Strategic export policy, monopoly carrier, and product differentiation

Takauchi, Kazuhiro

Faculty of Business and Commerce, Kansai University

7 August 2015

Strategic export policy, monopoly carrier, and product differentiation

Kazuhiro Takauchi*

First version: September 23, 2014

This version: August 7, 2015

Abstract

This paper examines strategic subsidy/tax policy in a third-country market model with a monopoly carrier. To transport its product to the third market, each exporting firm must use the carrier. We show that under Cournot duopoly, the optimal policy is an *export tax* if the degree of product differentiation is large enough. In a Bertrand duopoly, the optimal policy is always the export tax. We also show that the subsidized firm's exports in the Cournot duopoly are larger than those in the Bertrand duopoly if the degree of product differentiation is small enough.

Keywords: Export subsidy/tax; Monopoly carrier; Product differentiation

JEL Codes: F12; F13

*Kazuhiro Takauchi, Faculty of Business and Commerce, Kansai University, 3-3-35, Yamate-cho, Suita, Osaka 564-8680, Japan. Tel.: +81-06-6368-1817; Fax: +81-06-6369-7704; E-mail: kaz.takauch@gmail.com

1 Introduction

A central issue in strategic trade policy is *rent-shifting*. As shown by Brander and Spencer (1985), the government has an incentive to offer a positive export subsidy for its domestic firm in order to shift rent from a foreign competitor to a domestic one.[1] This strategic motive of government and the rent-shifting effect have been extensively examined.[2] In strategic export policy arguments, there has been a focus on rent-shifting among exporting firms and its effects on recommended export policy, but the role of international carriers and transport prices have not been paid much attention to. In contrast, recent empirical studies have emphasized that transport prices have a growing impact on export activity: for example, carriers have a certain monopoly power and maritime transport prices are marked up (Hummels et al., 2009), and transport prices are frequently a greater barrier than tariffs (Clark et al., 2004; Hummels, 2007). These empirical findings point out that transport charges have a considerable effect on exports. Because higher charges raise export costs, they possibly damp exports, can induce rent-shifting from exporting firms to carriers, and affect the recommended export policy.

This paper considers changes that appear in a recommended export policy when a monopoly carrier is incorporated into a third-country market model with product differentiation. We examine the following three-stage game: first, the home government chooses a subsidy/tax rate for its domestic firm. Second, the monopoly carrier

[1] The recommended export policy substantially differs based on the mode of competition. See Brander (1995) and Eaton and Grossman (1986).

[2] For a systematic survey of strategic trade policy, see Brander (1995) and Chang and Katayama (1995).

decides its transport charge. Third, two exporting firms compete in the third market. We show that in a Cournot duopoly, the optimal policy is an *export tax* if the degree of product differentiation is not small; however, in a Bertrand duopoly, the optimal policy is always an export tax. The subsidy/tax works as a commitment device for the carrier: a decrease (an increase) in the subsidy (tax) reduces the transport charge. Because this effect in the Cournot case is stronger when the degree of product differentiation is large, the government imposes an export tax (negative subsidy). Reducing transport charges and preventing rent-extraction from the domestic firm to the carrier is consistent with restraining excess production in price competition. Thus, the optimal policy in a Bertrand duopoly is an export tax. We also show that the subsidized home firm's Cournot output is *larger than* the Bertrand one if the degree of product differentiation is sufficiently small. This is because the optimal policy in a Cournot duopoly is a positive subsidy when the degree of product differentiation is small, but the optimal policy in a Bertrand duopoly is always an export tax.

This paper is related to several studies on the role of transport prices and the market power of carriers in international trade (Abe et al., 2014; Behrens et al., 2009; Behrens and Picard, 2011; Francois and Wooton, 2001; Kleinert and Spies, 2011; Takauchi, 2015).[3] These studies incorporate an international carrier (or transportation service industry) into various trade models. Although they focus on the market power of the carrier, they do not consider the strategic export policy. This paper is also related to some works on unionized oligopoly models with a strategic export policy (Bandyopad-

[3]Recently, several studies have considered the role of transport facilities (airports/seaports) and pricing strategy in an international oligopoly. See Matsumura and Matsushima (2012) and Matsushima and Takauchi (2014).

hyay and Bandyopadhyay, 1998, 1999; Bandyopadhyay et al., 2000).[4] Various oligopoly models examine a change in a recommended export policy when a labor union exits. Particularly, Bandyopadhyay et al. (2000) consider the optimal export policy in a third-country market model when the product market is a Bertrand duopoly. They show that the optimal policy is an export subsidy as long as the degree of product differentiation is not too small. In their model, union rent is included in the domestic welfare of the exporting country, and each exporter's union individually decides its wage. These two points crucially differ from our model. In their model, a higher subsidy increases the wage rate and union rent, and this effect dominates as long as the product market is not extremely competitive. Because the government can improve domestic welfare through an increase in union rent, it has an incentive to offer an export subsidy under a Bertrand duopoly.

The remainder of this paper is organized as follows. Section 2 provides the model setup. Section 3 derives the Cournot and Bertrand outcomes and examines the optimal policy in each mode of competition. Section 4 concludes.

2 Model

We consider the Brander and Spencer (1985) model with a monopoly carrier. There are three countries: two different exporting countries, home and foreign, which each have a single exporting firm, and one consuming country that does not have any producers. The home and foreign products are differentiated. The inverse differentiated demand

[4] Some works focus on the effect of lobbying activities for export policy. See, for example, Bandyopadhyay et al. (2004) and Ma (2008).

in the consuming country is

$$p_x = 1 - x - \gamma y; \quad p_y = 1 - y - \gamma x,$$

where p_x (p_y) is the product price of the home (foreign) firm, x (y) is the output of the home (foreign) firm, and γ is the degree of product differentiation between the home and foreign products. When the home and foreign products are homogeneous, $\gamma = 1$; when these products are maximally differentiated, $\gamma = 0$. Throughout the analysis, we assume that $0 \leq \gamma < 1$. Using these inverse differentiated demand functions, the following differentiated demand is derived.

$$x = \frac{1 - p_x - \gamma + \gamma p_y}{(1-\gamma)(1+\gamma)}; \quad y = \frac{1 - p_y - \gamma + \gamma p_x}{(1-\gamma)(1+\gamma)}.$$

The home and foreign firms do not have means of long-distance transportation, so the firms must use a carrier and pay a per-unit transport charge t to the carrier when they supply those products to the consuming country. We assume that the home and foreign firms have symmetric technology. They incur a constant marginal cost c ($0 \leq c < 1$) to produce their respective products. However, we consider that the home government solely subsidizes to the home firm. Offering a per-unit subsidy s, the home firm's marginal production cost is $c - s$. The profit of the home firm (π_H) and foreign firm (π_F) are

$$\pi_H \equiv (p_x - (c - s) - t)x; \quad \pi_F \equiv (p_y - c - t)y. \tag{1}$$

The carrier makes a take-it-or-leave-it offer to the home and foreign firms and decides the transport charge t. We also assume that the carrier does not price-

discriminate. The carrier belongs to the consuming country and transports $x + y$ units of products; thus, its profit is given by $r \equiv (t - t_0)(x + y)$, where t_0 is a unit cost associated with transportation. For simplicity, we set t_0 as 0, and thus, $r \equiv (x + y)t$.[5]

The timing of the game is as follows. First, the home government chooses an export subsidy/tax rate s. Second, the carrier decides its charge t. Last, the home and foreign firms compete in the consuming country's market. The game is solved using backward induction.

3 Results

We first examine a Cournot duopoly in the product market. In Section 3.2, we consider a Bertrand duopoly.

3.1 Cournot duopoly

Third stage. Taking the subsidy/tax rate s and transport charge t as a given, each firm decides quantities for its product. The inverse differentiated demand and (1) yield the following first-order conditions (FOCs) for the profit maximization of firms.

$$\begin{aligned} 1 - c - t + s - 2x - \gamma y &= 0, \\ 1 - c - t - \gamma x - 2y &= 0. \end{aligned}$$

Solving these FOCs, we obtain the outputs in the third stage.

$$x^C(s,t) = \frac{(1-c-t)(2-\gamma) + 2s}{(2-\gamma)(2+\gamma)}; \quad y^C(s,t) = \frac{(1-c-t)(2-\gamma) - \gamma s}{(2-\gamma)(2+\gamma)}. \tag{2}$$

[5]This assumption does not alter our results.

Under Cournot competition, we denote the outcomes in each stage of the game as "C."

Second stage. Under a given s, the carrier decides its charge. Because the carrier transports $x^C(s,t) + y^C(s,t)$ units of products (i.e., use (2)), the profit maximization problem of the carrier is

$$\max_t \; r^C(s,t) \;=\; \max_t \; \frac{(2(1-c)+s-2t)t}{2+\gamma}.$$

From this maximization problem, the FOC for the profit maximization of the carrier and its charge are

$$\frac{\partial r^C(s,t)}{\partial t} = \frac{2(1-c)+s-4t}{2+\gamma} = 0 \;\Rightarrow\; t^C(s) = \frac{2(1-c)+s}{4}.$$

Substituting $t^C(s)$ into (1) and (2), we obtain the second-stage outcomes.

$$\begin{aligned} x^C(s) &= \frac{2(2-\gamma)(1-c)+(6+\gamma)s}{4(2-\gamma)(2+\gamma)}; \quad \pi_H^C(s) = \left[x^C(s)\right]^2, \\ y^C(s) &= \frac{2(2-\gamma)(1-c)-(2+3\gamma)s}{4(2-\gamma)(2+\gamma)}; \quad \pi_F^C(s) = \left[y^C(s)\right]^2. \end{aligned}$$

First stage. To maximize domestic welfare, the home government offers a certain level of subsidy/tax. The domestic social surplus equals the differences between the profit of the home firm and the total subsidy payment: $W_H^C(s) \equiv \pi_H^C(s) - sx^C(s)$. Thus, the welfare of the home is given by

$$W_H^C(s) = \frac{(1-c)^2}{4(2+\gamma)^2} - \frac{(1-c)(2-\gamma-2\gamma^2)s}{4(2-\gamma)(2+\gamma)^2} - \frac{(6+\gamma)(10-\gamma-4\gamma^2)s^2}{16(4-\gamma^2)^2}.$$

The welfare maximization problem of the home government yields the following FOC

and the equilibrium subsidy/tax.[6]

$$\frac{\partial W_H^C(s)}{\partial s} = \frac{-2(1-c)(2-\gamma)(2-\gamma-2\gamma^2)-(6+\gamma)(10-\gamma-4\gamma^2)s}{8(2-\gamma)^2(2+\gamma)^2} = 0$$
$$\Rightarrow \; s^{C*} = -\frac{2(1-c)(2-\gamma)(2-\gamma-2\gamma^2)}{(6+\gamma)(10-\gamma-4\gamma^2)}. \tag{3}$$

Hereafter, we denote the equilibrium value as the asterisk "$*$." From (3), we obtain the following.

$$\begin{aligned} x^{C*} &= \frac{(1-c)(2-\gamma)}{10-\gamma-4\gamma^2}; \quad y^{C*} = \frac{(1-c)(16-6\gamma-5\gamma^2)}{(6+\gamma)(10-\gamma-4\gamma^2)}, \\ t^{C*} &= \frac{(1-c)(2+\gamma)(14-5\gamma-3\gamma^2)}{(6+\gamma)(10-\gamma-4\gamma^2)}. \end{aligned} \tag{4}$$

The equilibrium profit of the firms and carrier are $\pi_H^{C*} = (x^{C*})^2$, $\pi_F^{C*} = (y^{C*})^2$, and $r^{C*} = [2(t^{C*})^2]/(2+\gamma)$.

We first consider the effects of a change in γ on the export subsidy/tax, transport charge, and exports for the home and foreign firms.

$$\begin{aligned} \frac{1}{4}\left(\frac{\partial s^{C*}}{\partial \gamma}\right) &= \frac{\partial t^{C*}}{\partial \gamma} = \frac{(1-c)(128+80\gamma-148\gamma^2+8\gamma^3+31\gamma^4)}{(6+\gamma)^2(10-\gamma-4\gamma^2)^2} > 0, \\ \frac{\partial y^{C*}}{\partial \gamma} &= -\frac{2(1-c)(212-100\gamma-11\gamma^2+24\gamma^3+10\gamma^4)}{(6+\gamma)^2(10-\gamma-4\gamma^2)^2} < 0, \\ \frac{\partial x^{C*}}{\partial \gamma} &= -\frac{4(1-c)(2-4\gamma+\gamma^2)}{(10-\gamma-4\gamma^2)^2}. \end{aligned}$$

From these results and (3), we establish Lemma 1 and Proposition 1.

Lemma 1. *Under Cournot competition, (i) the exports of the home firm are U-shaped, but the exports of the foreign firm are increasing for the degree of product differentiation (decreasing for γ); (ii) s^{C*} and t^{C*} increase as γ increases.*

[6]The SOC for welfare maximization always holds, that is, $\partial^2 W_H^C(s)/\partial s^2 = -(6+\gamma)(10-\gamma-4\gamma^2)/[8(2-\gamma)^2(2+\gamma)^2] < 0$.

Proof. The sign of $\partial x^{C*}/\partial\gamma$ depends on $-(2-4\gamma+\gamma^2)$. Solving the inequality $-(2-4\gamma+\gamma^2) \geq 0$ for γ, $2-\sqrt{2} \leq \gamma < 1$. Thus, $-(2-4\gamma+\gamma^2) < 0$ for $\gamma < 2-\sqrt{2}$. Q.E.D.

Proposition 1. *Suppose that a monopoly carrier transports firm products. Under Cournot competition, (i) the optimal policy is an export subsidy if $\gamma > \gamma_a$; (ii) the optimal policy is free trade if $\gamma = \gamma_a$; (iii) the optimal policy is an export tax if $\gamma < \gamma_a$, where $\gamma_a \equiv (\sqrt{17}-1)/4 \simeq 0.780776$.*

Proof. From (3), the sign of s^{C*} depends on $-(2-\gamma-2\gamma^2)$. Thus, $s^{C*} > 0$ if $\gamma > (\sqrt{17}-1)/4$, $s^{C*} = 0$ if $\gamma = (\sqrt{17}-1)/4$, and $s^{C*} < 0$ if $\gamma < (\sqrt{17}-1)/4$. Q.E.D.

The results of Lemma 1 and Proposition 1 are depicted in Figure 1.

[Figure 1 here]

The logic behind Proposition 1 is explained as follows. First, offering a subsidy (or tax) works a commitment device to the carrier.[7] A smaller (larger) s corresponds to a lower (higher) t (see $t^C(s)$). Second, this commitment works better if the degree of product differentiation is large (i.e., if γ is small).

The first point results from the timing of the game. Because the subsidy/tax is decided in the first stage of the game, the policy affects the decision of the carrier. When s rises, the home firm's exports increase but the foreign firm's exports decrease owing to strategic substitutability in the quantity competition. On the other hand, an

[7] In a different context, Takauchi (2010) focuses on a similar effect of a subsidy policy. He considers the effects of a subsidy/tax on the content rate of rules of origin in an area with free trade.

increases in subsidies raises total outputs (i.e., $x+y$), so the demand for transportation increases and thus the transport charges rise. A rise in the transport charges reduces exports in each firm. That is, rent gained by the home firm shifts to the carrier when the subsidy increases. Therefore, if the rent shift from the foreign firm to the home firm is smaller and the rent shift from the home firm to the carrier is larger, the home government has no incentive to choose a positive subsidy. The commitment effect depends on the degree of product differentiation. When γ is sufficiently small, each product is sufficiently differentiated and each product market is relatively monopolized. Then, for the home firm, the effects of the foreign firm's action are small. That is, the rent shift from the foreign firm to the home firm is small. Thus, a larger (smaller) γ implies that rent shifting from the foreign firm caused a small increase in the subsidy rate is increased (reduced). Therefore, when γ is small, the home government chooses an export tax (i.e., a negative subsidy) and decreases the transport charge as much as possible.

In Lemma 1, the effects of γ on s^{C*}, t^{C*}, and y^{C*} are intuitive. As mentioned in the explanation for Proposition 1, an increase in s increases the transport charge but decreases the foreign firm's exports. Because an increase in γ increases the rent-shifting effect of subsidization, s^{C*} increases, and thus, t^{C*} is indirectly increased but y^{C*} is reduced. However, the effect of γ on exports (and thus, profit) in the home firm is ambiguous. To examine the effects of γ, we focus on the third-stage exports in the

home firm (2). Totally differentiating and rearranging (2), we find

$$\frac{dx^C}{d\gamma} = \underbrace{\frac{2}{(2-\gamma)(2+\gamma)}\left(\frac{ds}{d\gamma}\right)}_{(+)} + \underbrace{\frac{-1}{2+\gamma}\left(\frac{dt}{d\gamma}\right)}_{(-)} + \underbrace{\frac{-(1-c-t)}{(2+\gamma)^2}}_{(-)} + \underbrace{\frac{4\gamma s}{(2-\gamma)^2(2+\gamma)^2}}_{(+)/(-)},$$

where $\text{sign}(ds/d\gamma) = \text{sign}(\partial s^{C*}/\partial\gamma)$, $\text{sign}(dt/d\gamma) = \text{sign}(\partial t^{C*}/\partial\gamma)$, and s corresponds to s^{C*}. In this equation, $(+)$ denotes a positive value, $(-)$ denotes a negative value, and $(+)/(-)$ denotes both positive/negative values; thus, the sign in the sum of all terms is ambiguous. However, all terms except for the last term have a value that is either certainly positive or negative. The last term plays a key role in deciding the sign of $dx^C/d\gamma$ (i.e., $\partial x^{C*}/\partial\gamma$). When the home firm offers a positive subsidy, the last term is positive, and the sign $\partial x^{C*}/\partial\gamma$ can be positive. Otherwise, the last term is negative and the sign $\partial x^{C*}/\partial\gamma$ can be negative. In fact, when γ is small, the optimal policy is an export tax (i.e., $s < 0$ in the last term) and $\partial x^{C*}/\partial\gamma$ has a negative value. When γ is sufficiently large, the last term becomes positive and $\partial x^{C*}/\partial\gamma$ may be positive.

3.2 Bertrand duopoly

Third stage. The differentiated demand and (1) yield the following FOCs for the profit maximization of firms.

$$\begin{aligned} \frac{1+c+t-\gamma-s-2p_x+\gamma p_y}{(1-\gamma)(1+\gamma)} &= 0, \\ \frac{1+c+t-\gamma+\gamma p_x-2p_y}{(1-\gamma)(1+\gamma)} &= 0. \end{aligned}$$

From these FOCs, we obtain product prices in the third stage.

$$\begin{aligned} p_x^B(s,t) &= \frac{(2+\gamma)(1+c+t-\gamma)-2s}{(2-\gamma)(2+\gamma)}, \\ p_y^B(s,t) &= \frac{(2+\gamma)(1+c+t-\gamma)-\gamma s}{(2-\gamma)(2+\gamma)}. \end{aligned}$$

Exports are

$$\begin{aligned} x^B(s,t) &= \frac{(1-c-t)(2-\gamma-\gamma^2)+(2-\gamma^2)s}{(2-\gamma)(1-\gamma)(1+\gamma)(2+\gamma)}, \\ y^B(s,t) &= \frac{(1-c-t)(2-\gamma-\gamma^2)-\gamma s}{(2-\gamma)(1-\gamma)(1+\gamma)(2+\gamma)}. \end{aligned}$$

Under Bertrand competition, we denote outcomes in each stage of the game as "B."

Second stage. The maximization problem of the carrier is

$$\max_t \; r^B(s,t) \;=\; \max_t \; \frac{(2(1-c)+s-2t)t}{(2-\gamma)(1+\gamma)}.$$

This problem yields the following transport charge in the second stage:

$$\frac{\partial r^B(s,t)}{\partial t} = \frac{2(1-c)+s-4t}{(2-\gamma)(1+\gamma)} = 0 \quad \Rightarrow \quad t^B(s) = \frac{2(1-c)+s}{4} \; (= t^C(s)).$$

From $t^B(s)$, product prices are

$$p_x^B(s) = \frac{3+c-2\gamma}{2(2-\gamma)} - \frac{(6-\gamma)s}{4(4-\gamma^2)}; \;\; p_y^B(s) = \frac{3+c-2\gamma}{2(2-\gamma)} + \frac{(2-3\gamma)s}{4(4-\gamma^2)}.$$

Exports and profits in the second stage are

$$\begin{aligned} x^B(s) &= \frac{2(2-\gamma-\gamma^2)(1-c)+(6+\gamma-3\gamma^2)s}{4(2-\gamma)(1-\gamma)(1+\gamma)(2+\gamma)}; \;\; \pi_H^B(s) = (1-\gamma^2)\big[x^B(s)\big]^2, \\ y^B(s) &= \frac{2(2-\gamma-\gamma^2)(1-c)-(2+3\gamma-\gamma^2)s}{4(2-\gamma)(1-\gamma)(1+\gamma)(2+\gamma)}; \;\; \pi_F^B(s) = (1-\gamma^2)\big[y^B(s)\big]^2. \end{aligned}$$

First stage. Similar to the Cournot case, the home government chooses a certain subsidy/tax rate to maximizes its domestic welfare, $W_H^B(s) \equiv \pi_H^B(s) - sx^B(s)$. The

welfare in the home is

$$\begin{aligned} W_H^B(s) &= \frac{(1-c)^2(1-\gamma)}{4(2-\gamma)^2(1+\gamma)} - \frac{(1-c)(2-\gamma+\gamma^2)s}{4(2-\gamma^2)(1+\gamma)(2+\gamma)} \\ &\quad - \frac{(10-\gamma-\gamma^2)(6+\gamma-3\gamma^2)s^2}{16(2-\gamma)^2(1-\gamma)(1+\gamma)(2+\gamma)^2}. \end{aligned}$$

The maximization problem of the Home government yields the following FOC and the equilibrium subsidy/tax rate.[8]

$$\begin{aligned} \frac{\partial W_H^B(s)}{\partial s} &= -\frac{2(1-c)(1-\gamma)(2+\gamma)(2-\gamma+\gamma^2)}{8(4-\gamma^2)(1-\gamma^2)} - \frac{(10-\gamma-\gamma^2)(6+\gamma-3\gamma^2)s}{8(4-\gamma^2)(1-\gamma^2)} = 0 \\ \Rightarrow\ s^{B*} &= -\frac{2(1-c)(1-\gamma)(2+\gamma)(2-\gamma+\gamma^2)}{(10-\gamma-\gamma^2)(6+\gamma-3\gamma^2)} < 0. \end{aligned} \tag{5}$$

Thus, the optimal policy is an export tax.

The equilibrium tax formula in (5) yields

$$\begin{aligned} p_x^{B*} &= \frac{48-8\gamma-30\gamma^2+3\gamma^3+3\gamma^4+(12+12\gamma-7\gamma^2-\gamma^3)c}{(10-\gamma-\gamma^2)(6+\gamma-3\gamma^2)}, \\ p_y^{B*} &= \frac{44-2\gamma-34\gamma^2+5\gamma^3+3\gamma^4+(16+6\gamma-3\gamma^2-3\gamma^3)c}{(10-\gamma-\gamma^2)(6+\gamma-3\gamma^2)}, \\ x^{B*} &= \frac{(1-c)(2+\gamma)}{(1+\gamma)(10-\gamma-\gamma^2)};\quad y^{B*} = \frac{(1-c)(16+10\gamma-5\gamma^2-\gamma^3)}{(1+\gamma)(10-\gamma-\gamma^2)(6+\gamma-3\gamma^2)}, \\ t^{B*} &= \frac{(1-c)(2-\gamma)(14+9\gamma-5\gamma^2-2\gamma^3)}{(10-\gamma-\gamma^2)(6+\gamma-3\gamma^2)}. \end{aligned} \tag{6}$$

The profit of the firms and the carrier are $\pi_H^{B*} = (1-\gamma^2)(x^{B*})^2$, $\pi_F^{B*} = (1-\gamma^2)(y^{B*})^2$, and $r^{B*} = [2(t^{B*})^2]/[(2-\gamma)(1+\gamma)]$, respectively.

[8] The SOC for the welfare maximization always holds, that is, $\partial^2 W_H^B(s)/\partial s^2 = -(10-\gamma-\gamma^2)(6+\gamma-3\gamma^2)/[8(2-\gamma^2)(1-\gamma)(1+\gamma)(2+\gamma)^2] < 0$.

The comparative statics of (6) for γ yield

$$\begin{aligned}
\frac{\partial p_x^{B*}}{\partial \gamma} &= \frac{-(1-c)D_1}{(10-\gamma-\gamma^2)^2(6+\gamma-\gamma^2)^2} < 0, \\
\frac{\partial p_y^{B*}}{\partial \gamma} &= \frac{-(1-c)D_2}{(10-\gamma-\gamma^2)^2(6+\gamma-\gamma^2)^2} < 0, \\
\frac{1}{4}\left(\frac{\partial s^{B*}}{\partial \gamma}\right) &= \frac{\partial t^{B*}}{\partial \gamma} = \frac{(1-c)E}{(10-\gamma-\gamma^2)^2(6+\gamma-3\gamma^2)^2} > 0, \\
\frac{\partial x^{B*}}{\partial \gamma} &= \frac{-2(1-c)(4-4\gamma-4\gamma^2-\gamma^3)}{(1+\gamma)^2(10-\gamma-\gamma^2)^2}, \\
\frac{\partial y^{B*}}{\partial \gamma} &= \frac{2(1-c)F}{(1+\gamma)^2(10-\gamma-\gamma^2)^2(6+\gamma-3\gamma^2)^2},
\end{aligned}$$

where $D_1 \equiv 3\gamma^6+42\gamma^5-57\gamma^4-200\gamma^3+164\gamma^2+48\gamma+672 > 0$, $D_2 \equiv 9\gamma^6+18\gamma^5+63\gamma^4-240\gamma^3-426\gamma^2+824\gamma+296 > 0$, $E \equiv \gamma^6-34\gamma^5-11\gamma^4+136\gamma^3+84\gamma^2-208\gamma+128 > 0$, and $F \equiv 3\gamma^7+25\gamma^6-35\gamma^5-266\gamma^4+126\gamma^3+755\gamma^2+228\gamma-212$.

From (5) and the results of the comparative statics, we obtain the following.

Proposition 2. *Under Bertrand competition, the optimal policy is an export tax in the presence of a monopoly carrier.*

Lemma 2. *Under Bertrand competition, (i) product prices in the home and foreign firms decrease, the rate of export tax decreases, and the transport charge increases as γ increases; (ii) exports in the home and foreign firms are U-shaped for γ.*

Proof. The sign of $\partial x^{B*}/\partial\gamma$ depends on $-(4-4\gamma-4\gamma^2-\gamma^3)$, and the sign of $\partial y^{B*}/\partial\gamma$ depends on F. Using numerical calculation, $-(4-4\gamma-4\gamma^2-\gamma^3) < (\geq)\ 0$ if $\gamma < (\geq)$ $\tilde{\gamma} \equiv 0.594313$; $F < (\geq)\ 0$ if $\gamma < (\geq)$ $\hat{\gamma} \equiv 0.398778$. Q.E.D.

Proposition 2 is relatively intuitive. Under price competition, *excess production* occurs. The exporting country's government has an incentive to restrain this excess

production and raise the price of the product of the domestic firm (Markusen et al., 1995). Furthermore, in our model, the home government has an incentive to prevent rent extraction from the home firm to the carrier and decrease the subsidy (or increase the tax) in order to reduce the transport charge. For these two reasons, the home government imposes an export tax when the product market is under Bertrand competition. This result is in sharp contrast to Bandyopadhyay et al. (2000): in two exporting countries with a labor union (wage setter) and one consuming country with a market share rivalry model, they consider an optimal export policy. Under Bertrand competition, they show that the optimal policy is an *export subsidy* as long as the degree of product differentiation is not too small (i.e., except for the case where γ is close to 1). The difference in results mainly depends on the following factors: in Bandyopadhyay et al. (2000), domestic welfare includes union rent and each country's union individually sets its wage rate. The union offers a higher wage if the domestic subsidy increases. Because an increase in the domestic subsidy increases output and labor demand in the domestic firm, the union offers a higher wage rate if the domestic subsidy increases. In addition, through an interaction in the wage-setting stage of two unions, an increase in the domestic subsidy indirectly reduces the other country's wage rate and product price; thus, market competition is even keener. Therefore, a positive domestic subsidy induces a large increase in the domestic wage rate and union rent. As a result, in their model, the government can increase domestic welfare through a large increase in union rent by offering a positive subsidy.

The result in Lemma 2 can be explained as follows. A large γ corresponds to

keen competition in the product market such that product prices in both the home and foreign firms decrease as γ increases (i.e., $\partial p_x^{B*}/\partial\gamma < 0$ and $\partial p_y^{B*}/\partial\gamma < 0$). Because the home firm has a tax burden, increased competition makes the firm further disadvantaged. Thus, the home government reduces the export tax when γ increases ($\partial s^{B*}/\partial\gamma > 0$). Because the subsidy/tax increases as γ increases, the transport charge increases when γ increases ($\partial t^{B*}/\partial\gamma > 0$). The nature of the transport charge is the same in the Cournot duopoly (i.e., in the second-stage Nash equilibrium of two competition modes, $t^B(s) = t^C(s)$ holds).

In the Bertrand duopoly, exports in the home and foreign firms are U-shaped for γ. This result is basically the same as the outcome of the standard differentiated Bertrand duopoly.[9] However, in our model, by incorporating the carrier, the model logic differs from the standard one (e.g., Eaton and Grossman, 1986). To see this, let us employ a similar method in the Cournot duopoly used previously. Totally differentiating the third-stage exports and rearranging them, we obtain

$$\begin{aligned}\frac{dx^B}{d\gamma} &= \underbrace{\frac{2-\gamma^2}{(4-\gamma^2)(1-\gamma^2)}\left(\frac{ds}{d\gamma}\right)}_{(+)} + \underbrace{\frac{-2}{(2-\gamma)(1+\gamma)}\left(\frac{dt}{d\gamma}\right)}_{(-)} + \underbrace{\frac{2\gamma(6-4\gamma^2+\gamma^4)s}{(4-\gamma^2)^2(1-\gamma^2)^2}}_{(-)} \\ &\quad + \underbrace{\frac{-(1-2\gamma)(1-c-t)}{(2-\gamma)^2(1+\gamma)^2}}_{(+)/(-)},\end{aligned}$$

[9]For example, substituting $s = t = 0$ into $x^B(s,t)$ and $y^B(s,t)$, we obtain $(1-c)/[(2-\gamma)(1+\gamma)]$, which is U-shaped for γ.

and

$$\frac{dy^B}{d\gamma} = \underbrace{\frac{-\gamma}{(4-\gamma^2)(1-\gamma^2)}\left(\frac{ds}{d\gamma}\right)}_{(-)} + \underbrace{\frac{-1}{(2-\gamma)(1+\gamma)}\left(\frac{dt}{d\gamma}\right)}_{(-)} + \underbrace{\frac{-(4+5\gamma^2-3\gamma^4)s}{(4-\gamma^2)^2(1-\gamma^2)^2}}_{(+)}$$
$$+ \underbrace{\frac{-(1-2\gamma)(1-c-t)}{(2-\gamma)^2(1+\gamma)^2}}_{(+)/(-)},$$

where $\text{sign}(ds/d\gamma) = \text{sign}(\partial s^{B*}/\partial\gamma)$, $\text{sign}(dt/d\gamma) = \text{sign}(\partial t^{B*}/\partial\gamma)$, and s corresponds to $s^{B*} < 0$. The home firm has a positive effect from the reduced tax but suffers a negative effect from the export tax. The foreign firm has the opposite effect. On the other hand, the last term in these equations is negative when $\gamma < 1/2$ and positive when $\gamma > 1/2$. This shows that the negative (positive) effect can dominate when γ is sufficiently small (large).[10]

Lastly, we compare the home firm's Cournot exports with the Bertrand ones. A standard argument suggests that Cournot competitors produce "too little" and Bertrand competitors "too much" (Markusen et al., 1995). However, this argument does not always hold. From (4) and (6), we establish Proposition 3.

Proposition 3. *Suppose that a monopoly carrier transports the products of firms. Then, the home firm's exports under Cournot competition are larger than those under Bertrand competition if and only if* $\gamma > \gamma_b \equiv 2(\sqrt{2}-1) \simeq 0.82843$.

Proof. From (4) and (6), simple algebra yields $x^{B*} - x^{C*} = [(1-c)\gamma^2(4-4\gamma-$

[10]The minimizer of exports in the foreign firm is smaller than that in the home firm. The reason is as follows. The foreign firm has a larger market share than the home firm does because the home firm pays an export tax. Although each firm reduces its product price when γ increases, the foreign firm enjoys a greater positive effect from this price reduction because of a smaller cost (or larger demand). As a result, the foreign firm's export rapidly increases for γ.

$\gamma^2)]/[(1+\gamma)(10-\gamma-\gamma^2)(10-\gamma-4\gamma^2)]$. Solving the inequality $x^{B*} - x^{C*} < 0$, we obtain $2(\sqrt{2}-1) < \gamma < 1$. Q.E.D.

The result of Proposition 3 is depicted in Figure 2. As previously found in Proposition 1, the optimal policy under Cournot duopoly is an export subsidy when the degree of product differentiation is sufficiently small (i.e., γ is sufficiently large). On the other hand, under Bertrand duopoly, the optimal policy is always an export tax. In view of output, an export subsidy reduces the export cost and increases output, but an export tax increases the export cost and decreases output. As depicted in Figure 1, the subsidy increases as the degree of product differentiation decreases. Therefore, for a sufficiently large γ, the quantity in the Cournot and Bertrand outputs may be reversed (see Figure 2).

[Figure 2 here]

4 Conclusion

In this paper, we consider changes in recommended export policy in a third-country market model with product differentiation when a monopoly carrier exists. Although carriers and charges have a growing importance in international trade, these have not been given much attention in existing studies on strategic export policy. We show that under Cournot competition, the optimal policy is an export tax (subsidy) if the degree of product differentiation is large (small); however, under Bertrand competition, the optimal policy is always an export tax. We also show that quantity in the Cournot

output of a subsidized home firm can be larger than that under Bertrand competition. Our model developed herein shows opposite results to the standard strategic export promotion argument. These results depend on the behavior of the monopoly carrier and the interaction between transport charges and export policy. We believe that our model offers a new insight in studies of trade policy.

August 7, 2015, 14:40 p.m.

Acknowledgments

I thank Noriaki Matsushima for his helpful comments. All remaining errors are my own.

References

[1] Abe, K, K Hattori, and Y Kawagoshi (2014). Trade liberalization and environmental regulation on international transportation. *Japanese Economic Review*, 65, 468–482.

[2] Bandyopadhyay, S and SC Bandyopadhyay (1998). Monopoly unions and corporatism: Implications for strategic trade policy. *International Economic Journal*, 12, 1–22.

[3] Bandyopadhyay, S and SC Bandyopadhyay (1999). Unionization and international market share rivalry: A paradox. *Review of International Economics*, 7, 153–161.

[4] Bandyopadhyay, S, SC Bandyopadhyay, and E-S Park (2000). Unionized Bertrand duopoly and strategic export policy. *Review of International Economics*, 8, 164–174.

[5] Bandyopadhyay S, E-S Park, and HJ Wall (2004). Endogenous export subsidies and welfare under domestic cost heterogeneity. *Economics & Politics*, 16, 347–366.

[6] Behrens, K and PM Picard (2011). Transportation, freight rates, and economic geography. *Journal of International Economics*, 85, 280–291.

[7] Behrens, K, C Gaigné, and J-F Thisse (2009). Industry location and welfare when transport costs are endogenous. *Journal of Urban Economics*, 65, 195–208.

[8] Brander, JA (1995). Strategic trade policy. In Grossman, G and K Rogoff (Eds.), *Handbook of International Economics*, Vol. 3, pp. 1395-1455. Amsterdam: Elsevier.

[9] Brander, JA and BJ Spencer (1985). Export subsidies and international market share rivalry. *Journal of International Economics*, 18, 83–100.

[10] Chang, WW and S Katayama (1995). Theory and policy of trade with imperfect competition. In Chang, WW and S Katayama (Eds.), *Imperfect Competition in International Trade*, pp. 15–52. Boston/Dordrecht/London, Kluwer Academic Publishers.

[11] Clark, X, D Dollar, and A Micco (2004). Port efficiency, maritime transport costs, and bilateral trade. *Journal of Development Economics*, 75, 417–450.

[12] Eaton, J and GM Grossman (1986). Optimal trade and industrial policy under oligopoly. *Quarterly Journal of Economics*, 101, 383–406.

[13] Francois, JF and I Wooton (2001). Trade in international transport services: the role of competition. *Review of International Economics*, 9(2), 249–261.

[14] Hummels, D (2007). Transportation costs and international trade in the second era of globalization. *Journal of Economic Perspectives*, 21(3), 131–154.

[15] Hummels, D, V Lugovsky, and A Skiba (2009). The trade reducing effects of market power in international shipping. *Journal of Development Economics*, 89, 84–97.

[16] Kleinert, J and J Spies (2011). Endogenous transport costs in international trade. IAW Discussion Papers No. 74.

[17] Ma, J (2008). Is an export subsidy a robust trade policy recommendation toward a unionized duopoly? *Economics & Politics*, 20(2), 141–155.

[18] Markusen, JR, JR Melvin, WH Kaempfer, and KE Maskus (1995). *International Trade: Theory and Evidence*. New York: McGraw-Hill.

[19] Matsumura, T and N Matsushima (2012). Airport privatization and international competition. *Japanese Economic Review*, 63(4), 431–450.

[20] Matsushima, N and K Takauchi (2014). Port privatization in an international oligopoly. *Transportation Research Part B: Methodological*, 67, 382–397.

[21] Takauchi, K (2010). The effects of strategic subsidies under FTA with ROO. *Asia-Pacific Journal of Accounting & Economics*, 17(1), 57–72.

[22] Takauchi, K (2015). Endogenous transport price and international R&D rivalry. *Economic Modelling*, 46, 36–43.

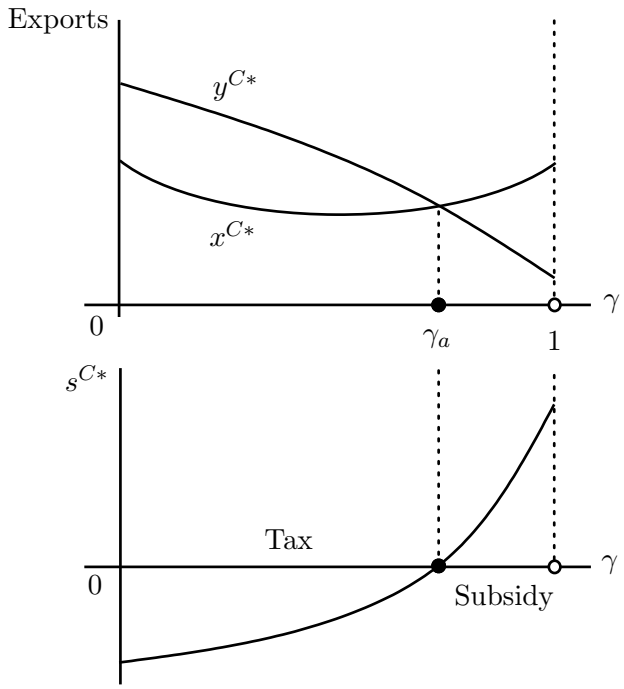

Figure 1: Optimal policy and exports in Cournot duopoly.

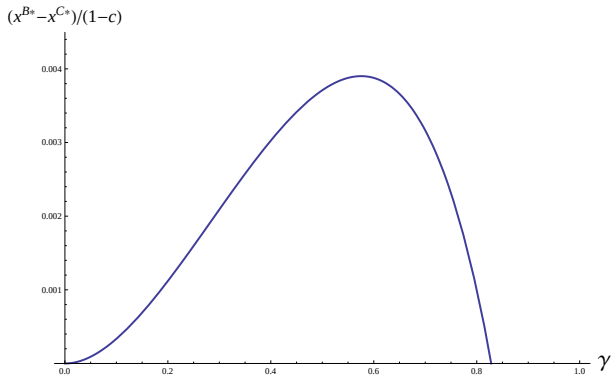

Figure 2: The difference in exports of Bertrand and Cournot.