Strategic export decisions in international trade

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February 2024

Discussion Paper No. 2401

GRADUATE SCHOOL OF ECONOMICS

KOBE UNIVERSITY

ROKKO, KOBE, JAPAN

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First version: December 18, 2022

This version: February 13, 2024

Abstract

As it is well known that export markets are often oligopolistic, we build an oligopoly trade model in which firms choose whether or not to export. We focus on the different roles of transport and fixed export costs with respect to the export decision, and show that depending on the sizes of both transport and fixed export costs, *all possible trade patterns* appear between two symmetric countries. If the transport cost is large because firms behave in different ways, "One-way trade" appears. If the fixed export cost is large because firms adopt the same behavior, situations of "No trade" and "Two-way trade" could occur.

Key words: Trade pattern; Fixed export cost; Transport cost; Oligopoly

JEL classification: F12; L13; D43

*This paper is a revised version of our discussion paper, Kazuhiro Takauchi and Tomomichi Mizuno, December 2022, "*Strategic exporting in an international oligopoly*," Discussion Paper No. 2216, Graduate School of Economics, Kobe University, Kobe, Japan. We thank Hajime Sugeta for several constructive comments on an earlier version of this paper. The usual disclaimer applies. We thank Dr Amanda Fitzgibbons from Edanz (https://jp.edanz.com/ac) for editing a draft of this manuscript.

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1 Introduction

In this study, we incorporate firm options of the Melitz (2003) type regarding "whether to export or not" into an oligopolistic competition. Then, we consider what size transport and fixed export costs result in unilateral entry to the foreign market in response to the export decision (i.e., "One-way trade") or a bidirectional entry to the foreign market (i.e., "Two-way trade"). We demonstrate the following trade pattern in equilibrium: [a] When the transport cost is large and the fixed export cost is small, *asymmetric equilibria in which only one country exports between two symmetric countries*, i.e., "One-way trade," can occur. [b] When the transport cost is small and the fixed export cost is large, *multiple equilibria involving "No trade" and "Two-way trade" between the two symmetric countries* can occur.

Studies on firm export activity and international trade using a Melitz-type model focus on the productivity differences among firms as a cause of the appearance of exporting firms. However, they tend to overlook *strategic interaction* among firms. It is well known that many export markets are oligopolistic and thus it is highly natural to expect that a firm's behavior depends on interactions with other firms in the export markets. In the real world, many export markets are reported to be oligopolistic, including the markets for iron, lead, tin, and zinc (Zhang and Lawell, 2017); rice-milling and cigarettes (Arnade et al., 1998); semiconductors and steel (Kim and Lee, 2017); automobiles (in the US) (Goldberg, 1995); and wheat (in the Caucasus region) (Gafarova et al., 2023).[1] Therefore, if we consider firms' export activity, focusing on oligopolistic competition is partially consistent with real-world examples.

We built an oligopoly model of the Brander and Krugman (1983) type, consisting of two symmetric countries and two firms. Each firm has two options: export to the foreign market and/or supply the local domestic market. If a firm exports, it pays not only transport costs but

[1] In addition, studies point out that both German exporters of beer and US exporters of linerboard paper have relatively large market power (Goldberg and Knetter, 1999).

also a fixed export cost. The firm only supplies the domestic market if it does not export. Each firm has a quadratic cost function, and first chooses whether to export, and subsequently decides on quantities.[2] In this situation, two kinds of multiple equilibria appear when the transport cost and the fixed export cost are at intermediate levels. [a] When the transport cost is large and the fixed export cost is small, an asymmetric equilibrium in which only one country exports (i.e., "One-way trade") appears. A firm exports if its rival decided to supply the domestic market rather than export. This is because the firm gains market share in the foreign country if it exports, and enjoys a monopoly in its local market. In contrast, a firm supplies the domestic market if its rival exports. This is because exporting is not attractive when the foreign market is relatively small and, moreover, competition in the local market is weak because entry barriers are high. [b] When transport cost is small and the fixed export cost is large, multiple equilibria involving "No trade" and "Two-way trade" appear. A firm exports if its rival exports. This is because, given that import barriers are low, there is strong competition in the local market. Furthermore, the size of the foreign market is relatively large because the transport cost is small. A firm supplies the domestic market if its rival does so in its country. The reason for this is that the entry barriers to the foreign market are high, and the firms can enjoy monopoly in their local markets.

In addition, we show that trade liberalization with a reduction in the transport cost can significantly reduce consumer welfare. If the fixed export cost is relatively small, "One-way trade" can appear. In this situation, let us consider that trade liberalization proceeds. Then, the trade pattern can switch from "No trade" to "One-way trade." That is, because the equilibrium regime can switch from a "No one exports" regime to a regime in which "only the home country becomes an exporting country," the consumer surplus in the home country can drop sharply when the transport cost falls below a certain level.

[2] In the Discussion section, we consider both differentiated quantity and price competition. See Section 5.

Furthermore, we discuss how the mode of competition affects the trade pattern. In differentiated quantity competition, our main result does not alter. However, in differentiated price competition, because the rivalry among firms increases compared with quantity competition, the equilibrium trade pattern becomes a multiple equilibria of "No trade" and "Two-way trade."

The three main contributions of our paper to the literature are as follows: First, we determine the trade pattern between two symmetric countries based on firms' strategic exporting behavior. As a result, we show that all possible trade patterns can appear according to the size of the transport and fixed export costs. This analysis presents new insights to the trade literature. Second, our study demonstrates that trade liberalization may reduce consumer welfare significantly. Therefore, competition authorities that value consumer welfare [e.g., the Federal Trade Commission (FTC) in the USA] should ensure that the governments of their countries pay attention to the effects of trade liberalization. Third, we show that each country should become a non-exporting country rather than an exporting country if the fixed export cost is relatively large. This result offers a new perspective to practitioners and policy makers, who tend to emphasize export promotion and exports of firms.[3] Thus, our result offers a unique policy implication.

This paper is related to the works of Melitz and others adopting Melitz-style models to investigate firm exporting behavior and international trade (e.g., Melitz, 2003; Demidova and Rodríguez-Clare, 2013; Melitz and Ottaviano, 2008; and Long et al., 2011).[4] To address firm heterogeneity well, Melitz (2003) incorporated a productivity distribution into a standard monopolistic competition model. Then, he showed that less-productive firms become non-exporting

[3]In fact, Van Biesebroeck et al. (2015) point out that export promotion programs are often observed.

[4]Other studies also use Melitz-type models to focus on the relationship between labor markets and trade liberalization (e.g., Egger and Kreickemeier, 2009; Helpman and Itskhoki, 2010; and Helpman et al., 2010). Egger and Kreickemeier (2009) emphasize workers' fair wage preferences. Helpman and Itskhoki (2010) consider wage bargaining and search and matching frictions in the labor market. Helpman et al. (2010) mainly consider labor market frictions and differences in workforce composition across firms.

firms and productive firms become exporting firms. A transport cost reduction brings about an export expansion through the "intensive margin" and "extensive margin."[5] Melitz showed that this "extensive margin" causes a reallocation of resources from less-productive firms to productive firms. Then, the country's welfare rises because of a fall in the price index.

Demidova and Rodríguez-Clare (2013) focused on a welfare analysis using a Melitz (2003)-type model.[6] They modified the Melitz (2003) model to an asymmetric two-country model composed of small and large countries with an endogenous wage rate, and demonstrated that trade liberalization raises the country's welfare because of reallocation effects.

Melitz and Ottaviano (2008) constructed a model with an endogenous markup rate. Trade liberalization results in higher (constant) welfare for the trade liberalizing country (the trade partner) because of a reallocation effect, including a lower markup rate in the short run; however, fewer (more) potential entrants lead to lower (higher) welfare in the long run.

These studies are central and significant to the literature focusing on a monopolistically competitive trade model with firm heterogeneity. However, as they are all based on monopolistic competition they do not analyze strategic interaction among firms. Therefore, the analyses do not consider all possible trade patterns that occur according to the size of the transport and fixed costs.

To consider the relationship between firm process innovation (or cost-reducing R&D activity) and trade liberalization, Long et al. (2011) incorporated Melitz-type firm exporting behavior into an oligopolistic competition model.[7] However, the main purpose of Long et al. (2011) was

[5]The "intensive margin" indicates the expected value of one firm's export volume. The "extensive margin" refers to the number of firms exporting from a certain country to the foreign country (Antràs, 2016, p. 38).

[6]Arkolakis et al. (2012) showed that the condition of gains from trade in the Melitz model depends on two factors. One is the shape of the productivity distribution, and the other is the expenditure share for the own country's products in the open economy.

[7]Impullitti et al. (2022) considered heterogeneous oligopolistic competition and R&D in a general equilibrium framework. Furthermore, Edmond et al. (2015) presented a general equilibrium model in which intermediate-good

to examine the effects of trade liberalization on R&D investment and hence, the *firms' strategic choice regarding whether to export* and *the decision of trade pattern* are omitted in their model.

This paper is also related to the studies in which firms endogenously determine whether to become a multiproduct producer (e.g., Basak and Mukherjee, 2018; Grossmann, 2007; and Kawasaki et al., 2023). In our model, firms consider whether to become an exporter. This situation is similar to single-product firms becoming multiproduct firms due to paying a fixed cost and by developing new products. Basak and Mukherjee (2018) consider new product development, that is, product R&D, in a unionized duopoly model. Kawasaki et al. (2023) examine downstream firms' new product development and upstream firms' cost-reducing R&D. Moreover, Grossmann (2007) builds a model in which firms decide the number of their products. Although these studies offer interesting results, their models are limited to the domestic market alone, and therefore, do not cover international trade.

The remainder of this paper is organized as follows. Section 2 presents the baseline model and Section 3 examines the trade patterns that arise. Section 4 presents the welfare considerations. Section 5 discusses the case where firms engage in differentiated quantity and price competition. Section 6 concludes.

2 Model

We consider a segmented market of the Brander and Krugman (1983) type. There are two symmetric countries, the home country (labeled H) and the foreign country (labeled F), and each country has a product market and a firm, which we refer to as firms H and F, respectively. Each firm has two options, that is, it must decide whether to export or not export, and it pays a fixed export cost $k \geq 0$ if it exports. When firm i exports, its output includes both "domestic supply" (labeled D) and "exports" (labeled E). To export one unit of product to the foreign

producers compete in Cournot fashion.

market, firms must pay a per unit transport cost $t \geq 0$. We assume that the firms have a quadratic cost function:[8] $(\gamma/2)\, q^2$, where $\gamma > 0$ is the production efficiency of firms and q is a quantity. According to the decisions made by the firms, four trade patterns appear. Figure 1 illustrates all possible trade patterns between the Home and Foreign firms. In the baseline model, firms engage in a homogenous quantity competition in both the Home and Foreign markets. In the discussion in Section 5, we consider differentiated quantity and price competition.

The inverse demand of country i when all firms export is $p_i = a - q_{ii} - q_{ji}$, $i \neq j$, $i, j = H, F$, where p_i is the product price, q_{ii} is the domestic supply of firm i, and q_{ji} is the export of firm j (or the imports of country i from country j). The inverse demand of country i when firm j does not export is $p_i = a - q_{ii}$. The consumer surplus in country i is given by $CS_i = Q_i^2/2$, where Q_i is aggregate output of country i. For example, if all firms choose E, the consumer surplus in country i becomes $CS_i = (q_{ii} + q_{ji})^2/2$ for $i \neq j$, $i, j = H, F$.

The profits of the firms depend on the trade pattern realized. When all firms choose E, two-way trade occurs. Then, firm i's profit without k (the fixed export cost) is given by:

$$\Pi_i \equiv (a - q_{ii} - q_{ji})q_{ii} + (a - q_{jj} - q_{ij} - t)q_{ij} - \frac{\gamma}{2}(q_{ii} + q_{ij})^2 \quad \text{for } i \neq j, i, j = H, F.$$

When only firm i $(\neq j)$ chooses D, its profit is:

$$\Pi_i \equiv (a - q_{ii} - q_{ji})q_{ii} - \frac{\gamma}{2}(q_{ii})^2 \quad \text{for } i \neq j, i, j = H, F.$$

[8]The production technology for manufacturing often involves decreasing returns to scale. Basu and Fernald (1997) found that a typical industry has decreasing returns to scale based on aggregate data of 34 manufacturing industries in the US. Kee (2002) empirically found that many manufacturing industries in Singapore have decreasing returns to scale. In addition, Xu et al (1994), among others, found that decreasing returns to scale can be observed in the transportation sector. Furthermore, a quadratic cost function is frequently adopted in theoretical studies of oligopoly. See, for example, Dastidar (1995), Delbono and Lambertini (2016), Goerke (2022), Mizuno and Takauchi (2020, 2024), Mukherjee (2014, 2024), Takauchi and Mizuno (2022), and von Weizsäcker (1980).

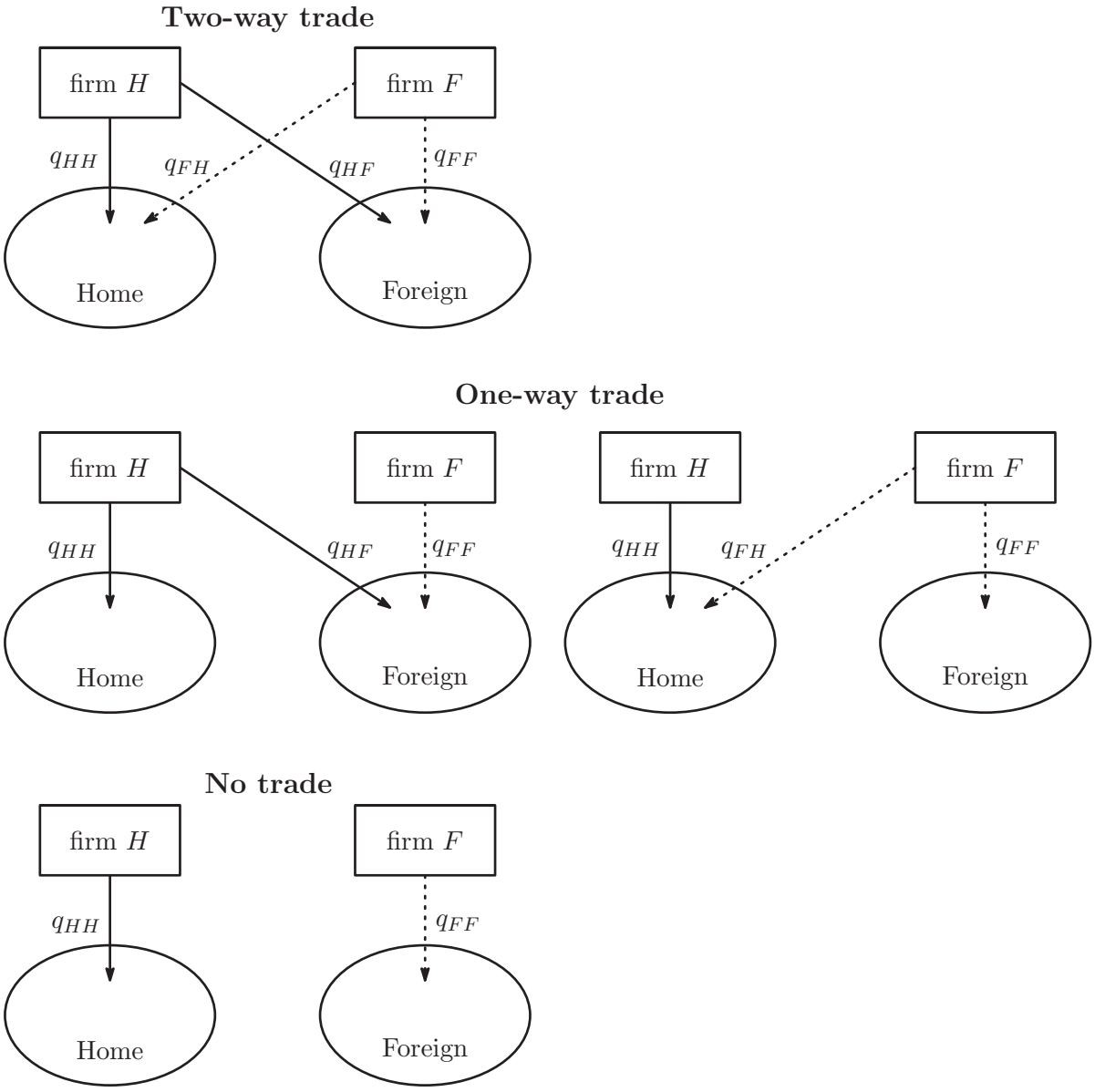

Figure 1: Trade patterns

When only firm i ($\neq j$) chooses E, its profit without k is:

$$\Pi_i \equiv (a - q_{ii})q_{ii} + (a - q_{jj} - q_{ij} - t)q_{ij} - \frac{\gamma}{2}(q_{ii} + q_{ij})^2 \quad \text{for } i \neq j, i, j = H, F.$$

When all firms choose D, there is no trade. Then, firm i's profit is:

$$\Pi_i \equiv (a - q_{ii})q_{ii} - \frac{\gamma}{2}(q_{ii})^2 \quad \text{for } i = H, F.$$

For simplicity, hereafter, we normalize γ at unity, i.e., $\gamma = 1$. This normalization does not alter our main results. In the Online Appendix, we illustrate the equilibrium of our model with

parameter γ. (Refer to the Online Appendix for further details.)

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 solution concept is the sub-game perfect Nash equilibrium. The game is solved by backward induction.

3 Trade Patterns

In the second stage of the game, each firm i ($i = H, F$) competes in Cournot fashion. Hence, the first-order conditions (FOCs) for the profit maximization of firms in each regime are as follows.

In the EE regime (where all firms choose E): $0 = a - q_{ji} - q_{ij} - 3q_{ii}$ and $0 = a - q_{jj} - 3q_{ij} - q_{ii} - t$ for $i \neq j$; $i, j = H, F$.

In the DE regime (where firm H chooses D and firm F chooses E): $0 = a - q_{FH} - 3q_{HH}$, $0 = a - 3q_{FF} - q_{FH}$, and $0 = a - q_{FF} - 3q_{FH} - q_{HH} - t$.

In the ED regime (where firm H chooses E and firm F chooses D): $0 = a - q_{HF} - 3q_{HH}$, $0 = a - q_{FF} - 3q_{HF} - q_{HH} - t$, and $0 = a - 3q_{FF} - q_{HF}$.

In the DD regime (where all firms choose D): $0 = a - 3q_{ii}$ for $i = H, F$.

By solving the above FOCs in each regime, we obtain the following outputs:

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

where "$*$" is an equilibrium value.

To ensure a positive quantity, we set Assumption 1.

Assumption 1. $\dfrac{t}{a} < \dfrac{1}{3}$.

Equation (1) yields the firms' equilibrium profit without k:

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

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 $\varphi_E \equiv \frac{4(a-3t)^2}{147} >(\leq)\, k/a^2$, 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 $\varphi_E \equiv \Pi_H^{ED*} - \Pi_H^{DD*} = \Pi_F^{DE*} - \Pi_F^{DD*} = \frac{4(a-3t)^2}{147}$. Q.E.D.

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 occurs. (ii) If $\varphi_E \leq k/a^2 \leq \varphi_D$, then DD&EE can arise. (iii) If $k/a^2 > \varphi_D$, then DD occurs.*
II. Suppose that $19/162 < t/a < 23/104$. (i) If $k/a^2 < \varphi_D$, then EE emerges. (ii) If $\varphi_D \leq k/a^2 \leq \varphi_E$, then DE&ED can occur. (iii) If $k/a^2 > \varphi_D$, then DD occurs.
III. Suppose that $23/104 \leq t/a < 1/3$. (i) If $k/a^2 \leq \varphi_E$, then DE&ED can occur. (ii) If $k/a^2 > \varphi_E$, then DD occurs.

The equilibrium trade pattern depends on the sizes of both the transport cost t and the fixed export cost k. (See Figure 2.) If both transport and fixed export costs are sufficiently high, exporting becomes too expensive and domestic supply (D) becomes the dominant strategy, and no firm chooses to export. Hence, the DD regime occurs. Conversely, if both transport and

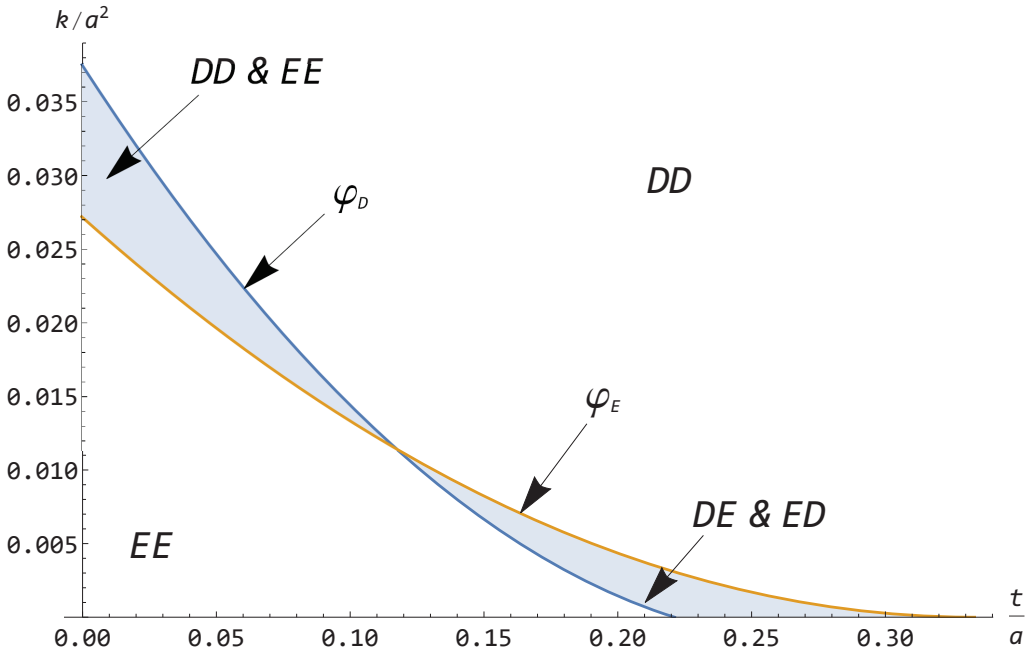

Figure 2: Four areas

fixed export costs are sufficiently small, exporting becomes the dominant strategy, and all firms export. Therefore, the EE regime occurs. If both transport and fixed export costs are at an intermediate level, there is no dominant strategy, and two kinds of multiple equilibria, $DE\&ED$ and $DD\&EE$, can occur.

We first consider [a] $DE\&ED$, i.e., the "One-way trade," and then [b] $DD\&EE$, i.e., "No trade" and "Two-way trade." [a] When the transport cost is high and the fixed export cost is small, $DE\&ED$ can emerge. If a foreign rival chooses D, the local market is a monopoly. Then, because a firm can gain a larger market share in the foreign country if it exports, despite the fact that its marginal costs increase, the firm chooses E. Conversely, suppose that the foreign rival chooses E. Now, the foreign market is relatively small; hence, the benefit of exporting is small. In this case, as the transport cost is relatively high and the import barriers are also high, the local market competition is weak. Furthermore, the firm's marginal cost increases if it chooses E. Hence, the firms choose D.

[b] When the transport cost is small and the fixed export cost is high, $DD\&EE$ can occur.

First, suppose that a foreign rival exports. Now, because the fixed export cost is large, the benefit of exporting is small. However, the transport cost is low, and domestic competition is strong. Although choosing to export increases the firm's own marginal costs, it experiences a large reduction in profits when the foreign rival enters into the local market. Therefore, the firm chooses E. Second, suppose that the foreign rival chooses D. In this case, the fixed export cost is large. The firm enjoys a local monopoly, the entry barriers into the foreign market are high, and new entry into the foreign market raises the firm's marginal cost. Therefore, the firm chooses D.

Our result on the trade patterns provides a new insight into firm export behavior and international trade. Following the pioneering study of Melitz (2003), many studies have conducted analyses based on Melitz-type models. [See, for example, Demidova and Rodríquez-Clare (2013) and Melitz and Ottaviano (2008).] As pointed out by Head and Spencer (2017), the mainstream practice in recent studies on international trade has been to adopt a monopolistic competition model or a monopolistic competition model with firm heterogeneity. However, in the monopolistic competition model, strategic interactions among firms are omitted and hence, multiple equilibria in which one country exports but the other country does not do not appear between symmetric countries. By contrast, our study—although it has the limitation of a being a partial equilibrium study—shows that by directly handling the strategic interactions among firms in oligopoly industries, all possible trade patterns can emerge with two symmetric countries. We believe that our results make a significant contribution to the literature.

4 Welfare Considerations

As illustrated in Figure 2, the welfare in each country can vary drastically because the size of transport cost t alters the trade pattern. Therefore, we now consider the effects of a change in the transport cost on the welfare in each country.

4.1 Consumer Surplus

Competition authorities often focus on consumer surplus compared with total surplus (e.g., Albæk, 2013; Viscusi et al., 2018); hence, we first consider how trade liberalization (i.e., a reduction in the transport cost t) affects the consumer surplus.

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

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

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

Equation (3) and Proposition 1 yield Proposition 2.

Proposition 2. *Suppose that $k/a^2 < 25/2187$. Then, trade liberalization involving a reduction in the transport cost, t, may suddenly lower the consumer surplus of the exporting country.*

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. Q.E.D.

Proposition 2 can be explained by ranking consumer surplus. (Figure 3 illustrates the relationship between consumer surplus and the transport cost.) In the regime in which only the foreign firm exports, the marginal cost of the home firm is small because it does not export. Hence, its domestic supply increases. In addition, imports exist and hence, aggregate outputs are the largest among all other regimes. Thus, the consumer surplus is also at its largest. In the regime in which everyone exports, each firm's marginal cost is large. Furthermore, because strategic substitutes exist in markets, the domestic firm's domestic supply decreases because of the rival's exports entering its market. Hence, the aggregate output in this regime is smaller than that in the regime in which only the foreign firm exports. In the regime in which no one exports, because there are no imports, the aggregate output in this regime is smaller than that

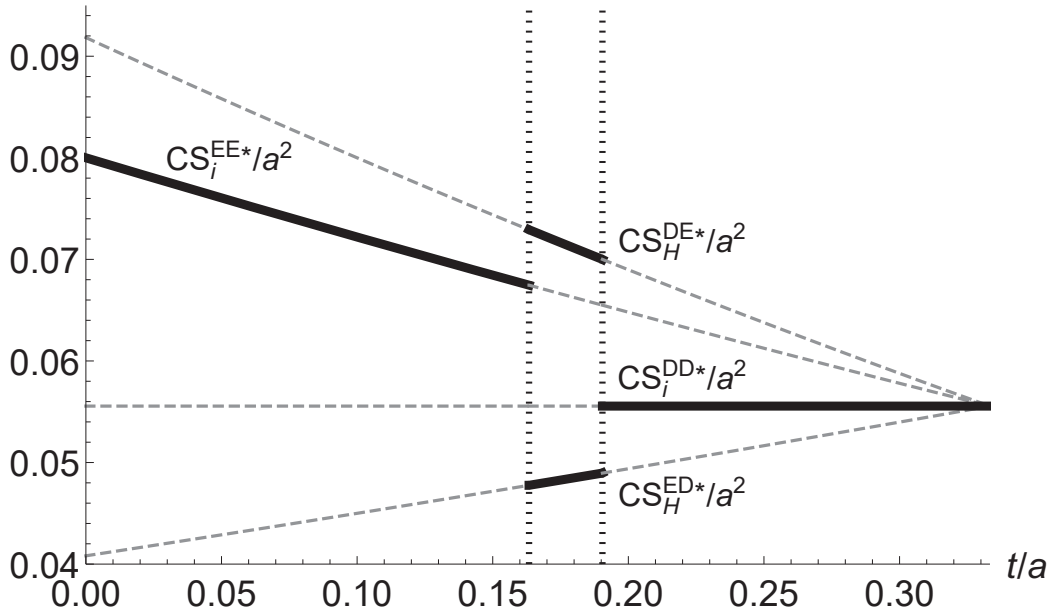

Figure 3: Effect of trade liberalization on consumer surplus ($k = 0.005$)

in the regime in which everyone exports. Finally, in the regime in which 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, the consumer surplus is at its smallest among all the regimes.

Proposition 2 and Figure 3 have important implications. As illustrated in Figure 3, trade liberalization with a reduction of transport costs can suddenly lower the consumer surplus in the exporting country. The reason is that the trade pattern switches from "No trade" to "One-way trade" (where the home country exports, and the foreign country does not) through the reduction in the transport cost. This switching in the trade pattern makes the home country's total output equal to firm H's domestic supply only (given the home country does not receive any imports).

Some studies in the literature have pointed out that trade liberalization can reduce consumer welfare (e.g., Kabiraj and Marjit, 2003; Marjit and Mukherjee, 2015; Takauchi and Mizuno,

2022).[9] Marjit and Mukherjee (2015) and Takauchi and Mizuno (2022) indicated that a reduction of trade costs (including tariffs and transport costs) may decrease consumer surplus in various vertical market structures. Furthermore, Kabiraj and Marjit (2003) showed that in a situation of technology licensing, an increase in the tariff rate in the country receiving the technology licensing causes a technology licensing from the superior foreign firm, which leads to a sudden rise in consumer surplus.[10] Hence, a decrease in the tariff rate sharply reduces consumer surplus.

In contrast, our study reveals that *trade liberalization can lead to a sudden decline in consumer surplus through an alteration in the trade pattern.* This substantially differs from the conclusions of the literature and therefore, our study provides new insights into trade liberalization.

Furthermore, the negative effects of trade liberalization on the consumer surplus may not be considered desirable by the government even if it can improve the domestic total surplus. This is because competition authorities, such as the FTC in the US.,[11] believe a sharp decline in the consumer surplus should be avoided because the consumer surplus is the standard used to measure welfare. Thus, the competition authorities will have strong incentives to pressure their governments to avoid a non-negligible reduction in the consumer surplus. Therefore, a meaningful policy implication of our study is that the government may need to pay particular attention to the effects of the trade liberalization.

[9] Moreover, although they focus on different situations, studies have examined international trade and consumer welfare. Mukherjee and Sinha (2019) showed that an export cartel between exporting firms can increase consumer surplus in the importing country under a third-market model. Mizuno and Takauchi (2018) demonstrated that if the initial level of the tariff is high, a tariff reduction by the final-good importing country in a free trade area decreases consumer surplus in that country.

[10] Similarly, Takauchi and Mizuno (2020) demonstrated that relatively high transport costs maximize consumer surplus in a two-country, two-way trade model with product innovation.

[11] In the US., the consumer welfare standard is adopted in practice (e.g., Viscusi et al., 2018, p. 97).

4.2 Total Surplus

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

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

By comparing these total surpluses, we obtain Proposition 3.

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 the Appendix.

To confirm that trade liberalization reduces total surplus, we illustrate total surplus as a function of transport costs in the figures below. In Figure 4, trade liberalization with a changing trade regime reduces total surplus. In addition, the total surplus of the non-exporting country in the DE or ED regimes decreases with t. Thus, we confirm results (i) and (ii-a) in Figure 5.

Figure 5 illustrates the total surpluses of the exporting country under the EE and $ED\&DE$ regimes at $k/a^2 = 0$. Note that from Proposition 1, either the EE or $ED\&DE$ regimes occur at $k/a^2 = 0$. In Figure 5, the shaded areas represent the case in which trade liberalization has a negative impact on total surplus.

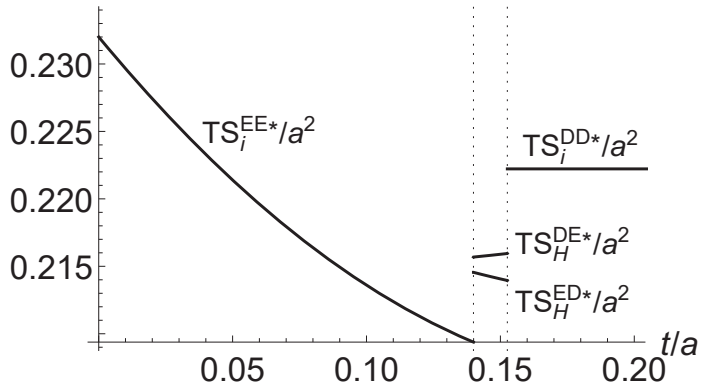

Figure 4: Effect of trade liberalization on total surplus ($k/a^2 = 0.008$)

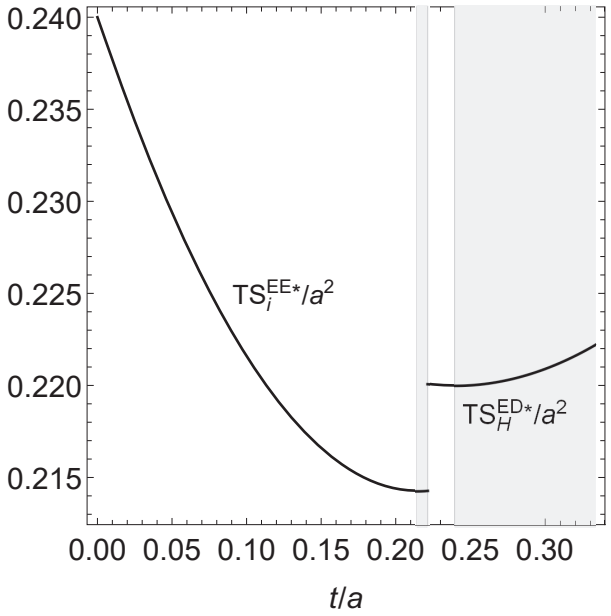

Figure 5: Welfare decreasing trade liberalization ($k/a^2 = 0$)

The intuition behind Proposition 3 is as follows: As trade liberalization (a 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 such that the dominant effect of trade liberalization is the reduction in consumer surplus. Thus, in each regime, trade liberalization

reduces the aggregate surplus in the region in which t is large: see (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.

Next, 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 that country is significantly reduced. Furthermore, because trade liberalization intensifies competition among firms, the profits of the firms that do not change their export decisions also decline. Although consumer surplus in the country increases, the total surplus of the country falls because this profit-lowering effect dominates: (i) in Proposition 3.

Finally, we consider a characteristic implication of the total surplus in the "One-way trade" situation.

Comparing TS_H^{ED*} with TS_H^{DE*}, we establish Proposition 4.

Proposition 4. *In the "One-way trade" situation, the welfare level of an importing country is larger than that of an exporting country if and only if the fixed export cost is relatively large. Formally,* $TS_H^{ED*} \leq TS_H^{DE*}$ *if and only if* $25a^2/2187 > k \geq (a-3t)^2/49$.

Proof. See the Appendix.

The result of Proposition 4 is illustrated in Figure 4. The logic behind Proposition 4 is intuitive. When the transport cost t is large, "One-way trade" holds (see Figure 2). A larger transport cost means that the increase in profit caused by choosing to export is smaller. In contrast, if firm i chooses D, country i can import from the foreign rival. The imports from the foreign rival raise the aggregate outputs, so the product price falls. Then, the consumer surplus

increases. If the fixed export cost is large, the dominant effect is the increase in the consumer surplus and thus the total surplus in the importing country is larger than that in the exporting country.

Proposition 4 indicates that in a situation of intra-industry trade, when firms can decide whether to export, the country can enhance its welfare if it becomes a net importer. This offers a new perspective to practitioners and policy makers who tend to emphasize that firms should choose to export. Thus, our welfare analysis offers a new insight into the context of international trade.

5 Discussion: Trade Patterns in Differentiated Products

In this section, we consider how the equilibrium trade pattern is affected by differentiated quantity and price competition.

5.1 Differentiated Quantity Competition

First, we consider differentiated quantity competition in both the Home and Foreign markets. In the EE regime, the inverse demand functions of country i $(i = H, F)$ are $p_{ii} = a - q_{ii} - bq_{ji}$ and $p_{ij} = a - q_{ij} - bq_{jj}$ for $i \neq j$, $i, j = H, F$. Note that $b \in [0, 1)$ is a measure of the degree of product differentiation between the Home and Foreign products. By adopting a similar method to that of the previous section, we obtain the following exports, $\hat{q}_{ij}$, and domestic supply, $\hat{q}_{ii}$, in each regime.

$$\hat{q}_{ii}^{EE*} = \frac{a(2-b)+(1+b)t}{(2-b)(4+b)}; \quad \hat{q}_{ij}^{EE*} = \frac{a(2-b)-3t}{(2-b)(4+b)},$$
$$\hat{q}_{HH}^{DE*} = \frac{2a(4-b)+3bt}{3(8-b^2)} = \hat{q}_{FF}^{ED*}; \quad \hat{q}_{FF}^{DE*} = \frac{a(3-b)(2+b)+3t}{3(8-b^2)} = \hat{q}_{HH}^{ED*},$$
$$\hat{q}_{FH}^{DE*} = \frac{a(2-b)-3t}{8-b^2} = \hat{q}_{HF}^{ED*}.$$

In the DD regime, all firms supply only the domestic market, and thus their demand is irrelevant to the parameter b. Hence, $\hat{q}_{ii}^{DD*} = a/3 = q_{ii}^{DD*}$ holds. (See equation (1).)

To ensure positive quantities, in this part we assume that $\tau \equiv t/a < \tau_{\max} \equiv (2-b)/3$.

The above outputs yield the equilibrium firms' profits without k.

$$\begin{aligned}
\pi_i^{EE*} &= \frac{8a(2-b)^2(a-t) + 3(8+b^2)t^2}{2(2-b)^2(4+b)^2}, \\
\pi_H^{DE*} &= \pi_F^{ED*} = \frac{[2a(4-b)+3bt]^2}{6(8-b^2)^2}, \\
\pi_H^{ED*} &= \pi_F^{DE*} = \frac{a^2(b^4-8b^2-32b+96) - 48a(2-b)t + 72t^2}{6(8-b^2)^2},
\end{aligned} \tag{4}$$

where $\pi_i^{DD*} = a^2/6 = \Pi_i^{DD*}$ in the DD regime. (See equation (2).)

From equation (4), the difference in profits without the fixed export cost k is given by:

$$\left.\begin{aligned}
\Delta_E &\equiv \pi_H^{EE*} - \pi_H^{DE*} = \pi_F^{EE*} - \pi_F^{ED*} > 0, \\
\Delta_D &\equiv \pi_H^{ED*} - \pi_H^{DD*} = \pi_F^{DE*} - \pi_F^{DD*} > 0.
\end{aligned}\right\} \tag{5}$$

From equation (5), we establish Proposition 5.

Proposition 5. *I. Suppose that $\tau < \tau_\delta(b)$. Then, $\Delta_D < \Delta_E$. (i) If $k < \Delta_D$, EE occurs. (ii) If $\Delta_D \le k \le \Delta_E$, EE&DD can emerge. (iii) If $\Delta_E < k$, DD occurs.*

II. Suppose that $\tau > \tau_\delta(b)$. Then, $\Delta_E < \Delta_D$. (i) If $k < \Delta_E$, EE occurs. (ii) If $\Delta_E \le k \le \Delta_D$, DE&ED can occur. (iii) If $\Delta_D < k$, DD emerges. Here, $\tau_\delta(b) \equiv \frac{(2-b)(64-40b-8b^2+3b^3)}{3(8+b^2)(8-b-b^2)}$.

Proof. See the Appendix.

The intuition for this result is equivalent to that for Proposition 1.

5.2 Differentiated Price Competition

Next, we consider differentiated price competition.

In the EE regime, the demand functions are:

$$q_{ii} = \frac{(1-b)a - p_{ii} + bp_{ji}}{1-b^2}; \quad q_{ij} = \frac{(1-b)a - p_{ij} + bp_{jj}}{1-b^2} \quad \text{for } i \neq j,\ i,j = H,F.$$

Here, note that $b \in [0, 1)$ again.

In the ED regime, the demand functions are:

$$q_{HH} = a - p_{HH}; \quad q_{HF} = \frac{(1-b)a - p_{HF} + bp_{FF}}{1-b^2}; \quad q_{FF} = \frac{(1-b)a - p_{FF} + bp_{HF}}{1-b^2}.$$

In the DE regime, the demand functions are:

$$q_{HH} = \frac{(1-b)a - p_{HH} + bp_{FH}}{1-b^2}; \quad q_{FH} = \frac{(1-b)a - p_{FH} + bp_{HH}}{1-b^2}; \quad q_{FF} = a - p_{FF}.$$

In the DD regime, the demand function is $q_{ii} = a - p_{ii}$ for $i = H, F$.

By adopting a similar method to that of the previous section,[12] we obtain the following equilibrium firm profits without k.

$$\bar{\pi}_i^{EE*} = \frac{4a(1-b)(2-b^2)(b+2)^2(a-t) + (2b^5+2b^4-11b^3-9b^2+24b+24)t^2}{2(1-b)(b+2)^2(b^2-b-4)^2},$$

$$\bar{\pi}_H^{DE*} = \bar{\pi}_F^{ED*} = \frac{(3-2b^2)\left[a(b+2)(3b-4) - 3bt\right]^2}{2(3b^4-20b^2+24)^2},$$

$$\bar{\pi}_F^{DE*} = \bar{\pi}_H^{ED*} = \frac{\left(3b^8-48b^6-24b^5+222b^4+104b^3-432b^2-96b+288\right)a^2}{2(3b^4-20b^2+24)^2} + \frac{2a(b^2-3)(2b^2+3b-6)(3b^2-4)t}{(3b^4-20b^2+24)^2} - \frac{3(b^2-3)^2(3b^2-4)t^2}{(3b^4-20b^2+24)^2},$$

where $\bar{\pi}_i^{DD*} = a^2/6 = \Pi_i^{DD*}$.

The above profits without the fixed export cost k yield the following:

$$\left.\begin{aligned} B_D &\equiv \bar{\pi}_H^{EE*} - \bar{\pi}_H^{DE*} = \bar{\pi}_F^{EE*} - \bar{\pi}_F^{ED*} > 0, \\ B_E &\equiv \bar{\pi}_H^{ED*} - \bar{\pi}_H^{DD*} = \bar{\pi}_F^{DE*} - \bar{\pi}_F^{DD*} > 0. \end{aligned}\right\} \tag{6}$$

Further, from equation (6), we obtain: $B_D > B_E$.[13]

The equation (6) and the relation "$B_D > B_E$" yield Proposition 6.

Proposition 6. *(i) If $k < B_E$, EE occurs. (ii) If $B_E \leq k \leq B_D$, EE&DD can arise. (iii) If $B_D < k$, DD emerges.*

[12] The equilibrium outputs and prices are reported in the Online Appendix.

[13] The derivation of $B_D > B_E$ is reported in the Online Appendix.

In differentiated price competition, rivalry among the firms is stronger than under quantity competition. Consequently, when firms engage in differentiated price competition, "One-way trade" does not occur, but the multiple equilibria comprising "No trade" and "Two-way trade" emerge.

The intuition for Proposition 6 can be explained as follows. Let firm i choose E if its rival chooses D. Because firm i newly enters the overseas market, its outputs increase and its marginal cost discontinuously jumps upwards. In the case of price competition, the rivalry among firms is strong and hence this dramatic rise in the marginal cost drastically reduces the competitiveness of firm i in its local market. Because this can lead to a profit reduction for firm i, it does not choose E.

In contrast, consider the situation where firm i chooses D if its rival chooses E. In the local market of firm i, competition is strong. Hence, new entry by a rival firm increases aggregate outputs and lowers product prices, which decreases firm i's profit. Therefore, like its rival, firm i chooses E, and enters the foreign market. From the above arguments, in the situation of differentiated price competition, the firms' responses are strategic complements and therefore the multiple equilibria emerge in which firms conduct the same strategy as their rivals.

6 Conclusion

This paper constructs a symmetric two-country homogeneous Cournot oligopolistic trade model *à la* Brander and Krugman (1983) to examine the effects of the sizes of both transport and fixed export costs on realizable trade patterns and the welfare level of each country.

Our main findings are summarized as follows: (i) Firms' exporting choices and trade patterns depend on transport and fixed export costs. When the sizes of both transport and fixed export costs are at an intermediate level, two kinds of multiple equilibria can appear. These two multiple equilibria involve characteristic trade patterns. One brings endogenous asymmetry,

that is, only one country becomes an exporter, creating "One-way trade." The other is based on strategic complements, and so causes both "No trade" and "Two-way trade." (ii) Trade liberalization, that is, a reduction in transport costs, changes consumer surplus and total surplus nonmonotonically and discontinuously through changes in the trade patterns. For example, trade liberalization switches the trade pattern from "No trade" to "One-way trade." If one country becomes an exporter, it does not import from overseas (because the other country does not export), that country's aggregate output is equal only to the local firm's domestic supply. Hence, the product price rises and the consumer surplus of that country experiences a sudden fall.

Moreover, we consider the cases in which the firms engage in differentiated quantity and price competition. Although the differentiated quantity competition does not alter the equilibrium trade pattern, the differentiated price competition can do so because competition is stronger compared with the quantity competition.

Furthermore, we derive a policy implication concerning trade liberalization. We find that trade liberalization may lower consumer surplus and total surplus as a result of the changes in trade patterns. Although practitioners and policymakers tend to believe trade liberalization always increases welfare, we caution that this may not always be the case.

Finally, we consider directions for future work. We used a partial equilibrium oligopoly model in this paper to examine the effects of trade liberalization on trade patterns and welfare. However, topics analyzed in a partial oligopoly model have been reexamined using a general equilibrium model since Neary (2003a, b) built a general oligopolistic equilibrium model. Extending the analysis in this paper using the general oligopolistic equilibrium model to analyze the general equilibrium effect would be a worthwhile endeavor. As it exceeds the scope of this paper, we leave this endeavor for future research.

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:

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

In addition, $TS_i^{DD*} - TS_H^{DE*}$ and $TS_H^{ED*} - TS_i^{EE*}$ are as follows:

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

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 the total surplus.

Now, 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. In addition, without an 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 the 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 the total surplus if $6/25 < t/a < 1/3$ and $k/a^2 < \varphi_E$.

Summarizing the above results, we obtain Proposition 3. Q.E.D.

Proof of Proposition 4. First, we obtain $TS_H^{ED*} - TS_H^{DE*} = (a-3t)^2/49 - k$. Hence, $k \geq (a-3t)^2/49 \Rightarrow TS_H^{ED*} \leq TS_H^{DE*}$. Second, we check that $(a-3t)^2/49$ does not exceed the level of k that brings about "One-way trade." Solving $\varphi_E - \varphi_D = 0$ with respect to t, we have $t = 19a/162$. Thus, $\varphi_E\,|_{t=19a/162} = \varphi_D\,|_{t=19a/162} = 25a^2/2187$ holds. Simple algebra yields:

$$\frac{25a^2}{2187} - \frac{(a-3t)^2}{49} = \frac{-962a^2 + 13122at - 19683t^2}{107163} > 0 \quad \forall t \in \left[\frac{19a}{162}, \frac{a}{3}\right).$$

This implies Proposition 4. Q.E.D.

Proof of Proposition 5. From equation (5), simple algebra yields:

$$\begin{aligned}&\Delta_E - \Delta_D \\ &= \frac{2b(ab-2a+3t)(3ab^4 - 14ab^3 - 24ab^2 + 144ab - 128a - 3b^4t - 3b^3t - 24bt + 192t)}{3(b-2)^2(b+4)^2\left(b^2-8\right)^2}.\end{aligned}$$

This yields the following.

$$\Delta_E \begin{cases} \geq \Delta_D & \text{if} \quad \tau \leq \tau_\delta(b) \equiv \dfrac{(2-b)(64-40b-8b^2+3b^3)}{3(8+b^2)(8-b-b^2)}, \\ < \Delta_D & \text{if} \quad \tau > \tau_\delta(b), \end{cases}$$

where $\tau_\delta(b) < \tau_{\max}$ holds. From the above formula and the definitions of Δ_E and Δ_D, we obtain Proposition 5. Q.E.D.

References

[1] Albæk, S. (2013). Consumer welfare in EU competition policy. *Aims and Values in Competition Law*, 67-88.

[2] Antràs, P. (2016). *Global production: Firms, contracts, and trade structure*. Princeton University Press.

[3] Arkolakis, C., A. Costinot, and A. Rodríguez-Clare (2012). New trade models, same old gains?. *American Economic Review*, 102(1), 94-130.

[4] Arnade, C., D. Pick, and M. Gopinath, M. (1998). Testing oligopoly power in domestic and export markets. *Applied Economics*, 30(6), 753-760.

[5] Basak, D. and A. Mukherjee (2018). Labour unionisation structure and product innovation. *International Review of Economics & Finance*, 55, 98-110.

[6] Basu, S. and J. G. Fernald (1997). Returns to scale in U.S. production: Estimates and implications. *Journal of Political Economy*, 105(2), 249-283.

[7] Brander, J. A. and P. R. Krugman (1983). A 'reciprocal dumping' model of international trade. *Journal of International Economics*, 15(3-4), 313-321.

[8] Dastidar, K. G. (1995). On the existence of pure strategy Bertrand equilibrium. *Economic Theory*, 5, 19-32.

[9] Delbono, F. and L. Lambertini (2016). Bertrand versus Cournot with convex variable costs. *Economic Theory Bulletin*, 4, 73-83.

[10] Demidova, S. and A. Rodríguez-Clare (2013). The simple analytics of the Melitz model in a small economy. *Journal of International Economics*, 90(2), 266-272.

[11] Edmond, C., V. Midrigan, and D. Y. Xu (2015). Competition, markups, and the gains from international trade. *American Economic Review*, 105(10), 3183-3221.

[12] Egger, H. and U. Kreickemeier (2009). Firm heterogeneity and the labor market effects of trade liberalization. *International Economic Review*, 50(1), 187-216.

[13] Gafarova, G., O. Perekhozhuk, and T. Glauben (2023). The oligopolistic behavior of Kazakh and Russian wheat exporters in the south caucasus: Evidence from a residual demand elasticity analysis. *Journal of Industry, Competition and Trade*, 23, 1-32.

[14] Goerke, L. (2022). Partisan competition authorities, Cournot-oligopoly, and endogenous market structure. *Southern Economic Journal*, 89(1), 238-270.

[15] Goldberg, P. K. (1995). Product differentiation and oligopoly in international markets: The case of the US automobile industry. *Econometrica*, 63(4), 891-951.

[16] Goldberg, P. K. and M. M. Knetter (1999). Measuring the intensity of competition in export markets. *Journal of International Economics*, 47(1), 27-60.

[17] Grossmann, V. (2007). Firm size and diversification: Multiproduct firms in asymmetric oligopoly. *International Journal of Industrial Organization*, 25(1), 51-67.

[18] Head, K. and Spencer, B. J. (2017). Oligopoly in international trade: Rise, fall and resurgence. *Canadian Journal of Economics*, 50(5), 1414-1444.

[19] Helpman, E. and O. Itskhoki (2010). Labour market rigidities, trade and unemployment. *The Review of Economic Studies*, 77(3), 1100-1137.

[20] Helpman, E., O. Itskhoki, and S. Redding (2010). Inequality and unemployment in a global economy. *Econometrica*, 78(4), 1239-1283.

[21] Impullitti, G., O. Licandro, and P. Rendahl (2022). Technology, market structure and the gains from trade. *Journal of International Economics*, 135, 103557.

[22] Kabiraj, T. and S. Marjit (2003). Protecting consumers through protection: The role of tariff-induced technology transfer. *European Economic Review*, 47(1), 113-124.

[23] Kawasaki, A., T. Mizuno, and K. Takauchi (2023). Downstream new product development and upstream process innovation. *Journal of Economics*, 140(3), 209-231.

[24] Kee, H. L. (2002). Markup, returns to scale, and productivity: A case study of Singapore's manufacturing sector. Policy Research Working Paper 2857, The World Bank (June 2002).

[25] Kim, H. and H. Lee (2017). Does the traditional exchange rate fully explain firms' exposure? *Applied Economics Letters*, 24(1), 8-13.

[26] Long, N. V., H. Raff, and F. Stähler (2011). Innovation and trade with heterogeneous firms. *Journal of International Economics*, 84(2), 149-159.

[27] Marjit, S. and A. Mukherjee (2015). Endogenous market structure, trade cost reduction, and welfare. *Journal of Institutional and Theoretical Economics*, 171(3), 493-511.

[28] Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6), 1695-1725.

[29] Melitz, M. J. and G. I. Ottaviano (2008). Market size, trade, and productivity. *Review of Economic Studies*, 75(1), 295-316.

[30] Mizuno, T. and K. Takauchi (2018). Rules of origin and uncertain compliance cost. *Asia-Pacific Journal of Accounting & Economics*, 25(5), 515-532.

[31] Mizuno, T. and K. Takauchi (2020). Optimal export policy with upstream price competition. *The Manchester School*, 88(2), 324-348.

[32] Mizuno, T. and K. Takauchi (2024). Bertrand competition in vertically related markets. *Applied Economics Letters*, 31(6), 524-529.

[33] Mukherjee, A. (2014). Licensing under convex costs. *Journal of Economics*, 111(3), 289-299.

[34] Mukherjee, A. (2024). Cooperative R&D for a new product under convex production costs. forthcoming in *Journal of Institutional and Theoretical Economics*.

[35] Mukherjee, A. and U. B. Sinha (2019). Export cartel and consumer welfare. *Review of International Economics*, 27(1), 91-105.

[36] Neary, J. P. (2003a). Globalization and market structure. *Journal of the European Economic Association*, 1(2-3), 245-271.

[37] Neary, J. P. (2003b). The road less travelled: Oligopoly and competition policy in general equilibrium. in Arnott, R., B. Greenwald, R. Kanbur and B. Nalebuff (eds.) *Economics for an Imperfect World: Essays in Honor of Joseph E. Stiglitz*, Cambridge, MA, MIT Press, 485-500.

[38] Takauchi, K. and Mizuno, T. (2020). Consumer-benefiting transport cost: The role of product innovation in a vertical structure. Graduate School of Economics, Kobe University, Discussion Paper No. 2017.

[39] Takauchi, K. and Mizuno, T. (2022). Endogenous transport price, R&D spillovers, and trade. *The World Economy*, 45(5), 1477-1500.

[40] Van Biesebroeck, J., E. Yu, and S. Chen (2015). The impact of trade promotion services on Canadian exporter performance. *Canadian Journal of Economics*, 48(4), 1481-1512.

[41] Viscusi, W. K., J. E. Harrington Jr., and D. E. Sappington (2018). *Economics of Regulation and Antitrust*, MIT press.

[42] von Weizsäcker, C. C. (1980). A welfare analysis of barriers to entry. *The Bell Journal of Economics*, 11(2), 399-420.

[43] Xu, K., R. Windle, C. Grimm, and T. Corsi (1994). Re-evaluating returns to scale in transport. *Journal of Transport Economics and Policy*, 28(3), 275-286.

[44] Zhang, W. and C. Y. C. L. Lawell (2017). Market power in nonrenewable resource markets: An empirical dynamic model. *Land Economics*, 93(1), 74-86.

Online Appendix of

"Strategic export decisions in international trade"
(Not for Publication)

by Kazuhiro Takauchi, Tomomichi Mizuno, and Katsufumi Fukuda

I. Trade Patterns with γ

In the body of the paper, for simplicity of the analysis, we normalize γ (coefficient of the quadratic cost function of firms) to unity. As mentioned in the paper, this normalization does not change our result; we only illustrate the equilibrium of the model with γ here.

To ensure positive quantities, we first assume the following.

Assumption A1. $t < \dfrac{a}{\gamma+2}$.

A similar computation as in the body of the paper yields the following equilibrium outcomes.

$$\Pi_i^{EE}(\gamma) = \frac{4a(\gamma+1)(a-t)+(\gamma+2)(4\gamma+5)t^2}{2(2\gamma+3)^2}, \quad i=H,F, \tag{A01}$$

$$\Pi_H^{DE}(\gamma) = \Pi_F^{ED}(\gamma) = \frac{[a(4\gamma+2)+(\gamma+2)t]^2}{2(\gamma+2)(4\gamma+3)^2}, \tag{A02}$$

$$\Pi_F^{DE}(\gamma) = \Pi_H^{ED}(\gamma) = \frac{a^2[4\gamma(4\gamma+7)+13]-8a(\gamma+1)(\gamma+2)t+4(\gamma+1)(\gamma+2)^2t^2}{2(\gamma+2)(4\gamma+3)^2}, \tag{A03}$$

$$\Pi_i^{DD}(\gamma) = \frac{a^2}{2(\gamma+2)}. \tag{A04}$$

From (A01)–(A04), we obtain the following.

$$[\Pi_H^{EE}(\gamma)-k]-\Pi_H^{DE}(\gamma) = \underbrace{\frac{2(-a+\gamma t+2t)\left(-8a\gamma^3-25a\gamma^2-27a\gamma-9a+16\gamma^4t+75\gamma^3t+122\gamma^2t+81\gamma t+18t\right)}{(\gamma+2)(2\gamma+3)^2(4\gamma+3)^2}}_{\equiv\varphi_D(\gamma)} -k. \tag{A05}$$

Note that $\varphi_D(\gamma) \equiv \Pi_H^{EE}(\gamma)-\Pi_H^{DE}(\gamma)$.

$$[\Pi_H^{ED}(\gamma)-k]-\Pi_H^{DD}(\gamma) = \underbrace{\frac{2(\gamma+1)(a-\gamma t-2t)^2}{(\gamma+2)(4\gamma+3)^2}}_{\equiv\varphi_E(\gamma)} -k. \tag{A06}$$

Note that $\varphi_E(\gamma) \equiv \Pi_H^{ED}(\gamma) - \Pi_H^{DD}(\gamma)$.

Thus, we obtain the best response of firm i from (A05) and (A06).

• Suppose that the rival (firm j, $j \neq i$) chooses E. Then,

$\varphi_D(\gamma) \leq k \Rightarrow$ firm i chooses D;

$\varphi_D(\gamma) > k \Rightarrow$ firm i chooses E.

• Suppose that the rival (firm j, $j \neq i$) chooses D. Then,

$\varphi_E(\gamma) \geq k \Rightarrow$ firm i chooses E;

$\varphi_E(\gamma) < k \Rightarrow$ firm i chooses D.

By taking the difference between $\varphi_E(\gamma)$ and $\varphi_D(\gamma)$, we find the following.

$$\begin{aligned} &\text{Case I.} \quad t \leq \frac{a(4\gamma^2+9\gamma+6)}{3(\gamma+1)(\gamma+2)(4\gamma+5)} \quad \Rightarrow \quad \varphi_E(\gamma) \geq \varphi_D(\gamma). \\ &\text{Case II.} \quad t > \frac{a(4\gamma^2+9\gamma+6)}{3(\gamma+1)(\gamma+2)(4\gamma+5)} \quad \Rightarrow \quad \varphi_E(\gamma) < \varphi_D(\gamma). \end{aligned} \tag{A07}$$

From the above arguments and (A07), we establish the following result.

Proposition A1.

I. Suppose $t \leq \frac{a(4\gamma^2+9\gamma+6)}{3(\gamma+1)(\gamma+2)(4\gamma+5)}$. *Then,* $\varphi_E(\gamma) \geq \varphi_D(\gamma)$.

(i) If $k < \varphi_D(\gamma)$, *EE appears. (ii) If* $\varphi_D(\gamma) \leq k \leq \varphi_D(\gamma)$, *ED&DE can appear. (iii) If* $\varphi_E(\gamma) < k$, *DD appears.*

II. Suppose $t > \frac{a(4\gamma^2+9\gamma+6)}{3(\gamma+1)(\gamma+2)(4\gamma+5)}$. *Then,* $\varphi_E(\gamma) < \varphi_D(\gamma)$.

(i) If $k < \varphi_E(\gamma)$, *EE appears. (ii) If* $\varphi_E(\gamma) \leq k \leq \varphi_D(\gamma)$, *EE&DD can appear. (iii) If* $\varphi_D(\gamma) < k$, *DD appears.*

II. Differentiated Price Competition

i. Equilibrium Output and Price in Each Regime

In this part, we present the equilibrium output and price of firms.

To ensure positive quantities, here, we set the following assumption.

Assumption A2. $\dfrac{t}{a} < \dfrac{6-3b-2b^2}{3(3-b^2)}$.

■ In a "two-way trade" situation (i.e., the EE regime), the equilibrium outputs of firms are

$$\bar{q}_{ii}^{EE*} = \frac{a(1-b)(b+2)+(b+1)t}{(b-1)(b+2)\,(b^2-b-4)}; \quad \bar{q}_{ij}^{EE*} = \frac{a(1-b)(b+2)-(3-b^2)t}{(b-1)(b+2)\,(b^2-b-4)}.$$

The equilibrium prices are

$$\bar{p}_{ii}^{EE*} = \frac{a(b+2)(b^2-3)-(b^2+b-1)t}{(b+2)(b^2-b-4)}; \quad \bar{p}_{ij}^{EE*} = \frac{a(b+2)(b^2-3)-(2b+3)t}{(b+2)(b^2-b-4)}.$$

■ In a "one-way trade" situation (i.e., both DE and ED regimes), the equilibrium outputs of firms are

$$\bar{q}_{HH}^{DE*} = \bar{q}_{FF}^{ED*} = \frac{a(-b-2)(3b-4)+3bt}{3b^4-20b^2+24}; \quad \bar{q}_{FH}^{DE*} = \bar{q}_{HF}^{ED*} = \frac{a(-2b^2-3b+6)+3(b^2-3)t}{3b^4-20b^2+24},$$
$$\bar{q}_{FF}^{DE*} = \bar{q}_{HH}^{ED*} = \frac{a(b-2)(b+1)(b^2+b-3)-(b^2-3)t}{3b^4-20b^2+24}.$$

The equilibrium prices of firms are

$$\bar{p}_{HH}^{DE*} = \bar{p}_{FF}^{ED*} = \frac{(b^2-2)[a(b+2)(3b-4)-3bt]}{3b^4-20b^2+24},$$
$$\bar{p}_{FF}^{DE*} = \bar{p}_{HH}^{ED*} = \frac{a(2b^4-14b^2-b+18)+(b^2-3)t}{3b^4-20b^2+24},$$
$$\bar{p}_{FH}^{DE*} = \bar{p}_{HF}^{ED*} = \frac{a(3b^4+3b^3-16b^2-5b+18)+(9-6b^2)t}{3b^4-20b^2+24}.$$

■ In a "no trade" situation (i.e., the DD regime), the equilibrium output of firms is $\bar{q}_{ii}^{DD*} = a/3 = q_{ii}^{DD*}$. (See equation (1) on page 8 of the body of the paper.)

The equilibrium price of firms is $\bar{p}_{ii}^{DD*} = (2a)/3$.

ii. Derivation of $B_D > B_E$

Both B_D and B_E have a strictly positive value. The difference between B_D and B_E is given by

$$\begin{aligned} B_E - B_D = & \frac{a^2 b J_1}{6(b-1)(b+2)^2\left(b^2-b-4\right)^2\left(3b^4-20b^2+24\right)^2} \\ & + \frac{abJ_2\, t}{6(b-1)(b+2)^2\left(b^2-b-4\right)^2\left(3b^4-20b^2+24\right)^2} \\ & + \frac{bJ_3\, t^2}{6(b-1)(b+2)^2\left(b^2-b-4\right)^2\left(3b^4-20b^2+24\right)^2} < 0. \end{aligned}$$

Here,

$$\begin{aligned} J_1 \equiv & 30b^{12} + 102b^{11} - 319b^{10} - 1123b^9 + 1537b^8 + 4421b^7 - 6216b^6 - 9568b^5 \\ & + 15728b^4 + 11536b^3 - 19584b^2 - 5760b + 9216, \\ J_2 \equiv & -36b^{12} - 36b^{11} + 480b^{10} - 6b^9 - 3498b^8 + 2658b^7 + 17898b^6 - 9948b^5 \\ & - 48840b^4 + 11376b^3 + 61056b^2 - 3456b - 27648, \\ J_3 \equiv & 27b^{10} + 297b^9 - 3b^8 - 3603b^7 - 2679b^6 + 15237b^5 + 14760b^4 - 27972b^3 \\ & - 30240b^2 + 18144b + 20736. \end{aligned}$$

As long as Assumption A2 holds, $B_D > B_E$.