Optimal tariffs for the co-existence of exporting and non-exporting firms

Kazuhiro Takauchi
Tomomichi Mizuno

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Optimal tariffs for the co-existence of exporting and non-exporting firms

Kazuhiro Takauchi*† Tomomichi Mizuno‡

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Abstract

We consider an optimal tariff policy with the coexistence of less efficient non-exporting and efficient exporting firms. Using a two-way oligopoly trade model with a firm's quadratic cost, we show that the optimal tariff rate is U-shaped with respect to the efficiency of non-exporting firms. This implies that under tariff competition, if relative production efficiency increases, both possibilities appear, that is, trade liberalization or protectionism can progress. We also show that the profit of the non-exporting firm can be greater than that of the exporting firm when the production efficiency of the non-exporting firm is sufficiently high.

Key words: Optimal tariff; Non-exporting firm; Two-way trade; Quadratic cost

JEL classification: F12; F13

*Corresponding author: Kazuhiro Takauchi, Faculty of Business and Commerce, Kansai University, 3-3-35 Yamate-cho, Suita, Osaka 564-8680, Japan. E-mail: kazh.takauch@gmail.com; Tel.: +81-6-6368-1817; Fax: +81-6-6339-7704.

†Research Fellow, Graduate School of Economics, Kobe University, 2-1 Rokkodai-cho, Nada-ku, Kobe-City, Hyogo 657-8501, Japan.

‡Graduate School of Economics, Kobe University, 2-1 Rokkodai-cho, Nada-ku, Kobe-City, Hyogo 657-8501, Japan. E-mail: mizuno@econ.kobe-u.ac.jp.

1 Introduction

As shown by Brander and Spencer (1984a, b) and Helpman and Krugman (1989), import tariffs can raise national welfare by shifting rents from foreign oligopoly firms to domestic firms. Hence, each country has an incentive to protect its domestic industry, especially the manufacturing industry. It is well known that in many manufacturing industries, the exporting firm is only a part of the entire industry. In general, within an industry, some firms export, but other firms only supply goods domestically (Bernard et al., 2007; Freund and Pierola, 2015).[1] In addition, it has been empirically demonstrated that exporting firms are more efficient in production than non-exporting firms (Clerides et al., 1998). If exporting and non-exporting firms coexist, what is the optimal tariff policy? How does the difference in production efficiency between exporting and non-exporting firms affect the optimal tariff rate?

This study considers a situation in which, using a two-country two-way oligopoly trade model, non-exporting firms and exporting firms coexist. The non-exporting firm is less efficient than the exporting one. Furthermore, non-exporting firms supply only domestically, whereas exporting firms conduct both exports and domestic supply. Under this setting, we show that the optimal tariff rate can be higher or lower owing to the degree of inefficiency of non-exporting firms.

A decrease in non-exporting firms' efficiency reduces their output and consumer surplus. By contrast, the import and domestic supply of exporting firms increases. Hence, whether the optimal tariff becomes high or low depends on government preference; that is, the government compensates for a reduction in consumer surplus by using either imports or the domestic supply of the exporting firm. When the efficiency of non-exporting firms is high, it is desirable for welfare to compensate for a reduction in consumer surplus to use an increase in imports. In this case, the government lowers the tariff rate for a fall of the non-exporting firm's efficiency. Conversely, if the

[1] For example, according to Bernard et al. (2007), in US data of 2002, the proportion of exporting firms in the entire manufacturing industry was 18%.

efficiency of a non-exporting firm is low, it is desirable for welfare to compensate for a reduction in consumer surplus to increase the domestic supply of the exporting firm. The government then increases the tariff rate if the non-exporting firm's efficiency decreases. Our analysis contributes to the literature by showing the specific conditions under which tariff competition results in a higher tariff, that is, protectionism continues, or in a lower tariff, that is, trade liberalization advances.

We also show that the profit of a non-exporting firm can be greater than that of an exporting firm. If the efficiency of the non-exporting firm is relatively high, its output is larger than the exports and domestic supply of the exporting firm. Therefore, the profit of the non-exporting firm is greater than that of the exporting firm. This result indicates that a less efficient domestic firm is not always inferior to an efficient exporting firm.

This study is related to the following works, which assume a quadratic cost function for the firms. Choi (2022) considers a competition mode in which exporting firms choose whether price or quantity is a strategic variable. Khoi et al. (2019) examine the optimal tariff policy under many-firm intra-industry trade. However, they do not consider the existence of a non-exporting firm or the differences in production efficiency among firms. In addition, Choi (2022) uses a third-market model, and hence, it does not consider a two-way trade situation.

Although the argument on the optimal tariff under an oligopoly market is in many branches, for example, we can mention the following three strands of literature.[2] The first is the argument on discriminatory tariffs (e.g., Choi, 1995; Hwang and Mai, 1991; Liao and Wong, 2006). The second argument is related to the vertical production structure (e.g., Ara and Ghosh, 2016; Ishikawa and Lee, 1997; Lahiri and Ono, 1999).[3] Third, studies have focused on the relationship with public policy, such as privatization (e.g., Chao and Yu, 2006; Long and Stähler, 2009; Pal

[2]Recently, optimal tariff policy under monopolistic competitive model with firm heterogeneity is also considered. See, for example, Felbermayr et al. (2013).

[3]In addition these, Takauchi (2011) considers optimal tariff policy for an importing country within a free trade area with vertically related markets.

and White, 1998). Choi (1995) compares the effects of the discriminatory tariff regime and the most favored nation clause on the technology choice of firms. Hwang and Mai (1991) focus on the relationship between discriminatory tariffs and firms' cost differences. Liao and Wong (2006) consider the differences in the preferable tariff regime between exporting and importing countries. Ara and Ghosh (2016) examine the optimal tariff under vertical specialization. Ishikawa and Lee (1997) find that tariffs may harm domestic inputs and final good producers. Lahiri and Ono (1999) consider tariff policies when producers and sellers differ. Chao and Yu (2006) consider the effect of partial privatization of publicly owned firms or foreign competition on optimal tariff policy. Long and Stähler (2009) show that optimal tariffs can be independent of the degree of state ownership. Pal and White (1998) consider the effects of privatization on optimal tariff and subsidy policies. Although these studies offer interesting results, their purposes and models differ substantially from ours.

The remainder of this paper is organized as follows. Section 2 presents the model, and Section 3 presents the results. Finally, Section 4 concludes the study.

2 Model

We consider Brander and Krugman's (1983) two-way trade model. There are two countries, A and B, and each country i ($i = A, B$) has two firms that produce homogenous goods. In each country, there are two types of firms: one engaging in only domestic supply, which we call a *non-exporting firm*. The other, which engages in both domestic supply and export, is called an *export firm*. The cost function of non-exporting firm i is $\gamma(q_i^d)^2/2$; $\gamma \geq 1$ represents the degree of production inefficiency compared to the exporting firm, and q_i^d is the firm's output. The cost function of exporting firm i is $(q_{ii}^e + q_{ij}^e)^2/2$, q_{ii}^e is the domestic supply, and q_{ij}^e represents exports ($i, j = A, B$ and $i \neq j$). A quadratic cost function is a popular setting and is often employed in oligopoly models (e.g., see Goerke, 2022; Von Weizsacker, 1980).

The inverse demand function in country i ($i = A, B$) is given by $p_i = a - q_i^d - q_{ii}^e - q_{ji}^e$, where p_i is the price of homogenous good and q_{ji}^e are the imports from country j ($j \neq i$).

Each country i imposes a specific tariff, t_i for imports. Hence, the profits of the non-exporting firm, π_i^d, and exporting firm, π_i^e, are given by

$$\pi_i^d \equiv p_i q_i^d - \frac{\gamma}{2}(q_i^d)^2, \tag{1}$$

$$\pi_i^e \equiv p_i q_{ii}^e + (p_j - t_j)q_{ij}^e - \frac{(q_{ii}^e + q_{ij}^e)^2}{2}. \tag{2}$$

A simple two-stage game is analyzed. In the first stage, each country independently and simultaneously decides on the tariff rate t_i to maximize total surplus. In the second stage, non-exporting and exporting firms compete in a Cournot manner in each market. The equilibrium concept is a subgame perfect Nash equilibrium; hence, the game is solved using backward induction.

3 Results

In the second stage of the game, each firm decides on its quantity. The FOCs for profit maximization are $a - q_{ii}^e - \gamma q_i^d - 2q_i^d - q_{ji}^e = 0$, $a - 3q_{ii}^e - q_{ij}^e - q_i^d - q_{ji}^e = 0$, and $a - q_{ii}^e - 3q_{ij}^e - q_{jj}^e - q_j^d - t_j = 0$, where $i, j = A, B$ and $i \neq j$. These FOCs yield the following second-stage output.

$$\begin{aligned}
q_i^d(t_i, t_j) &= \frac{3a(3\gamma + 4) + (4\gamma + 6)t_i - (\gamma + 2)t_j}{(3\gamma + 4)(5\gamma + 8)}, \\
q_{ii}^e(t_i, t_j) &= \frac{3a(3\gamma^2 + 7\gamma + 4) + (9\gamma^2 + 23\gamma + 14)t_i + (9\gamma^2 + 28\gamma + 22)t_j}{3(3\gamma + 4)(5\gamma + 8)}, \\
q_{ij}^e(t_i, t_j) &= \frac{3a(3\gamma^2 + 7\gamma + 4) - (3\gamma + 5)[2(\gamma + 1)t_i + (7\gamma + 10)t_j]}{3(3\gamma + 4)(5\gamma + 8)}.
\end{aligned} \tag{3}$$

In the first stage, the objective function of country i is total surplus.

$$SW_i \equiv CS_i + \pi_i^d + \pi_i^e + t_i q_{ji}^e,$$

where $CS_i = (q_i^d + q_{ii}^e + q_{ji}^e)^2/2$ is consumer surplus. By using (3), we obtain $SW_i(t_i, t_j)$. The

FOCs for the maximization of $SW_i(t_i, t_j)$ yield the following best-response function $BR_i(t_j)$.

$$
\begin{aligned}
t_i = BR_i(t_j) \equiv & \frac{3a(3\gamma+4)(33\gamma^3+133\gamma^2+212\gamma+130)}{1503\gamma^4+9276\gamma^3+21253\gamma^2+21428\gamma+8020} \\
& + \frac{(72\gamma^4+429\gamma^3+913\gamma^2+794\gamma+220)\,t_j}{1503\gamma^4+9276\gamma^3+21253\gamma^2+21428\gamma+8020} \quad \text{for} \quad i,j=A,B;\ i \neq j.
\end{aligned}
$$

This $BR_i(t_j)$ yields the following result.

Lemma 1. *The best response of each country is a strategic complement.*

Proof. From $BR_i(t_j)$, $\partial BR_i/\partial t_j > 0$ for $i \neq j$. □

When the foreign country (country j) raises the tariff rate, the exporting firm of country i decreases exports and increases domestic supply. At that time, if country i reduces its tariff rate, imports increase, and the domestic supply of the exporting firm decreases. To improve national welfare, it is necessary to increase the domestic supply of exporting firms; thus, country i also raises its tariff rate.

The best-response function of each country, BR_i, yields the optimal tariff rate:

$$
t_i^* = \frac{a(33\gamma^3+133\gamma^2+212\gamma+130)}{159\gamma^3+771\gamma^2+1232\gamma+650}. \tag{4}
$$

From (4), we establish Proposition 1.

Proposition 1. *I. Suppose* $1 \leq \gamma \leq \gamma^* \simeq 1.40847$. *A decrease in the production efficiency of the non-exporting firm (i.e., an increase in* γ*), lowers tariff rate. II. Suppose* $\gamma > \gamma^*$. *A decrease in the production efficiency of the non-exporting firm increases the tariff rate.*

Proof. Differentiating (4) with respect to γ, we obtain

$$
\frac{\partial t_i^*}{\partial \gamma} = \frac{8a(537\gamma^4+1737\gamma^3+343\gamma^2-3445\gamma-2795)}{(159\gamma^3+771\gamma^2+1232\gamma+650)^2}.
$$

By solving $\partial t_i^*/\partial \gamma \geq 0$ for γ, we find that $\partial t_i^*/\partial \gamma \geq (<) 0$ if $\gamma \geq (<) \gamma^* \simeq 1.40847$. □

Proposition 1 states that a tariff race can result in both lower and higher tariff rates. An increase in γ reduces the output of non-exporting firms and consumer surplus. This reduction in consumer surplus is partly compensated by an increase in the domestic supply of exporting firms and foreign firms' exports. Whether the government increases or decreases its tariff rate depends on whether the government prefers to rely on either an increase in the domestic supply of the exporting firm or an increase in exports of the foreign firm.

When γ is small, the output of the non-exporting firm significantly decreases as γ increases. Then, if the government compensates for the loss of consumer surplus using only an increase in the domestic supply of the exporting firm, because the marginal cost of the exporting firm increases widely, it is not desirable for welfare. In this case, lowering the tariff rate to promote exports of the foreign firm, and not increasing the exporting firm's marginal cost, is optimal for welfare.

By contrast, when γ is large, the consumer surplus does not so decrease, even if γ increases. Hence, even though the government compensates for the loss of consumer surplus mainly by increasing the domestic supply of the exporting firm, the firm's marginal cost does not so increase. Therefore, the government increases the tariff rate.

The equilibrium output is given by:

$$q_i^{d*} = \frac{2a(3\gamma+5)(17\gamma+26)}{159\gamma^3+771\gamma^2+1232\gamma+650}, \tag{5}$$

$$q_{ii}^{e*} = \frac{a(45\gamma^3+187\gamma^2+266\gamma+130)}{159\gamma^3+771\gamma^2+1232\gamma+650}, \quad q_{ij}^{e*} = \frac{6a\gamma(\gamma+3)(2\gamma+3)}{159\gamma^3+771\gamma^2+1232\gamma+650}. \tag{6}$$

(5) and (6) yield the following result:

Lemma 2. *I.* $(q_{ii}^{e*} + q_{ij}^{e*}) - q_i^{d*} > 0$ *for all* $\gamma \geq 1$.

II. (i) If $\gamma < \gamma_1 \simeq 1.20542$, *then* $q_i^{d*} > q_{ii}^{e*} > q_{ij}^{e*}$. *(ii) If* $\gamma_1 < \gamma < \gamma_2 \simeq 7.43869$, $q_{ii}^{e*} > q_i^{d*} > q_{ij}^{e*}$. *(iii) If* $\gamma > \gamma_2$, *then* $q_{ii}^{e*} > q_{ij}^{e*} > q_i^{d*}$.

Proof. See Appendix.

The exporting firm's productivity is higher than that of the non-exporting firm, so the total sales (total amount of domestic supply and exports) of the exporting firm is larger than that of the non-exporting firm. However, the individual outputs are different. The exporting firm must pay a tariff to export; hence, the domestic supply is always larger than its exports. In addition, the cost of the tariff exists, so the domestic supply of the exporting firm can be smaller than that of the non-exporting firm. If γ is sufficiently small, the non-exporting firm is highly efficient; hence, its output is larger. Thus, when γ is sufficiently small ($\gamma < \gamma_1$), the output of the non-exporting firm is the largest among all outputs. On one hand, because the output of the non-exporting firm decreases as γ increases, the output of the non-exporting firm is smaller than that of the exporting firm when γ is sufficiently large ($\gamma > \gamma_2$).

From (1) and (2), the equilibrium profits are:

$$\pi_i^{d*} = \frac{2a^2(\gamma+2)(3\gamma+5)^2(17\gamma+26)^2}{(159\gamma^3+771\gamma^2+1232\gamma+650)^2}, \tag{7}$$

$$\pi_i^{e*} = \frac{3a^2(2529\gamma^6+21242\gamma^5+73601\gamma^4+134364\gamma^3+136548\gamma^2+73840\gamma+16900)}{2(159\gamma^3+771\gamma^2+1232\gamma+650)^2}. \tag{8}$$

From (7) and (8), Proposition 2 is established.

Proposition 2. *I. If a non-exporting firm is relatively efficient, that is,* $\gamma < \gamma_3 \simeq 1.04676$, *then the profit of the non-exporting firm is larger than that of the exporting firm. Otherwise, the profit of the non-exporting firm is lower than that of the exporting firm.*

II. A decrease in the production efficiency of the non-exporting firm decreases its profit, but increases the profit of the exporting firm.

Proof. See Appendix.

From Lemma 2, when γ is sufficiently small, the output of the non-exporting firm is the largest among all other outputs. The non-exporting firm's profit increases as γ decreases. On the one hand, the exporting firm must pay a tariff, so the export is less efficient than domestic supply. Production inefficiency is a negative factor for exporting firms. Hence, when γ is sufficiently small, the profit of the non-exporting firm is greater than that of the exporting firm.

The output of non-exporting firm i decreases as γ increases. Then, because the strategic substitute works, exporting firm i's domestic supply and foreign exporting firm j's exports increase. The situation is the same in country j, so the exports of exporting firm i increase. Hence, if γ increases, the profit of the non-exporting firm decreases, whereas the profit of the exporting firm increases.

The equilibrium consumer surplus and total surplus are

$$CS_i^* = \frac{a^2(\gamma+3)^2(57\gamma^2+172\gamma+130)^2}{2(159\gamma^3+771\gamma^2+1232\gamma+650)^2}, \tag{9}$$

$$SW_i^* = \frac{2a^2(3\gamma+5)(17\gamma+26)(57\gamma^4+406\gamma^3+1118\gamma^2+1389\gamma+650)}{(159\gamma^3+771\gamma^2+1232\gamma+650)^2}. \tag{10}$$

From (9) and (10), the following result is obtained:

Proposition 3. *A decrease in the production efficiency of the non-exporting firm reduces consumer surplus and total surplus.*

Proof. See Appendix.

Proposition 3 is thus intuitive. An increase in γ worsens productivity; thus, aggregate output decreases. Hence, consumer surplus decreases as γ increases. Furthermore, because the reduction effect of consumer surplus is dominant, the total surplus decreases as γ increases.

4 Conclusion

Using a two-country oligopoly model, we consider the effects of technology differences between non-exporting and exporting firms on optimal tariff policy. The non-exporting firm is less efficient than the exporting firm, and conducts only domestic production. By contrast, exporting firms engage in both domestic production and exports. In this situation, we show that, according to the degree of efficiency of non-exporting firms, the optimal tariff rate becomes low or high. When the production efficiency of a non-exporting firm is high (low), the optimal tariff rate decreases (increases), as its efficiency decreases. We believe that our analysis contributes to the literature on the optimum tariff argument by showing that, under tariff competition, a low (or high) tariff is achieved and trade liberalization (or protectionism) continues.

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Appendix. Proofs

Proof of Lemma 2

I. From q_{ii}^{e*}, q_{ij}^{e*}, and q_i^{d*}, we have

$$(q_{ii}^{e*} + q_{ij}^{e*}) - q_i^{d*} = \frac{a(57\gamma^3 + 139\gamma^2 - 6\gamma - 130)}{159\gamma^3 + 771\gamma^2 + 1232\gamma + 650} > 0.$$

II. Some algebra yield

$$q_{ii}^{e*} - q_{ij}^{e*} = \frac{a\left(33\gamma^3 + 133\gamma^2 + 212\gamma + 130\right)}{159\gamma^3 + 771\gamma^2 + 1232\gamma + 650} > 0.$$

$$q_{ii}^{e*} - q_i^{d*} = \frac{5a\left(9\gamma^3 + 17\gamma^2 - 12\gamma - 26\right)}{159\gamma^3 + 771\gamma^2 + 1232\gamma + 650},$$

where $q_i^{d*} - q_{ii}^{e*} \geq (<) 0$ for $\gamma \leq (>) \gamma_1 \simeq 1.20542$.

$$q_i^{d*} - q_{ij}^{e*} = -\frac{4a\left(3\gamma^3 - 12\gamma^2 - 68\gamma - 65\right)}{159\gamma^3 + 771\gamma^2 + 1232\gamma + 650},$$

where $q_i^{d*} - q_{ij}^{e*} \geq (<) 0$ for $\gamma \leq (>) \gamma_2 \simeq 7.43869$. These imply Lemma 2. □

Proof of Proposition 2

I. A simple algebra yields

$$\pi_i^{d*}-\pi_i^{e*} = -\frac{a^2(7587\gamma^6+53322\gamma^5+133491\gamma^4+110768\gamma^3-78508\gamma^2-185120\gamma-84500)}{2(159\gamma^3+771\gamma^2+1232\gamma+650)^2}.$$

By numerically solving $\pi_i^{d*} - \pi_i^{e*} \geq 0$ for γ, we have $\gamma \leq \gamma_3 \simeq 1.04676$.

II. From the differentiation of profits:

$$\frac{\partial \pi_i^{d*}}{\partial \gamma} = -\frac{2a^2(3\gamma+5)(17\gamma+26)\left(8109\gamma^5+70866\gamma^4+247863\gamma^3+433528\gamma^2+378950\gamma+132340\right)}{\left(159\gamma^3+771\gamma^2+1232\gamma+650\right)^3} < 0,$$

$$\frac{\partial \pi_i^{e*}}{\partial \gamma} = \frac{24a^2\left(32640\gamma^7+339711\gamma^6+1517619\gamma^5+3746887\gamma^4+5477452\gamma^3+4693455\gamma^2+2151370\gamma+397150\right)}{\left(159\gamma^3+771\gamma^2+1232\gamma+650\right)^3} > 0.$$

These imply Proposition 2. □

Proof of Proposition 3.

Differentiating CS_i^* and SW_i^* with respect to γ, we obtain:

$$\frac{\partial CS_i^*}{\partial \gamma} = -\frac{10a^2(\gamma+3)(57\gamma^2+172\gamma+130)(1059\gamma^4+6498\gamma^3+15037\gamma^2+15548\gamma+6058)}{\left(159\gamma^3+771\gamma^2+1232\gamma+650\right)^3} < 0,$$

$$\frac{\partial SW_i^*}{\partial \gamma} = -\frac{2a^2\left[\begin{array}{l}286929\gamma^7+4079325\gamma^6+23685669\gamma^5+74023721\gamma^4+135748078\gamma^3\\ +146920410\gamma^2+87224540\gamma+21970000\end{array}\right]}{\left(159\gamma^3+771\gamma^2+1232\gamma+650\right)^3} < 0.$$

Hence, Proposition 3 holds. □

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Online Appendix (Not for Publication) on "Optimal tariffs for the coexistence of exporting and non-exporting firms"

Here, we present supplementary information related to the analysis in this study.

Lamma A1. *A sufficient condition for equilibrium to be asymptocically stable is satisfied, that is,* $|\partial BR_A/\partial t_B||\partial BR_B/\partial t_A| < 1$ *for all* $\gamma \geq 1$.

Proof. The best response function of each country, BR_i $(i = A, B)$, yields

$$\left|\frac{\partial BR_A}{\partial t_B}\right|\left|\frac{\partial BR_B}{\partial t_A}\right| - 1$$
$$= -\frac{3(3\gamma+4)(5\gamma+8)(159\gamma^3+771\gamma^2+1232\gamma+650)(315\gamma^3+1437\gamma^2+2134\gamma+1030)}{(1503\gamma^4+9276\gamma^3+21253\gamma^2+21428\gamma+8020)^2} < 0.$$

Hence, Lemma A1 holds. □

SOC for the welfare maximization

From the second stage outcome of the game, we obtain

$$\frac{\partial^2 SW_i}{\partial t_i^2} = -\frac{1503\gamma^4+9276\gamma^3+21253\gamma^2+21428\gamma+8020}{9(3\gamma+4)^2(5\gamma+8)^2} < 0,$$

and

$$\left(\frac{\partial^2 SW_A}{\partial t_A^2}\right)\left(\frac{\partial^2 SW_B}{\partial t_B^2}\right) - \left(\frac{\partial^2 SW_B}{\partial t_B \partial t_A}\right)\left(\frac{\partial^2 SW_B}{\partial t_A \partial t_B}\right)$$
$$= \frac{\left(159\gamma^3+771\gamma^2+1232\gamma+650\right)\left(315\gamma^3+1437\gamma^2+2134\gamma+1030\right)}{27(3\gamma+4)^3(5\gamma+8)^3} > 0.$$

Thus, the SOC is satisfied.