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TARIFF-QUOTA NON-EQUIVALENCE IN A COMPETITIVE GENERAL EQUILIBRIUM FRAMEWORK

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Abstract

We construct a standard multi-sector, multi-factor general equilibrium model, with goods outnumbering factors to argue that in such a general structure, tariff and quota can have drastically different impacts on trade patterns. This result casts doubt on one of the fundamental results in the theory of commercial policy.

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TARIFF-QUOTA NON-EQUIVALENCE IN A COMPETITIVE GENERAL EQUILIBRIUM FRAMEWORK

1. Introduction

Tariff-quota equivalence in a competitive market is one of the fundamental results in the theory of commercial policy. However, there are situations where such equivalence breaks down as one introduces several distortions in the system. Moreover, when such equivalence breaks down, a quota stands out as a more restrictive device than a tariff. The well-known contribution in the literature is by Bhagwati (1969). Subsequently, interesting papers by Fishelson and Flatters (1975), Pelcovitz (1976), Young and Anderson (1980), Kaempfer and Marks (1994) and others have discussed several facets of the problem. When all are said and done, the twin results of equivalence in a competitive market and the strength of quota as a more stringent, restrictive device than tariff are quite well accepted.

This paper attempts to challenge the twin results in terms of a multi-sector, multi-factor competitive general equilibrium model. First, we prove that when goods out number factors, quota and tariff can have drastically different implications on trade volume. This violates the equivalence result. Second, while one can guarantee some imports through a quota, its "equivalent tariff" would wipe out all imports, making the tariff a more restrictive policy.

Surprisingly, the model we use is a very common one which starkly reveals the role of general equilibrium in generating such results. We are not claiming that tariff and quota would not be equivalent under some stringent assumptions, but rather that they would be rarely equivalent in the general equilibrium model. For instance, Leontief's (1954) original test of the Heckscher-Ohlin model includes 38 traded goods and 2 factors of production. Likewise, in all available empirical models of trade, the number of goods far exceed that of factors.

The plan of the paper is as follows. Section 2 describes the model and the results. The last section concludes the paper.

2. Model and Results

Consider a small open economy with n goods and m factors of production, $n > m$. Production of each good is characterised by constant returns to scale (CRS) and diminishing marginal productivity. The demand structure assumes a simple Cobb-Douglas form with α_j being the share of expenditure on the jth good, $j = 1, ..., n$.[1]

The following symbols are used to describe the model:

P_j = price of the jth good, $j = 1, ..., n$.

w_i = price of the ith factor, $I = 1, ..., m$.

c_j = unit production cost of jth good.

X_j = production of the jth good.

V_i = inelastic supply of the ith factor.

D_j = demand for the jth good.

a_{ij} = per unit requirement of the ith factor in the production of the jth good.

$A \equiv \{a_{ij}\}$ = the n x m matrix with elements a_{ij}.

$w = \{w_i\}$ = the factor price vector.

$p = \{p_j\}$ = the commodity price vector.

$X = \{X_j\}$ = output vector.

$V = \{V_i\}$ = factor endowment vector.

From a small country's viewpoint, in the absence of protection, commodity prices are arbitrarily chosen in the world market. Hence, only m goods will be produced and the remaining (n - m) goods must be imported.[2] Although quotas on multiple goods can be considered, we narrow the focus on a single quota. Assume that for some good $k = m + 1$, unit cost c_k is less than the foreign price p_k^*, and that the government imposes and import quota Q^o to encourage some domestic production. Let us consider production of $k = (m + 1)$ goods, and appropriately define a submatrix A^o with k x k elements, a vector p^o and X^o with k elements each. Following Jones and Scheinkman (1977), we know that given p^o, the assumptions made so far, the following system of equations describing a competitive equilibrium generates a unique solution w^o.[3]

$$A^o w^o = p^o. \tag{1}$$

Note that in (1) only m output prices are independent, and they completely determine the factor prices. Although factor prices are uniquely determined, quantities are not, since we have more goods than factors of production. Let

$$c_j \equiv a_{1j}\, w_1 + a_{2j}\, w_2 + \dots a_{mj}\, w_m$$

denote the unit cost of good j. The typical price-unit cost equality relationships for these goods in competitive markets in (2a) must hold if any positive amount of these goods are to be produced.

$$c_j = p_j, j = 1, \dots, m, m + 1. \tag{2a}$$

Since the first m goods are freely traded, we have

$$c_j = p_j^*, j = 1, \dots, m, \tag{3a}$$

and by assumption

$$c_k > p_k^*, k = m + 1. \tag{3b}$$

Next, consider the set of (n - k) goods, which are not produced, indexing them by j = k + 1, ..., n. Note that in the absence of protection, domestic price p_j is given exogenously (small country assumption); factor prices (w_1, ..., w_m) are determined from (1) and by the CRS assumption; (a_{1j}, ..., a_{mj}) are functions of (w_1, ..., w_m). Since these goods are not produced, we assume that

$$c_j > p_j, j = k + 1, \dots, n, \tag{2b}$$

This assumption is made to start from the premise that these (n - k) goods will not be produced and consumption would rely solely on imports.

If the unit cost c_k exceeds the foreign price p_k^*, no domestic output is produced in that industry in the absence of intervention. Because of the Cobb-Douglas utility function, the demand curve approaches the price axis asymptotically. However, the residual demand curve, $D_k - Q^o$, has a vertical intercept if $Q^o > 0$. Given a binding import quota Q^o, if no domestic output is forthcoming, the domestic price rises to $p_k'(Q^o)$ in Figure 1. Let $I^o = \Sigma_I w^o_i V_i$ denote national income when the quota Q^o is imposed. It follows from out assumption that

$$p_k D_k = \alpha_k I^o. \tag{4}$$

Note that w_i^o is already known from (1), and α_k is given by the Cobb-Douglas preferences, $0 < \alpha_k < 1$. Hence, (4) determines domestic demand for good k, $D_k = D_k^o = \alpha_k I^o / p_k$. Since the quota is binding, quota Q^o is less than the import demand, D_k^o, as shown in Figure 1.

We are now in a position to discuss the implications of a quota and a tariff in the kth sector. As long as the quota is binding, competitive domestic producers take the residual demand ($D_k - Q^o$) as theirs, and supply that amount at the unit cost c_k. This process does not alter the factor price vector w^o but changes the output mix, X. For instance, if there were only three goods and two factors of production, K and L, and $k = 3$, domestic production of $X_3 = D_3^o - Q^o$ determines the input requirements (K_3, L_3), thereby leaving ($K - K_3$, $L - L_3$) for the production of the other two goods, whose production would then be determinate. However, if $n > k + 1$ and only one import quota is used, many different output compositions of the remaining goods would be feasible. Since this does not affect out subsequent argument, we leave it in the background.[4]

Since the quota is binding, some domestic output, $X_k^o = D_k - Q^o$, will be produced at unit cost c_k. The equivalent tariff of the quota is then defined by

$$t_k = c_k - p_k^*. \tag{7}$$

The Uruguay Round agreement on agricultural products includes "tariffication" of all nontariff border measures (conversion to tariff-equivalents). Tariffs resulting form the "tariffication" process are then to be reduced by a simple average of 36 percent over six years in the case of developed countries and 24 percent over 10 years in the case of developing countries.

Now suppose that in line with this requirement, the government replaces the quota by its equivalent tariff, thereby fixing the domestic price to c_k, equal to the domestic price under the quota. But now the *entire demand* D_k° can be satisfied by domestic production. The domestic demand for good k $D_k^{\circ} \equiv \alpha_k I^{\circ} / (p_k^{*} + t_k)$ remains unaffected by tariffication, because the domestic prices remain unchanged. One can release the resources from the initial endowment V to permit the increased production of kth good, and adjust outputs in the other sectors without affecting the domestic prices and hence factor prices w_j's. The domestic output X_k can be expanded to absorb the entire import demand with imports completely vanished from the scene. That is, tariffication of an import quota into its "equivalent" tariff eliminates import totally.

In the three-good, two-factor case, suppose that when an import quota is used on good 3 the country exports good 1 and that import of good 2 is zero. When the import quota Q° is replaced by its equivalent tariff, the resulting output mix also causes a drastic change in the trade patterns of the other two goods. For instance, this elimination of imports Q° must be balanced by a reduction in export of good 1 or an increase in import of good 2, or both.

Concluding Remarks

We have used a rather simple model and exploited the standard properties of a competitive general equilibrium structure in which the number of goods exceeds that of factors. This general model suggests that tariff and quota would have drastically different implications for total imports. Replacing an import quota by its "equivalent" tariff, as envisioned in the Uruguay Round agreement on agricultural products, wipes out imports in that sector, and hence necessarily requires adjustment in other sectors. This adjustment in other sectors may involve a reduction of exports in one sector or creation or an increase in imports in other sectors, or both. While a quota helps to sustain imports, a tariff may reduce them drastically, forcing a radical adjustment in the pattern of trade. The n x m structure was used to highlight the generality of the result.

One should note that when the domestic tariff-ridden price is given by $P_w + t$ there may arise a degree of indeterminacy of the equilibrium. At that price anyone may buy the product either from the foreign source or from the domestic source and therefore the quota-equivalent import of the product is a possibility. But one must appreciate the other possibilities as well including the one where imports vanish. In this sense there are infinitely possible 'non-equivalence' outcomes. The probability that we should hit the equivalence result is negligible.

Our result naturally holds in a Ricardian model where the number of goods exceeds the number of factors. By the same argument, if one starts with a typical n x n Heckscher-Ohlin-model and allows one factor to be internationally mobile, with its return determined exogenously, the stage is set for application of our result.

It should be noted that in his first test of the heckscher-Ohlin (HO) theory, using 1947 data, Leontief (1954) employed 50 sectors, of which 38 were traded good sectors. Since Leontief used only two factors, capital and labor, the n/m ratio was approximately 20. Using the U.S. trade pattern in 1951, Leontief (1956) conducted a second test of the HO theory, in which he decomposed the U.S. economy into 192 sectors. Since capital and labor were the only primary factors, the n/m ratio was approximately 100 in that study.

In a more recent test of the HO trade theory, Stern and Maskus (1981) constructed an HO model with three inputs for the period 1958 - 1976: physical capital, human capital, and labor. They classified industries into three categories: the Ricardian goods, the HO goods, and the Product Cycle goods. Intuitively, in the production of Ricardian goods, natural resource components (e.g., weather, mineral deposits) are important. the HO Goods are characterised by the use of standardised technology, whereas the Product Cycle goods are produced by constant product innovation. When they focused narrowly on the HO goods, the number of HO industries varied over the years, exceeding 120 industries during most of the period considered. Thus, in the Stern and Maskus study, the n/m ratio was about 40.

In a popular textbook, Caves, Frankel, and Jones (1993) also observed that 14,000 classifications of commodities enter the arena of international trade of the U.S. In this case, the n/m ration is about 7,000. All these empirical studies of U.S. trade patterns indicate that the n/m ratio far exceeds one, being perhaps one hundred or even higher.

One cannot hope to observe such an even case in the real world, except by coincidence. In so far as n far exceeds m, the chance that one would observe the supposed equivalence in the real world is virtually nil for all practical purposes. It would not be too far from the truth to claim that in a world with more goods than factors, tariff and quota would rarely have the same impact on trade patterns, contrary to the age-old belief.

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Endnotes

1. This assumption is not necessary for the generality of the result, however.

2. Even some of the m goods may be imported under free trade if their domestic production is insufficient.

3. Actually, only m equations are necessary to determine the unique factor prices. Unit costs of other goods can be derived from these factor prices.

4. If binding quotas on (n - m) goods are imposed, domestic production of those goods can be determined, and hence the remaining output mix can be completely determined.

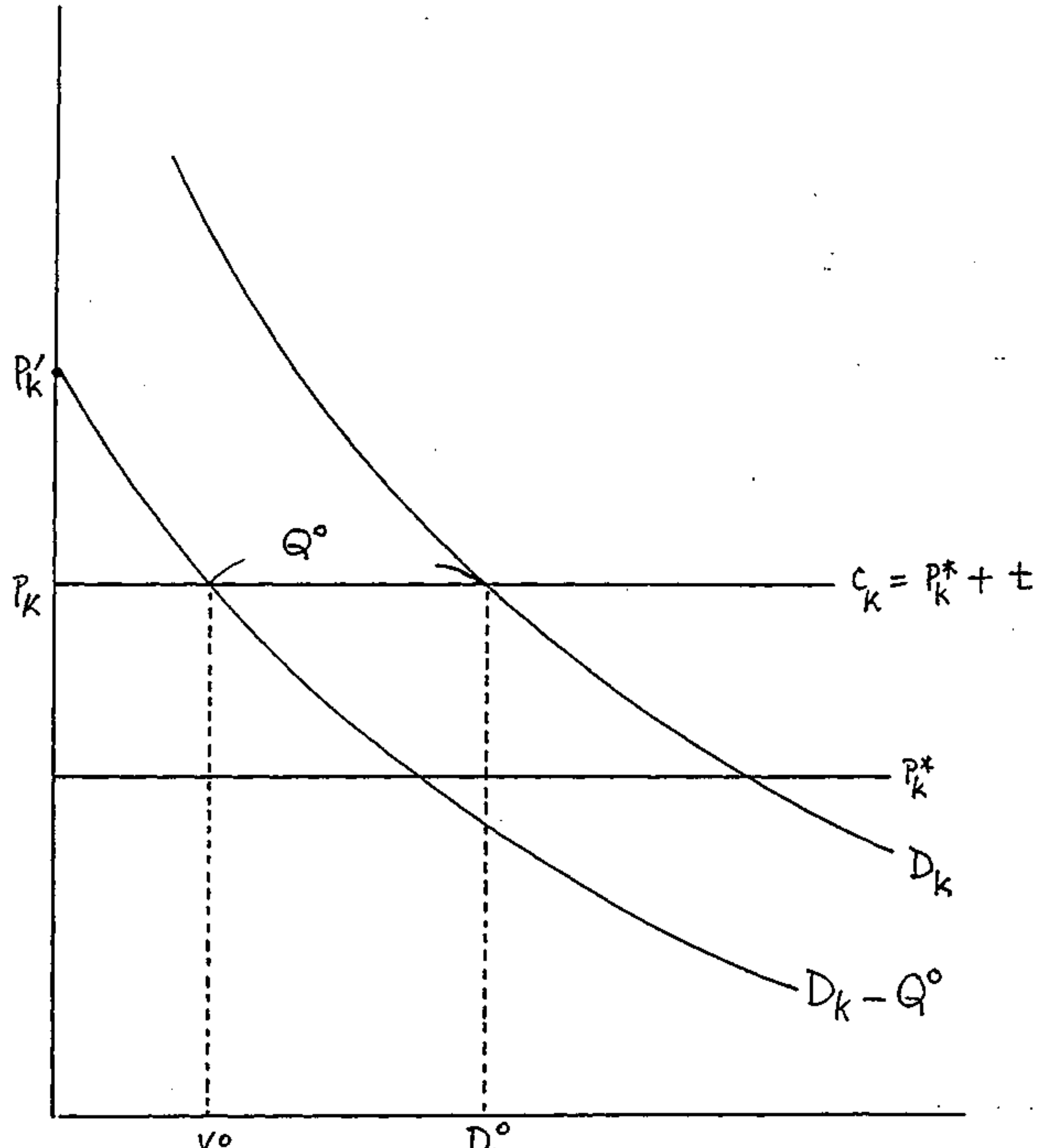

Figure 1.

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