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The Effect of Temporary Import Protection on Future Prices

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Thomas J. Holmes

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The Effect of Temporary Import Protection on Future Prices

by

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Abstract

This paper determines the effect of a temporary tariff or import quota on future prices. It assumes that the home country consumes a large portion of world output so that the tariff influences world prices. The temporary tariff affects current investment decisions and this is the channel through which the tariff influences future world prices. The tariff has offsetting effects on future prices because it expands future domestic supply and contracts future foreign supply. For a benchmark case it is shown that the net effect on future prices is positive, i.e., the temporary tariff increases domestic prices even after the tariff measure has expired.

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I. Introduction

A country consumes a large portion of the world output for a good, say 80 percent. It produces only 35 percent of world output so it has to import the difference. The country imposes a temporary import protection measure such as a tariff or quota that expires in five years. The industry is competitive. Standard textbook partial equilibrium analysis shows that the trade policy raises the price inside the home country during the five years the policy is in effect and lowers the price outside the home country.[1] The purpose of this paper is to determine the effect of the trade measure on prices after the five years is up and the measure has expired.

A temporary trade measure can affect future prices through several channels. The channel that I focus on here is the effect on investment decisions over the duration of the tariff.[2] For example, a domestic steel mill considering whether or not to expand capacity will be more likely to do so if import quotas are extended for five more years. This is true if the duration of the tariff is longer than the lead time for the installation of the new capacity. Even though domestic steel prices decline after the tariff expires, the presence of the higher initial price for the product raises the returns to domestic investment and hence the magnitude of domestic investment. Analogously, the policy depresses the initial returns to investment by foreign firms and such firms invest less while the trade protection is in effect. These investment decisions determine future capacity levels and hence future supply conditions. The temporary protection measure tends to shift the future domestic supply "curve" out and to the right and the future foreign supply "curve" in and to the left. This note nets out these two offsetting effects.

I derive a condition that determines the direction of the net effect. This condition depends upon the elasticities of demand and investment in the domestic and foreign sectors as well as the

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1 In a general equilibrium context a tariff can actually lower the domestic price for this good. This point was made by Metzler (1949).

2 There are a number of other channels. First, the enactment of a temporary tariff might increase the probability of subsequent trade protection as it may be easier politically to renew a preexisting tariff than to introduce a new tariff. The level of future trade protection is held fixed in this analysis. Second, there may be intertemporal linkages in demand (see Holmes (1990) for a model with such linkages). Third, there can be effects on the current account and macroeconomic linkages. See, for example, Djajic (1987), Sen and Turnovsky (1989) and Turnovsky (1991) and the references therein.

home country's consumption and production shares of the market. Some special cases illustrate the role of elasticity here. If foreign investment is perfectly inelastic while domestic investment is elastic, then clearly the temporary trade measure expands world capacity because it stimulates domestic investment but has no effect on the inelastic foreign investment. In this case the trade measure reduces future prices because of the initial expansion of world capacity. If domestic investment is perfectly inelastic and foreign investment is elastic, world capacity declines and future prices rise. If domestic demand is perfectly inelastic and foreign demand is elastic then the temporary trade measure increases future prices.

The main focus of this paper is the benchmark case in which the home country and foreign countries have the same demand elasticities and the same investment elasticities (but vary in levels of supply and demand so that the home country is an importer of the good). I find that the net effect on future prices of a temporary tariff or quota is strictly positive in this case. A tariff not only increases the domestic price during the period in which it is in effect but, because it reduces foreign investment by more than it increases domestic investment, it also raises domestic prices in periods beyond the expiration of the tariff.

I look at some numerical examples to get some idea about the magnitude of the effect on future prices. The findings suggest that if domestic consumption's share of the market is less than 30 or 40 percent, then the increases in future prices that result from the temporary tariff are rather negligible. On the other hand, if domestic consumption's share of the market is substantial (say over 80 or 90 percent) then the effects on future prices can be substantial. In fact, the discounted sum of the increases in future prices can exceed the increase in the domestic price during the period the trade restriction is in effect. Consumption market shares of this magnitude can occur in industries in which transportation costs are large enough relative to the value of the good so that the relevant marketplace is not the whole globe but rather a region of countries that are close to one another. One example discussed in the text is the newsprint industry in the U.S. and Canada. The U.S. produces 35 percent of the combined level of U.S. and Canada production while its consumption is 80 percent of this level.

The issues considered in this paper are closely related to the issues considered in studies of "dumping" and "infant industries." The "dumping" literature considers the possibility that a "predator" foreign firm will set price below cost in the short run to drive out rival firms in the home country and then, after the domestic firms are bankrupt, raise price to reap monopoly profits (see Berck and Perloff (1990) for a recent analysis along these lines). Tariffs or quotas that protect domestic industry can potentially benefit consumers in the long-run by preserving competition in the industry. The "infant-industry argument" pertains to a case where there is learning-by-doing in an industry and the home country has a long-run comparative advantage in the industry but has not yet developed the industry. Temporary trade production benefits the domestic industry by enabling it to march down the learning curve. According to the argument, temporary protection can also benefit consumers in the long run by creating an efficient domestic industry that will be able to set low prices. Hence with both the "dumping" argument and the "infant industry" argument, consumers trade off a higher current price for the benefit of a lower future price. Note, however, that while domestic firms may talk about "dumping" or "infant industries" to justify protectionist measures, it could very well be the case that the industry is a competitive one in which "learning-by-doing" is not a crucial factor. This paper shows that in this case of perfect competition there is no tradeoff between a higher current price and a lower future price; in the leading case the temporary protective measure raises future prices as well as the current price. The protection measure causes the foreign sector to shrink, and this loss more than offsets the gain to consumers from the increase in future domestic supply.

II. The Model

Consider a partial equilibrium model of an industry with domestic consumption and production sectors and foreign consumption and production sectors. The output of the industry depends upon the accumulated capital stock in the industry (for simplicity I assume there is no labor input). Let k_t and k_t^* denote the accumulated capital stock in, respectively, the domestic sector and the foreign sector as of the beginning of period t and let y_t and y_t^* denote the levels of investment in the industry during period t. The industry output in a period equals the size of the capital stock as of the end of the period. Production in period t is then $k_t + y_t$ in the domestic sector and $k_t^* + y_t^*$ in the foreign sector. The cost of investment level y in the domestic sector is $C(y)$ dollars. Analogously the cost of investment y^* in the foreign sector is $C^*(y^*)$ dollars. The functions $C(\cdot)$ and $C^*(\cdot)$ are both strictly increasing and strictly convex and twice continuously differentiable. Let the lower case denote marginal cost, $c(y) \equiv C'(y)$ and $c^*(y^*) \equiv C^{*\prime}(y^*)$. The capital stock depreciates between periods at rate $1-\lambda$. The domestic capital stock at the beginning of period $t+1$ is then $k_{t+1} = \lambda \cdot (k_t + y_t)$. The depreciation rate is the same in the foreign sector so $k_{t+1}^* = \lambda \cdot (k_t^* + y_t^*)$. The industry is competitive in both the domestic and foreign sectors.

Let x and x^* denote the consumption levels in the domestic and foreign sectors. Let $G(x)$ and $G^*(x^*)$ be the gross dollar value of consumption in the two sectors and assume that both functions are strictly increasing, strictly concave, and twice continuously differentiable. Let the lower case $g(x) \equiv G'(x)$ and $g^*(x^*) \equiv G^{*\prime}(x^*)$ denote the marginal values of consumption (these are the inverse demand curves for the product in the domestic and foreign sectors).

The home country selects a temporary protection measure in period 0 and removes this protection in period 1 and thereafter. To simplify the presentation I will discuss the case of a tariff only. The temporary tariff is denoted τ and its level is taken as exogenous throughout the analysis. The analysis of a quota would require a more complicated presentation but the results would be the same.[3]

The rest of this section determines the dynamic competitive equilibrium of the industry beginning in period 1 taking as given the capital stocks k_1 and k_1^* that exist at the beginning of period 1. This problem is a variant of the standard Ramsey growth model (See Stokey and Lucas, 1989). A standard technique for solving for the competitive equilibrium of this model is to solve the social planner's problem of maximizing total (world) surplus given the initial capital stocks. Only the total world capital stock $k^w = k + k^*$ matters to the social planner, not the division of the

[3] It is well known that in a static environment there exists a quota that is equivalent to a tariff except for a reallocation of surplus from the government to holders of quotas (see Bhagwati (1965, 1968)). A similar argument can be made here.

stock into its domestic and foreign components. Standard dynamic programming techniques can be used to solve this problem. Let $v(k^w)$ be the discounted present value of maximized total surplus given a world capital stock of k^w at the beginning of the current period (where the current period is taken to be period 1 or thereafter). This solves the following stationary discounted dynamic programming problem,

(1) $$v(k^w) = \max_{x,y,y^*} G(x) + G^*(k^w + y + y^* - x) - C(y) - C^*(y^*) + \delta v(\lambda \cdot (k^w + y + y^*))$$

Note that this formulation of the problem imbeds the world budget constraint that $x^* = k^w + y + y^* - x$ (foreign consumption equals total world output less domestic consumption). The current return in the social planner's problem equals the sum of gross domestic consumers' surplus plus gross foreign consumers' surplus less the cost of current investment in both sectors. Investment levels y and y^* result in a world capital stock of $\lambda \cdot (k^w + y + y^*)$ in the subsequent period. The last term is the discounted present value of entering the subsequent period with this world capital stock.

The first-order conditions of this problem after some manipulation can be written as

(2.a) $$g(x) - g^*(x^*) = 0;$$

(2.b) $$c(y) - c^*(y^*) = 0;$$

(2.c) $$g(x) - c(y) + \delta \lambda v(\lambda \cdot (k^w + y + y^*)) = 0.$$

The first condition says that consumption is allocated across the domestic and foreign sectors to equate marginal willingness-to-pay. The second says that investment is allocated across the two sectors to equate marginal cost. The third condition says that the marginal benefit of investing one more unit in the domestic sector equals the marginal cost.

Let $X(k^w)$, $Y(k^w)$ and $Y^*(k^w)$ be the optimal consumption and investment levels in a period as a function of the beginning-of-period world capital stock k^w. Let the optimal foreign consumption $X^*(k^w)$ be determined from the world budget constraint. Let $k_{t+1}^w = T(k_t^w)$ be the transition function determining the world capital stock at the beginning of next period as a function of the capital stock at the beginning of the current period,

(3) $$T(k^w) = \lambda \cdot \left(k^w + Y(k^w) + Y^*(k^w)\right).$$

This transition function $T(\cdot)$ has a number of properties the proofs of which are quite standard. The function $T(\cdot)$ is strictly increasing and has slope less than one (it is a contraction). This implies that the world capital stock converges monotonicly to a unique steady state or long-run level k_{LR}^w where $k_{LR}^w = T(k_{LR}^w)$. It is also straightforward to show that the consumption levels $X(k^w)$ and $X^*(k^w)$ are strictly increasing in the world capital stock. Suppose that the world capital stock at period 1 is below the long-run level, $k_1^w < k_{LR}^w$. In this case the world capital stock increases monotonically over time, $k_t^w < k_{t+1}^w$, converging from below to the long-run level, $\lim_{t \to \infty} k_t^w = k_{LR}^w$. Domestic and foreign consumption also increase monotonically over time, $x_t < x_{t+1}$ and $x_t^* < x_{t+1}^*$.

The price sequence that decentralizes the solution to the planner's problem can be obtained from consumers' marginal willingness-to-pay. At a world capital stock of k^w, domestic consumption is $X(k^w)$ and so the equilibrium price must be $P(k^w) = g(X(k^w))$. Let $p_{LR} = P(k_{LR}^w)$ be the long-run equilibrium price (the price when the world-capital stock is at the stationary level). Since marginal willingness to pay $g(x)$ diminishes in consumption x and since consumption increases in the world capital stock k^w, the current price strictly decreases in the level of the current world capital stock. Therefore, if the period-1 capital stock is below the long-run level, $k_1^w < k_{LR}^w$, then price will initially be above the long-run level, $p_1 > p_{LR}$, and will decline monotonically over time as the world capital stock converges from below to the long-run level.

III. Equilibrium with Temporary Protection

This section examines the dynamic competitive equilibrium beginning at period 0 when a temporary tariff of τ is levied. The analysis takes as given the capital stocks k_0 and k_0^* of the domestic and foreign sectors at the beginning of period 0 along with the temporary tariff τ that is in effect during period 0. The competitive equilibrium is determined by obtaining the solution to the following "pseudo" social planner's problem:

$$
(4) \quad v_0(k_0,k_0^*,\tau_0)=\max_{x,y,y^*} G(x)+G^*(k_0+k_0^*+y+y^*-x) \\ -C(y)-C^*(y^*)-\tau\cdot(x-k_0-y)+\delta v(\lambda\cdot(k_0+k_0^*+y+y^*))
$$

This program maximizes world consumers' surplus minus the cost of new investment and minus the tariff payments paid to the home government.[4] This takes the tariff revenue of the home country as a social loss. This would be the actual social planner's problem (and not a pseudo problem) if τ represented a transportation cost of shipping the product from the foreign sector to the home country so these expenditures actually involved real resource costs.

The first-order conditions from this problem are

(5.a) $g(x)-g^*(x^*)-\tau=0,$

(5.b) $c(y)-c^*(y^*)-\tau=0,$

(5.c) $g(x)-c(y)+\delta\lambda v'(\lambda\cdot(k_0+k_0^*+y+y^*))=0.$

These are the same as the first-order conditions for the original problem except that the tariff τ drives a wedge between domestic and foreign marginal willingness-to-pay and domestic and foreign marginal cost.

Let $X_0(k_0,k_0^*,\tau)$, $Y_0(k_0,k_0^*,\tau)$and $Y_0^*(k_0,k_0^*,\tau)$ be the optimal choices in period 0 given the initial capital stocks and the initial tariff. Let foreign consumption $X_0^*(k_0,k_0^*,\tau)$ be determined by the constraint. The equilibrium domestic price in period 0 equals marginal-willingness to pay in period 0 at the equilibrium domestic consumption level, $P_0(k_0,k_0^*,\tau)=g(X(k_0,k_0^*,\tau))$. The foreign price equals the domestic price less the tariff, $P_0^*(k_0,k_0^*,\tau)=P_0(k_0,k_0^*,\tau)-\tau$.

IV. Comparative Statics with the Temporary Tariff

The temporary tariff affects period-0 investments in both the domestic sector and the foreign sector. These investments determine the world capital stock at the beginning of period 1. This is the channel emphasized in this paper through which the temporary tariff affects future

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[4]In the event that net imports *x-k-y* are negative, i.e. the home country is exporting, τ can be interpreted as an export subsidy.

prices. This section shows that an increase in the temporary tariff raises domestic investment in period 0 and reduces foreign investment in period 0. It also derives the condition determining the net effect on world investment and hence the net effect on future price levels.

Let $Y_0(\tau)$ and $Y_0^*(\tau)$ be the equilibrium investment levels in period 0 as a function of the temporary tariff τ (since the initial capital levels k_0 and k_0^* are held constant throughout this analysis the functional dependence on these variables is left implicit). By totally differentiating first-order conditions (5.a) through (5.c) and use of straightforward algebra the following result can be obtained.

Result 1. Period-0 domestic investment $Y_0(\tau)$ is strictly increasing in the temporary tariff and period-0 foreign investment $Y_0^*(\tau)$ strictly decreases in the temporary tariff. World investment $Y_0(\tau)+Y_0^*(\tau)$ strictly decreases if and only if the following condition holds:

$$\text{(6)} \qquad \frac{c^{*\prime}(y_0^*)}{c'(y_0)} < \frac{g^{*\prime}(x_0^*)}{g'(x_0)}.$$

If the inequality in condition (6) goes the other way, then world investment increases with the tariff. Note that y_0, y_0^*, x_0, and x_0^* are all implicitly a function of τ in condition (6).

Condition (6) can be rewritten in elasticity form. First, the elasticity of investment is defined. A unit of capacity installed in period 0 earns p_0 in period 0, λp_1 in period 1 (the fraction of the unit that survives into period 1 is λ), $\lambda^2 p_2$ in period 2, and so forth. The present discounted value of the net revenue stream is

$$\text{(7)} \qquad R_0 = \sum_{t=0}^{\infty} (\lambda\delta)^t \cdot p_t$$

In competitive equilibrium the marginal cost of the last unit of investment will equal the present discounted net revenue from the investment, i.e., $c(y_0) = R_0$. Let $S(R_0)$ be equilibrium domestic investment when the discounted net revenue is R_0. It solves $c(S(R_0)) = R_0$. In discussion, this will sometimes be referred to as "new supply" or just "supply" (note that the supply from preexisting capacity is perfectly inelastic). Define the supply elasticity $\varepsilon^S(R_0)$ to be the percentage change in new investment from a percentage change in discounted revenue. The elasticity of demand ε^D in the domestic sector is defined in the usual way. Let ε^{S*} and ε^{D*} the supply and demand elasticities in the foreign sector. Straightforward algebra shows

Result 2. At $\tau = 0$, the condition under which investment strictly decreases with a tariff (equation (6)), can be written as

$$(8) \qquad \frac{y_0}{y_0^*} \cdot \frac{\varepsilon_0^S}{\varepsilon_0^{S*}} < \frac{x_0}{x_0^*} \cdot \frac{\varepsilon_0^D}{\varepsilon_0^{D*}}.$$

($\tau = 0$ is assumed because at a zero tariff the domestic price is the same as the foreign price and the prices in the elasticity terms in the numerator and denominator cancel each other out.) This condition determines the effect on world investment when a small temporary tariff is levied. The direction of the effect depends upon the ratio of the domestic elasticity of supply to the foreign elasticity of supply as well as the ratio of the demand elasticities, the ratio of investment levels, and the ratio of consumption levels.

Consider, for example, the special case in which foreign investment is perfectly inelastic while domestic investment is not perfectly inelastic. In this case the left-hand side of (8) blows up and the condition is violated. This means that levying a temporary tariff raises world investment and hence reduces future prices. World investment increases because domestic investment increases while foreign investment does not change because it is perfectly inelastic. Consider next the case in which domestic demand is perfectly inelastic while foreign demand is not perfectly inelastic. The right-hand side of (8) is then zero and the condition is violated. A small temporary tariff increases world investment and therefore lowers future prices. An increase in the tariff lowers the foreign price and since foreign demand is elastic foreign consumption increases. Since domestic demand is unchanged (it is perfectly inelastic) world consumption must increase. This is only possible if world investment increases.

The rest of the paper focuses on the special case in which the domestic and foreign sectors have identical demand elasticities and identical supply elasticities. Suppose that marginal cost and marginal benefit in the foreign sector take the following forms:

$$(9.a) \qquad g^*(x^*) = g(\alpha x^*),$$

(9.b) $c^*(y^*) = c(\beta y^*)$.

Given this parameterization, if domestic consumers and foreign consumers faced the same market price in a period, then domestic demand would equal α times foreign demand (the marginal-willingness to pay would have to be the same in each country so $g^*(x^*) = g(\alpha x^*)$ would have to equal $g(x)$ which implies that αx^* would have to equal x). Analogously, domestic new investment supply equals β times foreign new investment when the discounted net revenue is the same. Let $\phi^D \equiv \frac{\alpha}{\alpha+1}$ be the domestic share of world consumption when the domestic and foreign prices are the same. Let $\phi^S \equiv \frac{\beta}{\beta+1}$ be the domestic share of world investment. In this parameterization the domestic and foreign sectors have the same demand and supply elasticities but the levels of supply and demand differ. It is assumed that $\phi^D > \phi^S$ which implies that the home country imports the product when there is no government intervention. The result is

Result 3. Suppose that foreign marginal cost and foreign marginal benefit have the form given by equations (9.a) and (9.b). Suppose $\phi^D > \phi^S$. Then condition (6) is satisfied at $\tau = 0$. Hence a small tariff strictly decreases total world investment in period 0. This implies that a small tariff at period $t = 0$ increases prices for all periods $t \geq 1$.

Proof. At τ=0, $p_0 = \tilde{p}_0$, which implies $g(x_0) = g^*(x_0^*)$. From equation (9.a), $g^*(x_0^*) = g(\alpha x_0^*)$. Hence, $x_0 = \alpha x_0^*$. Differentiating (9.a) yields $g^{*\prime}(x_0^*) = \alpha g'(\alpha x_0^*)$. But $x_0 = \alpha x_0^*$ then implies that $g^{*\prime}(x_0^*) = \alpha g'(x_0)$. Hence, the ratio on the left-hand side of condition (6) equals α. A similar argument shows that the ratio on the right-hand side of (6) equals β. The result then follows because $\phi^D > \phi^S$ implies $\alpha > \beta$.

Up to this point I have assumed that the tariff is levied only in period 0. I now briefly discuss tariffs in later periods. Suppose, for example, a permanent tariff of $\bar{\tau}$ is levied at period 0. Letting $(\tau_0, \tau_1, \tau_2, ...)$ be the vector specifying the tariff level τ_t in period t, the tariff vector is $(\bar{\tau}, \bar{\tau}, \bar{\tau}, ...)$ under a permanent tariff of $\bar{\tau}$. To determine the effect of a permanent tariff, we need to compare the allocation under tariff vector $(\bar{\tau}, \bar{\tau}, \bar{\tau}, ...)$ with the allocation under tariff vector (0,0,0,...). One way to make this comparison is to determine first the effect of moving from (0,0,0,...) to $(\bar{\tau}, 0, 0, ...)$, and second the effect of moving from $(\bar{\tau}, 0, 0, ...)$ to $(\bar{\tau}, \bar{\tau}, 0, ...)$, and third the effect of moving from $(\tilde{\tau},\tilde{\tau},0,0,...)$ to $(\tilde{\tau},\tilde{\tau},\tilde{\tau},0,...)$, and so forth. This paper has focused on the first step, the movement of (0,0,0,...) to $(\tilde{\tau},0,0,...)$. Now consider the movement from $(\tilde{\tau},0,0,...)$ to $(\tilde{\tau},\tilde{\tau},0,...)$. The tariff in period 1 depresses investment by foreign firms in period 1 but it also depresses their investment in period 0 as these firms anticipate a reduced return. The tariff expands the investment by domestic firms in both period 1 and period 0 as these firms anticipate an increased return. The tariff in period 1 has offsetting effects on investment in period 0 and hence offsetting effects on the price in period 0. I suspect that Result 3 can be generalized to periods other than $t = 0$. Specifically, for the benchmark case (assumptions (9.a) and (9.b)), I suspect that a tariff in period 1 leads to a net increase in the price in period 0, i.e. that the negative effect of the future tariff on foreign supply outweighs its positive effect on domestic supply.

IV. Magnitudes

The previous section showed that temporary import protection raises future prices in the benchmark case in which the domestic and foreign sectors have the same elasticities. This section discusses the factors that determine the magnitude of these effects on future prices. Let p_t^τ be the domestic price in period t when the tariff τ is levied in period 0 and let p_t^0 be what the domestic price would be in period t if a tariff in period 0 were never levied. The effect of the temporary tariff on the price in period t is then $\Delta p_t = p_t^\tau - p_t^0$. It is clear that the tariff increases the domestic price in the period it is levied, $\Delta p_0 > 0$. The previous section showed that the effect is positive in future periods as well, i.e. $\Delta p_t > 0$for $t \geq 1$, because the net effect on world investment in period 0 is negative. Note that, while strictly positive, Δp_t is arbitrarily small for periods far enough in the future, since the world capital stock converges to the long-run level k_{LR}^w whether or not there is a temporary tariff. Nevertheless, it is potentially significantly above zero in the "near" future. The measure of the significance of the trade policy on future prices that will be used here is the "Future Impact Ratio" (FIR). The FIR is the discounted sum of future price changes expressed as a percentage of the change in the initial domestic price (i.e. the price change in the period in which the tariff is levied),

(10) Future Impact Ratio $= \frac{\sum_{t=1}^{\infty} \Delta p_t}{\Delta p_0}$.

This section calculates the FIR for some examples. Throughout the discussion it is assumed that demand is of the constant elasticity form and that the elasticity of new supply is also constant.[5] The analysis assumes the industry is in long-run equilibrium in period $t = -1$ when the tariff is imposed in period $t = 0$. The tariff is set to one half of the long-run equilibrium price.

Consider first comparative statics with the domestic share of world consumption ϕ^D and the domestic share of world supply ϕ^S shown in Table 1. This table was calculated by using numerical methods to solve programs (1) and (4). For this table the elasticity of demand ε^D and the elasticity of supply ε^S are both set equal to one, a focal case. The discount factor is set equal to .8, corresponding to a period length of about four or five years. It is not obvious what the appropriate depreciation rate should be for a period of this length. For Table 1, λ is set equal to .8, the same as the discount factor (so capital depreciates 20 percent over the course of a period).

Table 1 shows that the Future Impact Ratio strictly increases with the domestic share of world consumption. When the domestic share is negligible, the tariff has a negligible effect on total world investment, and hence a negligible impact on future prices. At the other extreme in which the home country is a monopsonist, the Future Impact Ratio is greater than 1, i.e., the discounted sum of the future price increases exceed the current domestic price increase.

For this example the FIR decreases in the domestic share of world supply, but the effect of changing ϕ^S is not as strong as changing ϕ^D. Note that when $\phi^D = 1$ (perfect monopsony), the FIR is large even when the domestic production share is large.[6] At the point where $\phi^S = \phi^D$, the

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5 Let $g(x) = \omega x^{-\eta}$ and $c(y) = \mu y^{\theta}$. Then $\varepsilon^D = \frac{1}{\eta}$ and $\varepsilon^S = \frac{1}{\theta}$. $g^*(x^*)$ and $c^*(y^*)$ are derived from equations (9.a) and (9.b). The FIR is independent of the scale parameters ω and μ.

6 When the production share is large the tariff tends to lower the price foreign producers get rather than raise the price domestic producers get. Hence the denominator in (10) is small. This accounts for why the figures in the bottom row of table 1 are so high even for large ϕ^S.

effect on future prices is actually negative. To avoid corner solutions, I assume that τ is an export subsidy in the event that net imports are negative. This assures that the foreign price in period 0 will be τ units less than domestic price, $p_0^* = p_0 - \tau$, regardless of whether the home country imports or exports. When ϕ^S is substantially below ϕ^D the home country is an importer of the product even with the temporary protection measure. However, when ϕ^S is close enough to ϕ^D the policy causes the home country to be an exporter in period 0. This subsidy causes the world capital stock to increase and future prices fall.

Consider first industries in which transportation costs are low relative to the value of the good so that the market is global. Generally speaking, only the first few rows of Table 1 would ever be relevant in this case, i.e., even the very largest countries (e.g. the United States, the European Community) generally consume no more than 30 or 40 percent of world production for most goods. (There may be exceptions to this in cases where, for cultural reasons, a country consumes a good that the rest of the world doesn't consume.) For consumption shares less than 40 percent, the magnitude of the future impact on prices of temporary trade protection is likely to be quite small. Some examples illustrate this. In 1989, the U.S. consumption share of the world coffee market was 21 percent and its production share was virtually zero.[7] Table 1 shows that the discounted sum of the future increases in price are only a fraction .014 of the current increase in price for these share values. The FIR continues to be small for these share values even if different values of the other parameters (e.g. demand elasticity) are substituted in. Another example is the oil industry.[8] In 1989 the U.S. consumed 27 percent of the world's crude oil and produced 13 percent.[9] The FIR for these share values is on the order of .011.

Now consider industries in which transportation costs are high enough so that the market area is not the entire globe but low enough so as to not preclude trading across countries within

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7 The source for these figures is the United Nations, *International Trade Statistics* and the *Statistical Yearbook*.

8 Of course the model may be of limited relevance in discussing the oil industry because of the exhaustible resource nature of that industry.

9 The source of these figures is *Market Share Reporter*, tables 901 and 902.

the same region. The newsprint industry has these characteristics. Transportation costs are substantial in this industry.[10] The United States and Canada together can be defined as a trading region in that imports from other countries besides the U.S. and Canada into this region are small and exports from the region to areas outside the region are also relatively small (the amount of newsprint imported to the region from countries outside the region accounted for 2.4 percent of the region's production in 1987 while exports from the region accounted for 8.9 percent of production).[11] The U.S. is the dominant consumer in this industry and Canada is the dominant producer. The U.S. imposes no tariff on newsprint.[12] U.S. consumption as a fraction of combined Canadian and U.S. production averaged .80 over the period 1980-89. U.S. production had an average share of .35 of combined production over this same time period.[13] These are the share numbers that will be used in the analysis below. The analysis in effect assumes the newsprint industry in the U.S./Canada region is a closed economy though there is admittedly some spillover from the region to the European market and elsewhere.

Table 2 shows the future impact ratios for various values of the demand elasticity, supply elasticity, the discount factor and the depreciation factor. These numbers are fairly large, with the sum of discounted price increases as high as a fraction .161 of the contemporaneous increase in price. In the range presented, the FIR increases as the elasticity of supply increases and as the elasticity of demand decreases.[14]

The parameter values that yield the maximum FIR in table 2 are $\varepsilon^D = .5$, $\varepsilon^S = 2$, $\delta = .8$, and $\lambda = .8$. The FIR in this case is .161. Table 3 traces the evolution of the industry for these parameter values. The industry in long-run equilibrium in period $t = -1$. The long-run

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10 See Margolin and McLendon (1952), for an early study of transportation costs in the newsprint industry.

11 These import and export figures are calculated from table 14 of *The Pulp and Paper Industries in the OECD Member Countries.*

12 U.S. trade policy in the newsprint industry was particularly controversial around the turn of the century. The interests of U.S. newsprint producers were pitted against the interests of newspaper publishers. The latter group apparently had more political influence and won out. For details of this battle see Ellis (1960).

13 These shares were calculated from data in *Business Statistics, 1963-1991*, p. 128.

14 While the FIR is higher for lower elasticity of demand in the table, when the elasticity is lowered all the way to zero the FIR goes to zero. With perfectly inelastic demand world quantity is fixed so the world capital stock is fixed and independent of tariff policy.

equilibrium price level is normalized to 100. The long-run beginning-of-period world capacity is also normalized to 100 (hence the long-run level of domestic capacity is 35 and of foreign capacity is 65). A tariff of 50 is levied in period 0 raising the domestic price to 117.2 in the period and lowering the foreign price to 67.2=117.2-50. Encouraged by the higher price, domestic capacity expands and is higher by 1 unit at the beginning of the next period ($t = 0$). Foreign investment is discouraged by the lower foreign price and is lower by 2.7 units. The net result is that world capacity is 1.7 units below the long-run level at the beginning of period 1. The reduction in world capacity drives up the price in period 1 by 1.9 units to 101.9. Over time world capacity rises and approaches its long-run level and price falls back to its long-run level.

Appendix

Proof of Result 1.

The first-order conditions to the social planner's problem are:

(A1.a) $g(x)-g^*(k_0^w+y+y^*-x)-\tau=0,$

(A1.b) $c(y)-c^*(y^*)-\tau=0,$

(A1.c) $g(x)-c(y)+\delta\lambda v'(\lambda\cdot(k_0^w+y+y^*))=0.$

(A1.a) through (A1.c) are the same as (5.a) through (5.c) in the text with the substitutions $k_0^w=k_0+k_0^*$ and $x_0^*=k_0^w+y+y^*-x$. Differentiating this system with respect to τ yields

(A.2) $$\begin{pmatrix} g'+g^{*\prime} & -g^{*\prime} & -g^{*\prime} \\ 0 & c' & -c^{*\prime} \\ g' & -c'+\delta\lambda^2 v'' & \delta\lambda^2 v'' \end{pmatrix}\cdot\begin{pmatrix} dx/d\tau \\ dy/d\tau \\ dy^*/d\tau \end{pmatrix}=\begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}.$$

Let H denote the (3x3) matrix on the LHS of (A.2). Using Cramer's rule

(A.3) $$\frac{dy}{d\tau}=\frac{\begin{vmatrix} g'+g^{*\prime} & 1 & -g^{*\prime} \\ 0 & 1 & -c^{*\prime} \\ g' & 0 & \delta\lambda^2 v'' \end{vmatrix}}{|H|}=\frac{(g'+g^{*\prime})(\delta\lambda^2 v'')+g'\cdot(-c^{*\prime}+g^{*\prime})}{|H|}$$

(A.4) $$\frac{dy^*}{d\tau}=\frac{\begin{vmatrix} g'+g^{*\prime} & -g^{*\prime} & 1 \\ 0 & c' & 1 \\ g' & -c'+\delta\lambda^2 v'' & 0 \end{vmatrix}}{|H|}$$

$$=\frac{(g'+g^{*\prime})(c'-\delta\lambda^2 v'')+g'\cdot(-g^{*\prime}-c')}{|H|}$$

Combining (A.3) and (A.4) yields

$$\text{(A.5)} \qquad \frac{dy}{d\tau}+\frac{dy^*}{d\tau}=\frac{g'\cdot(-c^{*\prime}+g^{*\prime})+(g'+g^{*\prime})c'+g'(-\tilde{g}'-c')}{|H|}=\frac{-g'c^{*\prime}+g^{*\prime}c'}{|H|}$$

Now

$$\text{(A.6)} \quad |H|=(g'+g^{*\prime})\left(c'\delta\lambda^2v''+c^{*\prime}(-c'+\delta\lambda^2v'')\right)+g'(g^{*\prime}c^{*\prime}+g^{*\prime}c')$$

$$=g'g^{*\prime}(c^{*\prime}+c')-(g'+g^{*\prime})c'c^{*\prime}+(g'+g^{*\prime})(c^{*\prime}+c')\delta\lambda^2v''>0,$$

which is positive since $g'<0$, $g^{*\prime}<0$, $c'>0$, $c^{*\prime}>0$, and $v''<0$ (the concavity of v follows from standard arguments). Equation (A.5) then implies that $Y_0(\tau)+Y_0^*(\tau)$ is strictly increasing in τ if and only if

$$\frac{c^{*\prime}(y_0^*)}{c'(y_0)}<\frac{g^{*\prime}(x_0^*)}{g'(x_0)}.$$

Q.E.D.

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Table 1
Discounted Future Price Changes
(as a percent of contemporaneous domestic price change)
(δ=.8, λ=.8, $\varepsilon^D = 1$, $\varepsilon^S = 1$)

Consumption Market Share	**Production Market Share**									
	.00	.10	.20	.30	.40	.50	.60	.70	.80	.90
.10	.004	-.003								
.20	.014	.003	-.007							
.30	.021	.011	.001	-.010						
.40	.033	.023	.012	.000	-.012					
.50	.050	.038	.024	.010	-.003	-.014				
.60	.069	.058	.043	.028	.011	-.005	-.020			
.70	.104	.088	.071	.053	.035	.014	-.006	-.025		
.80	.162	.143	.125	.100	.074	.053	.027	-.006	-.028	
.90	.309	.283	.251	.220	.181	.140	.101	.066	.009	-.037
1.00	1.243	1.233	1.248	1.244	1.206	1.231	1.215	1.167	1.149	1.015

Table 2
Discounted Future Price Changes
Further Comparative Statics
(ϕ^D =.85, ϕ^S =.35)

Table 2a
Comparative Statics with
η and θ
(δ=.8 and λ=.8)

	$\boldsymbol{\theta}$		
$\boldsymbol{\eta}$	.5	1	2
.5	.110	.144	.161
1	.057	.087	.115
2	.023	.038	.057

Table 2b
Comparative Statics with
δ and λ
(η=1 and θ=1)

	$\boldsymbol{\lambda}$		
$\boldsymbol{\delta}$	.7	.8	.95
.7	.085	.077	.035
.8	.098	.089	.040
.95	.119	.102	.029

Table 3
Evolution of Prices and Capacities
$(\phi^D = .85,\ \phi^S = .35, \delta = .8,\ \lambda = .8,\ \varepsilon^D = .5,\ \varepsilon^S = 2))$

Period	Tariff	Prices		Beginning of Period Capacity		
		Domestic	Foreign	Domestic	Foreign	World
-1	0	100.0	.	35.0	65.0	100.0
0	50	117.2	67.2	35.0	65.0	100.0
1	0	101.9	.	36.0	62.3	98.3
2	0	101.1	.	35.9	63.1	99.0
3	0	100.6	.	35.8	63.6	99.5
4	0	100.3	.	35.7	64.0	99.7
5	0	100.2	.	35.6	64.2	99.8
6	0	100.1	.	35.5	64.4	99.9
7	0	100.1	.	35.4	64.5	99.9
8	0	100.0	.	35.3	64.6	100.0
. .	. .	. .	. .	. .	. .	. .
∞	0	100.0	.	35.0	65.0	100.0

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