On the Revenue Implication of Trade Liberalization under Bertrand Competition

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In this paper we set up a simple model of a small open economy in which the government imposes an import tariff on intermediate goods and a profit tax on the profits of domestic oligopoly firms that produce final goods by using the intermediate goods. We examine whether the government can collect enough profit tax revenue to compensate the loss of government revenue caused by a tariff reduction when firms produce differentiated goods and compete in a Bertrand-Nash fashion. We will show that, for any given number of firms, there always exists a degree of product differentiation such that the government can always find a profit tax to achieve its objective. Under this reform both consumers and firms can be better off and the government can keep its revenue unchanged at the level before the tariff reduction. It is also shown that the government needs higher degree of product differentiation when firms compete in prices than when firms compete in quantities to attain the goal of the tariff and tax reform.

Ⅰ. Introduction

The deepening of globalization in the last two decades can be observed, for example, in a rapid increase of number of WTO members from 77 in 1995 to 157 in 2012. Also the number of regional trade agreements reported to WTO has increased from 27 in 1990 to 352 (in forth) in 2012. More than 80 % of the members in WTO are regarded as developing and transitional market economy countries. Those developing and transitional market economy countries have liberalized their good/service markets as well as capital markets. It appeared that the developing countries that have relied relatively large share of the government revenue on the import tariff revenue have been suffered with the decline of governments' revenue associated with the reduction of import tariffs. Thus those countries were forced to work on the reform of domestic tax systems to raise their government revenue.

As an example of empirical analyses, among others, Khattry and Rao (2002), using a panel of 80 developing and developed countries over 1970 to 1998, showed that low-income and upper middle-income countries have experienced declining tax revenues as a result of falling income and trade tax revenues and that structural characteristics of the economies have been significant in explaining the decline. Using panel data for 117

countries over the period 1975-2006, Baunsgaard and Keen (2010) examined whether countries have recovered from domestic taxes the revenues they have lost by the trade liberalization and showed that high income and middle income countries have succeeded in replacement of tax bases. However the result for low income countries shows that the recovery of the revenue has still been, in many instances, problematic.[1)]

This revenue issue has attracted much attention of many theorists in the area of international trade and public finance. In a perfectly competitive framework, Hatzipanayotou, Michael and Miller (1994) set up a general equilibrium model of a small open economy in which some factors of production are internationally mobile and showed that a uniform tariff reduction accompanied by consumption tax increase to hold consumer prices constant raises both national welfare and government revenue if the initial position provides a net subsidy to producers. Keen and Ligthart (2002) extended their analysis to include non-traded goods and intermediate inputs and showed that the tariff- tax reform which keeps consumer prices constant raises both national welfare and government revenue.

Some writers have extended the analysis on this coordinated tariff-tax reform issue to those in imperfectly competitive settings. Keen and Ligthart (2005) worked on the same types of tariff and tax reform under an international duopoly setting and showed that both the point-for-point reform and the reform which keeps consumer price unchanged unambiguously reduce national welfare. This result shows a sharp contrast to that obtained by the same authors in a compefitive small open eonomy setting. Naito and Abe (2008) extended Keen and Ligthart (2005) by introducing a vertical trade of inputs to a model where domestic oligopolists produce their final goods by using imported inputs and compete with foreign exporters in domestic final good market. The government imposes import tariffs both on intermediate inputs and imported final goods and also imposes consumption tax on final goods. They derived the conditions under which the government can raise national welfare without reducing its revenue. These analyses focused on the reform under imperfect competition in which domestic consumption tax is used as a policy measure of the reform associated with tariff reduction.

On the other hand, Mujumdar (2004) and Haque and Mukherhee (2005) focused on the case where the government relies on profit tax imposed on domestic firms as a policy tool for the reform. Mujumdar (2004) set up a small open economy model where there exist n identical oligopoly firms in an industry, and

each firm produces a final good by using a key imported input and sells all products in the domestic market. The price of imported input is assumed to be determined in the world market and constant. The government imposes both an import tariff on the input and a profit tax on the profit of each firm in the market. He showed that (i) only when the industry is a monopoly, the profit tax alone can generate enough revenue to make up for the shortfall in tariff revenue caused by a reduction in the tariff rate while ensuring that consumers and producers are still better off than their respective pre-tariff reduction states, and (ii), for any given profit tax rate, as the number of firms in the industry increases, the likelihood of the profit tax alone being able to meet the revenue-welfare objective of the government will become lower.

A reduction of import tariff on the imported input (intermediate good) reduces the cost of oligopoly firms and raises both the output and the profit of each firm. Thus consumers are also better off by the reduction of the import tariff on the input. On the other hand, the profit tax does not affect equilibrium output of each firm. Thus Mujumdar (2004) showed that if the number of firms is very small and is actually equal to one, that is, the industry is a monopoly, and the profit of the firm is relatively high then the government can collect enough profit tax revenue to make up for the decline in the tariff revenue while ensuring both consumers and producers are better off in comparison to their respective pre-tariff reduction states.

In the Mujumdar setting, all firms are assumed to produce a homogenous final good and compete in a Cournot-Nash fashion. Haque and Mukherhee (2005) extended the Mujumdar analysis to a setting where the oligopoly firms produce heterogeneous differentiated goods and compete in a Cournot-Nash way. They showed that the Mujumdar result is not robust when the products are differentiated and that there always exists a degree of product differentiation such that the government can achieve Mujumdar's goal for any finite number of firms.

Here one may naturally have a following question: How robust is the Haque and Mukherhee (2005) result if the oligopoly firms that are producing differentiated goods compete in a Bertrand-Nash fashion? Can their result survive even when the firms compete in their prices?

Our paper is closely related to Mujumdar (2004) and Haque and Mukherhee (2005) and aims to examine the above question. We will show that the Haque and Mukherhee (2005) result can survive even when firms compete in a Bertrand-Nash fashion, but the probability that the government can achieve its gool of the reform would be smaller because the market is generally

considered to be more competitive under Bertrand competition than under Cournot competition.

This paper is organized as follows. In section Ⅱ we review the model and results of Haque and Mukherhee (2005). In section Ⅲ, we set up a simple model where firms compete in a Bertrand-Nash way and compare our result with that of Haque and Mukherhee (2005). Our concluding remarks are in section Ⅳ.

Ⅱ. Cournot-Nash Equilibrium

Following Haque and Mukherhee (2005), we set up a simple model of a small open economy with an industry with n firms. Firms are symmetric, have the same cost function and import a key input. The price of the input is determined in the world market and kept constant. One unit of output of each firm requires one unit of input. The cost of assembling the input is, for simplicity, assumed to be zero.

We assume that the utility function of the domestic consumers is of a quasi-linear quadratic form:

$$U = a\sum_{i=1}^{n} q_i - \frac{1}{2}\sum_{i=1}^{n} q_i^2 - \theta\sum_{i\neq j}^{n-1} q_i q_j + m, \tag{1}$$

where $a>0$ denotes a positive parameter, q_i (q_j) denotes the output of firm i(firm j) ($i, j = 1, 2, \ldots, n, i \neq j$), and $\theta \in [0, 1]$ is a parameter which shows the degree of product differentiation. When $\theta = 0$, the products are isolated goods and when $\theta = 1$, the products are perfect substitutes and are homogeneous goods. The term m is the consumption of the numeraire good and its price is normalized to 1. The budget constraint for the consumers can be written as $\sum_{i=1}^{n} P_i q_i + m = I$, where P_i is the price of good i and I denotes consumers' constant income. The first-order conditions for the utility maximization can be written as

$$\frac{\partial U}{\partial q_i} = a - q_i - \theta\sum_{j\neq i}^{n-1} q_j - P_i = 0, \quad i, j = 1, 2, \ldots, n, i \neq j \tag{2}$$

From the first-order conditions we obtain the inverse demand function for good i as:

$$P_i = a - q_i - \theta\sum_{j=1}^{n-1} q_j,\ i = 1, 2, \ldots, n \text{ and } i \neq j \tag{3}$$

Let p^f denote the import price of the input and t be an ad valorem tariff imposed on each unit of input. Let q_i denote output of firm $i (i = 1, 2, \ldots, n)$. The total cost of firm i can be written as $C_i = p^f(1+t)q_i$. For simplicity, we assume away any other costs of production. We assume the oligopolists compete in a Cournot-Nash fashion.

The net profit of firm i can be written as $(1-T)[P_i - p^f(1+t)]q_i$, where $T \in (0, 1)$ is a profit tax imposed by the government. The optimal output of firm i and the total industry output can be written as

$$q_i^C = \frac{a - p^f(1+t)}{2+\theta(n-1)} \quad \text{and}$$

$$Q^C \equiv nq_i^C = \frac{n[a-p^f(1+t)]}{2+\theta(n-1)} \quad (4)$$

where the variable with superscript C denotes that it is the value of the variable in Cournot-Nash equilibrium. The equilibrium price of the product of firm i is

$$P_i^C = \frac{a+[1+\theta(n-1)]p^f(1+t)}{2+\theta(n-1)}, \quad (5)$$

From (4) and (5), the pre-tax profit of industry can be written as

$$\Pi^C = [P_i^C - p^f(1+t)]Q^C$$
$$= n[\frac{a-p^f(1+t)}{2+\theta(n-1)}]^2 \quad (6)$$

Let us now turn to the effects of a tariff and tax reform by the government under trade liberalization. We assume the government reduces the ad valorem tariff rate imposed on the input, and see whether the government can rely on the profit tax to make up for the decline in the tariff revenue caused by the tariff reduction.

We can see from (4) and (5) that tariff reduction raises the output of each firm and reduces the price of each product. Thus consumers are made better off by the tariff reduction. Since the national welfare consists of consumer surplus, domestic industry profit and the government revenue, the government now can confine its attention to its revenue and industry profit.

Hence we now examine whether the following two requirements are satisfied: (i) the industry's after-tax profit in the post-liberalization is greater than its pre-liberalization level and (ii) the total revenue of the government in the post-liberalization is kept to be equal to its pre-liberalization level. The above two requirements (i) and (ii) may be written formally as:

$$T_A\Pi_A^C + t_A p^f Q_A^C = T_B\Pi_B^C + t_B p^f Q_B^C \quad (7)$$

and

$$(1-T_A)\Pi_A^C > (1-T_B)\Pi_B^C, \quad (8)$$

where the variable with subscript A (resp, B) denotes its post-liberalization (resp, pre-liberalization) state. We can rewrite (7) and (8) together as

$$\Pi_A^C - \Pi_B^C > t_B p^f Q_B^C - t_A p^f Q_A^C. \quad (9)$$

We can easily find from (6) that the left hand of (9) is positive: $\Pi_A > \Pi_B$. We can see that the right-hand of (9) can be rewritten as

$$t_B p^f Q_B^C - t_A p^f Q_A^C = \frac{np^f}{2+\theta(n-1)}(t_B - t_A)$$
$$[a-p^f(1+t_A+t_B)] \quad (9)'$$

Thus the tariff reduction ($t_A < t_B$) reduces the tariff revenue if

$$a > p^f(1+t_A+t_B). \quad (10)$$

We assume that (10) is satisfied. Recalling (4) we see that (10) is sufficient for the positive output of each firm in the market. Note that if the increase in the industry's pre-tax profit is larger than the shortfall in the tariff revenue, the government can change the profit tax rate in a way to make up for the reduction in the revenue. Since firms are symmetric, we can rewrite (9) as

$$[P_A^C - p^f(1+t_A)]Q_A^C$$
$$-[P_B^C - p^f(1+t_B)]Q_B^C > t_B p^f Q_B^C - t_A p^f Q_A^C \quad (11)$$

or

$$\frac{Q_A^C}{Q_B^C} > \frac{P_B^C - p^f}{P_A^C - p^f}, \qquad (11)'$$

Substituting (4) and (5) in (11)', we may rewrite (11)' as

$$\frac{a - p^f(1+t_A)}{a - p^f(1+t_B)} > \frac{a - p^f + [1+\theta(n-1)]p^f t_B}{a - p^f + [1+\theta(n-1)]p^f t_A} \qquad (12)$$

or

$$\theta < \frac{p^f(t_A + t_B)}{(n-1)[a - p^f(1+t_A+t_B)]} \equiv \theta^C. \qquad (13)$$

We find that if $\theta = 1$ then (13) reduces to the case in Mujumdar (2004) where firms produce homogeneous products. Since $a > p^f(1+t_A+t_B)$ from (10), $\theta^C > 0$ for any finite number of firms. It follows that, for any given number of firms, the government can achieve its objective when the products are sufficiently differentiated. As the number of firms increases, θ^C becomes smaller and thus the likelihood that the government can achieve the objective becomes smaller as well. However since $\theta^C > 0$, there always exists a degree of product differentiation such that the government can attain this objective for any finite number of firms. Then Haque and Mukherjee (2005) have reached following Proposition 1.

Proposition 1 (Haque and Mukherjee (2005))

(i) For any given number of firms, there always exists a degree of product differentiation such that the government can always find a profit tax to achieve the objective.

(ii) As the number of firms increases, the likelihood that the government can always find a profit tax to achieve the objective decreases.

Proposition 1 (i) in Haque and Mukherjee (2005) shows sharp contrast to Mujumdar (2004) in that product differentiation introduces a bias in favor of profit taxes relative to tariffs as a source of revenues. The tariff reduction reduces the tariff revenue on one hand, and on the other hand, it raises the profit of each firm by reducing cost of production. Thus higher profit with higher profit tax revenue raises the government's profit tax revenue. If the product differentiation is maximal ($\theta = 0$) and each product is isolated then it implies that each of n firms is a monopolist for its product. Thus in this situation, the result of Mujumdar (2004) holds for each of n monopolists: The higher profit tax revenue can make up for the reduction of tariff revenue. Since outputs and profits are continuous with the value of degree of product differentiation (i.e., the value of θ), each firm becomes a near monopolist for its product when the products are sufficiently differentitated.

Proposition 1 (ii) shows that there exists a negative relationship between n and θ^C. As n increases, the competition between firms also increases. Hence, higher product differentiation is required

to increase profit significantly so that enough profit tax can be generated to compensate the loss of tariff revenue. Thus, for a given degree of product differentiation, an increase in n reduces the likelihood that profit tax compensates the loss of tariff revenue caused by a tariff reduction.

Ⅲ. Bertrand-Nash Equilibrium

1. The model of price competition

In this section we study the welfare effect of a tariff and tax reform when domestic firms compete in a Bertrand-Nash fashion and see how the difference in the mode of firms' competition affects the results in Proposition 1. To that end, we first derive explicitly the demand function which firm k will face.

Solving the first-order conditions for the utility maximization of the consumers, we obtain, after some calculations, the demand function firm k faces as follows:

$$q_k = \frac{[1+\theta(n-2)](a-P_k)-\theta\sum_{j\neq k}^{n-1}(a-P_j)}{(1-\theta)[1+\theta(n-1)]}. \tag{14}$$

Recall that p^f denotes the import price of an input which is constant irrespective of the imports by the firms. The government imposes an ad valorem tariff t on each unit of input. Therefore, the total cost of firm k is $C_k = p^f(1+t)q_k$. We here assume that domestic firms compete in a Bertrand-Nash fashion. The after-tax profit of firm k can be written as

$$\pi_k = (1-T)[P_k - p^f(1+t)]q_k,$$

where $T \in (0,1)$ denotes profit tax rate. The first-order condition for the profit maximization of firm k can be written as

$$\frac{[1+\theta(n-2)](a-P_k)-\theta\sum_{j\neq k}^{n-1}(a-P_j)}{(1-\theta)[1+\theta(n-1)]} - [P_k - p^f(1+t)]\left\{\frac{1+\theta(n-2)}{(1-\theta)[1+\theta(n-1)]}\right\}=0$$
$$k=1,\ldots,n \tag{15}$$

Since all domestic firms are symmetric and impose the same price: $P_k \equiv P$, the equilibrium price can be written as

$$P^B = \frac{(1-\theta)a + p^f(1+t)[1+\theta(n-2)]}{2+\theta(n-3)} \tag{16}$$

where the variable with superscript B denotes that it is the value of the variable in Bertrand-Nash equilibrium.

The optimal output of each firm and the total industry output are, respectively,

$$q^B = \frac{[a-p^f(1+t)][1+\theta(n-2)]}{[1+\theta(n-1)][2+\theta(n-3)]}, \tag{17}$$

and

$$Q^B \equiv nq^B = \frac{n[a-p^f(1+t)][1+\theta(n-2)]}{[1+\theta(n-1)][2+\theta(n-3)]} \tag{18}$$

Finally, pre-tax industry profit Π^B becomes

$$\Pi^B = [P^B - p^f(1+t)]Q^B = \frac{n(1-\theta)[a-p^f(1+t)]^2[1+\theta(n-2)]}{[1+\theta(n-1)][2+\theta(n-3)]^2} \tag{19}$$

2．The welfare effect of tariff-tax reform

We first see that, even when the firms compete in Bertrand-Nash way, the government can generate sufficient profit tax revenue and make up for any shortfall in tariff revenue associated with trade liberalization. It is seen from (16) and (17) that a tariff reduction leads to lower price and lager output level in equilibrium. Therefore, the consumers can be unambiguously better off. Thus the government here again can confine its attention only to its revenue and industry profit.

The government's objective is thus to satisfy following two requirements: (i) the total revenue in the post-liberalization is equal to its pre-liberalization level, and (ii) the industry's after-tax profit in the post-liberalization is greater than its pre-liberalization level. We here again formulate the requirements (i) and (ii) as

$$T_A\Pi_A^B+t_Ap^fQ_A^B=T_B\Pi_B^B+t_Bp^fQ_B^B \tag{20}$$

and

$$(1-T_A)\Pi_A^B>(1-T_B)\Pi_B^B, \tag{21}$$

The above two requirements in (20) and (21) can be written together as

$$\Pi_A^B-\Pi_B^B>t_Bp^fQ_B^B-t_Ap^fQ_A^B. \tag{22}$$

Note that a tariff reduction implies $t_A<t_B$. Then we find from (19) that if $t_A<t_B$ then $\Pi_A^B>\Pi_B^B$, and that the left-hand side of equation (22) is positive.

Assume here that the tariff reduction reduces the tariff revenue, i.e., $t_Bp^fQ_B^B-t_Ap^fQ_A^B>0$. We here see under what condition the reduction of tariff rate reduces the tariff revenue. Recalling (18) we find that

$$t_Bp^fQ_A^B-t_Ap^fQ_B^B=\frac{np^f[1+\theta(n-2)]}{[1+\theta(n-1)][2+\theta(n-3)]}(t_B-t_A)[a-p^f(1+t_A+t_B)] \tag{23}$$

Thus it follows that if

$$a-p^f(1+t_A+t_B)>0 \tag{24}$$

then the tariff reduction ($t_A<t_B$) reduces the tariff revenue. We assume (24) is satisfied.

In the case of input tariff reduction, if the increase in the industry's pre-tax profit is greater than the shortfall in tariff revenue, the government can raise a profit tax rate in a way to make up the shortfall in its revenue. Substituting (19) into (22), we obtain that

$$[P_A^B-p^f(1+t_A)]Q_A^B-[P_B^B-p^f(1+t_B)]Q_B^B>t_Bp^fQ_B^B-t_Ap^fQ_A^B,$$

or

$$\frac{Q_A^B}{Q_B^B}>\frac{P_B^B-p^f}{P_A^B-p^f}. \tag{25}$$

Note that symmetry implies that each firm charges the same equilibrium market price. Substituting (16) and (18) into (25), we find that

$$\frac{a-p^f(1+t_A)}{a-p^f(1+t_B)}>\frac{(1-\theta)(a-p^f)+[1+\theta(n-2)]p^ft_B}{(1-\theta)(a-p^f)+[1+\theta(n-2)]p^ft_A},$$

or

$$\theta<\frac{p^f(t_A+t_B)}{(n-1)[a-p^f(1+t_A+t_B)]+p^f(t_A+t_B)}\equiv\theta^B \tag{26}$$

Since $\theta^B>0$ in (26), we see, by the similar reasoning to that in the Cournot

competition case, that, for any given finite number of firms, the government can achieve its goal to compensate the loss of tariff revenue if the products are sufficiently differentiated.

If there is only one firm in the market, the monopoly earns monopoly rent. Therefore, the government can collect sufficient revenue through the profit taxation. However, as the number of firms increases, the industry becomes more competitive implying that the market comes close to perfect competition where each firm earns zero profit. In this case, the government cannot achieve its goal. Nevertheless, if the products of domestic firms are sufficiently differentiated, the firms can have some price control and can earn higher profits. Thus the government can collect larger amount of profit tax revenue.

Comparing our result in (26) with that of Haque and Mukherjee (2005) in (13), we see that $\theta^B < \theta^C$ and that the government needs higher degree of product differentiation in the domestic market to compensate the loss of tariff revenue under Bertrand competition than under Cournot competition.[2)] As shown by Vives (1985), this is because the competition among firms under price competition is more intense than that under quantity competition. In a Cournot competition, firms choose its output level taking the other firms' outputs as given. Since each firm recognizes that if one firm raises its output level then the price of the products will fall, each firm would not expand the output level too much. On the other hand, in a Bertrand competition, each firm chooses its price of the product taking other firms' prices as given. Since the prices are viewed as constant, each firm does not pay much attention to the fall in price due to the output expansion. Therefore, in equilibrium, the prices and the profits are higher under Cournot competition than under Bertrand competition. Thus, it is more difficult for the government to collect enough profit tax revenue under price-setting game than under quantity-setting game. We can summarize our result in Proposition 2:

Proposition 2

(i) When firms compete in a Bertrand-Nash fashion, for any given number of firms, there always exists a degree of product differentiation such that the government can always find a profit tax to achieve its objective. Under this reform both consumers and firms can be better off and the government can keep its revenue unchanged at the level before the tariff reduction.

(ii) The degree of product differentiation in the domestic industry must be higher to make up for shortfall in tariff revenue through the profit taxation under price competition than

under quantity competition.

Thus we have shown in Proposition 2 that even when domestic firms compete in their prices, there exists a degree of product differentiation that the government can achieve its goal to make up for the loss of tariff revenue by raising profit tax on the firms. However, the degree of product differentiation must be higher than that when firms compete in their prices in the market.

Ⅳ. Concluding Remarks

In this paper we set up a simple model of a small open economy in which the government imposes import tariff on intermediate goods and profit tax on the profits of domestic oligopoly firms that produce final goods by using the intermediate goods.

In the setting, Mujumdar (2004) showed that when firms produce a homogeneous good and compete in Cournot-Nash fashion, the government can collect enough profit tax revenue to compensate the loss of government revenue caused by the tariff reduction only when the market is a monopoly. Under this reform both consumers and the monopoly can be better off and the government can keep its revenue unchanged at the level before the tariff reduction.

Haque and Mukherjee (2005) extended the model of Mujumdar (2004) to a case where the products of the firms are differentiated and firms compete in a Cournot-Nash fashion. They have shown that the result by Mujumdar is not robust and that there always exists degree of differentiation of the products such that the government can achieve its goal for any finite number of firms.

In this paper we studied the case where the products are differentiated and firms compete in a Bertrand-Nash fashion. Since, as is shown in Vives (1985), it is common wisdom that price competition is more competitive and more efficient than the quantity competition, it is not so certain that the results of Haque and Mukherjee (2005) can survive to the case where firms compete in a Bertrand-Nash fashion. We have shown that the results of Haque and Mukherjee (2005) can survive even when firms compete in prices. However, it was also shown that there needs higher degree of product differentiation when firms compete in prices than when firms compete in quantities for the government to attain the goal of tariff and tax reform.

A number of developing countries are competing to attract foreign direct investment (FDI) from abroad. Attracting foreign firms are considered to bring various benefits to the host countries such as increases in domestic employment, increase in the business opportunities of local firms, spillovers of technical and/or management know-how to local firms, broadening of tax base and so on.

Therefore including foreign firms in the domestic market in our setting would be an interesting direction of extending our analysis. This work however would be left as our future research.

Notes

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1) Kowalski (2005) also provided a comprehensive review of empirical papers and a simulation of the welfare effects of reducing tariffs and simultaneously replacing recline of the revenues by domestic consumption tax. On the other hand, Acharya (2010), by setting up a computable general equilibrium (CGE) model of Nepal, also examined, among others, the effects of replacement of domestic taxes with import tariff on the income distribution and national welfare.

2) We assume that the government imposes the same import tariff rates, t_B and t_A regardless of the mode of competition of domestic firms.

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