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On the Welfare Effect of an Equivalent Tariff and Quota

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ABSTRACT

Over many years, the comparison of tariffs and quotas has retained an important place in the study of trade restrictions. This note shows that there are substantial differences in the welfare effects of an equivalent tariff and quota designed to achieve identical import restrictions. When there is an increase in demand, the deadweight loss from an import quota will be greater than that of a tariff. Geometric presentations are executed by way of comparative static analyses for a small open economy. Moreover, measurements of welfare effects in terms of the demand elasticity and the supply elasticity are explicitly derived algebraically. A case involving monopoly is also explored to highlight the relative merit of a tariff as a means of import restriction.

1. INTRODUCTION

IN A SMALL ECONOMY in which the volume of a traded commodity is an insignificant portion of that item in world trade, the imposition of a tariff or a quota will have a negligible effect on the country's terms of trade. Under such a condition, partial equilibrium analysis is a very useful tool to analyze the welfare effects of tariffs and quotas.

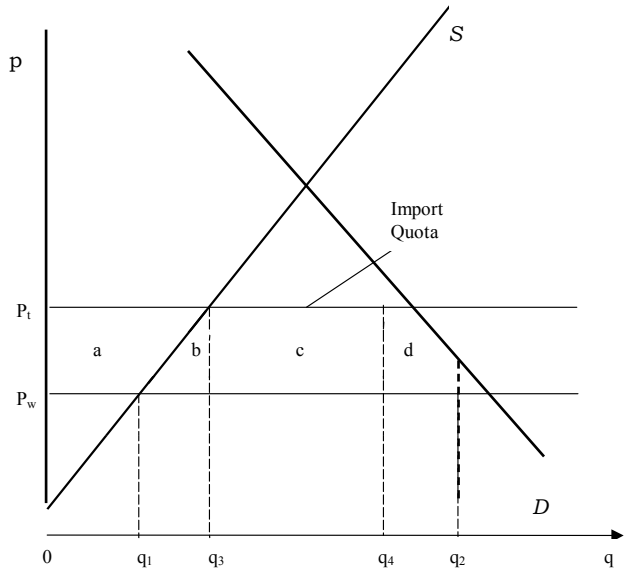
Even in the current WTO era, trade restrictions are still often used by many countries, especially among smaller developing economies.[2] The comparative static analysis of tariffs and quotas remains an important part of international trade teaching. Since an import quantity restriction can be accomplished by either import quota or tariff, the comparison of welfare effects of the equivalent tariff and quota becomes important in policy decision-making. In this brief note, we will present a simple geometric analysis of the 'equivalent' tariff and quota when the demand and supply conditions change. More precise measurement of the welfare (deadweight) loss and the specific composition of the welfare loss between the equivalent tariff and quota under changing demand can be computed by equations which involve both the elasticities of the domestic supply function and the demand function. In the last

section, some welfare effects of the equivalent tariff and quota in the presence of monopoly will be discussed. In order to simplify the presentation, the demand and the supply functions are assumed linear throughout and all the shifts in demand are parallel shifts.

2. EQUIVALENT TARIFFS AND QUOTAS

In Figure 1, given the demand (D) and the supply (S) of a traded commodity X in a small country and a constant world price (P_w), with free trade domestic production will be q_1, domestic consumption will be q_2, and there will be a sizable import of (q_2 - q_1). Suppose that in order to promote or protect domestic production, a certain degree of tariff is imposed. The domestic price will be raised to P_t (the price with a tariff), and domestic production will be q_3, domestic consumption will be q_4, and the size of imports will be reduced to (q_4 - q_3). The same result will be obtained if an import quota of (q_4 - q_3) is imposed. There is an equivalence between the tariff and the quota restriction with respect to the amount imported.

Figure 1: Demand and supply of a traded good X and the tariff



The trade restriction creates a sizable consumer surplus loss of the area (a + b + c + d). With the tariff, area (a) is the gain in producer surplus, and area (c) is the tariff revenue gain for the government, thus the net welfare loss (deadweight loss) is equal to area (b + d). However, there is a redistribu-

tion effect from consumers to producers (*a*) and to the government (*c*). With the equivalent quota, similar results will prevail except that area (*c*) will not automatically become government revenue unless the import licenses can be auctioned through a well designed competitive mechanism. Quite often import licenses are granted to producers or importers so that producers can gain area (*a* + *c*) or the importers gain (*c*) as rent. In a country with rampant corruption, licensees and government officials will most likely share this quota rent *c*.[3]

In Figure 1 the free trade price is given as P_w. With the *ad valorem* tariff protection the price rises to $P_t = P_w(1 + t)$, where t is the tariff rate in percentage form. After tabulating the changes in the consumer surplus, the producer surplus, and the government revenue the deadweight loss with tariff is represented by two triangles, *b* and *d*, which can be expressed in the following form:

$$DW_1 = \tfrac{1}{2} \cdot t \cdot P_w \cdot \Delta q_D + \tfrac{1}{2} \cdot t \cdot P_w \cdot \Delta q_S = \tfrac{1}{2} \cdot t \cdot P_w \cdot (\Delta q_D + \Delta q_S)$$

where $\Delta q_S = q_3 - q_1$, i.e. the rise in the production of q in figure 1; $\Delta q_D = q_2 - q_4$, i.e. the demand-side reaction; $P_w \cdot t$ is simply the change in the price after the tariff is applied. Clearly, the demand and supply elasticities with respect to the price change are:

$\varepsilon^D = (\Delta q_D / q_2)/(P_w \cdot t / P_w)$, and $\varepsilon^S = (\Delta q_S / q_1)/(P_w \cdot t / P_w)$, respectively.

Therefore:

$$\Delta q_D = \varepsilon^D \cdot t \cdot q_2 \text{ and } \Delta q^S = \varepsilon^S \cdot t \cdot q_1,$$

and

$$DW_1 = \tfrac{1}{2} \cdot t^2 \cdot P_w (\varepsilon^S q_1 + \varepsilon^D q_2). \quad (1)$$

It is easy to see that the graeter the supply and/or demand elasticities, the larger the distortion will be and consequently, a greater deadweight loss the country will incur. A detailed historical development of the (non)equivalence of quotas and tariffs can be found in Cagatay (1985, pp. 32-34)

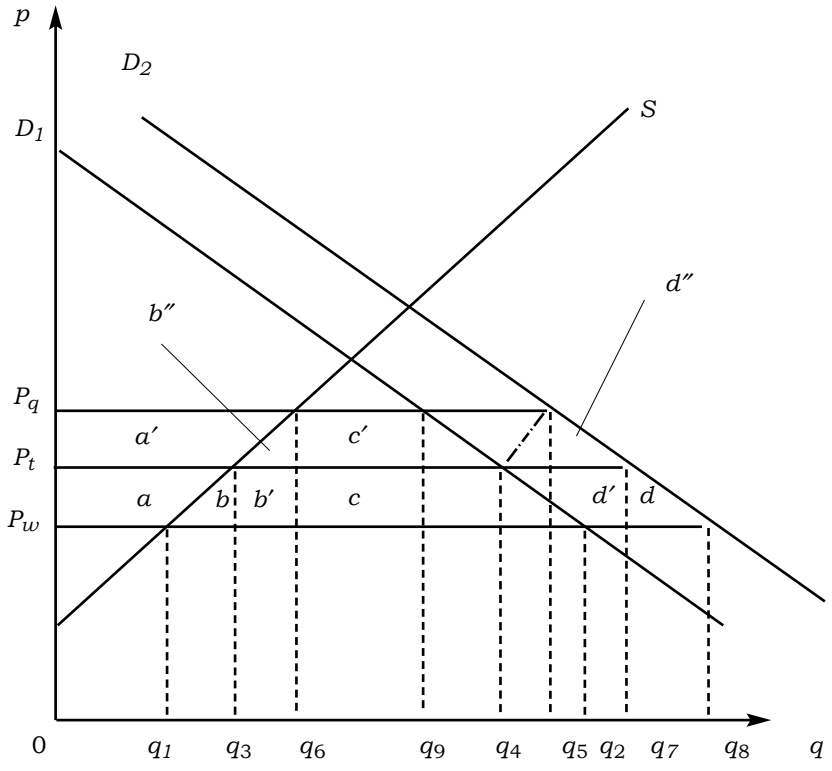
3. Comparative statics

The discussion in section 2 above is a brief synthesis of the standard analysis in international trade textbooks such as Krugman and Obstfeld (2003), Salvatore (2001) and Carbaugh (2004). We have explicitly shown the roles the demand elasticity and supply elasticity play in determining the total deadweight loss. Salvatore (2001, pp. 283-4) briefly discusses the effect of a change in the demand for *X* commodity but does not fully analyze the welfare effect. Suppose there is an increase in demand for *X* so that the demand curve shifts from D_1 to D_2 in Figure 2. Under the tariff, the price P_t and domestic produc-

tion q_3 will remain unchanged, but domestic consumption will increase from q_4 to q_7 and imports will increase from (q_4 - q_3) to (q_7 - q_3). The producer surplus (a) is unchanged, government tariff revenue (c) increases in proportional to the increase in imports[4] but the deadweight loss is unchanged, i.e. (b + d). There is a sizable consumer surplus increase.

However, with a strict import quota such that (q_5 - q_6) = (q_4 - q_3), the increase in demand will raise the price to P_q, producers will produce more at q_6 than at q_3 and will gain (a') as surplus, whilst the import license owners will reap huge profits, equal to (P_q - P_w)·(q_5 - q_6). Consumers' extra loss will be (a' + b" + c' + d") even though extra consumption means there is additional consumer surplus. The deadweight loss will be [(b + b' + b") + (d + d' + d")], equivalent to an additional loss of [(b' + b") + (d' + d")]. The producers' gain is substantial but the import license grantees will have potential quota rent as

Figure 2: Demand increase and welfare effect change



mentioned above.

The opportunity of securing the quota rent gives import license applicants strong incentives to bribe corrupt government officials in charge of granting the licenses. Producers also prefer maintaining a strict import quota for their benefit in an expanding economy.

In the case where demand decreases, P_t remains constant under the given tariff but imports decrease. The biggest loser is the government because of the reduction in tariff revenue, but producers continue to produce the same output with the same producer surplus. However, if the quota is maintained, and as long as P_q is higher than P_w, there is some quota-rent (profit) and the amount of the quota will be imported. With a lower price, consumers will enjoy greater consumer surplus which will come from the reduction in producer surplus and from import quota license holders' quota rent.

When demand rises from D_1 to D_2 in Figure 2, the deadweight loss remains the same as with the tariff, i.e. DW_1. But with quota the excess burden (DW_2) actually increases:

$$DW_2 = \tfrac{1}{2}\cdot\Delta q_{2S}\cdot\Delta P + \tfrac{1}{2}\cdot\Delta q_{2D}\cdot\Delta P = \tfrac{1}{2}\cdot\Delta P[\Delta q_{2S} + \Delta q_{2D}]$$

where $\Delta q_{2S} = q_6 - q_1$ and $\Delta q_{2D} = q_8 - q_5$, $\Delta P = P_q - P_w > P_w \cdot t$

Thus, in the case of an import quota with an increase in demand, we obtain the following expression for the deadweight loss:

$$DW_2 = \tfrac{1}{2}\cdot\Delta P\cdot(\Delta P/P_w)[\varepsilon^S q_1 + \varepsilon^D q_8] = \tfrac{1}{2}\,(\Delta P^2/P_w)(\varepsilon^S\, q_1 + \varepsilon^D\, q_8) \qquad (2)$$

This is because $\Delta q_{2S} = (\varepsilon^S\cdot\Delta P\cdot q_1)/P_w$ and $\Delta q_{2D} = (\varepsilon^D\cdot\Delta P\cdot q_8)/P_w$.

The extra welfare loss [$b' + b'' + d' + d''$], in the case of a demand increase with given import quota, can be computed as the difference between corresponding deadweight losses, i.e. DW_2-DW_1:

From (1), $DW_1 = \tfrac{1}{2}\, t^2\, P_w(\varepsilon^S\, q_1 + \varepsilon^D\, q^2)$
$= [\tfrac{1}{2}(P_w\, t)^2/P_w\,]\,(\varepsilon^S\, q_1 + \varepsilon^D\, q_2)$.

Thus, $DW_2 - DW_1 = \tfrac{1}{2}\,(\Delta P^2/P_w)\,(\varepsilon^S\, q_1 + \varepsilon^D\, q_2) - [\tfrac{1}{2}\,(P_w\, t)^2/P_w]\,(\varepsilon^S\, q_1 + \varepsilon^D q_2)$
$= (1/2P_w)\,\{\varepsilon^S\, q_1\,[\Delta P_2 - (P_w t)^2] + \varepsilon^D\,[\Delta P_2\, q_8 - (P_w\, t)^2\, q_2\,]\}$.

Since $\Delta P > P_w t$ and $q_8 > q_2$, we have $DW_2 > DW_1$. The converse holds true as well when there is a decline in demand, which can be proven analogously. Since the shifts in demand are frequent while changes in tariffs and quotas are infrequent, the implication of this result is that the level of the welfare loss can be kept stable by using a tariff rather than a quota.

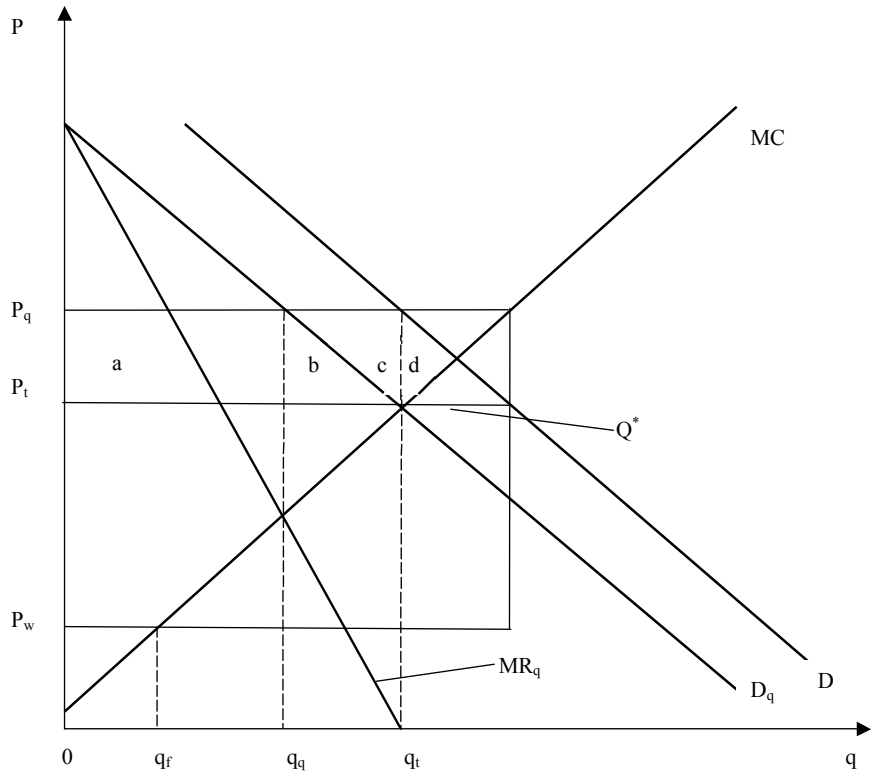
4. The equivalent tariff-and-quota with monopoly

Krugman and Obstfeld provided a brief discussion of the equivalent tariff and quota in the presence of a monopoly in the domestic market. They simply con-

cluded that under the quota the quantity produced would be less and the price higher than the case of the equivalent tariff.

In Figure 3 below, the equivalent tariff and quota will be shown with a decrease in the demand curve from *D* to D*q*, with the leftward shift equal to

Figure 3: Tariff and quota in the presence of a monopoly



the import quota *Q**. Suppose the domestic market is initially controlled by a monopoly firm. *MRq* would be the marginal revenue curve of the firm.

In the case where trade is unrestricted, the monopoly revenue is limited to area $M_f = (P_w)\cdot(q_f)$ because the monopolist cannot raise the price higher than the world price P_w. Other potential importers will be able to import at the world price by virtue of free trade. The monopolist is quite likely to be a loser and there would be a sizable consumer surplus. The government may wish to protect the monopoly industry (e.g. using the infant industry argument), either by imposing an import quota or the equivalent tariff. With the tariff, P_t will prevail and the monopolist will produce at q_t and total revenue will be $M_t = (P_t)(q_t)$. With the import quota, however, the monopolist can maximize its profit by

selling where his/her *MC* and MR_q are equal, thus the monopoly output is lowered to q_q and the price is raised to P_q. The extra consumer surplus loss is represented by area $(a + b + c + d)$ where (a), which is equal to $(P_q - P_t)\cdot(q_q)$, is the gain for the monopolist. The parallelogram $(c + d)$, with $(c + d) = (P_q - P_t)\cdot(Q^*)$, is the extra gain in quota rent for the import quota grantees. The total import quota rent will be $Q^*(P_q - P_w)$. The size of $(c + d)$ depends upon the elasticity of demand *D*. The more inelastic the demand, i.e. the steeper the *D* curve, the higher will be P_q and the increase in the quota rent will be greater. On top of the mal-distribution effect of $(c + d)$ from consumers to importers and (a) from consumers to producers, there is a net deadweight loss of (b).

Let the net deadweight loss $(b) = DW_m$. As before, P_t is the price with tariff and P_q is the price with quota. The elasticity of demand $\varepsilon^D = (\Delta q/q_t)/(\Delta P/P_t)$. So, $\Delta q = (\varepsilon^D \cdot q_t \Delta P)/P_t$. Therefore,

$$DW_m = \tfrac{1}{2} \cdot (\Delta P)\ (\varepsilon^D \cdot q_t \cdot \Delta P/P_t) = 1/2(\Delta P^2)\ (\varepsilon^D \cdot q_t/P_t) \qquad (3)$$

Thus, in the presence of monopoly, consumer welfare will be maximized only with free trade. If for any reason imports must be restricted, a tariff should be used rather than the equivalent import quota in order to avoid the rent-seeking (e.g. bribing) activities by the monopolist and import license applicants on one hand and to minimize consumer welfare loss on the other.

5. Conclusions

By employing the concepts of consumer surplus, producer surplus, and deadweight loss, a comparative study of the welfare effects of an equivalent tariff and quota is conducted in this paper. The analysis is carried out by both geometric and algebraic methods, and it provides an elementary but rigorous outcome in terms of varying demand and supply elasticities. An application involving the presence of a domestic monopoly producer demonstrates that in order to achieve a given degree of import restriction, a tariff is to be preferred to a quota in order to keep welfare losses to a minimum.

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Endnotes

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2. For example, the champion of free trade — the United States government, has recently imposed a substantial tariff on imported steel.

3. An alternative trade restriction, the voluntary export restriction (VER), can be adopted with similar results. In this case, *c* will be foreign exporters' gain and the welfare loss for the country will be area $(b + c + d)$.

4. The increase in the tariff revenue is $(P_t - P_w)\ (q_7 - q_4)$.

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