On the Equivalence of Tariffs and Quotas with a Monopolistic Non-traded Intermediate Good Market : A Simple General Equilibrium Approach

Masayuki OKAWA

1. Introduction

It is well known that if an import market is perfectly competitive, tariffs and quotas are equivalent. It is also well understood that if there is a monopoly element in the import market, the equivalence of tariffs and quotas breaks down and the output of the monopolist is smaller and the price is lower under quotas than under tariffs [See Bhagwati (1965, 1968)]. These are however two polar cases, perfect competition and monopoly. Since Bhagwati initiated the discussion, many researchers have discussed the problem in many market structure settings that lie somewhere between perfect competition and pure monopoly. See, for example, Itoh and Ono (1982, 1984) and Hwang and Mai (1988). Itoh and Ono (1982, 1984) developed a price-leadership model and Hwang and Mai (1988) adopted a conjectural variations approach.

All of the analyses however have been conducted in partial equilibrium settings. Thus it has been assumed that the domestic firms compete with foreign firms only in the domestic market, that is, the final good is consumed only in the domestic country. Moreover the role of the distribution of tariff and quota revenues is completely neglected.

Moreover all the analyses cited above have focused on the monopolistic element in the import market of a *final good*.

In this paper we set up a simple general equilibrium two-country, three-good (two final goods and one nontraded intermediate good), many-primary factor trading model. We assume that final goods are produced under conditions of perfect competition and free entry, and are traded internationally. A final good is produced using a nontraded intermediate good produced by a monopolist as well as primary factors, and the market for the good is protected by protectionist policie, i. e., tariffs or quotas.

In the framework, we examine the equivalence of tariffs and quotas, i. e., the effects of changes in the regime from tariffs to quotas set at the equilibrium level of imports under tariffs on the behavior of the monopolist and on the welfare of the import country. We show that even if the protected final good market is perfectly competitive, tariffs and quotas are *not* generally equivalent. The profits of the monopolists in both trading countries are always greater under quotas than under tariffs. Moreover if the value of the conjectural variation of the monopolist in the importing country is greater (resp. smaller) than a positive critical value, then the importing country is potentially better off (resp. worse off) under quotas than under tariffs. Similarly, if the value of the conjectural variation of the monopolist in the exporting country is greater (resp. smaller) than some critical value, the exporting country is potentially better off (resp. worse off) under quotas than under tariffs.

This paper is organized as follows. Section 2 sets up our model. In Section 3 we describe a trading equilibrium under tariffs. In Section 4 we examine the effects of the change in the regime from tariffs to quotas on the behavior of the monopolist in each country and on the welfare of each trading country. Section 5 contains concluding remarks.

2. The model

Consider a two-country, two-final good, one-intermediate good, arbitrarily many-primary factor trading model. The countries are labeled α and β. In each country, the same two final goods and one intermediate good are produced. The two final goods are produced under conditions of free entry and perfect competition, while the intermediate good is produced by a monopolist.

In each country, the same ℓ primary factors are inelastically supplied, move freely among industries and are fully employed.

There are two classes of agents in each country, the class of factor owners and the monopolist. The monopolist owns his firm but possesses no capital and supplies no labor. He consumes only the first final good and therefore maximizes his utility by maximizing his profit. All factor owners in each country are identical in all respects ; that is, they have the same preferences and factor endowments. Without loss of generality, we normalize the number of factor owners in each country to 1. Both the monopolist and the factor owners may differ across countries.

In each country the monopolist chooses his output as his control and is a price-taker in factor markets. We take a conjectural variations approach that includes particular static oligopoly solutions, such as the Cournot-Nash and collusive solutions, as special cases.

The first final good and the intermediate good are produced by the ℓ primary factors only while the second final good is produced by the primary factors and an intermediate good. The first final good is taken as the numeraire. Thus all intermediate goods produced by the oligopolists are hired in the second final good industry in each country.

Therefore the production functions are written as

$$X_1^i = F_1(V_{11}^i, V_{21}^i, .., V_{l1}^i),\ i=\alpha, \beta$$
$$X_2^i = F_1(V_{12}^i, V_{22}^i, .., V_{l2}^i, M^{di})$$
$$M^i = G(V_{1M}^i, V_{2M}^i, .., V_{lM}^i)$$

where

$X_f^i\,(f=1, 2)$: the output of the fth final good in the ith country,

M^{di} : the amount of the intermediate good employed in the second final good industry in i th country,

$V_{jk}^i\,(j=1, 2, .., \ell;\ k=1, 2, M)$: the amount of the j th primary factor employed in the k th industry,

M^i : the output of the intermediate good produced by the monopolist in country i

We assume that each production function is subject to (1) no-joint products, (2) constant returns to scale, (3) positive and diminishing marginal productivity of each factor, and (4) the property of strict quasi-concavity in its argument.

3. The optimal behavior of the monopolists under tariffs

We assume that country α imports the second final good and exports the first final good while country β exports the second final good and imports the first final good. We assume that the α-government imposes import tariffs on commodity 2. The tariff revenue is distributed to the α-factor owners only.

Let us first consider the optimal behavior of the monopolist producing the nontraded intermediate good in country α under tariffs. The α-monopolist seeks to maximize his profit:

$$\pi^\alpha = p_M^\alpha M^\alpha - C^\alpha(M^\alpha) \tag{1}$$

where π^α is the profit of the monopolist, M^α is his output of the nontraded intermediate good in country α, p_M^α is the relative price of the intermediate good in α and $C^\alpha(.)$ is the total cost of producing M^α. Keeping factor prices constant and differentiating (1), we obtain a simple form of the first-order condition for the monopolist:

$$p_M^\alpha + M^\alpha(\partial p_M^\alpha/\partial M^\alpha) - dC^\alpha/dM^\alpha = 0 \tag{2}$$

Our next step is to elucidate the feedback term $(\partial p_M^\alpha/\partial M^\alpha)$. We first resort to the zero-profit condition for the second final good 2 in α:

$$a_{12}^\alpha(w_1^\alpha, ., w_l^\alpha, p_M^\alpha)\,w_1^\alpha + a_{22}^\alpha(w_1^\alpha, ., w_l^\alpha, p_M^\alpha)\,w_2^\alpha + \ldots\, a_{M2}^\alpha(w_1^\alpha, ., w_l^\alpha, p_M^\alpha)\,p_M^\alpha = p_2^\alpha \tag{3}$$

where w_j^i is the price of the j th primary factor in country i, $a_{j2}^\alpha(.)$ is the (input j/output 2) ratio in i, p_2^i is the relative price of final good 2 in i, $p_2^\alpha = (1+t)p^{\beta}{}_2$ and t is the tariff rate in country i.

It is known that in a two-country, perfectly competitive trading model, the optimal tariff rate is positive. However, in our trading model there exists a monopoly in each country and the optimal tariff rate may be negative. Therefore we here assume that $t > -1$.

Keeping factor prices constant and differentiating (3), we find that

$$\partial p_M^\alpha/\partial M^\alpha = (1/a_{M2}^\alpha)\ (\partial p_2^\alpha/\partial M^\alpha) \tag{3'}$$

We next turn to the world market-clearing condition for the second final good 2 :

$$\sum_{i=\alpha,\beta} D_2^i(p_2^i, y^i) = \sum_{i=\alpha,\beta} X^i{}_2 \tag{4}$$

where $D_2^i(.)$ is the Marshallian demand function of a typical factor owner in country i, X_2^i is the total output of final good 2 in i and y^i is the income of a factor owner in i:

$$y^\alpha = F^\alpha + R^\alpha \tag{5-1}$$
$$y^\beta = F^\beta \tag{5-2}$$

where $F^i \equiv \sum_{j=1}^{l} w_j^i V_j^i$ is a typical factor owner's factor income in country i, V_j^i is his endowment of the j th primary factor and R^α is the tariff revenue in country α:

$$R^\alpha = tp_2^\beta (D_2^\alpha - X_2^\alpha) \tag{6}$$

Keeping factor prices constant and differentiating (4) and (6), respectively, we find that

$$-\sum_{i=\alpha,\beta} (D_2^i \eta^i / p_2^i)\, dp_2^i)\, dp_2^i + (\phi^\alpha / p_2^\alpha)\, dR^\alpha = \sum_{i=\alpha,\beta} dX_2^i \tag{4'}$$

$$dR^\alpha = t\Big(1 - \frac{t\phi^\alpha}{1+t}\Big)^{-1}\Big[\Big(-D_2^\alpha \eta^\alpha + Q^\alpha\Big) dP_2^\beta - p_2^\beta dX_2^\alpha\Big] \tag{6'}$$

where $\eta^i \equiv (p_2^i / D_2^i)\ (\partial D_2^i / \partial p_2^i) > 0$, $\phi^i \equiv p^i (\partial D_2^i / \partial y^i)$ and $Q^\alpha \equiv D_2^\alpha - X^\alpha{}_2 > 0$. Let us now turn to the market-clearing condition for the nontraded intermediate good in each country :

$$a_{M2}^i (w_1^\alpha, ., w^\alpha{}_l, p_M^i) X_2^i = M^i \tag{7}$$

Keeping factor prices constant, differentiating (7) and substituting from (3') in it, we obtain

$$dX_{M2}^i = (1/a_{M2}^i)\ [dM^i - X_2^i (\partial a_{M2}^i / \partial p_M^i)\ (1/a_{M2}^i)\, dp_2^i] \tag{7'}$$

Substituting from (7') in (6'), we find that

$$dR^\alpha = A dp_2^\beta - (tp_2^\beta / a_{M2}^\alpha)\ \Big[1 - \frac{t\phi^\alpha}{1+t}\Big] dM^\alpha \tag{6''}$$

where $A \equiv t\Big[1 - \dfrac{t\phi^\alpha}{1+t}\Big]^{-1} \{-D_2^\alpha \eta_2^\alpha + Q^\alpha + [p_2^\alpha X_2^\alpha / (a_{M2}^\alpha)^2]\ (\partial a_{M2}^\alpha / \partial p_M^\alpha)\}$. On the other hand, substituting from (7') in (4'), we obtain

$$B dp_2^\beta + (\phi^\alpha / p_2^\alpha)\, dR^\alpha = [(1/a_{M2}^\alpha) + (1/a_{M2}^\beta)\lambda^\alpha]\, dM^\alpha \tag{4''}$$

where $B \equiv \Big\{-\Big[\Big(\sum_{i=\alpha,\beta} D_2^i \eta^i\Big)/p_2^\beta\Big] + (1+t)\ (X_2^\alpha / a_{M2}^\alpha\ (\partial a_{M2}^\alpha / \partial p_M^\alpha)\ (1/a_{M2}^\alpha))\Big\} < 0$ and $\lambda^\alpha \equiv dM^\beta / dM^\alpha$ is the conjectural variations term that describes the change in the output of the β-monopolist anticipated by the α-monopolist in response to a unit change in the latter's output. In principle, λ^α can take any value, with special interest attaching to the value of zero (the Cournot-Nash case). Solving (4'') and (6'') for $\partial p_2^\beta / \partial M^\alpha$, we find that

$$\partial p_2^\beta/\partial M^\alpha = -(a_{M2}^\alpha)^{-1}\Big[\frac{1+t}{1+t(1-\phi^\alpha)} + (a_{M2}^\beta/a_{M2}^\alpha)\lambda^\alpha\Big] \tag{8}$$

where $G \equiv -(\phi^\alpha/p_2^\alpha)A - B$. We here assume that

(A. 1) $\eta^\alpha > Q^\alpha/D_2^\alpha$

and

(A. 2) The final goods are normal: $1 > \phi^\alpha > 0$.

Then we find that $G>0$ for $t>0$. We next show that $G>0$ for $0>t>-1$ also. We can re-write G as

$$G = \Big[\frac{1+t}{1+t(1-\phi^\alpha)}\Big]\Big[\frac{D_2^\alpha \eta^\alpha}{p_2^\beta} - (1+t)\frac{X_2^\alpha}{(a_{M2}^\alpha)^2}\Big(\frac{\partial a_{M2}^\alpha}{\partial p_M^2}\Big)\Big] - (t\phi^\alpha/p_2^\alpha)Q^\alpha$$
$$>0 \quad \text{for} \quad -1<t<0.$$

Substituting from (8) in (2), we obtain a more explicit form of the first-order condition for the α-monopolist under tariffs:

$$P_M^\alpha - (1+t)\Big[\frac{M^\alpha}{G(a^\alpha{}_{M2})^2}\Big]\Big[\frac{1+t}{1+t(1-\phi^\alpha)} + (a_{M2}^\beta/a_{M2}^\alpha)\lambda^\alpha\Big] = dC^\alpha/dM^\alpha \tag{9}$$

We next turn to the optimal behavior of the β-monopolist under tariffs. To avoid repetition of the calculations, let us barely state the first-order condition for the monopolist:

$$p_M^\beta - \Big(\frac{M^\beta}{a_{M2}^\alpha a_{M2}^\beta G}\Big)\Big[\frac{1+t}{1+t(1-\phi^\alpha)}\lambda^\beta + \Big(\frac{a_{M2}^\alpha}{a_{M2}^\beta}\Big)\Big] = C^\beta, \tag{10}$$

where $\lambda^\beta \equiv dM^\alpha/dM^\beta$ is the conjectural variations term of the β-monopolist.

3. The optimal behavior of the α-monopolist under quotas

In this section we assume that the α-government imposes import quotas which are set at the equilibrium level of imports of the second final good under tariffs:

$$Q^{\alpha T} \equiv D_2^{\alpha T}(p_2^{\alpha T}, y^{\alpha T}) - X_2^{\alpha T} \tag{11}$$

where the variables with superscript T are evaluated at the equilibrium under the tariff. We assume that the a-government buys $Q^{\alpha T}$ of the final good 2 from country β at the equilibrium price of the good under the tariff and that the β-government accepts the quota. The premium $(p_2^\alpha - p_2^{\beta T})Q^{\alpha T}$ goes to the factor owners in country α.

Let us now examine the optimal behavior of the α-monopolist under the specified quota. By familiar reasoning, we obtain a simple form of the first-order condition for the monopolist under the quota:

$$p_M^\alpha + (M^\alpha/a_{M2}^\alpha)\ (\partial p_2^\alpha/\partial M^\alpha)^Q - dC^\alpha/dM^\alpha = 0 \tag{12}$$

To pin down the term $(\partial p_2^\alpha/\partial M^\alpha)^Q$, we resort to the market-clearing condition for the second final good in country α under the quota:

$$D_2^\alpha(p_2^\alpha, y^\alpha) = X_2^\alpha + Q^{\alpha T} \tag{13}$$

where $y^\alpha = F^\alpha + (p_2^\alpha - p_2^{\beta T})Q^{\alpha T}$. Keeping factor prices, $p_2^{\beta T}$ and $Q^{\alpha T}$ constant, and differentiating (13), we find that

$$-p_2^\alpha(D_2^\alpha\eta^\alpha - \phi^\alpha Q^{\alpha T})\,dp_2^\alpha = dX_2^\alpha \tag{13'}$$

Substituting from (4') in (13'), we obtain

$$(\partial p_2^\alpha/\partial M^\alpha)^Q = (1/a_{M2}^\alpha)\ \{-(1/p_2^\alpha)\ (D_2^\alpha\eta^\alpha - \phi^\alpha Q^{\alpha T}) + [X_2^\alpha/(a_{M2}^\alpha)^2]\ (\partial a_{M2}^\alpha/\partial p_M^\alpha)\}^{-1} \tag{14}$$

Substituting (14) in (12), we obtain an more explicit form of the first-order condition for the monopolist:

$$\begin{aligned} &p_M^\alpha + [M^\alpha/(a_{M2}^\alpha)^2]\ \{-(1/p_2^\alpha)\ (D_2^\alpha\eta^\alpha - \phi^\alpha Q^{\alpha T}) + [X_2^\alpha/(a_{M2}^\alpha)^2]\ (\partial a_{M2}^\alpha/\partial p_M^\alpha)\}^{-1} \\ &= dC^\alpha/dM^\alpha \end{aligned} \tag{14'}$$

We now compare the optimal outputs of the α-monopolist under the specified quota and under a tariff. To that end let us introduce a function

$$\begin{aligned} J^{\alpha Q}(M^\alpha) &\equiv \partial\pi^{\alpha Q}/\partial M^\alpha \\ &= p_M^\alpha + [M^\alpha/(a_{M2}^\alpha)^2]\ \{-(1/p_2^\alpha)\ (D_2^\alpha\eta^\alpha - \phi^\alpha Q^{\alpha T}) + [X_2^\alpha/(a_{M2}^\alpha)^2]\ (\partial a_{M2}^\alpha/\partial p_M^\alpha)\}^{-1} \\ &\quad - dC^\alpha/dM^\alpha \end{aligned} \tag{15}$$

Letting $M^{\alpha Q}$ be the optimal output of the α-monopolist under the quota, we find that $J^{\alpha Q}(M^{\alpha Q}) = 0$. Moreover we here assume that

(A. 3) $dJ^{\alpha Q}(M^\alpha)/dM^\alpha < 0$ (16)

(A. 3) implies the stability of the Marshallian adjustment process for the monopolist under a quota:

$$\dot{M}^\alpha = \varphi[MR^\alpha(M^\alpha) - MC^\alpha(M^\alpha)]$$

where φ is a positive constant. It follows that $M^{\alpha Q} \gtreqless M^{\alpha T}$ if and only if $J^{\alpha Q}(M^{\alpha T}) \gtreqless 0$. Evaluating (14) at $M^\alpha = M^{\alpha T}$, we see from (9) that

$$J^{\alpha Q}(M^{\alpha T}) = \frac{(1+t)M^{\alpha T}a_{M2}^{\beta T}}{(a_{M2}^{\alpha T})^3 G^T}(\lambda^{\alpha T} - \Phi^T) \tag{17}$$

where $\Phi \equiv -H[(1+t)\ (a_{M2}^\beta)E]^{-1} > 0$,

$$H\equiv\frac{D_2^{\beta}\eta^{\beta}}{p_2^{\beta}}+\frac{\phi^{\alpha}(1+t)Q^{\alpha}}{p_2^{\alpha}[1+t(1-\phi)]}-\frac{X_2^{\beta}}{(a_{M2}^{\beta})^2}\left(\frac{\partial a_{M2}^{\beta}}{\partial p_M^{\beta}}\right)>0,$$

$$E\equiv-[(D_2^{\alpha}\eta^{\alpha}-\phi^{\alpha}Q^{\alpha})/p_2^{\alpha}]+\frac{X_2^{\alpha}}{(a_{M2}^{\alpha})^2}\left(\frac{\partial a_{M2}^{\alpha}}{\partial p_M^{\alpha}}\right)<0.$$

Thus

$$M^{\alpha Q}\gtreqless M^{\alpha T}\Leftrightarrow\lambda^{\alpha T}\gtreqless\Phi^{T}. \tag{18}$$

Let us turn to the welfare effects of the change in the regime from tariffs to the quotas. We here introduce the maximum bonus which is defined as the difference between maximum income and the income needed to maintain given utility levels of economic agents. [See Wan (1965).] Given the utility levels of the α-factor owners and the α-monopolist under tariffs, i. e., $u^{\alpha T}$ and $\pi^{\alpha T}$, the maximum bonus of country α under the specified quota is

$$\begin{aligned}Z^{\alpha}(M^{\alpha})\equiv y^{\alpha}(M^{\alpha})+[p_2^{\alpha}(M^{\alpha})-p_2^{\beta T}]Q^{\alpha T}+[p_M^{\alpha}(M^{\alpha})M^{\alpha}-C^{\alpha}(M^{\alpha})]\\-e^{\alpha}[p_2^{\alpha}(M^{\alpha}),u^{\alpha T}]-\pi^{\alpha T}\end{aligned} \tag{19}$$

Differentiating (19) totally, we obtain

$$dZ^{\alpha}(M^{\alpha})/dM^{\alpha}=p_M^{\alpha}-C^{\alpha\prime}>0 \tag{19'}$$

We assume that there is a scheme of lumpsum compensation which ensures that after the change in the regime, either all agents are not worse off or all agents are not better off. Therefore country α is potentially better off (resp. worse off) under a quota than under a tariff if the output of the α-monopolist is greater (resp. smaller) under a quota than under a tariff. We now arrive at our first proposition.

Proposition 1. (1) If (A. 1)-(A. 3) and the inequality $\lambda^{\alpha T}<\Phi^{\alpha}$ are satisfied, the equilibrium output of the nontraded intermediate good of the α-monopolist is smaller and the profit of the monopolist is greater under a quota than under a tariff. Moreover country α is potentially worse off under a quota than under a tariff.
(2) If (A. 1)-(A. 3) and the inequality $\lambda^{\alpha T}>\Phi^{\alpha}$ are satisfied, the equilibrium output of the nontraded intermediate good of the α-monopolist is greater and the profit of the monopolist is greater under a quota than under a tariff. Moreover country α is potentially better off under a quota than under a tariff.

4. The optimal behavior of the β-monopolist and welfare of country β under quotas

In this section let us very briefly look at the effects of the change in the regime in country α on the behavior of the β-monopolist and on the welfare of country β.

Let us first consider the optimal behavior of the β-monopolist. The analysis will proceed in the similar way to that in section 3. Thus let us again state the results only. Under the assumption that

(A. 4) $dJ^{\beta Q}(M^{\beta})/dM^{\beta}<0$,

where $J^{\beta Q}(M^{\beta})\equiv\partial\pi^{\beta Q}/\partial M^{\beta}$

$$=p_M^{\beta}+[M^{\beta}/(a_{M2}^{\beta})^2]\ \{-D_2^{\beta}\eta^{\beta}/p_2^{\beta})+[X_2^{\beta}(\partial a_{M2}^{\beta}/\partial p_M^{\beta})/(a_{M2}^{\beta})^2]\}-C^{\beta\prime}(M^{\beta}),$$

we find that

$$M^{\beta Q}\gtreqqless M^{\beta T}\Leftrightarrow\lambda^{\beta T}\gtreqqless\Psi^{\beta T}$$

where $\Psi^{\beta}\equiv\dfrac{[1+t(1-\phi^{\alpha})]}{(1+t)a_{M2}^{\beta}R}(G+R)$, $R\equiv-(D_2^{\beta}\eta^{\beta}/p_2^{\beta})+[X_2^{\beta}(\partial a_{M2}^{\beta}/\partial p_M^{\beta})/(a_{M2}^{\beta})^2]<0$, and G is defined in (8).

Moreover we assume that there exists a scheme of lumpsum compensation which ensures that after the change in the regime, either all agents are not worse off or all agents are not better off. Then country β is potentially better off (resp. worse off) under a quota than under a tariff if and only if the output of the β- monopolist is greater (resp. smaller) under a quota than under a tariff. Thus we have established our second proposition.

Proposition 2. (1) If (A. 1), (A. 2), (A. 4) and the inequality $\lambda^{\beta T}<\Psi^{\beta T}$ are satisfied, the equilibrium output of the β- monopolist is smaller and the profit of the monopolist is greater under a quota than under a tariff. Moreover country β is potentially worse off under a quota than under a tariff.

(2) If (A. 1), (A. 2), (A. 4) and the inequality $\lambda^{\beta T}>\Psi^{\beta T}$ are satisfied, the equilibrium output of the β- monopolist is greater and the profit of the monopolist is greater under a quota than under a tariff. Moreover country β is potentially better off under a quota than under a tariff.

5. Concluding remarks

In this paper we set up a simple general equilibrium two-country, three-good (two-final good and one nontraded intermediate good), many-primary factor trading model in which final goods are produced in perfectly competitive markets and the nontraded intermediate good is produced by a monopolist. In the model we examined the equivalence of tariffs and quotas, i. e., effects of the change in the regime from tariffs to quotas set at the equilibrium level of imports under tariffs on the behavior of the monopolist and on the welfare of the import country. We showed that even if the protected final good market is perfectly competitive, tariffs and quotas are *not* generally equivalent : The profits of the monopolists in both trading countries are always greater under quotas than under tariffs. Moreover if the value of the conjectural variation of the α-monopolist is greater (resp. smaller) than a positive critical value, the country α is potentially better off (resp. worse off) under quotas than under tariffs. Similarly, if the value of the conjectural variation of the β-monopolist is greater (resp. smaller) than a some critical value, the country β is potentially better off (resp. worse off) under quotas than under tariffs.

The economic intuition associated with our results are very clear. Even though the intermediate goods are not traded *directly*, they are traded indirectly, and that makes the monopolists behave as though their own products are traded.

Finally let us turn to the case where there exists factor market distortion in each country. We here restrict our attention to a simple case where the nominal wage is fixed constant and there exists unemployment of labor in each country. Then it is seen that the propositions 1 and 2 are still correct. Moreover the total amount of labor employed in each country is smaller under a quuota than under a tariff.

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