Strategic exporting in an international oligopoly

Takauchi, Kazuhiro

Mizuno, Tomomichi

(Citation)
神戸大学経済学研究科 Discussion Paper,2216:1-10

(Issue Date)
2022-12

(Resource Type)
technical report

(Version)
Version of Record

(URL)
https://hdl.handle.net/20.500.14094/0100478205

Strategic exporting in an international oligopoly

Kazuhiro Takauchi
Tomomichi Mizuno

December 2022

Discussion Paper No. 2216

GRADUATE SCHOOL OF ECONOMICS

KOBE UNIVERSITY

ROKKO, KOBE, JAPAN

Strategic exporting in an international oligopoly

Kazuhiro Takauchi*† Tomomichi Mizuno‡

December 18, 2022

Abstract

In this paper, we build a model in which firms choose whether to export. We show that if the fixed export cost is small and the transport cost is high, the coexistence of exporters and non-exporters can appear. We also show that trade liberalization may reduce consumer and total surpluses. Because the competition authority often cherishes consumer welfare, our finding offers an important insight into the relation between export activity and competition policy.

Key words: Exporting; Fixed export cost; Transport cost; Trade liberalization; Oligopoly

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

In many manufacturing industries, exporters and non-exporters coexist. For example, Bernard et al. (2007) reported that, in US data from 2002, exporters in Computer and Electronic Product were 38% and those in Machinery Manufacturing were 33%.

It is well known that exporting is a mode of entry into a foreign market and it must have a sunk entry cost. In practice, the empirical study of Roberts and Tybout (1997) rejected the idea that the sunk entry cost is zero. This implies that firms have options regarding whether to export, and they must pay a fixed export cost if they export their products to a foreign market.

The purpose of this paper is to build a model in which firms choose whether to export in an oligopolistic intra-industry trade framework. We show that the coexistence of exporters and non-exporters can appear if the transport cost is high, whereas multiple equilibria in which firms choose the same action as their rival can appear if the transport cost is low. Hence, our result is partially consistent with empirical evidence. We also show that trade liberalization may reduce consumer and total surpluses. The competition authority cherishes consumer welfare; hence, our finding offers an important insight related to competition policy.

In our model, firms can choose whether to export. Because the product market divides into two when a firm exports, this paper is related to studies in which the firm's choice of the number of products was considered. For example, Grossmann (2007) offered a model in which firms decide the number of products. However, his model is limited to the domestic market, and hence, does not consider international competition.

2 Model

There are two symmetric countries: Home (labeled H) and Foreign (labeled F). Each country has a firm, which we call firm H and firm F, respectively. Each firm has two options, that is, whether to export or not, and pays a fixed cost $k > 0$ if it exports. When firm i exports, its

output includes both domestic supply (labeled D) and exports (labeled E). We assume that firms have a quadratic cost function.[1] The inverse demand of country i when all firms export is $p = a - q_{ii} - q_{ji}$, $i \neq j$, $i, j = H, F$, where p is the product price, q_{ii} is the domestic supply of firm i, and q_{ji} is the export of firm j. The inverse demand of country i when firm j does not export is $p = a - q_{ii}$.

According to the decisions made by firms, profits are as follows: When all firms choose E, their profits without k are $\Pi_i \equiv (a - q_{ii} - q_{ji})q_{ii} + (a - q_{jj} - q_{ij} - t)q_{ij} - \frac{1}{2}(q_{ii} + q_{ij})^2$ for $i \neq j$, $i, j = H, F$, where $t > 0$ is the per unit transport cost. When only firm i chooses D, its profit is $\Pi_i \equiv (a - q_{ii} - q_{ji})q_{ii} - \frac{1}{2}(q_{ii})^2$. When only firm i chooses E, its profit without k is $\Pi_i \equiv (a - q_{ii})q_{ii} + (a - q_{jj} - q_{ij} - t)q_{ij} - \frac{1}{2}(q_{ii} + q_{ij})^2$. When all firms choose D, their profits are $\Pi_i \equiv (a - q_{ii})q_{ii} - \frac{1}{2}(q_{ii})^2$.

We consider the following two-stage game: In the first stage, each firm chooses either E or D. If a firm chooses E, it pays k. In the second stage, each firm enters a homogeneous quantity competition. The game is solved by backward induction.

3 Results

By solving the Cournot competition in the second stage of the game, we obtain the following outputs:

$$
\begin{aligned}
& q_{ii}^{EE*} = \frac{a + 2t}{5}, \quad q_{ij}^{EE*} = \frac{a - 3t}{5}, \\
& q_{HH}^{DE*} = \frac{2a + t}{7} = q_{FF}^{DE*} = q_{HH}^{ED*} = q_{FF}^{ED*}, \quad q_{FH}^{DE*} = \frac{a - 3t}{7} = q_{HF}^{ED*} \\
& q_{ii}^{DD*} = \frac{a}{3}.
\end{aligned} \tag{1}
$$

Note that variable "EE" denotes "all firms choose E" and "DE" denotes "firm H chooses D and firm F chooses E," where "$*$" is an equilibrium value.

[1] A quadratic cost function is often used in the oligopoly model. See, for example, von Weizsäcker (1980).

To ensure a positive quantity, we assume $t/a < 1/3$.

Equation (1) yields the equilibrium profit of firms:

$$\begin{aligned}
\Pi_i^{EE*} &= \frac{1}{50}\left(8a^2 - 8at + 27t^2\right), \\
\Pi_H^{DE*} &= \Pi_F^{ED*} = \frac{3}{98}(2a+t)^2, \\
\Pi_F^{DE*} &= \Pi_H^{ED*} = \frac{1}{98}\left(19a^2 - 16at + 24t^2\right), \\
\Pi_i^{DD*} &= \frac{a^2}{6}.
\end{aligned} \tag{2}$$

From equation (2), we obtain Lemma 1.

Lemma 1. *(i) Suppose that rival (firm j) chooses E. If $\varphi_D \equiv \frac{2(23a-104t)(a-3t)}{1225} >(\leq)\, k/a^2$, firm i chooses E (D).*

(ii) Suppose that rival chooses D. If $\varphi_E \equiv \frac{4}{147}(a-3t)^2 >(\leq)\, k/a^2$, firm i chooses D (E).

Proof. $\varphi_D \equiv \Pi_H^{EE*} - \Pi_H^{DE*} = \Pi_F^{EE*} - \Pi_F^{ED*} = \frac{2(23a-104t)(a-3t)}{1225}$ and $\varphi_E \equiv \Pi_H^{ED*} - \Pi_H^{DD*} = \Pi_F^{DE*} - \Pi_F^{DD*} = \frac{4}{147}(a-3t)^2$. □

From Lemma 1, we establish Proposition 1.

Proposition 1. *I. Suppose that $t/a \leq 19/162$. (i) If $k/a^2 < \varphi_E$, then EE appears. (ii) If $\varphi_E \leq k/a^2 \leq \varphi_D$, then DD&EE can appear. (iii) If $k/a^2 > \varphi_D$, then DD appears.*

II. Suppose that $19/162 < t/a < 23/104$. (i) If $k/a^2 < \varphi_D$, then EE appears. (ii) If $\varphi_D \leq k/a^2 \leq \varphi_E$, then DE&ED can appear. (iii) If $k/a^2 > \varphi_D$, then DD appears.

III. Suppose that $23/104 \leq t/a < 1/3$. (i) If $k/a^2 \leq \varphi_E$, then DE&ED can appear. (ii) If $k/a^2 > \varphi_E$, then DD appears.

The equilibrium pattern depends on the sizes of both transport and fixed costs. (See Figure 1.) We first consider (a) $DE\&ED$ and then (b) $DD\&EE$. (a) When the transport cost is high and the fixed cost is small, $DE\&ED$ can appear. If the rival chooses D, the domestic market is a monopoly. Then, because firms can gain market share in the foreign market if they export, firms

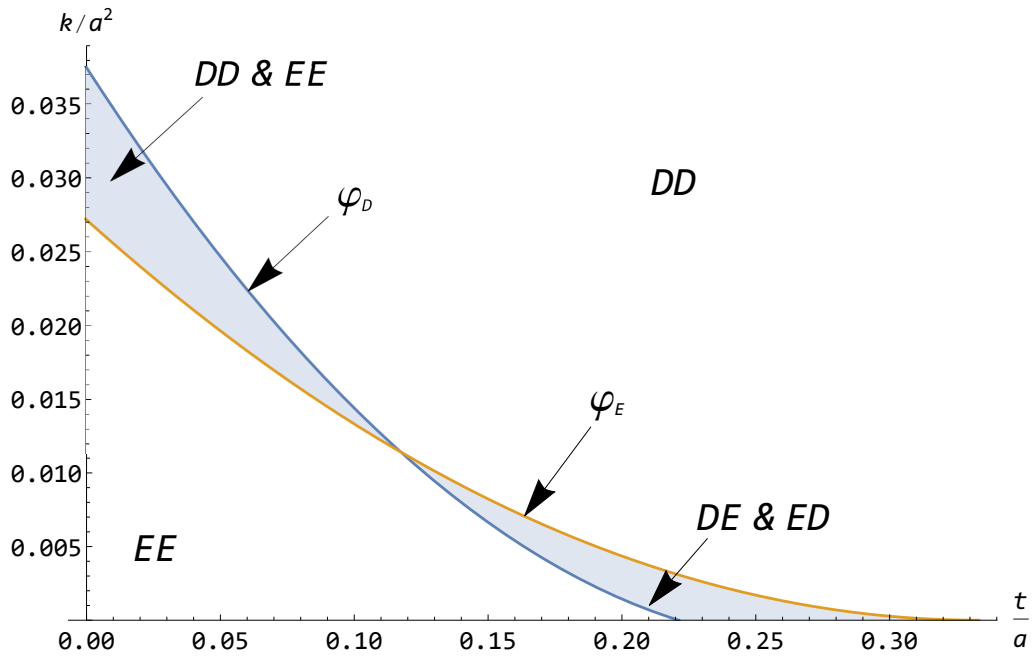

Figure 1: Four areas

choose E. Conversely, suppose the rival chooses E. Now, the foreign market is relatively small; hence, the benefit of exporting is small. Furthermore, because the transport cost is relatively high and the import barrier is also high, domestic market competition lessens. Hence, firms choose D.

(b) When the transport cost is small and the fixed cost is high, $DD\&EE$ can appear. First, suppose that there are rival exports. Now, although the fixed cost is large, the benefit of exporting is large. Furthermore, because the transport cost is low, domestic competition is tougher. Then, a degree of profit reduction occurs because the foreign firm's entry is large in the domestic market; hence, firms choose E. Second, suppose the rival chooses D. In this case, the fixed cost is large. Because the export barrier is large and firms enjoy a domestic monopoly, they choose D.

4 Consumer surplus

Competition authorities often cherish consumer welfare compared with total surplus (e.g., Albaek, 2013); hence, we focus on consumer surplus.

From equation (1), consumer surplus in each regime is

$$CS_i^{EE*} = \frac{1}{50}(2a-t)^2,\ CS_i^{DD*} = \frac{a^2}{18},\ CS_H^{DE*} = \frac{1}{98}(3a-2t)^2,\ CS_H^{ED*} = \frac{1}{98}(2a+t)^2, \quad (3)$$

where $CS_H^{DE*} = CS_F^{ED*}$ and $CS_H^{ED*} = CS_F^{DE*}$.

Equation (3) yields Proposition 2.

Proposition 2. *Suppose that $k/a^2 < 25/2187$. Then, trade liberalization with a small reduction of t may reduce consumer surplus.*

Proof. First, $DE\&ED$ can appear if $k/a^2 < 25/2187$. Second, $\forall t/a < 1/3$, $CS_H^{DE*} > CS_i^{EE*} > CS_i^{DD*} > CS_H^{ED*}$. Hence, $\forall k/a^2 < 25/2187$, consumer surplus can drop if t decreases. □

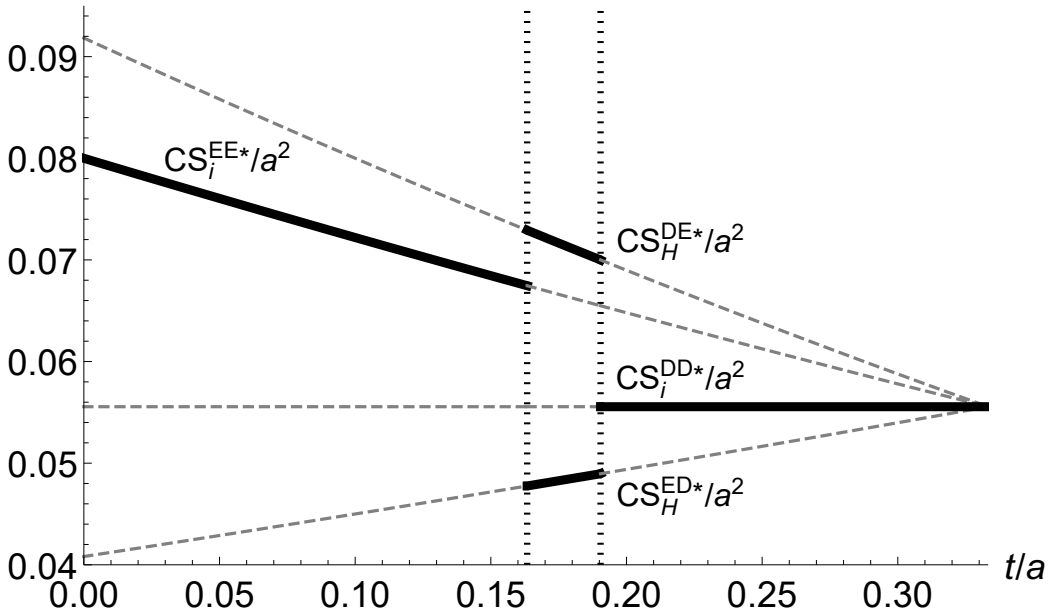

Figure 2: Effect of trade liberalization on consumer surplus ($k = 0.005$)

Proposition 2 can be explained by ranking consumer surplus. (Figure 2 draws the relationship between consumer surplus and transport cost.) In the regime "only the foreign firm exports,"

because the home firm does not export, its marginal cost is small. Hence, its domestic supply increases. Additionally, imports exist; hence, aggregate outputs are largest among all other regimes. Thus, consumer surplus is largest too. In the regime "everyone exports," each firm's marginal cost is large. Furthermore, because strategic substitutes work in markets, the domestic firm's domestic supply decreases because of the rival's exports. Hence, the aggregate output in this regime is smaller than that in the regime "only the foreign firm exports." In the regime "no one exports," because there are no imports, the aggregate output in this regime is smaller than that in the regime "everyone exports." Finally, in the regime "only the domestic firm exports," because the domestic firm supplies two markets, its marginal cost increases. Hence, its domestic supply decreases. In this case, there are no imports; hence, the aggregate output equals the domestic supply. As a result, consumer surplus is smallest among all other regimes.

5 Total surplus

We show that trade liberalization may reduce total surplus. Total surplus in each regime is as follows:

$$TS_i^{EE*} = \frac{2(3a^2 - 3at + 7t^2)}{25} - k, \quad TS_H^{ED*} = TS_F^{DE*} = \frac{23a^2 - 12at + 25t^2}{98} - k,$$
$$TS_H^{DE*} = TS_F^{ED*} = \frac{3a^2 + t^2}{14}, \quad TS_i^{DD*} = \frac{2a^2}{9}.$$

By comparing the total surpluses, we obtain the following result.

Proposition 3. *(i) If trade liberalization changes the trade regime, it always reduces total surplus. (ii-a) Without changing the trade regime, trade liberalization always reduces the total surplus of the non-exporting country. (ii-b) Without changing the trade regime, the total surplus of the exporting country decreases if* $3/14 < t/a < 23/104$ *and* $k/a^2 < \varphi_D$ *in the EE regime, and if* $6/25 < t/a < 1/3$ *and* $k/a^2 < \varphi_E$ *in the ED regime.*

Proof. See Appendix.

To confirm that trade liberalization reduces total surplus, we drew figures with total surplus as a function of t. In Figure 3, trade liberalization with a changing trade regime reduces total surplus. Additionally, the total surplus of the non-exporting country in the DE or ED regimes decreases with t. Thus, we confirm the results (i) and (ii-a) in Figure 3.

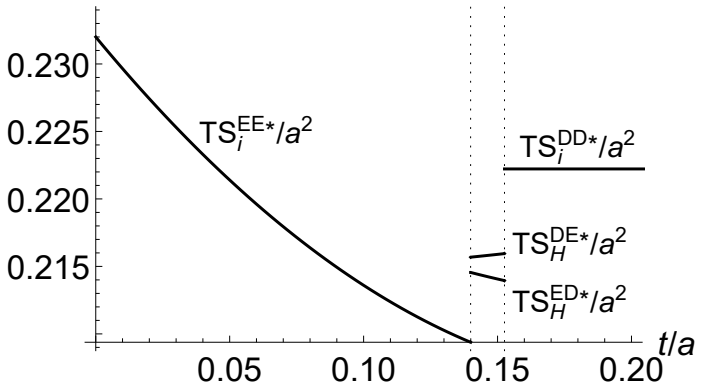

Figure 3: Effect of trade liberalization on total surplus ($k/a^2 = 0.008$)

We drew the total surpluses of the exporting country in the EE and $ED\&DE$ regimes at $k/a^2 = 0$. Then, we obtained Figure 4. Note that from Proposition 1, either the EE or $ED\&DE$ regimes occur at $k/a^2 = 0$. In Figure 4, the shadow areas represent the case in which trade liberalization has a negative impact on total surplus.

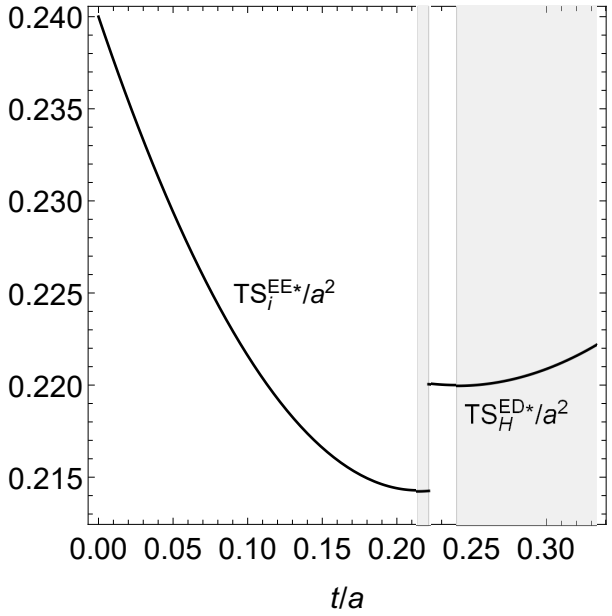

Figure 4: Welfare decreasing trade liberalization ($k/a^2 = 0$)

The intuition behind Proposition 3 is as follows: As trade liberalization (decrease in t) progresses, the exporting firm's supply shifts from the domestic market to foreign markets. As a result, the domestic firm's profit increases and the domestic consumer surplus decreases. Which of these effects is larger determines whether total surplus increases. If t is large, the supply to the foreign market is small and the supply to the domestic market is large. In this case, a decrease in t significantly changes the supply to the domestic market so that the effect of trade liberalization on lowering consumer surplus dominates. Thus, in each regime, trade liberalization reduces the aggregate surplus in the region in which t is large: (ii-b) in Proposition 3.

When the foreign firm trades and the domestic firm does not, trade liberalization increases the domestic consumer surplus but reduces the domestic firm's profit. In our model, this profit-decreasing effect dominates; hence, the total surplus of the non-exporting country decreases with trade liberalization: (ii-a) in Proposition 3.

Finally, the same intuition applies when a decrease in t changes the trade regime. When a slight decrease in t changes the trade regime, the profit of the firm that begins to export changes little. However, the total surplus of the country in which firms begin to export falls because the supply to the country is significantly reduced. Furthermore, because trade liberalization intensifies competition among firms, the profits of firms that do not change their export decisions also decline. Although consumer surplus in the country increases, the total surplus of the country also falls because this profit-lowering effect dominates: (i) in Proposition 3.

Acknowledgements

The first author's work was supported by the Japan Society for the Promotion of Science (JSPS), KAKENHI [grant number 20K01646]. All errors are our own.

Appendix

Proof of Proposition 3

We distinguish two scenarios in which trade liberalization reduces total surplus: (i) trade liberalization with a changing trade regime and (ii) trade liberalization without a changing trade regime.

We consider case (i). From Proposition 1, the trade regime change occurs at $k/a^2 = \varphi_D$ or $k/a^2 = \varphi_E$. From Proposition 1, for $t/a \leq 19/162$, we compare TS_i^{DD*} with TS_i^{EE*} at $k/a^2 = \varphi_D$ or $k/a^2 = \varphi_E$:

$$\left(TS_i^{DD*} - TS_i^{EE*}\right)_{k=\varphi_D a^2} = \frac{2(a-3t)(109a+93t)}{11025} > 0,$$
$$\left(TS_i^{DD*} - TS_i^{EE*}\right)_{k=\varphi_E a^2} = \frac{2(a-3t)(52a+579t)}{11025} > 0.$$

Hence, for $t/a \leq 19/162$, trade liberalization reduces the total surplus of both countries.

Next, we consider case (i) with $t/a > 19/162$. By evaluating $TS_i^{DD*} - TS_H^{ED*}$ at $k/a^2 = \varphi_E$, we obtain the following equation:

$$\left(TS_i^{DD*} - TS_H^{ED*}\right)_{k=\varphi_E a^2} = \frac{(a-3t)(13a+3t)}{882} > 0.$$

Additionally, $TS_i^{DD*} - TS_H^{DE*}$ and $TS_H^{ED*} - TS_i^{EE*}$ are

$$TS_i^{DD*} - TS_H^{DE*} = \frac{(a-3t)(a+3t)}{126} > 0, \quad TS_H^{ED*} - TS_i^{EE*} = \frac{(249t-13a)(a-3t)}{2450} > 0.$$

Substituting $k/a^2 = \varphi_D$ into $TS_H^{DE*} - TS_i^{EE*}$, we obtain

$$\left(TS_H^{DE*} - TS_i^{EE*}\right)_{k=\varphi_D a^2} = \frac{(29a-17t)(a-3t)}{2450} > 0.$$

Therefore, trade liberalization with a changing trade regime always reduces total surplus.

We consider case (ii): trade liberalization without a changing trade regime. By differentiating the total surplus in each trade regime with respect to t, we obtain the following:

$$\frac{\partial TS_i^{EE*}}{\partial t} = -\frac{2(3a-14t)}{25a^2}, \quad \frac{\partial TS_H^{ED*}}{\partial t} = -\frac{6a-25t}{49}, \quad \frac{\partial TS_H^{DE*}}{\partial t} = \frac{t}{7} > 0, \quad \frac{\partial TS_i^{DD*}}{\partial t} = 0.$$

Hence, if the trade regime is ED or DE, trade liberalization always reduces the total surplus of the non-exporting country. Additionally, without the exporting country, trade liberalization

has no effect on total surplus.

Because $\partial TS_i^{EE*}/\partial t > 0$ if $t/a > 3/14$, trade liberalization reduces total surplus if $3/14 < t/a < 23/104$ and $k/a^2 < \varphi_D$. Next, because $\partial TS_H^{ED*}/\partial t > 0$ if $t/a > 6/25$, trade liberalization reduces total surplus if $6/25 < t/a < 1/3$ and $k/a^2 < \varphi_E$.

Summarizing the above results, we obtain Proposition 3.□

References

[1] Albaek, S., 2013. Consumer welfare in EU competition policy. Aims and Values in Competition Law, 67–88.

[2] Bernard, A., Jensen, B., Redding, S. J., Schott, P. K., 2007. Firms in international trade. J. Econ. Perspect. 21(3), 105–130.

[3] Brander, J. A., Krugman, P. R., 1983. A 'reciprocal dumping' model of international trade. J. Int. Econ. 15, 313–321.

[4] Grossmann, V., 2007. Firm size and diversification: Multiproduct firms in asymmetric oligopoly. Int. J. Ind. Organ. 25, 51–67.

[5] Roberts, M. J., Tybout, J. R., 1997. The decision to export in Colombia: An empirical model of entry with sunk costs. Am. Econ. Rev. 87(4), 545–564.

[6] von Weizsäcker, C. C., 1980. A welfare analysis of barriers to entry. Bell. J. Econ. 11, 399–420.