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Negotiated Trade Restrictions with Private Political Pressure

by

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1. Introduction

Recent literature in international trade has emphasized that trade barriers often result from political objectives. These include the desire of politicians to satisfy a majority of voters (Mayer, 1984), or respond to special interest lobbying groups.[1] The empirical basis for these models is well established (see Baldwin, 1986). It is surprising, however, this literature has only considered a small country setting trade barriers without any foreign repercussions. Thus, while the interests of domestic groups are of critical importance, those of foreigners are completely neglected. Related to this, the type of trade barrier (i.e., tariff or quota) is usually taken as exogenous.

In this paper we shall consider a home government with political pressure to restrict trade, at the expense of foreigners. The foreign country is compensated with an income transfer, which can be thought of as a portion of the tariff revenues or quota rents. In this setting the two countries should negotiate over the level of tariff and transfer of rents, depending on the level of political pressure at home. However, if this pressure cannot be directly observed abroad, then the home country may have an incentive to claim arbitarily high political need and seek corresponding high trade barriers. We shall resolve this problem by determining incentive compatible trade policies, in which the home government has no incentive to overstate (or understate) the political pressure for protection.[2]

While our analysis is theoretical, it has direct policy implications. Studies in the U.S. have recently called for the auctioning of trade quotas with the proceeds going to the U.S. Treasury, or to developing countries, or used to buy off domestic groups lobbying for protection.[3] The incentive structure of each of these schemes must be critically examined. For example, if the quota rents accrue to the U.S. Treasury then it would have little incentive to recommend reduced trade barriers. These issues are addressed in Feenstra and Lewis (1987).

In section 2 we outline a simple political model of protection. We adopt Mayer's (1984) median voter model, in which the government seeks to restrict imports and shift income towards labor. In section 3 we introduce the foreign country and discuss the incentives of some conventional trade policies. If the home country receives all the tariff revenue, it will generally have an incentive to overstate the political pressure. In section 4 we solve for the incentive compatible trade policies. These generally take the form of "tariff-rate quotas," or "tariff-quotas," in which the tariff is applied to imports exceeding some limit. Varying this limit permits the revenue/rents to be allocated across countries, and therefore affects the incentives for protection at home. In section 5 we briefly consider the case where political pressure exists in both countries, and section 6 concludes. More technical proofs are gathered in the Appendix.

2. Median Voter Model

We consider a two good, two factor economy with constant returns to scale, where the import competing good is labor intensive. Let p denote the domestic price of this good, with the export good as numeraire. Then factor prices are $w = w(p)$ and $r = \rho(p)$, where $w' > 0$ and $\rho' < 0$ due to our factor intensity assumption. Protecting the import good will raise p and shift income towards labor.

As in Mayer (1984), we shall suppose that consumers are endowed with both labor and capital. Individuals have equal amounts of labor and we normalize the total population to unity. Let α denote the capital/labor endowment of individuals, which is distributed with mean of $\bar{\alpha}$ and median α_0. We assume that $\alpha_0 < \bar{\alpha}$, which applies when the distribution of capital is skewed to the right. In this model consumers differ only in their factor income. Under majority voting, the government will respond to the interests of the consumer with capital endowment α_0 - the median voter. In this section we shall derive a reduced form expression for the utility of the median voter, which will serve as the government's objective function. While the median voter model of government policy choice is not universally descriptive, it does provide us with a simple and concrete basis for generating political costs associated with imports (see Mayer (1984) and some of the references cited therein for a discussion of the limitations of the median vote model). Of course there are other explanations for the presence of political costs of importing, which the reader is free to adopt in considering our model.

Denoting consumption of the importable by c_1 and of the exportable as c_2, let the utility of an individual be $\phi(c_1) + c_2$, with $\phi' > 0$, $\phi'' < 0$. The additively seperable form simplifies our analysis, and means that all individuals choose the same c_1, regardless of their type, assuming they have sufficient income. Recalling that the population is normalized at unity, in the aggregate we will have $c_1 = y_1(p) + z$ where $y_1(p)$ is domestic supply supply ($y_1' > 0$) and z are imports. The equilibrium domestic price can be determined from the consumers' first-order condition:

$$\phi'(y_1(p)+z) = p \quad \Rightarrow \quad p = \pi(z), \tag{1}$$

where $\pi' = \phi''/(1-\phi' y_1') < 0.$

Consumption c_2 will be total income minus pc_1. Income consists of factor earnings $w + \alpha r$ (per unit of labor) plus redistributed tariff revenue. Denoting exports by x, the terms of trade are (x/z) so tariff revenue is $[p-(x/z)]z = pz - x$, which is also the trade balance evaluated at domestic prices. We assume the revenue is distributed as a poll subsidy, equally across individuals. Thus, individual consumption of good 2 is:

$$
\begin{aligned}
c_2 &= (w+\alpha r) + (pz-x) - pc_1 \\
&= (w+\bar{\alpha}r) + (pz-x) - (\bar{\alpha}-\alpha)r - pc_1 \\
&= (py_1+y_2) + (pz-x) - (\bar{\alpha}-\alpha)r - pc_1 \\
&= y_2 - x - (\bar{\alpha}-\alpha)r. \qquad (2)
\end{aligned}
$$

The third equality in (2) follows since the value of factor income $(w+\bar{\alpha}r)$ equals output (py_1+y_2) in our competitive, constant returns economy. In the last equality note that y_2-x equals the aggregate (and average) consumption of good 2. Then c_2 for an individual will be greater (less) than the average when that person's capital/labor endowment is greater (less) than the mean.

We can now collect our results and derive an expression for utility. Define:

$$
\begin{aligned}
u(z) &\equiv \phi(y_1(\pi(z))+z) + y_2(\pi(z)), \\
r(z) &\equiv \rho(\pi(z)), \qquad (3a)
\end{aligned}
$$

where[4]

$$u' = p > 0, \quad \text{and} \quad r' = \rho'\pi' > 0. \qquad (3b)$$

The last result occurs because an increase in imports lowers the domestic price p and thus raises the return to capital. Using (3), we can write utility $\phi(c_1) + c_2$ as follows:

Proposition 1. The utility of an individual with capital/labor endowment α is

$$U(z,x,\alpha) = u(z) - x - (\bar{\alpha}-\alpha)r(z). \quad (4)$$

To interpret this result, note that the consumer with average capital endowment of $\bar{\alpha}$ receives utility u(z) - x. The median voter will receive lower utility by the amount $(\bar{\alpha}-\alpha_0)r(z)$, where this reduction is an increasing function of imports z. Thus, imports impose a component of welfare loss on the median voter, by lowering p and shifting income from labor to capital. The government will have an incentive to shift income in the opposite direction using trade restrictions.[5]

Before examining trade policy, we note a special case of Proposition 1. If the production functions in the economy are Leontief (fixed coefficients on labor and capital) and $\phi(c_1)$ is quadratic, the u(z) will be quadratic and r(z) linear in (4). We shall refer to this as the quadratic case, and use it occasionally. This case guarantees that $U_{zz} < 0$ in (4). However, we will make the stronger assumption that $U_{zz} < 0$ in general, which will ensure that certain second order conditions are satisfied.

3. Negotiated Trade and Incentive Compatible Policies

Let the foreign country's utility function be,

$$V(z,x) = x - v(z), \quad (5)$$

where v represents the cost of supplying z, with $v' > 0$, $v'' > 0$. A treatment of political pressure abroad is deferred to section 5. In a slight change of notation, let α denote the capital/labor endowment of the median voter at home. The identity of this voter will depend on population dynamics and other socio-economic patterns, which we summarize by giving α a probability density $f(\alpha)$ with strictly positive support over $[\underline{\alpha},\bar{\alpha}]$.[6] This density is common knowledge but only the home government observes the realization of α.

We shall assume that the foreign and domestic country are initially governed by a trade agreement which specifies the level of imports z^0 and exports x^0 to be exchanged. While we treat $\langle z^0, x^0\rangle$ as arbitrarily specified, in practice they would be determined by economic and political conditions as well as the relative bargaining positions of the two countries. Given this original agreement, the home country may wish to change the level and terms of trade occasionally to account for the political costs of importation at home. For example if α turns out to be low, so the redistributive costs of imports are high, the domestic government may want to apply for a reduction in imports to ease the political pressure it faces.

Towards this end, we assume that the two countries negotiate a schedule of trades $\langle z(\alpha), x(\alpha)\rangle$ which are applied contingent on the value of α announced by the home country. For this negotiated agreement to be feasible we require that it be incentive compatible (IC), meaning that the menu of trades $\langle z(\alpha), x(\alpha)\rangle$ must be designed so that the home country truthfully reports α.[7] To formalize this idea let $U(\alpha'/\alpha)$ denote the utility of the home country when it announces α' and α is the actual value. $U(\alpha'/\alpha)$ is defined by

$$U(\alpha'/\alpha) = u(z(\alpha')) - x(\alpha') - (\bar{\alpha}-\alpha)r(z(\alpha')). \tag{6}$$

Incentive compatibility requires

$$U(\alpha/\alpha) > U(\alpha'/\alpha) \quad \text{for all} \quad \alpha, \alpha'. \tag{IC}$$

(IC) restricts the set of trade policies which can be implemented. For example, consider a first best policy designed to maximize the sum of domestic and foreign country welfare, inclusive of the political costs of importing as perceived by the home country. Denote this sum by

$$W(z,\alpha) \equiv u(z(\alpha)) - (\bar{\alpha}-\alpha)r(z(\alpha)) - v(z(\alpha)),$$

and let $z^*(\alpha) = \text{argmax } W(z,\alpha)$, where z^* satisfies

$$W_z = u'(z^*(\alpha)) - (\bar{\alpha}-\alpha)r'(z^*(\alpha)) - v'(z^*(\alpha)) = 0. \tag{7}$$

z^* is the "politically optimal" level of trade. It provides for efficient trade subject to political constraints at home. Note that $z^{*\prime} = r'/(v''-U_{zz}) > 0$, since lower values of α raise the redistributive cost of imports, and reduce their optimal level. In principle $z^*(\alpha)$ could be implemented with a specific tariff of

$$\tau(\alpha) \equiv (\bar{\alpha}-\alpha)r'(z^*(\alpha)), \tag{8}$$

provided the home country were to reveal the true value of α.

Incentives for truthful revelation would depend on how the tariff revenues were to be distributed. For example, suppose that the home country were to collect all of the tariff revenue. Then foreigners are paid their marginal cost so that $x(\alpha) = v'(z^*(\alpha))z^*(\alpha)$. In this case utility at home would be

$$U(\alpha'/\alpha) = u(z^*(\alpha')) - v'(z^*(\alpha'))\, z^*(\alpha') - (\bar{\alpha}-\alpha)r(z^*(\alpha')). \tag{9}$$

Differentiating (9) with respect to the announcement α' and evaluating it at $\alpha' = \alpha$ we obtain

$$U_1(\alpha/\alpha) = -v''z^*z^{*'} < 0, \tag{10}$$

using (7). Thus the home country would have an incentive to announce a lower value of α than actually occurred, or it would overstate the pressure for protection.

Alternatively, suppose that the foreign country were to collect all the tariff revenues, as would occur under "voluntary" export restraints. Foreigners would receive the full domestic prices of imports so $x(\alpha) = u'(z^*(\alpha))z^*(\alpha)$, and

$$U(\alpha'/\alpha) = u(z^*(\alpha')) - u'(z^*(\alpha'))z^*(\alpha') - (\bar{\alpha}-\alpha)r(z^*(\alpha')). \tag{11}$$

Differentiating (11) with respect to the announcement α', and evaluating at $\alpha' = \alpha$, yields

$$U_1(\alpha/\alpha) = -\, z^{*'}[u''z^*(\alpha) + (\bar{\alpha}-\alpha)r']. \tag{12}$$

This expression is of ambiguous sign, so there may be an incentive to understate or overstate the value of α. This is because all consumers would experience a decline in utility due to the higher import price, but the factor income for the median voter would also rise, and the relative magnitude of these effects is ambiguous.[8]

To conclude this section we characterize the set of trade policies which are incentive compatible. Assuming that $z(\alpha)$ and $x(\alpha)$ are differentiable, a local characterization of (IC) requires that

$$U_1(\alpha/\alpha) = 0 \quad \text{for all } \alpha. \tag{13a}$$

$$U_{11}(\alpha/\alpha) < 0 \quad \text{for all } \alpha. \tag{13b}$$

Define $U(\alpha) \equiv U(\alpha/\alpha)$. Then (13a) also implies that

$$U'(\alpha) = U_2 = r(z(\alpha)). \tag{14}$$

Differentiating (13a) totally with respect to α implies $U_{11} + U_{12} = 0$ or $U_{12} > 0$ by (13b). Hence

$$U_{12} = r'(z(\alpha))\, z'(\alpha) > 0 \tag{15}$$

implying that $z'(\alpha) > 0$ since $r'(z(\alpha)) > 0$. It turns out that given our assumptions, the local (IC) conditions are sufficient to insure (IC) holds globally as well. These results are formally summarized in:

Proposition 2 Necessary and sufficient conditions for (IC) are:

(a) $U'(\alpha) = r(z(\alpha))$,

(b) $z(\alpha)$ is nondecreasing.

In what follows, the more technical proofs of our results appear in the appendix. Condition (a) of Proposition 2 has a natural interpretation. As α increases so that the political costs of importing decline, there are two sources of welfare improvements. There is a direct improvement which accrues at the rate $r(z)$. This measure the decrease in political costs holding the current level of imports constant. This gain accrues entirely to the domestic country. The other welfare gain occurs as the level of imports is adjusted to coincide with the lower political costs. (13a) implies that this gain in total welfare accrues to the foreign country, since $U'(\alpha) = r(z)$. The domestic country captures only the direct gain, hence there is no incentive for it to misrepresent its political costs, since it can not gain by affecting changes in either the level of trade or the terms of trade.

4. Determination of Trade Restrictions

One requirement for $z(\alpha)$, $x(\alpha)$ to be feasible is that it satisfy (IC). Another requirement is that $z(\alpha)$, $x(\alpha)$, be individually rational (IR), meaning that both countries must weakly prefer the trade vector $\langle z(\alpha), x(\alpha)\rangle$ to the status quo vector $\langle z^0, x^0\rangle$. This guarantees the voluntary participation of each country in the negotiated agreement. (IR) is formally characterized by two conditions:[9]

$$U(z(\alpha),x(\alpha),\alpha) > U(z^0,x^0,\alpha) \quad \text{for all } \alpha,$$

$$\int_{\underline{\alpha}}^{\bar{\alpha}} V(z(\alpha),x(\alpha))f(\alpha)d\alpha > V(z^0,x^0). \tag{IR}$$

Notice that since the home country can observe α, we require that it prefer $\langle z(\alpha), x(\alpha)\rangle$ to $\langle z^0, x^0\rangle$ for all realizations of α. The foreign country cannot observe α so that we only require that it prefer $\langle z(\alpha), x(\alpha)\rangle$ to $\langle z^0, x^0\rangle$ in an expected value sense. The determination of $\langle z(\alpha), x(\alpha)\rangle$ would presumably involve bilateral negotiations between the home and foreign country. One can imagine a myriad of different processes and arrangements by which such trade agreements would be constituted. For our purposes it is convenient to assume that negotiations are handled by a third party (perhaps by an institution like GATT) who evaluates the claims of the home and foreign country in constructing a trade agreement. In particular we imagine that the agreement $\langle z(\alpha), x(\alpha)\rangle$ is determined by maximizing the weighted sum of expected home country and foreign country welfare subject to (IC) and (IR) constraints. Formally $\langle z(\alpha), x(\alpha)\rangle$ is the solution to the following trade problem (TP):

$$\underset{x(\alpha),z(\alpha)}{\text{Maximize}} \quad \int_{\underline{\alpha}}^{\bar{\alpha}} [\lambda U(z(\alpha),x(\alpha),\alpha) + V(z(\alpha),x(\alpha))]f(\alpha)d\alpha \qquad \text{(TP)}$$

subject to (IC), (IR). In (TP) the weight λ might be though of as reflecting the relative bargaining power of the two countries. By varying λ we may examine how optimal trade policy responds to different bargaining situations.

4.1 Solution for $\lambda > 1$

An interesting special case occurs when $\lambda = 1$, for then the integrand in (TP) simply becomes $W(z,\alpha)$. The solution to (TP) for the case where $\lambda > 1$ is recorded in:

Proposition 3 Suppose $\lambda > 1$. Then $<z(\alpha), x(\alpha)>$ satisfy:

(a) $z(\alpha) = z^*(\alpha)$ for all α;

(b) $V(z(\alpha), x(\alpha)) = V(z^0, x^0)$ for all α;

(c) $U(z(\alpha), x(\alpha), \alpha) = W(z,\alpha) - V(z^0, x^0)$.

Proof

Suppose $\lambda = 1$, then the integrand in (TP) becomes $W(z,\alpha)$ and the pointwise maximization of $W(z,\alpha)$ requires that $z(\alpha) = z^*(\alpha)$ by (7). It's clear from (b) and (c) that (IR) is satisfied. The proof is completed by demonstrating that (IC) is also satisfied by Proposition 2. According to (c),

$$\frac{d}{d\alpha} U(z(\alpha), x(\alpha), \alpha) = \frac{d}{d\alpha} W(z,\alpha) = r(z(\alpha)).$$

Also $z'(\alpha) = z^{*\prime}(\alpha) > 0$, thus completing the proof for $\lambda = 1$. When $\lambda > 1$, more weight is placed on the welfare of the domestic country, but its welfare it already maximized for the case of $\lambda = 1$, as indicated by (b) and (c). Hence the solutions to (TP) for $\lambda > 1$ and $\lambda = 1$ coincide.

Proposition 3 is illustrated in Figure 1. Suppose the initial situation is that of free trade, $z^0 = z^*(\bar{\alpha})$. If the home country experience political pressure of $\alpha < \bar{\alpha}$, the politically optimal position would be $z^*(\alpha)$. This could be achieved with the tariff $\tau(\alpha)$ in (8), and satisfies (IC) if the foreign country's welfare is held constant. In Figure 1 this means that the area BCEF is collected as tariff revenue, while ABCD is transferred back to foreigners. In practice this income transfer could occur by applying the tariff τ only to imports exceeding the limit $\tilde{z}$, where $\tilde{z} \equiv z^*$ABCD/BCEF. This tariff-quota policy would achieve the political optimum and also be incentive compatible. Note that by construction the median voter at home gains from this trade restriction. The magnitude of gain is measured as area ABG in Figure 1, which is the difference between marginal utility and marginal cost of imports, integrated over the reduction in z.

Proposition 3 demonstrates the existence of incentive compatible agreements that provide for politically optimal trade. While such agreements are feasible (they satisfy IR and IC) they require that all of the extra rents generated by the agreement are captured by the home country, as indicated by parts (b) and (c) of Proposition 3. Such an uneven distribution of rents is unlikely to result from a bargaining process. Thus while the case $\lambda > 1$ serves as a useful benchmark for our analysis, the more likely scenario is that $\lambda < 1$. This allows for some of the differential rents generated by the negotiated agreement to accrue to the foreign country.

4.2 Solution for $\lambda < 1$

To solve (TP) for the case where $\lambda < 1$, it turns out to be convenient to rewrite the problem taking explicit account of the constraints. (IR) requires that $U(z(\alpha), x(\alpha),\alpha) > U(z^o,x^o,\alpha)$ for all realizations of α. The graph of $U(x^o,z^o,\alpha)$ appears in Figure 2. The slope of $U(x^o,z^o,\alpha)$ with respect to α is $r(z^o)$. Recall that (IC) requires that $\frac{d}{d\alpha} U(z(\alpha),x(\alpha)\alpha) = r(z(\alpha))$ and that $z(\alpha)$ be nondecreasing. Since $r'(z) > 0$, this means that the slope of $U(z(\alpha),x(\alpha),\alpha)$ is nondecreasing as well. Cases where $U(z(\alpha),x(\alpha),\alpha) = U(z^o,x^o,\alpha)$ over two distinct intervals are not possible, since then $\frac{d}{d\alpha} U(z(\alpha),x(\alpha)\alpha)$ is not increasing everywhere.[10] Hence $U(z(\alpha),x(\alpha),\alpha)$ and

$U(z^o,x^o,\alpha)$ can only coincide over a single interval as depicted in Figure 2. Further since $\lambda < 1$, (IR) for the home country will always bind over some interval.

Let us denote the interval over which (IR) binds as $[\alpha_1,\alpha_2]$, where $\underline{\alpha} < \alpha_1 < \alpha_2 < \bar{\alpha}$. Then (IC) implies:

$$U(\alpha) = \begin{cases} U(z^o,x^o,\alpha_1) - \int_{\alpha}^{\alpha_1} r(z(a))da & \alpha\epsilon[\underline{\alpha},\alpha_1] \\ U(\alpha) = U(z^o,x^o,\alpha) & \alpha\epsilon[\alpha_1,\alpha_2] \\ U(z^o,x^o,\alpha_2) + \int_{\alpha_2}^{\alpha} r(z(a))da & \alpha\epsilon[\alpha_2,\bar{\alpha}]. \end{cases} \tag{16}$$

In what follows it will be useful to solve for $x(\alpha)$ in terms of u, v, and r. Recall,

$$U(\alpha) = u(z(\alpha)) - (\bar{\alpha}-\alpha)r(z(\alpha)) - x(\alpha).$$

Substituting for $U(\alpha)$ above from (16) and solving for $x(\alpha)$ yields:

$$x(\alpha) = \begin{cases} u(z(\alpha)) - (\bar{\alpha}-\alpha)r(z(\alpha)) - U(z^o,x^o,\alpha_1) + \int_{\alpha}^{\alpha_1} r(z(a))da, & \alpha\epsilon[\underline{\alpha},\alpha_1] \\ x^o & \alpha\epsilon[\alpha_1,\alpha_2] \\ u(z(\alpha)) - (\bar{\alpha}-\alpha)r(z(\alpha)) - U(z^o,x^o,\alpha_2) - \int_{\alpha_2}^{\alpha} r(z(a))da, & \alpha\epsilon[\alpha_2,\bar{\alpha}] \end{cases} \tag{17}$$

Substituting the expression in (17) for $x(\alpha)$ in the statement of (TP), we have after some simplification,

$$\underset{z(\alpha),\alpha_1,\alpha_2}{\text{maximize}} \quad \int_{\underline{\alpha}}^{\alpha_1} \{W(z,\alpha) - (1-\lambda)[U(z^o,x^o,\alpha_1) - \int_{\alpha}^{\alpha_1} r(z(a))da]\}f(\alpha)d\alpha$$

$$+ \int_{\alpha_1}^{\alpha_2} \{W(z^o,\alpha) - (1-\lambda)\, U(z^o,x^o,\alpha)\}f(\alpha)d\alpha$$

$$+ \int_{\alpha_2}^{\bar{\alpha}} \{W(z,\alpha) - (1-\lambda)[U(z^o,x^o,\alpha_2) + \int_{\alpha_2}^{\alpha} r(z(a))da]\}f(\alpha)d\alpha$$

subject to (IC), (IR). Finally, integrating by parts allows us to express the trade problem as,

$$\underset{z(\alpha),\alpha_1,\alpha_2}{\text{maximize}} \quad \int_{\underline{\alpha}}^{\alpha_1} \{W(z,\alpha) - (1-\lambda)[U(z^o,x^o,\alpha) - \frac{r(z)F(\alpha)}{f(\alpha)}]\}f(\alpha)d\alpha$$

$$+ \int_{\alpha_1}^{\alpha_2} \{W(z^o,\alpha) - (1-\lambda)U(z^o,x^o,\alpha)\}f(\alpha)d\alpha \qquad \text{(TP')}$$

$$+ \int_{\alpha_2}^{\bar{\alpha}} \{W(z,\alpha) - (1-\lambda)[U(z^o,x^o,\alpha) + \frac{r(z)(1-F(\alpha))}{f(\alpha)}]\}f(\alpha)d\alpha$$

subject to (IR) and (IC), where $F(\alpha)$ is the cumulative density for α.

To solve (TP') we require that the following regularity condition (RC) on the density $f(\alpha)$ be satisfied:

$$\frac{d}{d\alpha}\frac{F(\alpha)}{f(\alpha)} > 0 \text{ for all } \alpha, \qquad \frac{d}{d\alpha}\frac{[1-F(\alpha)]}{f(\alpha)} < 0 \text{ for all } \alpha. \qquad \text{(RC)}$$

(RC) is satisfied by a wide class of densities including the uniform and normal densities. With (RC) we are guaranteed that $z(\alpha)$ is nondecreasing in the solution to (TP'), as required by (IC).[11]

A characterization of the trade policy which solves (TP') is given by:

<u>Proposition 4</u> Suppose $\lambda < 1$, and (RC) holds. Then the solution to (TP') for $z^0 \varepsilon (z^*(\underline{\alpha}), z^*(\bar{\alpha}))$ satisfies:

(a) $\underline{\alpha} < \alpha_1 < \alpha^* < \alpha_2 < \bar{\alpha}$, where α^* is defined by $z^*(\alpha^*) = z^0$;

(b) $z^*(\alpha) < z(\alpha) < z^0$, for all $\alpha \varepsilon (\underline{\alpha}, \alpha_1)$, $z(\underline{\alpha}) = z^*(\underline{\alpha})$,

$z(\alpha) = z^0$, for all $\alpha \varepsilon [\alpha_1, \alpha_2]$,

$z^0 < z(\alpha) < z^*(\alpha)$, for all $\alpha \varepsilon (\alpha_2, \bar{\alpha})$, $z(\bar{\alpha}) = z^*(\bar{\alpha})$;

(c) $U(z(\alpha), x(\alpha), \alpha) \ \substack{> \\ =} \ U(z^0, x^0, \alpha)$ for $\alpha \ \substack{\notin [\alpha_1, \alpha_2] \\ \varepsilon [\alpha_1, \alpha_2]}$,

$V(z(\alpha), x(\alpha)) \ \substack{> \\ =} \ V(z^0, x^0)$ for $\alpha \ \substack{\notin [\alpha_1, \alpha_2] \\ \varepsilon [\alpha_1, \alpha_2]}$;

(d) $dz(\alpha)/d\lambda < 0$, for all $\alpha \ \varepsilon \ [\underline{\alpha}, \alpha_1]$,

$dz(\alpha)/d\lambda > 0$, for all $\alpha \ \varepsilon \ [\alpha_2, \bar{\alpha}]$,

$d\alpha_1/d\lambda > 0$,

$d\alpha_2/d\lambda < 0$;

(e) $z(\alpha)$ is nondecreasing.

Results for the corner case where $z^0 = z^*(\underline{\alpha})$ or $z^0 = z^*(\bar{\alpha})$ will be seen to be limiting cases of Proposition 4.

4.3 Interpretation of Negotiated Trade Policy

Parts (a) -(c) of Proposition 4 are illustrated in Figures 2 and 3. Figure 2 illustrates that (IR) binds along an interior interval of the support for α. Figure 3 shows the relationship between the negotiated import level $z(\alpha)$, the status quo level z^0, and the politically optimal level of imports $z^*(\alpha)$.

Recall that when $\lambda > 1$, negotiated trade is politically optimal with $z(\alpha) = z^*(\alpha)$ for all α. The problem with this is that the home country earns all of the rents from the negotiation. By allowing $\lambda < 1$ we distribute some of the rents from negotiation to the foreign country as indicated by part c of Proposition 4. However, when $\lambda < 1$, the negotiated trade vector is no longer politically optimal. According to Proposition 4 and Figure 3, the level of imports is too large for small realization of α and it is too small for large realizations of α. This deviation from politically optimal trade is explained as follows.

Let's suppose for the sake of illustration that one attempts to implement a policy with $z(\alpha) = z^*(\alpha)$ for all α, and that all of the gains accrue to the foreign country subject to satisfying (IR) at home. In this case $x(\alpha) = W(z^*(\alpha),\alpha)) - U(z^0,x^0,\alpha) + v(z^*(\alpha))$. Does this policy satisfy (IC)? Given the trade vector $<z^*(\alpha), x(\alpha)>$ we have,

$$U(\alpha'/\alpha) = u(z^*(\alpha')) - (\bar{\alpha}-\alpha)r(z^*(\alpha')) - v(z^*(\alpha')) - W(z^*(\alpha'),\alpha') + U(z^0,x^0,\alpha').$$

Differentiating $U(\alpha'/\alpha)$ with respect to α' and evaluating the expression at $\alpha' = \alpha$ yields,

$$U_1(\alpha/\alpha) = r(z^0) - r(z^*(\alpha)) \gtrless 0 \text{ for } \alpha \lessgtr \alpha^*, \tag{18}$$

where α^* satisfies $z^0 = z^*(\alpha^*)$. According to (18) there is an incentive to overstate the political costs of importing for $\alpha > \alpha^*$, and there is an incentive to understate these costs when $\alpha < \alpha^*$.

When $\alpha < \alpha^*$ the way to prevent the home country from claiming that it's political costs are low when they are really high (i.e., when α is small) is to force the country to import more when it declares that its costs are low. This discourages a high cost country from behaving like a low cost importer. Similarly, when $\alpha > \alpha^*$, the way to prevent the home country from claiming large political costs when its costs are really low, is to restrict the level of imports when the country claims high political costs. This makes it less attractive for a low cost country to claim that it is a high cost importer. The necessity to eliminate incentives for misrepresentation by the home country explains the distortions of the import level $z(\alpha)$ from the politically optimal level. Note that at the end points $\underline{\alpha}$ and $\bar{\alpha}$, it is not necessary to distort import levels and $z(\alpha) = z^*(\alpha)$. This is because there are no lower α types who would try to claim that they are an $\underline{\alpha}$ type, and there are no higher α types who would try to claim they are an $\bar{\alpha}$ type.

An alternative way to characterize the negotiated trade policy is to examine the tariff, $\tau = u'-v'$, which is the difference between the domestic and foreign price of the import, and the marginal political cost of importing which is $MC_p = (\bar{\alpha}-\alpha)r'(z)$. Under negotiated trade both τ and MC_p fall as political costs decline:

$$\frac{d\tau}{d\alpha} = (u''-v'')z'(\alpha) < 0,$$

$$\frac{dMC_p}{d\alpha} = -r'(z) + (\bar{\alpha}-\alpha)r''(z)z'(\alpha) < 0,$$

by part e of Proposition 4.[12] Generally, however, the tariff will not equal the marginal political cost of importing as would be required if the level of imports were politically optimal. Part b of Proposition 4 implies that

$$W_z \{\lesseqgtr\} 0 \qquad \text{as} \qquad \alpha \{\lesseqgtr\} \alpha^*.$$

Hence when $\alpha < \alpha^*$ so that political costs are high, $W_z < 0$ implies that $\tau < (\bar{\alpha}-\alpha)r'(z) = MC_p$ or that the tariff is less than the marginal political costs of importing. The tariff exceeds the marginal political cost of importing when political costs are relatively low, such that $\alpha > \alpha^*$.

An interesting feature of the negotiated trade agreement $\langle z(\alpha), x(\alpha)\rangle$ is the extent to which it coincides with the status quo agreement $\langle z^o, x^o\rangle$. One way to implement negotiated trade is to allow the home country to select an import-export combination from the specified trade schedule $\langle z(\alpha), x(\alpha)\rangle$. The amount of autonomy afforded the home country is reflected in the degree to which $\langle z(\alpha), x(\alpha)\rangle$ differs from $\langle z^o, x^o\rangle$. Note that the choice of z^o is politically optimal for some level of costs, α^*. Figure 3 shows that for values of α sufficiently close to α^*, negotiated trade simply calls for implementing $\langle z^o, x^o\rangle$ since z^o is close to being politically optimal. However, as indicated in Figure 3, greater decision making authority is afforded the home country when realized political costs differ significantly from α^*. The home country is allowed to use its knowledge of political costs to pick an import level which is more efficient than the status quo level z^o.

Part d of Proposition 4 indicates that the coincidence between $<z(\alpha), x(\alpha)>$ and $<z^o, x^o>$ diminishes as λ increases. When more weight is placed on the welfare of the home country, it is afforded more decision making authority. In Figure 3, higher λ means that the interval (α_1,α_2) shrinks, and $z(\alpha)$ moves closers to $z^*(\alpha)$. In the limit when $\lambda = 1$, the home country is delegated complete authority to choose imports, and $z(\alpha) = z^*(\alpha)$. However this is done at the expense of the foreign country. Hence the autonomy of the home country must be restricted if the foreign country is to obtain any gain from the negotiated agreement.

To conclude this section we note that the preceeding discussion has assumed that $z^*(\underline{\alpha}) < z^o < z^*(\bar{\alpha})$. The negotiated trade policy does not change significantly in the corner cases where either (i) $z^o < z^*(\underline{\alpha})$ or (ii) $z^o > z^*(\bar{\alpha})$. In case (i) one can show $<z(\alpha), x(\alpha)>$ coincides with $<z^o, x^o>$ over some interval $[\alpha_1,\alpha_2]$ where $\underline{\alpha} = \alpha_1 < \alpha_2 < \bar{\alpha}$. For $\alpha\varepsilon(\alpha_2,\bar{\alpha})$, $z(\alpha) < z^*(\alpha)$ and $z(\bar{\alpha}) = z^*(\bar{\alpha})$. In case (ii) one can show that $<z(\alpha), x(\alpha)>$ coincides with $<z^o, x^o>$ over $[\alpha_1,\alpha_2]$ where $\underline{\alpha} < \alpha_1 < \alpha_2 = \bar{\alpha}$. For $\alpha\varepsilon(\underline{\alpha},\alpha_1)$, $z(\alpha) > z^*(\alpha)$ and $z(\underline{\alpha}) = z^*(\underline{\alpha})$. It can be seen that these corner cases are just limiting cases of the policy described in Proposition 4.

5. Political Pressure in Both Countries

Suppose that the foreign government also has pressure to raise the income of its median voter. With the labor-intensive good exported abroad, the optimal foreign trade policy would involve expanding exports. We shall incorporate the foreign political pressure into our statement of (TP), and investigate whether a negotiated trade restriction can satisfy (IC) for both countries.

Analogous to $U(z,x,\alpha)$ in Proposition 1, utility of the median voter abroad can be stated as

$$V(z,x,\beta) = x - v(z) - (\bar{\beta}-\beta)s(z), \tag{19}$$

where $\beta\varepsilon[\underline{\beta},\bar{\beta}]$ is the median capital/labor endowment abroad, and $s(z)$ is the foreign rental on capital depending on exports. An increase in exports would reduce the amount of the labor-intensive good available abroad, thereby raising its price and lowering the rental, so $s' < 0$. The countries will now negotiate a schedule of trades $\langle z(\alpha,\beta), x(\alpha,\beta)\rangle$ contingent on α and β announced by each of them. We shall consider a dominant strategy where, for any value of β, the home government has an incentive to truthfully announce α, and similarly for the foreign country. Let $U(\alpha,\beta)$ and $V(\alpha,\beta)$ denote welfares with the announced and true values of (α,β). Then analogous to Proposition 2, (IC) at home requires:[13]

$$U_\alpha = [u'-(\alpha-\bar{\alpha})r']\, z_\alpha - x_\alpha + r(z) = r(z), \tag{20a}$$

$$z_\alpha(\alpha,\beta) > 0. \tag{20b}$$

Similarly, (IC) abroad requires:

$$V_\beta = -[v' + (\bar{\beta}-\beta)s']\, z_\beta + x_\beta + s(z) = s(z), \tag{21a}$$

$$z_\beta(\alpha,\beta) < 0. \tag{21b}$$

Consider maximizing the integral of world welfare $W(z,\alpha,\beta)$, defined as the sum of (4) and (19), subject to (IC) and a statement of (IR) for both countries. We are interested in the set of trade schedules $z(\alpha,\beta)$ which can satisfy the (IC) constraints. Differentiating (20a) with respect to β we obtain an expression for $x_{\alpha\beta}$, while differentiating (21a) with respect to β yields $x_{\beta\alpha}$. Setting these equal and simplifying, we obtain the following partial differential equation for $z(\alpha,\beta)$:

$$W_{zz}z_{\alpha}z_{\beta} + W_{z}z_{\alpha\beta} = 0. \qquad (22)$$

The class of solutions to (22), where statements of (IR) can be used to provide boundary conditions, defines the set of trade schedules over which world welfare can be maximized. We have not been able to obtain any non-trivial solutions to (22).[14] However, it is significant that we <u>rule out</u> the politically optimal level of trade $z^*(\alpha,\beta)$, at which $W_z(z^*,\alpha,\beta) = 0$ and world welfare is maximized without the (IC) constraints.[15] To see this, differentiate the latter condition to obtain $z^*_{\alpha} = -r'/W_{zz} > 0$ and $z^*_{\beta} = -s'/W_{zz} < 0$, where $W_{zz} < 0$ is assumed.[16] Thus, with politically optimal trade (22) reduces to $r's'/W_{zz} = 0$, which can never hold. We have therefore established:

<u>Proposition 5</u> Politically optimal trade $z^*(\alpha,\beta)$ cannot satisfy (IC) for both countries.

Proposition 5 can be understood as follows. With political pressure only at home, the optimum $z^*(\alpha)$ was incentive compatible when the home country received all the gains from restricting trade (Proposition 3). Foreign welfare was constant at its status quo level. However, in the discussion around (18) we argued that a constant level of welfare could not be incentive compatible for that country. Thus, with political pressure in both countries, (IC) requires some sharing of the gains from negotiated trade. Analogous to

Proposition 4, this implies a trade schedule which is not at the first best optimum.

6. Conclusions

Our results can be given two interpretations. First, as a positive theory, they suggest a reason for the use of "voluntary" trade restraints rather than tariffs. A VER is generally requested by the importing country, but the quota rents are earned by the exporter. One reason for the transfer of rents is that the exporter is compensated for the trade restriction (as discussed by Deardorff, 1986), and so retaliation is not expected. However, our analysis suggests another reason: the transfer of rents means that the trade restriction is incentive compatible, i.e., if the importing country did not actually face strong political pressure, it would not find it beneficial to have the restriction. Thus, the transfer of rents becomes a policing device to ensure that political pressure is truthfully revealed.

However, it should be noted that an incentive compatible policy will not generally involve a full transfer of the quota rents, as occurs under the VER. For example, in Proposition 3 the transfer is just sufficient to return the foreign country to its status quo utility. We characterized this policy as a "tariff-quota," in which the tariff is applied only to imports exceeding some limit. In Proposition 4 the foreign country obtains higher welfare, but the transfer would equal the full revenue/rents only by coincidence. The interpretation of our model as an explanation for VER's is therefore limited.

Another interpretation of our results is as a normative theory, suggesting a policy which could be applied to actual trade restrictions. The simple results (Proposition 3) state that the foreign country should be exactly compensated for any trade restriction, keeping its utility unchanged. The amount of compensation required is easily calculated from the foreign supply curve, as illustrated in Figure 1, and could be implemented with an appropriate tariff-quota. To raise foreign welfare beyond its status quo level requires a more complicated policy (Proposition 4). In this case the initial level of trade is preserved over a discrete interval of α (see Figure 3). For levels of political pressure outside this interval, trade is restricted or increased, but does not coincide with the first best political optimum. The private nature of political pressure at home is in this case imposing a cost which lowers world welfare. This result also occurs with private political pressure in both countries (Proposition 5), even if the countries have equal weight in world welfare.

Footnotes

1. See Brock and Magee (1978), Findlay and Wellisz (1982), Feenstra and Bahgwati (1982), Young and Magee (1986) and Wilson and Wellisz (1986).

2. The idea of incentive compatible trade policies was introduced in Feenstra (1987), who considered production uncertainty with two possible states. The present paper is also related to Jensen and Thursby (1986), who suppose that the foreign country does not know the home objective function with certainty. They examine Nash equilibrium tariffs of Bayesian games.

3. See The Wall Street Journal, Feb. 6, 1987, p. 40; Newsweek, Jan. 12, 1987, p. 40; and Hufbauer and Rosen (1986).

4. To show that $u' = p$, use (1) and (3) to derive $u' = \phi'(y_1\pi'+1) + y_2\pi' = p + \pi'(py_1'+y_2') = p$, since $py_1' + y_2' = 0$ when the competitive economy maximizes GNP.

5. We do not examine alternative policies to raise income of the median voter. See Mayer and Riezman (1987).

6. We assume that $\underline{\alpha}$ is not so low that the home government would want to reverse the pattern of trade. This is ensured if $\underline{\alpha}$ equals the capital labor ratio which, if used in production, would yield autarky. Then the optimal trade policy for the median voter will not restrict trade that far.

7. The Relevation Principle assures us that there is no loss in generality from considering incentive compatible policies (see Myerson, 1979).

8. A presumption that (12) is negative, leading to an overstatement of political pressure, is obtained by requiring that home welfare under the VER is greater than with free trade. Free trade occurs when $\alpha = \bar{\alpha}$, yielding utility $U(\bar{\alpha}/\alpha)$. Then $U(\alpha/\alpha) > U(\bar{\alpha}/\alpha)$ implies that $U_1(a/\alpha) < 0$ for some $a \in [\alpha, \bar{\alpha}]$, and if this condition holds for $a = \alpha$ then (12) is negative. For the quadratic case mentioned after Proposition 1, we can show that $U_1(a/\alpha)$ is minimized at $a = \alpha$, and so we must have $U_1(\alpha/\alpha) < 0$ leading to an overstatement of political pressure.

9. With minimal loss of generality, we assume that $z^*(\underline{\alpha}) < z^0 < z^*(\bar{\alpha})$. Other cases are dealt with at the end of section 4.3.

10. This is readily seen by redrawing Figure 2, with $U(z(\alpha), x(\alpha), \alpha)$ coinciding with $U(z^0, x^0, \alpha)$ on two seperate intervals.

11. If $z(\alpha)$ is decreasing in the solution to (TP') then the solution must be modified to satisfy the constraint that $z(\alpha)$ be everywhere nonedecreasing. Typically this means that there will be intervals over which $z(\alpha)$ is constant.

12. To sign the change in MC_p we also require $r'' < 0$. This would be satisfied in the quadratic case mentioned after Proposition 1, for which $r'' = 0$.

13. For concreteness, we shall assume that z and x are twice continuously differentiable functions of (α, β).

14. It is not difficult to construct solutions for which z_α or z_β are identically zero, while also satisfying (IR) for both countries.

15. This result is not surprising. It is well known that dominant strategy pareto efficient mechanisms typically don't exist in general economic environments (e.g., Groves and Ledyard, 1985).

16. This concavity condition is guaranteed if the quadratic case discussed after Proposition 1 is applied to both countries.

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APPENDIX

Proof of Proposition 2

Necessity. Follows from arguments presented in the text.

Sufficiency. Integrating (14) we can express U in (4) as

$$U(x,z,\alpha) = u(z(\alpha)) - x(\alpha) - (\bar{\alpha}-\alpha)r(z(\alpha))$$

$$= \Psi(\underline{\alpha}) + \int_{\underline{\alpha}}^{\alpha} U(a)da$$

$$= \Psi(\underline{\alpha}) + \int_{\underline{\alpha}}^{\alpha} r(z(a))da \qquad (A2.1)$$

where $\Psi(\underline{\alpha})$ is an arbitrary constant. Using (A2.1) we have (assuming $\alpha^2 < \alpha^1$)

$$U(\alpha^1/\alpha^1) - U(\alpha^2/\alpha^1)$$

$$= u(z(\alpha^1)) - x(\alpha^1) - (\bar{\alpha}-\alpha^1)r(z(\alpha^1))$$

$$- [\, u(z(\alpha^2)) - x(\alpha^2) - (\bar{\alpha}-\alpha^1)r(z(\alpha^2)]$$

$$= \Psi(\underline{\alpha}) + \int_{\underline{\alpha}}^{\alpha^1} r(z(a))da - [\Psi(\underline{\alpha}) + \int_{\underline{\alpha}}^{\alpha^2} r(z(a))da] \qquad (A2.2)$$

$$- (\bar{\alpha}-\alpha^2)r(z(\alpha^2)) + (\bar{\alpha}-\alpha^1)r(z(\alpha^2))$$

$$= \int_{\alpha^2}^{\alpha^1} [r(z(a)) - r(z(\alpha^2)]\, da > 0$$

where the second inequality follows by adding and subtracting $(\bar{\alpha}-\alpha^2)r(z(\alpha^2))$ and using (A2.1). The final line of (A2.2) follows from $\alpha_1 > \alpha_2$ and $z(\alpha)$ nondecreasing. A similar proof applies when $\alpha_1 < \alpha_2$.

Proof of Proposition 4

Pointwise maximization of (TP') yields the following conditions

$$W_z(z,\alpha) + (1-\lambda)\,\frac{r'F(\alpha)}{f(\alpha)} \geq 0 \ (= \text{ if } z(\alpha) < z^0) \qquad \alpha\epsilon[\underline{\alpha},\alpha_1] \qquad \text{(A4.1)}$$

$$W_z(z,\alpha) - (1-\lambda)\,\frac{r'[1-F(\alpha)]}{f(\alpha)} \leq 0 \ (= \text{ if } z(\alpha) > z^0) \qquad \alpha\epsilon[\alpha_2,\bar{\alpha}] \qquad \text{(A4.2)}$$

where (IC) implies $z(\alpha) \leq z^0$ for $\alpha\epsilon[\underline{\alpha},\alpha_1]$ and $z(\alpha) \geq z^0$ for $\alpha\epsilon[\alpha_2,\bar{\alpha}]$. Let $H(\alpha_1,\alpha_2)$ be the integral over $[\underline{\alpha},\bar{\alpha}]$ of the total weighted surplus for (TP'). Applying Leibniz rule for differentiation we obtain

$$\frac{\partial H}{\partial \alpha_1} = W(z(\alpha_1),\alpha_1) - W(z^0,\alpha_1) + \frac{(1-\lambda)r(z(\alpha_1))F(\alpha_1)}{f(\alpha^1)} \qquad \ldots \text{(A4.3)}$$

$$\frac{\partial H}{\partial \alpha_2} = -\,(W(z(\alpha_2),\alpha_2) + W(z^0,\alpha_2) + \frac{(1-\lambda)r(z(\alpha_2))[1-F(\alpha_2)]}{f(\alpha_2)} \qquad \ldots \text{(A4.4)}$$

Note (IC) implies that $z(\alpha) \leq z(\alpha_1) \leq z^0$ for all $\alpha \leq \alpha_1$. According to (A4.1) $W_z(z,\alpha) < 0$ for $\alpha \leq \alpha_1$. This together with the fact that W is concave and $z(\alpha) \leq z^0$ implies $\frac{\partial H}{\partial \alpha_1} > 0$. Hence, α_1 is determined as $\inf(\alpha/z(\alpha) = z^0)$ provided $\alpha_1 \geq \underline{\alpha}$. Otherwise $\alpha_1 = \underline{\alpha}$, which occurs when $z^0 = z^*(\alpha)$.

To determine α_2 we note that when $z(\alpha_2) = z^0$, $\frac{\partial H}{\partial \alpha_2} > 0$. Since $W_z(z,\alpha) > 0$ for $\alpha \geq \alpha_2$, and W is concave we must have $z(\alpha_2) > z^0$ at α_2 in order for $\frac{\partial H}{\partial \alpha_2} = 0$, provided $\alpha_2 < \bar{\alpha}$. If $z^0 = z^*(\bar{\alpha})$, then $\alpha_2 = \underline{\alpha}$.

Suppose $z^0 = z^*(\tilde{\alpha})$ for $\tilde{\alpha}\varepsilon(\underline{\alpha},\bar{\alpha})$. Then since $\alpha_1 = \inf(\alpha/z(\alpha) = z^0)$ and $W_z(z,\alpha_1) < 0$ we have $\alpha_1 < \tilde{\alpha}$. It also follows that $\alpha_2 > \tilde{\alpha}$ since $\frac{\partial H}{\partial \alpha_2}(\tilde{\alpha}) > 0$. This proves part (a) of Proposition 4.

According to (A4.1) and (A4.2)

$$W_z(z,\alpha) = 0 \quad \text{for} \quad \alpha = \underline{\alpha}, \bar{\alpha}, \tag{A4.5}$$

thus implying $z(\alpha) = z^*(\alpha)$ for $\alpha = \underline{\alpha}, \bar{\alpha}$. Recall that W is concave in z. This together with (A4.1) and (A4.2) imply

$$\begin{aligned} z(\alpha) &> z^*(\alpha) \quad , \quad \alpha\varepsilon(\underline{\alpha},\alpha_1) \\ z(\alpha) &< z^*(\alpha) \quad , \quad \alpha\varepsilon(\alpha_2,\bar{\alpha}). \end{aligned} \tag{A4.6}$$

Finally $z(\alpha) = z^0$ for $\alpha\varepsilon[\alpha_1,\alpha_2]$ by construction. This completes the proof for part b.

Note that for $\alpha\varepsilon[\alpha_1,\alpha_2]$ $z(\alpha) = z^0$ and $x(\alpha) = x^0$ so that

$$\begin{aligned} U(z(\alpha),x(\alpha),\alpha) &= U(z^0,x^0,\alpha) \\ V(z(\alpha),x(\alpha)) &= V(z^0,x^0). \end{aligned} \tag{A4.7}$$

By (IC), for $\alpha\varepsilon[\underline{\alpha},\alpha_1)$

$$\begin{aligned} U(z(\alpha),x(\alpha),\alpha) &= U(z^0,x^0,\alpha_1) - \int_{\alpha}^{\alpha_1} r(z(a))da \\ &= U(z^0,x^0,\alpha) - \int_{\alpha}^{\alpha_1} [r(z(a))-r(z^0)]da \\ &> U(z^0,x^0,\alpha), \end{aligned} \tag{A4.8}$$

where the second line of (A4.8) follows from rewriting the expression $U(z^o,x^o,\alpha_1)$ and the third line follows from $z(\alpha) < z^o$ for $\alpha < \alpha^1$. A similar argument can also be used to show that $U(z(\alpha),x(\alpha),\alpha) > U(z^o,x^o,\alpha)$ for $\alpha\varepsilon(\alpha_2,\bar{\alpha}]$.

For $\alpha\varepsilon\ [\underline{\alpha},\alpha_1)$ we have

$$
\begin{aligned}
V(z(\alpha),x(\alpha)) &= W(z(\alpha),\alpha) - U(z(\alpha),x(\alpha),\alpha) \\
&= W(z^o,\alpha_1) - \int_{\alpha}^{\alpha_1} [W_z z'(a) + r(z(a))]da \\
&\quad - [U(z^o,x^o,\alpha_1) - \int_{\alpha}^{\alpha_1} r(z(a)da)] \\
&= V(z^o,x^o) - \int_{\alpha}^{\alpha_1} W_z z'(a)da > V(z^o,x^o),
\end{aligned}
\qquad \text{(A4.9)}
$$

where the second line of (A4.9) follows from rewriting $W(z(\alpha),\alpha)$ and $U(z(\alpha),x(\alpha),\alpha)$ and the third line follows from the fact that $W_z < 0$ for $\alpha\varepsilon[\underline{\alpha},\alpha_1)$. An argument similar to (A4.9) serves to establish $V(z(\alpha),x(\alpha)) > V(z^o,x^o)$ for $\alpha\varepsilon(\alpha_2,\bar{\alpha}]$. This completes our proof of part (c).

To establish the comparative static effects of a change in λ, one totally differentiates (A4.1) and (A4.2) with respect to λ to obtain

$$
\frac{dz(\alpha)}{d\lambda} = \frac{-\ r'F(\alpha)/f(\alpha)}{W_{zz} + (1-\lambda)\ r''F(\alpha)/f(\alpha)} < 0 \qquad \alpha\varepsilon[\underline{\alpha},\alpha_1)
$$

... (A4.10)

$$
\frac{dz(\alpha)}{d\lambda} = \frac{r'[1-F(\alpha)]/f(\alpha)}{W_{zz} - (1-\lambda)\ r''[1-F(\alpha)]/f(\alpha)} > 0 \qquad \alpha\varepsilon(\alpha_2,\bar{\alpha}]
$$

where the denominators in (A4.10) are both negative, provided the second order conditions for pointwise maximization of (TP') are satisfied.

To establish the comparative statics results for a change in λ on α_1, recall that α_1 is determined by the condition $z(\alpha) = z^o$, where $z(\alpha)$ satisfies (A4.1). Differentiating (A4.1) totally with respect to λ reveals that $dz(\alpha)/d\lambda < 0$, implying that $d\alpha_1/d\lambda > 0$. For α_2 recall that α_2 is determined by $dH/d\alpha_2 = 0$. Differentiating this expression totally with respect to λ and recognizing that $z(\alpha_2) > z^o$ yields $\frac{d\alpha_2}{d\lambda} < 0$, thus completing the proof of part d.

To complete the proof of the Proposition we must show that $z(\alpha)$ is nondecreasing. Totally differentiating (A4.1) and (A4.2) with respect to α and employing (RC) yields the desired results that $z'(\alpha) > 0$ for all α.

Figure 1

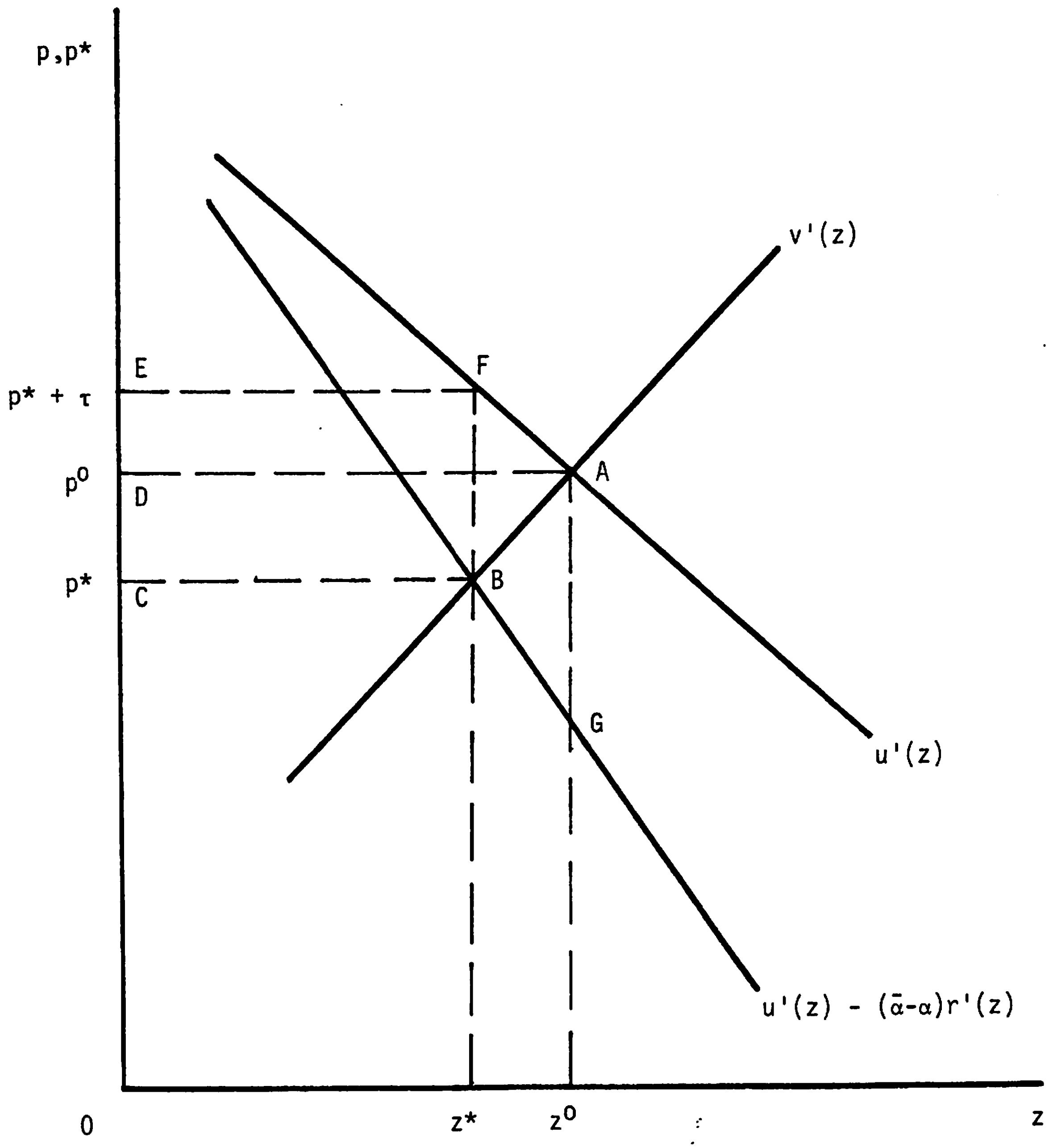

Figure 2

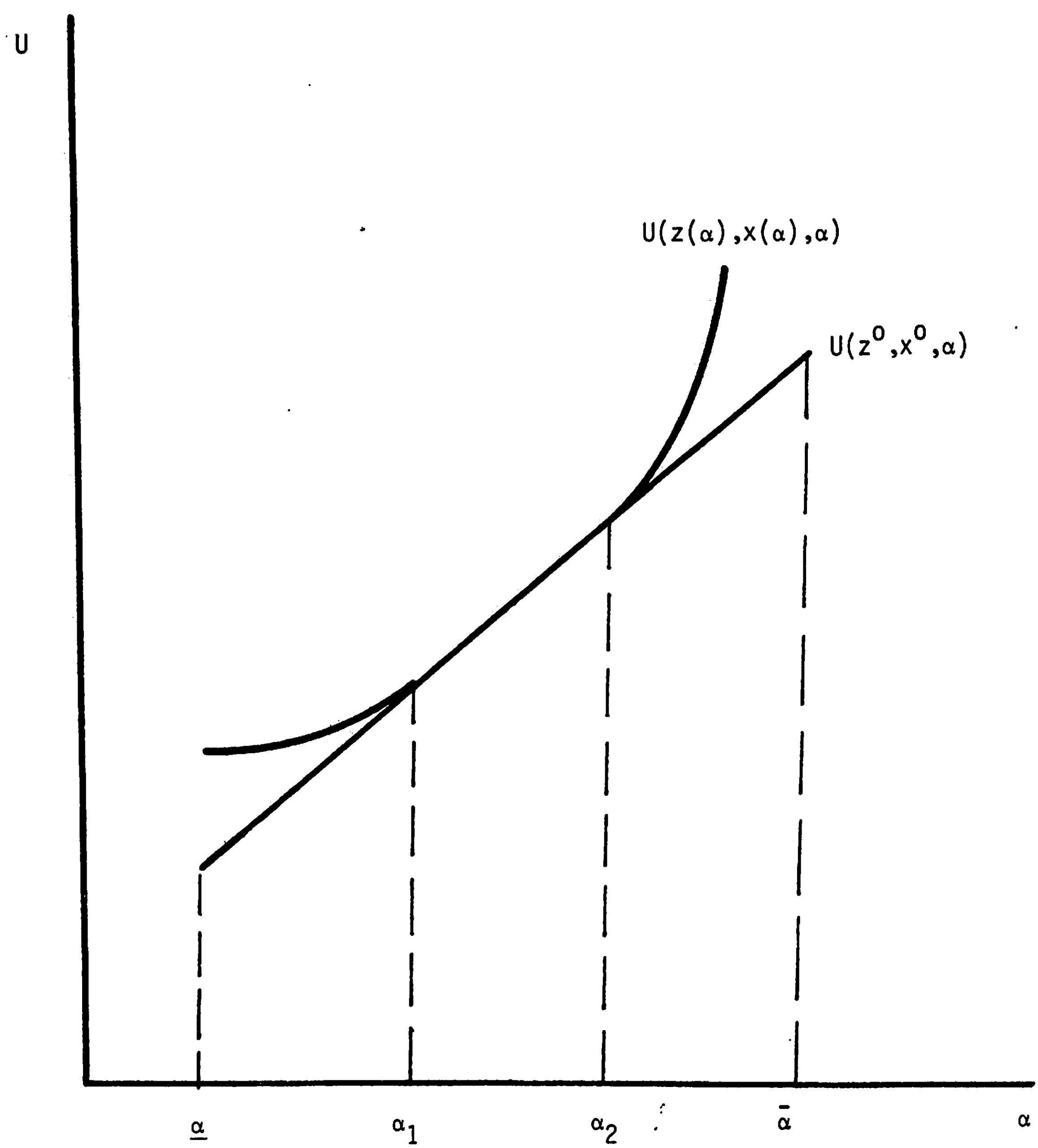
U
$U(z(\alpha),x(\alpha),\alpha)$
$U(z^o,x^o,\alpha)$
$\underline{\alpha}$
α_1
α_2
$\bar{\alpha}$
α

Figure 3