p - p_s^a),$$

$$(A6) \quad [dp/dp_s^a] = [S'_f(1 - \delta F_y) K / W] < 0;$$

$$\text{thus } d\delta/dp_s^a < 0.$$

From (14), after substitution and simplification

$$(A7) \quad [dV/dp_s^a] = [V_y S'_f / W].$$

$$[\delta \beta K + (\bar{X}' - \bar{S}'_f)(t\bar{S}'_f - \delta \bar{X}')] = 0 \Rightarrow,$$

$$(A8) \quad t^* > (t^* \bar{S}'_f / \bar{X}') > \delta^* > 0$$

since $\bar{X}' > \bar{S}'_f$ at a consistent solution.

The *ex ante FRT*, at the consistent tariff/tax solution, is

$$(A9) \quad FRT = [\bar{p} + (\bar{X}' / \bar{X}')] \\ = [\bar{p} + \{t^*(\bar{X}' - \bar{S}'_f) / \bar{X}'\}] \\ = [p^* - (t^* \bar{S}'_f / \bar{X}')] < [p^* - \delta^*].$$

Hence, as stated, $p^* > p_s^* > \text{ex ante FRT} > \bar{p}^*$. From (A5) and (A6), $\delta^* > 0 \Rightarrow p^* > p^c > p^0$ and $\bar{p}^* > \bar{p}^c$, which implies foreign exporters gain from the tax.

Finally, define $\bar{p}(p_s^a)$ as the consistent solution to (11), given exogenously determined (p_s^a), and define (\hat{p}_s^a) s.t. $\bar{p}(\hat{p}_s^a) = \bar{p}^0$. From Section I, $\bar{p}(p^0) < \bar{p}^0$; using (A5) this implies $\hat{p}_s^a < p^0$. But $p^0 = \text{ex ante FRT}$ at \bar{p}^0 . Hence, $p_s^* > \text{ex ante FRT} \Rightarrow p_s^* > \hat{p}_s^a \Rightarrow \bar{p}^* < \bar{p}^0$. Thus, the production tax/tariff equilibrium is Pareto inferior to the *ex ante* optimum, completing the proof of Proposition II.

REFERENCES

Bhagwati, Jagdish N. and Srinivasan, T. N., *Lectures on International Trade*, Cambridge: MIT Press, 1983.

Eaton, Jonathan and Grossman, Gene M., "Tariffs as Insurance: Optimal Commercial Policy When Domestic Markets Are Incomplete," *Canadian Journal of Economics*, May 1985, 18, 258–72.

Graaff, J. De V., "On Optimum Tariff Structures," *Review of Economic Studies*, 1949–50, 17, 47–59.

Karp, Larry "Optimality and Consistency in a Differential Game with Non-Renewable Resources," *Journal of Economic Dynamics and Control*, October 1984, 8, 73–97.

Kydland, Finn and Prescott, Edward "Rules Rather Than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy*, June 1977, 85, 473–93.

Newbery, David M. G., "Oil Prices, Cartels and the Problem of Dynamic Inconsistency," *Economic Journal*, September 1981, 91, 617–46.

Staiger, Robert W. and Tabellini, Guido, "Discretionary Trade Policy and Excessive Protection," *American Economic Review*, December 1987, 77, 832–37.