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Second-mover advantage under strategic subsidy policy in a third market model

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Abstract

This paper examines which of the Stackelberg leader or its follower has the advantage under strategic subsidy policy in a third market model. We show that even if governments choose export subsidies in whichever of a simultaneous-move or sequential-move game, the leader firm always loses its first-mover advantage in a Stackelberg duopoly. Furthermore, we examine the endogenous timing of subsidies by governments and show that the second-mover advantage occurs with regard to profit and welfare under the endogenous timing of subsidies.

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1. Introduction

This paper examines which of the Stackelberg leader or its follower has the advantage under strategic subsidy policy in a third market model.

Since Brander and Spencer (1985) analyze the rent-shifting effect of export subsidy and the strategic interaction between export subsidies in a third-country model, many articles have dealt with export subsidies in the context of the strategic trade policy (see Eaton and Grossman, 1986; Hamilton and Slutsky, 1990).[1] Although their successors deal with the general demand structure and illuminate several aspects of strategic trade policy, most of them limit their analyses to the situation in which competitive firms and their governments choose their strategic variables simultaneously. There are several articles on the sequential-move game under strategic subsidy policy which should be referred to. Arvan (1991) concludes that demand uncertainty may cause the sequential-move of the policy choice by governments in the third-country model. Ohkawa, Okamura, and Tawada (2002) have endogenized the timing of government intervention under international oligopoly. Although the sequential-move game by governments is analyzed in their papers, they focus on the endogenous timing of the policy decision by governments and are not interested in Stackelberg competition. On the other hand, Balboa, Daughety, and Reinganum (2004) analyze Cournot and Stackelberg competition, although they focus only on the situation in which governments simultaneously choose to provide subsidies for their firms.

In reality, due to the differences in the abilities of the governments in implementing and enforcing trade policies, there exists a time lag between the subsidy decisions made by the governments. In this paper, taking the Stackelberg quantity competition into consideration, we examine how the competitive advantage between firms changes depending on the timing of the policy decision-making. We show that even if governments choose export subsidies in whichever of a simultaneous-move or sequential-move game, the leader firm always loses its first-mover advantage in a Stackelberg duopoly. Furthermore, we examine the endogenous timing of subsidies by governments and show that the second-mover advantage occurs for the follower firm and its government under the endogenous timing of subsidies. This paper explains how the effectiveness of subsidy policy is influenced by the timing of output decision.

The remainder of the article is organized as follows. In Section 2, we describe the model. In Section 3, the profit and welfare in Stackelberg equilibrium are derived under the exogenous timing of the subsidy choice by governments, and the main results on the competitive advantage are presented. We examine whether the governments move first or second in the first-stage and show that second-mover advantage occurs under the endogenous timing of subsidy choice by governments. Section 4 concludes the paper.

[1] For an appropriate survey on strategic trade policy under international oligopoly, see Lahiri and Ono (2004).

2. The Model

Let us consider an imperfect quantity competition in a third country *à la* Brander and Spencer (1985). Two identical firms produce and sell homogenous goods in a third country. The firm from country $i = 1, 2$ is indexed as firm $i = 1, 2$. Both firms produce only for the third market. Firm i produces quantity q_i and the total quantity is $Q \equiv q_1 + q_2$. The inverse demand function is denoted by $P(Q) \equiv a - bQ$. For analytical simplification, it is assumed that all firms have an identical cost structure. The constant marginal cost is denoted by c. It is assumed that $a > c > 0$ and $b > 0$.

Government i of country i can implement the per unit export subsidy, $s_i \geq 0$. The profit of firm i is denoted by $\pi^i(q_i, q_j; s_i) \equiv (P(Q) - e_i)q_i; e_i \equiv c - s_i$. The welfare of country i is denoted by $W^i(s_i, s_j)$, which comprises the profit from the exporting firm i minus the cost of the export subsidy, i.e., $W^i(s_i, s_j) \equiv \pi^i(q_i(s_i, s_j), q_j(s_i, s_j); s_i) - s_i q_i(s_i, s_j)$. Government i maximizes this welfare. The solution concept is the subgame perfect equilibrium.

The timing of the game is as follows. In the first stage, governments choose subsidy levels simultaneously or sequentially. In the second stage, firms choose output levels in a Stackelberg quantity competition fashion. Subsidy policies can be committed by both the governments and observed by both the firms before the competition stage.

We now derive the subsidy, output, and profit in the equilibrium by inducing backward. We solve the subgame in the second stage in the following subsection and analyze the Stackelberg duopoly in subsection 2.2.

2.1. Stackelberg competition in the second stage

Suppose that firm 1 is the Stackelberg leader and firm 2 is the follower w.l.o.g. Anticipating the reaction function of firm 2, which is defined by $q_2 = R_2(q_1)$, firm 1 maximizes its profit, $\pi^1(q_1, R_2(q_1))$. The f.o.c. is $\pi^1_1 + \pi^1_2 R'_2(q_1) = 0$.[2] The Stackelberg output pairs are derived as follows:

$$(q_1^S(s_1, s_2),\ q_2^S(s_1, s_2)) = (\frac{a - 2e_1 + e_2}{2b},\ \frac{a - 3e_2 + 2e_1}{4b}). \tag{1}$$

The profits under Stackelberg competition are derived as follows:

$$(\pi^{S1}(s_1, s_2),\ \pi^{S2}(s_1, s_2)) = (\frac{b}{2}(q_1^S)^2,\ b(q_2^S)^2) = (\frac{(a - 2e_1 + e_2)^2}{8b},\ \frac{(a - 3e_2 + 2e_1)^2}{16b}). \tag{2}$$

The comparative statics are presented as follows: $\frac{\partial q_1^S(s_1,s_2)}{\partial s_1} = \frac{1}{b}$, $\frac{\partial q_1^S(s_1,s_2)}{\partial s_2} = -\frac{1}{2b}$, $\frac{\partial q_2^S(s_1,s_2)}{\partial s_2} = \frac{3}{4b}$, and $\frac{\partial q_2^S(s_1,s_2)}{\partial s_1} = -\frac{1}{2b}$.

[2] The subscripts of the profit function denote the partial derivatives with regard to q_j, i.e., $\pi^i_j \equiv \frac{\partial \pi^i}{\partial q_j}$.

2.2. The subsidy decision in the first stage

In the first stage, government $i = 1, 2$ maximizes the domestic welfare, i.e., $\max_{s_i \geq 0} W^i(s_i, s_j) \equiv \pi^i(q_i, q_j; s_i, s_j) - s_i q_i$. The f.o.c. for government i is as follows:

$$\frac{\partial W^i(s_i, s_j)}{\partial s_i} = \frac{\partial \pi^i(q_i, q_j; s_i)}{\partial s_i} - q_i - s_i \frac{\partial q_i}{\partial s_i} = 0, \tag{3}$$

if $s_i \geq 0$. If $\frac{\partial W^i(s_i, s_j)}{\partial s_i} < 0$, the solution is $s_i = 0$.[3]

3. The Second-mover Advantage

In subsection 3.1. to 3.3., we derive the Stackelberg equilibrium under the exogenous timing of subsidy choice by governments. We classify three cases: (i) both governments move simultaneously; (ii) government 1 moves first and government 2 moves second; (iii) government 2 moves first and government 1 moves second.

3.1. Simultaneous case

First, let us consider the simultaneous case in which both governments choose subsidies simultaneously. Government 1 of the leader maximizes $W^{S1}(s_1, s_2) = \pi^1(q_1^S(s_1, s_2), q_2^S(s_1, s_2); s_1) - s_1 q_1^S$, given s_2. By the f.o.c., the reaction function is $s_1^{sim} = R_1(s_2^{sim}) = 0$. Government 2 of the follower maximizes $W^{S2}(s_1, s_2) = \pi^2(q_2^S(s_1, s_2), q_1^S(s_1, s_2); s_2) - s_2 q_2^S$, given s_1. By the f.o.c., the reaction function is $s_2^{sim} = R_2(s_1^{sim}) = \frac{-2s_1^{sim} + a - c}{3}$. We solve the intersection of the reaction function as follows:

$$s_1^{sim} = 0, \ s_2^{sim} = \frac{a - c}{3}. \tag{4}$$

The equilibrium output and profit levels are obtained as follows:

$$(q_1^S(s_1^{sim}, s_2^{sim}), \ q_2^S(s_1^{sim}, s_2^{sim})) = (\frac{a - c}{3b}, \ \frac{a - c}{2b}), \tag{5}$$

$$(\pi^{S1}(s_1^{sim}, s_2^{sim}), \ \pi^{S2}(s_1^{sim}, s_2^{sim})) = (\frac{(a - c)^2}{18b}, \ \frac{(a - c)^2}{4b}). \tag{6}$$

When both governments decide on subsidy levels simultaneously, the subsidy policy of the government of the leader firm does not work in the Stackelberg model.

The equilibrium welfare levels are obtained as follows:

$$(W^{S1}(s_1^{sim}, s_2^{sim}), \ W^{S2}(s_1^{sim}, s_2^{sim})) = (\frac{(a - c)^2}{18b}, \frac{(a - c)^2}{12b}). \tag{7}$$

[3] The s.o.c. and the stability of the equilibrium are satisfied.

3.2. Sequential case in which government 1 moves first

Second, let us examine the sequential case in which government 1 chooses its subsidy level first. Government 1 moves first and then government 2 decides s_2 after observing s_1. Government 2 decides the subsidy $s_2 = R_2(s_1)$ in order to maximize $W^{S2}(s_1, s_2)$ $= \pi^2(q_2^S(s_1, s_2), q_1^S(s_1, s_2); s_2) - s_2 q_2^S$, given s_1. By direct calculation, the reaction function is obtained as $s_2^{seq1} = R_2(s_1^{seq1}) = \frac{-2s_1^{seq1}+a-c}{3}$. The reaction function is obtained using the same procedure as in the simultaneous case.

Government 1 induces this reaction function and maximizes $W^{S1}(s_1, R_2(s_1))$. By the f.o.c., the following equality is obtained: $s_1 = \frac{b}{4}q_1 = \frac{a-2(c-s_1)+(c-R_2(s_1))}{8}$.

In this case, the equilibrium subsidy levels are obtained as follows:

$$s_1^{seq1} = \frac{a-c}{8}, \; s_2^{seq1} = R_2(s_1^{seq1}) = \frac{a-c}{4}. \tag{8}$$

Note that if the cost is almost identical, $s_2^{seq1} > s_1^{seq1}$, that is, the subsidy given to the follower is larger than that given to the leader.

Substituting s_1, the equilibrium output and profit levels are obtained as follows:

$$(q_1^S(s_1^{seq1}, s_2^{seq1}), \; q_2^S(s_1^{seq1}, s_2^{seq1})) = (\frac{a-c}{2b}, \frac{3(a-c)}{8b}), \tag{9}$$

$$(\pi^{S1}(s_1^{seq1}, s_2^{seq1}), \; \pi^{S2}(s_1^{seq1}, s_2^{seq1})) = (\frac{(a-c)^2}{8b}, \frac{9(a-c)^2}{64b}). \tag{10}$$

The output of the leader is larger than that of the follower, $q_1^S(s_1^{seq1}, s_2^{seq1}) > q_2^S(s_1^{seq1}, s_2^{seq1})$.

The equilibrium welfare levels are obtained as follows:

$$(W^{S1}(s_1^{seq1}, s_2^{seq1}), \; W^{S2}(s_1^{seq1}, s_2^{seq1})) = (\frac{(a-c)^2}{16b}, \frac{3(a-c)^2}{64b}). \tag{11}$$

3.3. Sequential case in which government 2 moves first

Third, we examine the sequential case in which government 2 moves first and then government 1 decides s_1 after observing s_2. Observing s_2, government 1 decides the subsidy $s_1 = R_1(s_2)$ to maximize $W^{S1}(s_1, s_2) = \pi^1(q_1^S(s_1, s_2), q_2^S(s_1, s_2); s_1) - s_1 q_1^S$, given s_2. The reaction function is $s_1^{seq2} = R_1(s_2^{seq2}) = 0$. Government 2 induces this reaction by government 1 and maximizes $W^{S2}(0, s_2)$. Thus, the obtained result is the same as that in the simultaneous case.

Lemma 1. *Suppose that firm 1 is the Stackelberg leader. The equilibrium in the sequential case in which government 2 moves first is the same as that in the simultaneous case.*

In this case, the government does not subsidize its Stackelberg leader firm.

3.4. Comparison of the equilibrium profits of the leader and follower

By comparing the equilibrium profits of the leader and follower in the above three cases, the following proposition is immediately obtained.

Proposition 1. *Suppose that firm 1 is the Stackelberg leader. Regardless of the timing of the moves of both governments, firm 1's profit is smaller than that of firm 2,* $\pi^{S1} < \pi^{S2}$*. In other words, second-mover advantage occurs.*

Proposition 1 implies that in the previous stage wherein the governments decide the subsidy levels, the profit of the leader is less than that of the follower in contrast to the usual result under Stackelberg competition. If the governments can exercise the subsidy policies simultaneously, the leader firm loses its first-mover advantage under the Stackelberg competition. This is because the government of the Stackelberg leader firm cannot provide any advantage by subsidizing it. In the sequential case in which the government of the leader moves first, the government of the leader firm faces a trade-off. The government desires both to improve the competitive position of the domestic firm and to maintain a lower subsidy level. As the Stackelberg leader produces more than the follower, the government of the leader firm is not required to improve its competitive position, and hence, it can reduce subsidy.

Although, at the first glance, it appears that the Stackelberg leader has the first-mover advantage, the government of the leader cannot influence the improvement of its competitive position, and the follower can be supported by its government.

3.5. The Second-mover Advantage under the Endogenous Timing

In subsection 3.4., we show that the second-mover advantage occurs under the exogenous timing of subsidy choice by governments. In this subsection, we examine whether the governments prefer moving first or second and present the main result under the endogenous timing of subsidy choice by governments.

Let us consider the situation in which both governments can choose the timing of move in the first stage, in order to maximize its welfare level. In this game wherein governments choose whether to move first or second, suppose that if both governments choose to move first or second, the subsidy decision is made simultaneously in the first stage. Otherwise, one government chooses to move first, the other government chooses to move second, and the subsidy decision is made sequentially. From (7), (11), and Lemma 1, the game of the endogenous timing by governments is presented in the following normal-form representation:

Table 1 around here

As shown in Table 1, to move first is the weakly dominant strategy for both governments, and it is confirmed that the pure-strategy Nash equilibria of this game are (first, first) and (second, first). The mixed-strategy Nash equilibrium is represented as that in which government 1 chooses to move first with any probability $p \in [0,1]$, and government 2 moves first.

By comparing the equilibrium profit and welfare, the result is summarized in the following proposition.

Proposition 2. *Suppose that firm 1 is the Stackelberg leader, and governments can choose the timing for deciding on the subsidy. The welfare of government 1 is smaller than that of government 2, and the profit of the Stackelberg leader is smaller than that of the follower, i.e.,* $W^{S1} < W^{S2}$ *and* $\pi^{S1} < \pi^{S2}$*. In other words, second-mover advantage occurs for the firm and the government.*

Proof. In the game of the endogenous timing, it is satisfied that $W^{S1} = \frac{(a-c)^2}{18b} < W^{S2} = \frac{(a-c)^2}{12b}$ and $\pi^{S1} = \frac{(a-c)^2}{18b} < \pi^{S2} = \frac{(a-c)^2}{4b}$. $\square$

Proposition 2 implies that the government of a country with the Stackelberg leader enjoys less welfare than the government in another country with the follower. When governments compete in subsidy, the original competitive advantage possessed by the Stackelberg leader is lost. This result suggests that government intervention via subsidy is possible to change the competitive condition significantly.

4. Conclusion

This paper examined which of the Stackelberg leader or its follower has the advantage under strategic subsidy policy in a third market model. Two main results expressed in Proposition 1 and 2 are as follows: First, regardless of the timing of moves of both governments, the profit of the leader is smaller than that of the follower. We show that the second-mover advantage occurs under the exogenous timing of subsidy choice. Second, we show that taking the endogenous timing of subsidy choice by governments into consideration, the second-mover advantage occurs for the firm and the government.

Our result suggests that if governments can intervene in domestic firms with any policy instruments, the competitive advantage of firms may vastly change from the initial market competitive condition such as Cournot and Stackelberg competition. Even if a firm is a Stackelberg follower in the third market, the subsidization by its government can eliminate the initial competitive disadvantage entirely. Therefore, we conclude that the timing of export subsidy policies enforced by governments affects the firms' competitive position more significantly.

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Table 1: The endogenous timing of subsidy choice

		Government 2	
		First	Second
Government 1	First	$\frac{(a-c)^2}{18b}$, $\frac{(a-c)^2}{12b}$	$\frac{(a-c)^2}{16b}$, $\frac{3(a-c)^2}{64b}$
	Second	$\frac{(a-c)^2}{18b}$, $\frac{(a-c)^2}{12b}$	$\frac{(a-c)^2}{18b}$, $\frac{(a-c)^2}{12b}$