

ON THE EQUIVALENCE OF TARIFFS AND QUOTAS UNDER MACROECONOMIC FRAMEWORK

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ABSTRACT

This paper shows that the conventional equivalence between tariffs and quotas could be reserved under macroeconomic framework. We extend the equivalence in terms of national incomes and demonstrate that depending on the price elasticity of import demand and the size of export volumes, non-equivalence of tariffs and quotas ensues. We further take into account the risk attitude of the policy makers within the model and find that a risk-averse policy maker would prefer tariffs to mean-equivalent quota for the price-inelastic imported goods, while quota is preferred to tariffs for the price elastic imports. For the risk-loving policy makers, we obtain the opposite results.

I. INTRODUCTION

The issue of the equivalence of tariffs and quotas has been an interesting as well as a controversial one since Bhagwati (1965) published his seminal paper, "On the Equivalence of Tariffs and Quotas." Equivalence is defined as that a tariff rate brings an import level which when alternatively set as

a quota will result in the same price levels. And non-equivalence thus refers to the case that the price levels under tariffs and quotas will be different. Many researches have been done on this topic but with different means, for example, Bhagwati (1965,1968), Shibata (1968), and Sweeney, Tower, and Willett (1977) are all under monopolistic framework; Ono (1978) and Itoh and Ono (1982,1984) dealt with duopolistic behavior between an exporter and a host country firm. A general theme of these researches is that the equivalence breaks down with the introduction of monopoly elements into the various assumptions.

However, the above researches are mainly under microeconomic framework. Several researchers did address the issue of tariffs versus quotas from macroeconomic view points, such as Young and Anderson (1980,1982) and Young (1979,1980,1984). They found that under uncertainty tariffs schedule is by and large preferred to quotas. This paper modifies Young's (1984) analysis considering risk attitude and attempts to present some implications of tariffs and quotas for the policy makers in a synthesized and systematic way. In Section II, we re-establish the equivalence argument under macroeconomic setting. In Section III, we compare the effects of tariffs and quotas on national income under export disturbances. Henceforth, the equivalence of tariffs and quotas is referred to national incomes in lieu of price levels. In Section IV, we propose a model considering policy-maker's risk attitude toward fluctuations in national income. Summary and conclusion are reached in Section V.

II. THE EQUIVALENCE OF TARIFFS AND QUOTAS UNDER MACROECONOMIC SETTING

The national income under tariff regime Y^t can be expressed as the summation of aggregate expenditure A ($A=C+I+G$, where C denotes linear consumption function, I investment, and G government expenditure) and

exports X subtracting imports $P^t M$, where P^t is the import price under tariff rate t and import quantity M is a function of income Y^t and P^t :

$$Y^t = A(Y^t) + X - P^t M(Y^t, P^t) \quad (1)$$

Now, suppose the importing country imposes a quota \bar{M} at the level

$$\bar{M} = M(Y^t, P^t) \quad (2)$$

Under this quota regime, the national income Y^q and the import price P^q satisfy the following equations:

$$Y^q = A(Y^q) + X - P^q M(Y^q, P^q) \quad (3)$$

$$\text{and } M(Y^q, P^q) = \bar{M} \quad (4)$$

Proposition 1

For any fixed value X and any tariff rate t , if we impose the import quantity as a quota \bar{M} , then we would obtain the equivalence of tariffs and quotas in terms of national incomes and price levels.

Proof. By (1) and (2), (Y^t, P^t) satisfies the same pairs of equations as (3) and (4), we would have $Y^t = Y^q$ and $P^t = P^q$, provided (3) and (4) have a unique solution.

By (3), let function f be

$$f(Y^q, P^q) = Y^q - A(Y^q) + P^q M(Y^q, P^q) = X$$

We denote (3) by schedule K and (4) by schedule L .

By implicit function theorem, the slope of schedule K is given by

$$\frac{dY^q}{dP^q} = -\frac{df/dP^q}{df/dY^q} = -\frac{P^q M_p + M}{1 - A_y + P^q M^y} = -\frac{M_p + M/P^q}{M_y + s/P^q} \quad (5)$$

where the subscripts denote the various first derivatives.

Assuming investment I and government expenditure G remain fixed, then

$$1 - A_y = 1 - dA/dY = 1 - mpc = mps = s,$$

where mpc denotes marginal propensity to consume, and mps denotes marginal propensity to save.

By (4), let function g be $g(Y, P) = M(Y^q, P^q) = \bar{M}$.

By implicit function theorem, the slope of schedule L is:

$$\frac{dY^q}{dP^q} = -\frac{dg/dP^q}{dg/dY} = -\frac{M_p}{M_y} \quad (6)$$

Comparing (5) and (6), at all values of (Y, P) , M is always larger than s , schedule K is always steeper than schedule L , there is a unique intersection. So (3) and (4) have a unique solution, and we have $Y^t = Y^q$, $P^t = P^q$. Q.E.D.

Hence, we have proved that under tariff and the equivalent quota, we would obtain the same macroeconomic equilibrium, i.e., the same import level, the same national income, and the same domestic prices of import goods.

III. COMPARISONS OF TARIFFS AND QUOTAS UNDER EXPORT DISTURBANCES

Suppose that exports X fluctuates, we let u be a variable representing exports, then the home national income becomes:

$$Y^t(u) = A(Y^t(u)) + u - P^t M(Y^t(u), P^t) \quad (7)$$

In state u , the home country imposes a quota which equals $M(Y^t(u), P^t)$. This quota M changes with u . Assuming tariffs and import price P^t remains fixed in face of the exports disturbances, we have the following proposition.

Proposition 2

If the price elasticity of import demand $a < 1$, then $u \geq u_0$ implies $Y^t(u) \geq Y^q(u)$. (where u_0 is the unique intersection of $Y^t(u)$ and $Y^q(u)$).

Proof. We compare home national incomes schedules under tariffs and under quotas respectively. Initially, under tariff, by (7) we define a function f :

$$f(Y^t, u) = Y^t - A(Y) + P^t M(Y^t, P^t) - u = 0$$

By implicit function theorem,

$$Y_u^t = -\frac{df/du}{df/dY^t} = -\frac{-1}{1 - A_y + P^t M_y} = \frac{1}{S + P^t M_y} \quad (8)$$

When under quota, we know that domestic price of import goods $P^q(Y)$ is the solution to

$$\bar{M} = M(Y^q, P^q) \quad (9)$$

Similarly, by implicit function theorem,

$$P_y^q = \frac{dP}{dY} = -\frac{M_y}{M_p} \quad (10)$$

Further, national income $Y^q(u)$ satisfies

$$Y^q = A(Y^q) + u - P^q(Y^q)\overline{M} \quad (11)$$

Let function g be

$$g(Y^q, u) = Y^q - A(Y^q) + P^q(Y^q)\overline{M} - u = 0 \quad (12)$$

Again, by implicit function theorem,

$$\begin{aligned} Y_u^q &= -\frac{dg/du}{dg/dY^q} = -\frac{-1}{1 - A_y + P_y^q \overline{M}} \\ &= \frac{1}{s - M M_y / M_p} \quad \text{by (10)} \end{aligned} \quad (13)$$

Now, we shall show that $Y^t(u)$ and $Y^q(u)$ intersect at u_0 which satisfies $\overline{M} = M(Y^t(u_0), P^t)$ and that this u_0 is unique.

$$\begin{aligned} \text{At } u_0, \quad Y - A(Y) + PM(Y, P) &= u_0 \\ \overline{M} &= M(Y, P) \end{aligned} \quad (14)$$

Since $Y^q(u_0)$ satisfies (11) with $u = u_0$, $Y - A(Y) + P^q(Y)\overline{M} = u_0$ and $P^q(Y)$ satisfies (9), $\overline{M} = M[Y, P^q(Y^q(u_0))]$ then $Y^q(u_0)$, $P^q(Y^q(u_0))$ satisfy (14).

Similarly, since $Y^t(u_0)$ satisfies (7) with $u = u_0$, we have

$$\begin{aligned} Y - A(Y) + P^t M(Y, P^t) &= u_0 \\ \text{and } \overline{M} &= M[Y^t(u_0), P^t] \end{aligned}$$

then $Y^t(u_0)$, P^t also satisfy (14).

But (14) has a unique solution, so $Y^t(u_0) = Y^q(u_0)$ and $P^t = P^q(Y^q(u_0))$.
Hence, graphs of $Y^t(u)$ and $Y^q(u)$ have a unique intersection at $u = u_0$.

Next, we define the price elasticity of import demand as

$$a = -\frac{dM/M}{dP/P} = -\frac{PM_p}{M}$$

$$\text{at } [Y^t(u_0), P^t], \quad a = -P^t M_p / \bar{M} > 0 \quad \text{where } M_p < 0 \quad (15)$$

If $a < 1$, then $P^t < \frac{\bar{M}}{-M_p}$, multiply both sides of the above inequality by M_y :

$$P^t M_y < -\bar{M} \frac{M_y}{M_p}$$

add both sides by s , we get

$$s + P^t M_y < s - \bar{M} \frac{M_y}{M_p} \quad (16)$$

with (16), we compare (8) and (13) and have

$$Y_u^t > Y_u^q$$

i. e., $Y^t(u)$ is steeper than $Y^q(u)$.

Then for $u > u_0$, $Y^t(u)$ schedule is above $Y^q(u)$, $Y^t(u) > Y^q(u)$, and for $u < u_0$, $Y^t(u)$ schedule is beneath $Y^q(u)$, $Y^t(u) < Y^q(u)$. Hence, we have proved that

if $a < 1$, then $u \geq u_0$ implies $Y^t(u) \geq Y^q(u)$.

Q.E.D.

Proposition 2 shows that for high value of exports $u > u_0$, the home national income is higher under tariff than under equivalent quota. While for low value of exports $u < u_0$, the home national income is higher under quota than under equivalent tariff.

Similarly, the following proposition can be easily shown.

Proposition 3

If $a > 1$, then $u \geq u_0$ implies $Y^q(u) \geq Y^t(u)$.

Proof. From the proof in Proposition 2, specifically by (15). If $a > 1$, then $P^t > -\bar{M}/M_p$, multiply both sides of the above inequality by M_y :

$$P^t M_y > -\bar{M} M_y / M_p$$

and both sides by s , we have

$$s + P^t M_y > s - \bar{M} M_y / M_p \quad (17)$$

With (17), we compare (8) and (13) and have $Y_u^t < Y_u^q$, i. e.,

$Y^t(u)$ is flatter than $Y^q(u)$, then

for $u > u_0$, $Y^q(u)$ schedule is above $Y^t(u)$, $Y^q(u) > Y^t(u)$, and for $u < u_0$, $Y^q(u)$ schedule is beneath $Y^t(u)$, $Y^q(u) < Y^t(u)$. Q.E.D.

The policy implication of Propositions 2 and 3 is that the characteristics of the imported goods and the size of the exports volumes should be considered in the policy maker's decision process. For example, suppose the imported tobacco and wine are price inelastic and the exports volume of the country is large, imposing the tariff is a better choice than the equivalent

quota in raising the national incomes.

IV. COMPARING TARIFFS AND QUOTAS UNDER DIFFERENT RISK ATTITUDES OF POLICY MAKERS

Let the policy maker's risk attitudes toward fluctuations in national income be expressed by the degree of concavity of the utility function $U(Y)$, which is an increasing function of income Y , then we seek comparisons between tariffs and quotas valid for general utility functions.

Lemma 1

If $EY^t(u) \geq EY^q(u)$, then $U[EY^t(u)] \geq U[EY^q(u)]$.

Proof. Since we assumed that the utility function $U(Y)$ is an increasing function of national income Y , no matter the policy-maker is a risk-lover (with $U_{yy}(Y) > 0$), risk-neutral (with $U_{yy}(Y) = 0$), or risk-averser (with $U_{yy}(Y) < 0$), it holds true that $EY^t(u) \geq EY^q(u)$ implies $U[EY^t(u)] \geq U[EY^q(u)]$. Q.E.D.

Lemma 2

If $a < 1$, then $\bar{u} \geq u_0$ and $Y_{uu}^t(u) \geq Y_{uu}^q(u)$ imply $EY^t(u) \geq EY^q(u)$.

Proof. From Proposition 2:

if $a < 1$, then $u \geq u_0$ implies $Y^t(u) \geq Y^q(u)$.

we have: if $a < 1$, then $\bar{u} \geq u_0$ implies $Y^t(\bar{u}) \geq Y^q(\bar{u})$.

$$\text{or } Y^t(\bar{u}) - Y^q(\bar{u}) \geq 0. \tag{18}$$

where \bar{u} is the mean value of u .

By Jensen's inequality:

$$\begin{aligned} Y_{uu}^t(u) - Y_{uu}^q(u) \geq 0 \text{ implies } E[Y^t(u) - Y^q(u)] &\geq Y^t(\bar{u}) - Y^q(\bar{u}) \\ &\geq 0 \quad \text{by (18)} \end{aligned}$$

i. e., $Y_{uu}^t(u) \geq Y_{uu}^q(u)$ implies $EY^t(u) \geq EY^q(u)$. Q.E.D.

Lemma 3

If $a > 1$, then $\bar{u} \geq u_0$ and $Y_{uu}^q(u) \geq Y_{uu}^t(u)$ imply $EY^q(u) \geq EY^t(u)$.

Proof. From Proposition 3:

If $a > 1$, then $u \geq u_0$ implies $Y^q(u) \geq Y^t(u)$.

We have: If $a > 1$, then $\bar{u} \geq u_0$ implies $Y^q(\bar{u}) \geq Y^t(\bar{u})$.

$$\text{or } Y^q(\bar{u}) - Y^t(\bar{u}) \geq 0 \quad (19)$$

By Jensen's inequality:

$$\begin{aligned} Y_{uu}^q(u) - Y_{uu}^t(u) \geq 0 \text{ implies } E[Y^q(u) - Y^t(u)] &\geq Y^q(\bar{u}) - Y^t(\bar{u}) \\ &\geq 0 \quad \text{by (19)} \end{aligned}$$

i. e., $Y_{uu}^q(u) \geq Y_{uu}^t(u)$ implies $EY^q(u) \geq EY^t(u)$. Q.E.D.

By use of the above lemmas, we have the following propositions.

Proposition 4

If $a < 1$,

then $U_{yy} \geq 0$ and $Y_{uu}^t(u) \geq Y_{uu}^q(u)$ imply $U[EY^t(u)] \geq U[EY^q(u)]$.

Proof. By Jensen's inequality, $U_{yy} \geq 0$ implies $EU(Y) \geq U(\bar{Y})$

$$\text{or } U(Y_0) \geq U(\bar{Y})$$

where Y_0 is the certainty equivalent of national income Y , and \bar{Y} is the mean value of Y .

Since $U(Y)$ is an increasing function of national income,

$$U(Y_0) \geq U(\bar{Y}) \text{ implies } Y_0 \geq \bar{Y}$$

and since national income Y is an increasing function of the export disturbances u , $Y_0 \geq \bar{Y}$ implies $u_0 \geq \bar{u}$.

To summarize the above process, $U_{yy} \geq 0$ implies $\bar{u} \geq u_0$

By Lemma 2, we have:

If $a < 1$, then $U_{yy} \geq 0$ and $Y_{uu}^t(u) \geq Y_{uu}^q(u)$ imply $EY^t(u) \geq EY^q(u)$.

Further, by Lemma 1:

If $EY^t(u) \geq EY^q(u)$, then $U[EY^t(u)] \geq U[EY^q(u)]$.

Hence, we have:

If $a < 1$,

then $U_{yy} \geq 0$ and $Y_{uu}^t(u) \geq Y_{uu}^q(u)$ imply $U[EY^t(u)] \geq U[EY^q(u)]$. Q.E.D.

Proposition 4 shows that if $a < 1$, then a policy maker who is risk averse (with $U_{yy} < 0$) with respect to national income will prefer tariffs to mean-equivalent quotas, while the policy maker who is a risk lover (with $U_{yy} > 0$) will prefer quotas to mean-equivalent tariffs. Note that Y_{uu}^t and Y_{uu}^q represent the second derivative of Y^t and Y^q with respect to export u and should be considered by the policy maker.

Proposition 5

If $a > 1$,

then $U_{yy} \geq 0$ and $Y_{uu}^q(u) \geq Y_{uu}^t(u)$ imply $U[EY^q(u)] \geq U[EY^t(u)]$.

Proof. Similarly, as the proof in Proposition 4, we have

$$U_{yy} \geq 0 \text{ implies } \bar{u} \geq u_0$$

By Lemma 3, we have:

If $a > 1$, then $U_{yy} \geq 0$ and $Y_{uu}^q(u) \geq Y_{uu}^t(u)$ imply $EY^q(u) \geq EY^t(u)$.

Further, by Lemma 1:

If $EY^t(u) \geq EY^q(u)$, then $U[EY^t(u)] \geq U[EY^q(u)]$.

Hence, we have:

If $a > 1$,

then $U_{yy} \geq 0$ and $Y_{uu}^q(u) \geq Y_{uu}^t(u)$ imply $U[EY^q(u)] \geq U[EY^t(u)]$. Q.E.D.

Proposition 5 shows that for the price elasticity of import demand greater than 1, a policy maker who is risk averse (with $U_{yy} < 0$) with respect to national income would prefer quota to mean-equivalent tariff, while the policy maker who is a risk lover (with $U_{yy} > 0$) would prefer tariffs to mean-equivalent quotas. Also note that Y_{uu}^q and Y_{uu}^t measure the second derivative of Y^q and Y^t with respect to export u .

V. SUMMARY AND CONCLUSION

The conventional equivalence of tariffs and quotas argument could be re-established under macroeconomic framework. While the equivalence is instead referred to national income, we showed that depending on the price elasticity of import demand, the size of exports volumes would entail non-equivalence between tariffs and quotas. For price-inelastic import demand and for large exports volumes, the home national income is higher under tariffs than under equivalent quota. The opposite is true for small exports volumes. Hence, notwithstanding free trade gains, imposing a tariff on imported tobacco and wine seems to be a better policy than the equivalent quota in raising Taiwan's national income, assuming the demands for tobacco and wine are price inelastic.

When we take into account the risk attitude of the policy maker within our model, we found that a risk-averse policy maker would prefer tariffs to mean-equivalent quota for the price-inelastic imported goods, while quota is preferred to mean-equivalent tariffs for the price-elastic imports. To the contrary, for a risk loving policy maker, quota is a better measure if the imports are price inelastic, while tariff is preferred to quota if the price elasticity of import demand exceeds one. Therefore, the policy implication of this analysis is that the characteristics of the imported goods, the size of

the export volumes, and the risk attitudes of the policy makers all have a pull on selecting the appropriate policy instruments in raising national incomes.

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總體經濟架構下關稅與配額對等性 之研究

何 憲 章

摘 要

本文證明在總體經濟架構下，傳統的關稅與配額對等性依然成立。當對等性以國民所得為準時，依照進口需求的價格彈性及出口額大小，關稅及配額的不對等性存在。我們將政策製訂者的風險態度考慮於模型內發現：對於趨避風險的政策製訂者而言，當進口品的價格彈性小時，他會較偏好關稅；當進口品的價格彈性大時，他會較偏好配額。至於愛好風險的政策製訂者，我們獲得相反的結果。