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Do Transport Costs Change Organizational Form under Two-way Trade Market?*

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Abstract Focusing on the asymmetric freight rates associated with backhaul problem, we analyze firms' choice of organizational form between the unitary form (U-form) and the multidivisional form (M-form). With exogenous freight rates, choosing M-form is the dominant strategy even though collective choice of the U-form benefits both firms (prisoners' dilemma situation). Allowing for endogenous freight rates results in asymmetric freight rates between port pairs due to trade imbalances. In this case, unlike previous studies, diverse types of organization form, i.e., both firms U-form, both firms M-form, and only one firm U-form, arise depending on the product substitutability and marginal cost of transport firm. In any case, the U-form is preferred to the M-form from the welfare perspective in the symmetric organizational forms between firms.

Keywords Delegation, M-form, U-form, transport costs, trade

JEL Classification F12, F13, L13

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1. INTRODUCTION

It is frequently observed that the freight rates between port pairs differ depending on the direction of shipment due to the trade imbalance. The data for the dry bulk ships reveals that there are large asymmetries in transport costs across space: for instance, the freight rates shipping from Australia to China is 30% more expensive than the reverse, reflecting that China mostly imports raw materials such as iron ore and coal from Australia (Brancaccio *et al.*, 2020). This price asymmetry has been documented also in container shipping. With the US showing a huge trade deficit with China, the container freight rates from China to the US ($1900 per container) is more than three times the return cost ($600 per container) (Wong, 2022). In fact, UNCTAD's annual report on the freight rates in three major liner trade routes shows significant differences between pairwise direction of shipments (see Table 1).

Table 1. Freight rates (market average) per FUE in three major liner trade routes ($ per FEU)

	Transpacific		Europe-Asia		Transatlantic	
	Asia-North America	North America-Asia	Asia-Europe	Europe-Asia	North America-Europe	Europe-North America
2018	2,426	1,009	1,782	967	858	1,518
2019	2,603	1,111	1,847	870	1,109	1,742
2020	2,711	1,269	1,916	1,004	1,323	2,256
Average	2,580	1,129	1,848	947	1,097	1,838

Source: UNCTAD (2021).
Note: The average is unweighted based on represented main ports.

One of the most important reasons for this directional imbalance in freight rates is the bilateral trade imbalance on a given round trip. An important point is that the usual transportation service between pairs of countries is provided under conditions of joint production (fronthaul and backhaul) and fixed schedules. Therefore, a bilateral trade imbalance implies an underutilization of the available capacity that carriers have allocated for the bilateral transport markets. The difference in capacity utilization of the vessel across the two bilateral transport markets causes a gap between the associated transport costs. And the prospect of having to travel without cargo (termed "ballast") after offloading at the destination leads to higher freight rates on the round trip. In the transportation economics literature this issue is referred to as the *backhaul problem*[1], which is mainly dealt with in the domestic trucking industry operating on fixed round-trip routes.

The above discussion suggests that the trade model should include endogenous transport costs in an explicit manner with the underlying transport sector. In much of the literature, however, the treatment of transport costs is ad hoc. The standard way is to apply the 'iceberg' specification introduced by Samuelson (1954) (e.g. Krugman, 1980; Eaton and Kortum, 2002; Melitz, 2003): a fraction of the traded goods' value is lost in the transportation, where the fraction is given exogenously. Thus this specification implicitly assumes that the transport costs are exogenous and symmetric across countries.

With the growing awareness for the importance[2] of transport costs, various attempts to treat transport costs as endogenous have resulted in rich theoretical and empirical findings, providing insights on maritime economics as well as international trade that is not available with conventional theory (Anderson and Wincoop, 2004; Behrens and Picard, 2011; Takahashi, 2011; Irarrazabal *et al.*, 2015; Matsushima and Takauchi, 2014; Ishikawa and Tariu, 2018; Brancaccio *et al.*, 2020; Hayakawa *et al.*, 2020). In this paper, focusing on the endogenous determination of transport costs in the transport sector, we examine firm's choice of internal organization between unitary form (U-form) and multidivisional form (M-form) when firms compete à la Bertrand[3] in an international oligopolistic

[1]To understand this, suppose a case where a cargo ship travels between the two regions (region i and j) and the magnitude of the cargo is asymmetric depending on the direction of shipment. Shipping is thus constrained by the shipping capacity (for example, the number of ships), and the transport firm needs to commit to the maximum capacity required for a round trip. Providing transport service to ij market that transports cargos from region i to region j automatically creates transport supply for the ji market (i.e., the returning trip). If this supply of transport in the ji market is not met with the demand for transport by shippers, it creates the, so-called, backhaul problem for carriers that incur the joint cost of fronthaul (i.e., ij market) and backhaul (i.e., ji market) combined.

[2]The importance of transport costs in terms of both magnitude and economic significance has been documented in the recent literature (Anderson and Wincoop, 2004; Hummelsad, 2007; UNCTAD, 2021). Anderson and Wincoop (2004) estimates that the ad-valorem tax equivalent of freight costs for industrialized countries is 10.7 percent while that of tariffs and non-tariffs is 7.7 percent. A similar fact is pointed out by UNCTAD (2021): that is, for the average country international transport costs amounted to approximately 9 percent of the value of imports during the decade 2005-2014. Particularly, in recent years, the world is experiencing an unprecedented surge in freight shipping costs due to the COVID-19 pandemic. Containerized maritime freight shipping costs have roughly tripled in 2020. In this regard, Hummelsad (2007) states: "As tariffs become a less important barrier to trade, the contribution of transportation to total trade costs - shipping plus tariff - is rising."

[3]The two most common models to describe the strategic interactions between firms in an

environment and try to answer several questions on the internal organizational form. First, if firms' strategic considerations determine the organizational form endogenously in the presence of transportation costs, then what will be the industry's organizational form in equilibrium? Second, is the organizational form in equilibrium consistent with social welfare as well as firms' collective profit?

A firm's choice of organizational form (U-form or M-form) affects its competitive position in the market, especially when the market is in an oligopolistic environment (Amatori and Colli, 2007). In fact, firms have chosen diverse organizational forms by adapting to the market environment. In this context, understanding why firms have different organizational forms and what factors influence the choice of firms' organizational form has been one of the most fascinating questions in economics. Reflecting the interests in optimal organizational design, the literature on firms' organizational form has become richer and more diverse by introducing various factors[4]. To our knowledge, however, there are only limited studies (e.g., Harstad, 2007; Guadalupe and Wulf, 2010; Marin and Verdier, 2012; Li and Zhou, 2021; Bai, 2021) in economics that explicitly considers global factors affecting the flows of international trade to the internal organization of firms. In particular, Harstad (2007) develops a model consisting of product market, labor market, and organization design, and explores the effects of competition in the choice of U-form vs M-form by firms. He shows that if competition becomes tougher, transparent firms decentralize while nontransparent firms concentrate control, and firms switch from U-form to M-form.

Although above studies contribute to the literature by examining the relationship between market competition caused by trade liberalization and firms' internal organization, none of them addresses the role of transport costs, emerg-

oligopolistic market are Cournot competition and Bertrand competition, depending on whether the strategic variable employed is quantity or price. Examples of quantity competition (Cournot) would be petroleum and natural gas, chemicals, textile, aircraft, shipping containers, and health-care industry. Examples of price competition (Bertrand) would be smartphone, airlines, tobacco products, pharmaceutical products, and most of personal service industries. Bloomfield (2021) categorizes 48 industries as Cournot versus Bertrand using three different measures for the mode of competition.

[4]Firms' optimal organization can vary depending on a number of factors, including : complementarity between the tasks other (Harris and Raviv, 2002; Puschke, 2009); firm size and product diversity (Aghion and Tirole, 1995; Spiegel, 2009); the possibility of collusion between firms (Choi and Gerlach, 2013; **?**); the provision of incentives and the accuracy of intra-firm performance measures (**?**; Besanko *et al.*, 2005; Puschke, 2009; Berkovitch *et al.*, 2010); firms' strategic incentive regarding internal organization (Baye *et al.*, 1996; **?**; Barcena-Ruiz and Espinosa, 1999; Tan and Yuan, 2003; Creane and Davidson, 2004; Huck *et al.*, 2004; Zhou, 2005); the role of coordination within an organization (Qian *et al.*, 2006; Alonso *et al.*, 2008; Rantakari, 2008; Burton and Obel, 2018; Yang and Zhang, 2019).

ing as an important barrier to trade instead of import tariffs, in firm's organization determination. In order to tackle this problem, we explicitly include the transport sector with market power into the standard two-country reciprocal trade model, in which firm's owner delegates price decision to his/her manager based on either corporate performance (U-form) or divisional performance (M-form). In the latter (M-form), each division is in charge of the decisions concerning one market and managers are rewarded on the basis of divisional performance in each domestic and abroad market, while, in the former (U-form), activities are concentrated in a single decision center, where managers are rewarded on the basis of corporate performance in both domestic and abroad markets.

The main contributions of this paper to the literature are as follows. First, unlike traditional models on internal organization design, our model incorporates the features of international transport market[5]. To incorporate asymmetric transport costs associated with backhaul problem, we specifically introduce transport sector with market power into standard reciprocal trade model, and assume that the transport firm needs to commit to the maximum capacity required for a round trip. This is quite different from the traditional trade model, which treats the transport costs as exogenously given assuming "iceberg" type transport costs.

Second, this study extends Barcena-Ruiz and Espinosa (1999) and Zhou (2005), which analyze firms' choice of an optimal organizational form in an oligopolistic market[6], in the following two aspects. Unlike two studies above mentioned, we explicitly take into account the role of maritime transport cost (particularly, maritime freight shipping costs) in the firms' choice of internal organization. We show that the transport costs matter in determining firms' organizational structure and social welfare, depending on the degree of imperfect substitutability between goods and firm's delegation type to her/his manager.

In addition, in the previous studies, division in the M-form organization is a product unit responsible for its own operations and profits, whereas in our model,

[5]The international transport market has the following features: i) it is highly concentrated in a few firms with market power, ii) additive (as opposed to iceberg) freight rates are empirically supported, and iii) transport firms commit to their shipping capacity to meet the largest shipping volume (Ishikawa and Tariu, 2021). The above features imply an underutilization of the available capacity of maritime carriers, which creates the, so called, backhaul problem for carriers that incur the joint cost of serving the bilateral transport markets.

[6]Barcena-Ruiz and Espinosa (1999), using the multiproduct oligopoly model, show that firms provide corporate incentives (i.e., U-form) irrespective of competition modes when goods are substitutes, while Zhou (2005), which examines the determinants of a firm's organizational form in the context of an imperfectly competitive industry, shows that the advantage of being an M-form firm increases with the number of firms in an oligopolistic market as far as the ratio of firms' organizational form is unchanged.

division is a market (i.e., geographic) unit such as domestic sales and overseas sales. Of course, inclusion of multi-product and multi-market would provide a more natural rationale for the diverse combination of organizational forms, but it would unfortunately mix-up the implications of transport costs on the choice of organizational form. To focus on the role of transport costs in determining firms' internal organization, we ignore the possibility of divisional organization by product unit.

Third, our study also relates to the literature on the role of managerial incentives by firms' owners in optimal trade policies (Das, 1997; Moner-Colonques, 1997; Miller and Pazgal, 2005; Wang *et al.*, 2009; Xu and Lee, 2021, Choi and Lee, 2022). As competition among firms in the global market intensifies and business activities become more complex, the managerial performance is becoming an important key to the overall performance of the firm. Reflecting these changes in the economic environment, recent advances in international trade theory emphasize strategic incentive of managerial delegation and its implications for trade policies[7]. However, while above studies focus on the interaction of managerial delegation with optimal trade policies set by the government, our study on the interaction with the endogenous freight rates set by the transport firm with market power. An important addition in our case is that the strategic use of organization forms based on either divisional incentives or unitary incentives is considered.

The main findings of our study are as follows. First, with exogenous freight rates, prisoners' dilemma situation arises in the choice of firms' internal organization. Each owner pursuing rational self-interest chooses M-form instead of U-form as its organization even though both choosing U-form is collectively profitable and socially desirable, because the latter (the U-form) internalize the

[7]Among others, Das (1997) examined the implications of managerial delegation by firms' owners for trade policies, and showed that delegation reduces the magnitude of strategic trade policy in an exporting industry, but in an import-competing industry, the optimal tariff level with delegation is lesser or greater than the level without delegation depending on whether firms compete in quantity or price. Moreover, taking into account that managers compete in domestic and abroad markets, Moner-Colonques (1997) analyzed delegation problem with subsidy and tariff policies assuming firms give incentives according to both domestic and the foreign market. Using relative-performance incentive schemes, Miller and Pazgal (2005) showed that the optimal strategic trade policy does not depend on the mode of competition (i.e., Cournot and Bertrand competition). Focusing on market-share delegation and the generalized Nash bargaining, Wang *et al.* (2008) and Wang *et al.* (2009) also analyzed the influence on the strategic trade policy of managerial delegation in a trade duopoly context. They showed that different forms of delegation coupled with cost asymmetry (i.e., subsidy and tariff) will induce different degrees of government intervention.

negative effects of transport costs on exports. Second, on the other hand, if the freight rates are determined endogenously by the monopolistic transport firm, diverse types of organizational forms arise. Both firms choose U-form (resp. M-form) if the degree of imperfect substitutability is low (resp. high). If the substitutability of goods is intermediate, asymmetric organizational form that only one firm chooses M-form arises. Unlike Barcena-Ruiz and Espinosa (1999) where U-form is the Nash Equilibiurm organization, we have shown that diverse types of organizational form arises depending on the degree of substitution of goods and the marginal cost of transport firms. Third, the U-form organization is preferred to the M-form from the welfare perspective because the former internalizes externalities and has the effect of reducing transportation costs.

This paper is organized as follows. A simple two-way oligopolistic trade model in which managerial delegation is implemented based on either corporate performance or divisional performance is outlined in Section 2. This section also presents a discussion on the strategic nature of managerial delegation. Section 3 derives the outcomes under each three possible organization structures. Section 4 and Section 5 deal with the endogenous determination of firms' internal organization under exogenous and endogenous freight rates, respectively. In particular, in order to allow possible asymmetry in freight rates for shipping in opposite directions, Section 5 introduces capacity constraint in determining freight rates by the transport firm. Section 6 concludes.

2. THE MODEL

We consider a two-way oligopolistic trade model. There are two countries, home (country 1) and foreign (country 2) country. There is a single manufacturing firm in each country (firm $i; i = 1,2$) and a single transport firm: firm S[8]. Firm 1 and firm 2 produce a differentiated products and serve both countries. Transportation services are required for the overseas supply of goods. The utility function of the representative consumer in country i is given by $U = q_{ii} + q_{ji} - \frac{q_{ii}^2 + q_{ji}^2 + 2dq_{ii}q_{ji}}{2} + m$; $i, j = 1,2, i \neq j$, where m is the consumption of the outside good; q_{ii} (resp. q_{ji}) represents the quantity of firm i's (resp. j's) products demanded in country i; and $d \in (0,1)$ denotes the degree of product substitutability, that is, the higher the value of d, higher will be the degree of substitutability between the products. Given the utility function of the represen-

[8]Firm S may locate in country 1 or country 2 or in the third country. The location becomes crucial when analyzing welfare, but we assume for the simplification of the analysis that firm S is located in a third country.

tative consumer mentioned above, the direct demand function for good i can be written as follows[9]:

$$q_{ii} = \frac{1-d-p_{ii}+dp_{ji}}{1-d^2}, \quad q_{ji} = \frac{1-d-p_{ji}+dp_{ii}}{1-d^2}; \; i,j=1,2, i \neq j, \quad (1)$$

where p_{ii} (resp. p_{ji}) refers to the market price of firm i's (j's) products sold in country i. For simplicity, the marginal cost (MC) of producing the good is assumed to be zero. In addition, it is assumed that the two markets are segmented and that the two manufacturing firms engage in Bertrand competition in each market[10]. The gross profit of firm i, Π, is given by

$$\Pi_i = \pi_{ii} + \pi_{ij} = p_{ii}q_{ii} + (p_{ij} - T_{ij})q_{ij}; \; i,j=1,2, i \neq j, \quad (2)$$

where π_{ii} (resp. π_{ij}) represents the profits of firm i in the market of country i (resp. country j) and T_{ij} is the freight rate when shipping the good from country i to country j. We assume that the freight rate is linear and additive as defined later. The owner of manufacturing firm hires a manager (or managers) and delegates the strategic decision to the manager(s). There are two possible choices for the owner of manufacturing firm with respect to delegation of decisions to the manager. Since each manufacturing firm is selling its products in both countries, firm's owner should make a decision whether to organize the firm in two independent divisions, so that each division is in charge of decisions of relevant market, or to concentrate all decisions on both markets in a single decision center. In M-form (multidivisional form), manager of each division receives incentives on the basis of divisional performances while in the U-form (unitary form), compensation is based on corporate performances.

A firm in U-form is defined here as follows. The owner provides a linear incentive scheme to a manager, who is responsible for decisions concerning both home and foreign markets:

$$M_i = \Pi_i + \theta_i(q_{ii}+q_{ij}) = p_{ii}q_{ii} + (p_{ij} - T_{ij})q_{ij} + \theta_i(q_{ii}+q_{ij}); i,j=1,2, i \neq j, \quad (3)$$

[9]When considering consumer surplus, CS with the representative consumer maximizes $CS = q_{ii} + q_{ji} - \frac{q_{ii}^2 + q_{ji}^2 + 2dq_{ii}q_{ji}}{2} + m - p_{ii}q_{ii} - p_{ji}q_{ji}$ subject to the budget constraint $I = m + p_{ii}q_{ii} + p_{ji}q_{ji}$ where I is income of the consumer and m is numeraire good which price is normalized to 1. Hence, eliminating m and dropping the constant term I, leads to $\max_{q_{ii},q_{ji}} CS$, which produces direct (and also indirect) demand function of manager in Eq. (1).

[10]Some readers may concern that it should consider the case of Cournot competition. If we employ Cournot competition with same setting, we can find that choosing M-form for both firms is dominant strategy whether the freight rates are determined endogenously or not, which brings about Pareto efficiency for firm's profit and social welfare. The detailed analysis for the Cournot case is given in Appendix E.

where M_i is the objective function of the manager in firm i and θ_i is the incentive parameter that is designed by firm i's owner and may be either positive or negative, depending on whether the owner provides incentives or disincentives for manager's market performance. If $\theta_i = 0$, firm i's manager is pure profit maximizer while if $\theta_i \neq 0$, then he/she is a more ($\theta_i > 0$) or less ($\theta_i < 0$) aggressive seller in the market.

In an M-from consisting of domestic sales division and export sales division, however, the owner provides different linear incentive schemes for the manager of domestic sales (q_{ii}) and the manager of export sales (q_{ij}). That is,

$$\begin{aligned} M_{ii} &= \pi_{ii} + \beta_{ii} q_{ii} = p_{ii} q_{ii} + \beta_{ii} q_{ii}, \\ M_{ij} &= \pi_{ij} + \beta_{ij} q_{ij} = (p_{ij} - T_{ij}) q_{ij} + \beta_{ij} q_{ij}; i, j = 1, 2, i \neq j, \end{aligned} \tag{4}$$

where M_{ii} (resp. M_{ij}) is the objective function of the manager who is responsible for domestic (resp. export) sales division; and β_{ii} (resp. β_{ij}) is the incentive parameter set by the owner with respect to the compensation scheme for the manager of the domestic (resp. export) sales[11].

Each country's social welfare, SW_i, is defined as the sum of consumer surplus, CS_i, and producer surplus, Π_i. That is,

$$SW_i = q_{ii} + q_{ji} - \frac{q_{ii}^2 + q_{ji}^2 + 2d q_{ii} q_{ji}}{2} + m - p_{ji} q_{ji} - p_{ii} q_{ii} + \Pi_i. \tag{5}$$

We posit a four-stage game. In the first stage of the game, owner of each firm selects firm's organizational form (i.e., U-form or M-form). The second stage involves the determination of freight rates. In case of endogenous freight rates, firm S sets freight rates and makes a take-it-or-leave-it offer to manufacturing firms. In the third stage, each owner writes his or her manager's incentive contract θ_i or β_{ii} with β_{ij}, in which the manager's objective function is specified. We call it the contract stage. In the last stage, each manager simultaneously chooses price in order to maximize its profits. We solve a subgame perfect Nash equilibrium (SPNE) using backward induction.

3. MARKET EQUILIBRIUM UNDER BERTRAND COMPETITION

Since each manufacturing firm has two choices with respect to organizational form, there are three possible combinations of organizational forms based on

[11] Similar to the case of θ_i, if $\beta_{ii}, \beta_{ij} = 0$, firm i's manager is pure profit maximizer while if $\beta_{ii}, \beta_{ij} \neq 0$, then he/she is a more ($\beta_{ii}, \beta_{ij} > 0$) or less ($\beta_{ii}, \beta_{ij} < 0$) aggressive seller in the market.

manufacturing firms' decisions: one firm is an M-form and the other has a U-form, or both are M-form, or both are organized in U-form. Before solving for the subgame perfect Nash equilibrium for each possible organizational form, we first solve the last stage of the game, managers' profit maximization problem, following the backward induction method.

Given the organizational form, freight rates and managerial incentives set in the previous stages, the maximization problem of each manager can be written as

$$\max_{p_{ii}} p_{ii}q_{ii} + \beta_{ii}q_{ii} \quad \text{and} \quad \max_{p_{ij}} (p_{ij} - T_{ij})q_{ij} + \beta_{ij}q_{ij} \text{ if firm } i \text{ adopts M-from.}$$
$$\max_{p_{ii},p_{ij}} p_{ii}q_{ii} + (p_{ij} - T_{ij})q_{ij} + \theta_i(q_{ii} + q_{ij}) \text{ if firm } i \text{ adopts U-form.}$$

By solving the system of the firms' price-reaction functions in the market of country i, we obtain equilibrium prices and quantities in this stage of the game as follows ($\Xi = (1-d)(2+d)$):

$$q_{ii}[\mathbf{L_i}; T_{ji}] = \frac{\Xi + (2-d^2)\lambda_{ii} - d(\lambda_{ji} - T_{ji})}{(1-d^2)(4-d^2)},$$
$$q_{ji}[\mathbf{L_i}; T_{ji}] = \frac{\Xi + (2-d^2)(\lambda_{ji} - T_{ji}) - d\lambda_{ii}}{(1-d^2)(4-d^2)}, \tag{6}$$

$$Q_i[\mathbf{L_i}, \mathbf{L_j}; \mathbf{T}](\equiv q_{ii} + q_{ij}) = \frac{2\Xi + (2-d^2)\lambda_{ii} - d\lambda_{jj} + (2-d^2)(\lambda_{ij} - T_{ij}) - d(\lambda_{ji} - T_{ji})}{(1-d^2)(4-d^2)}, \tag{7}$$

$$p_{ii}[\mathbf{L_i}; T_{ji}] = \frac{\Xi - 2\lambda_{ii} - d(\lambda_{ji} - T_{ji})}{4-d^2},$$
$$p_{ji}[\mathbf{L_i}; T_{ji}] = \frac{\Xi - 2(\lambda_{ji} - T_{ji}) - d\lambda_{ii}}{4-d^2}, \tag{8}$$

where $\mathbf{L_i} = (\lambda_{ii}, \lambda_{ji})$, $\mathbf{L_j} = (\lambda_{jj}, \lambda_{ij})$, and $\mathbf{T} = (T_{ij}, T_{ji})$. In addition, $\lambda_{ii} = \beta_{ii}$ and $\lambda_{ij} = \beta_{ij}$ if firm $i(i, j = 1, 2, i \neq j)$ adopts M-form while $\lambda_{ii} = \lambda_{ij} = \theta_i$ if it is organized in U-form. It holds that $\frac{\partial q_{ii}}{\partial \lambda_{ii}} = \frac{\partial q_{ji}}{\partial \lambda_{ji}} > 0$ and $\frac{\partial q_{ii}}{\partial \lambda_{ji}} = \frac{\partial q_{ji}}{\partial \lambda ii} < 0$, implying that an increase in sales incentives of own firm raises output but that of the rival firm reduces output. In addition, if round trip freight rates are symmetric (i.e., $T_{12} = T_{21} = T$), then firm i's total output $Q_i(\equiv q_{ii} + q_{ij})$ is a positive (resp. negative) function of a simple sum of incentive parameters of its own firm (resp.

rival firm)[12]. Therefore, if the sum of firm's incentive parameters is the same across different organizational structures, then the total output of the firm is the same irrespective of its organizational form.

3.1. ASYMMETRIC ORGANIZATIONAL STRUCTURE

We solve first the subgame where one firm (here, firm 1) is M-form and the other (firm 2) is organized in U-form. With this asymmetric organizational form across firms, the equilibrium prices and quantities in the last stage of the game are given in Eqs. (6) and (8) by replacing $\lambda_{11} = \beta_{11}$, $\lambda_{12} = \beta_{12}$ and $\lambda_{21} = \lambda_{22} = \theta_2$. That is,

$$\begin{aligned} q_{11}^{MA} &= \frac{(2-d^2)(1+\beta_{11}) - d(1+\theta_2 - T_{21})}{(1-d^2)(4-d^2)}, \\ q_{12}^{MA} &= \frac{(2-d^2)(1+\beta_{12} - T_{12}) - d(1+\theta_2)}{(1-d^2)(4-d^2)}, \end{aligned} \tag{9}$$

$$\begin{aligned} q_{21}^{UA} &= \frac{(2-d^2)(1+\theta_2 - T_{21}) - d(1+\beta_{11})}{(1-d^2)(4-d^2)}, \\ q_{22}^{UA} &= \frac{(2-d^2)(1+\theta_2) - d(1+\beta_{12} - T_{12})}{(1-d^2)(4-d^2)}. \end{aligned} \tag{10}$$

Regarding $q_{ij}^{MA}(q_{ij}^{UA})$, for example, the superscript 'A' stands for an asymmetric organizational structure between firms, and 'M (U)' in superscript MA (UA) represents that only firm i (the first number in the subscript) takes the M-form (U-form) organization. Therefore, q_{12}^{MA} represents export volume from country 1 to country 2 when firm 1 is M-form while firm 2 is organized in U-form. It is obvious that $\frac{\partial q_{11}^{MA}}{\partial \beta_{11}} = \frac{\partial q_{12}^{MA}}{\partial \beta_{12}} > 0$ and $\frac{\partial q_{11}^{MA}}{\partial \beta_{12}} = \frac{\partial q_{12}^{MA}}{\partial \beta_{11}} = 0$ while $\frac{\partial q_{21}^{UA}}{\partial \theta_2} = \frac{\partial q_{22}^{UA}}{\partial \theta_2} > 0$. In addition, if $\beta_{11} + \beta_{12} = 2\theta_2$ with symmetric freight rates, then the total output of firm 1 (M-form) is the same as that of firm 2 (U-form)[13]; i.e., $Q_1^{MA} = Q_2^{UA}$.

In the third stage, linear incentive schemes are decided, taking into account their influence on the production levels of the ensuing stage. The owner of firm

[12] Suppose $T_{12} = T_{21} = T$. From equations, we get $Q_i = \frac{(2-d-d^2)(2-T)+(2-d^2)(\lambda_{ii}+\lambda_{ij})-d(\lambda_{jj}+\lambda_{ji})}{(1-d^2)(4-d^2)}$. The total output of firm $i(i,j = 1,2, i \neq j)$ is positive function in $\lambda_{ii} + \lambda_{ij}$ but negative function in $\lambda_{jj} + \lambda_{ji}$.

[13] With symmetric freight rates (i.e., $T_{12} = T_{21} = T$), the total output of firm is given from Eqs. (9) and (10) as follows: $Q_1^{MA}(\equiv q_{11}^{MA} + q_{12}^{MA}) = \frac{(2-d-d^2)(2-T)+(2-d^2)(\beta_{11}+\beta_{12})-2d\theta_2}{(1-d^2)(4-d^2)}$ and $Q_2^{UA}(\equiv q_{22}^{UA} + q_{21}^{UA}) = \frac{(2-d-d^2)(2-T)+(2-d^2)2\theta_2-d(\beta_{11}+\beta_{12})}{(1-d^2)(4-d^2)}$. Therefore, if $\frac{\beta_{11}+\beta_{12}}{2} = \theta_2$, then $Q_1^{MA} = Q_2^{UA}$ holds.

1 (M-form) decides β_{11} and β_{12} such that

$$\max_{\beta_{11},\beta_{12}} \Pi_1^{MA}(\mathbf{B_1},\theta_2;\mathbf{T})(\equiv \pi_{11}^{MA}(\beta_{11},\theta_2;T_{21})+\pi_{12}^{MA}(\beta_{12},\theta_2;T_{12})),$$

where $\mathbf{B_1}=(\beta_{11},\beta_{12})$ and $\mathbf{T}=(T_{12},T_{21})$. Similarly, The owner of firm 2 (U-form) decides θ_2 to maximize $\Pi_2^{UA}(\mathbf{B_1},\theta_2;\mathbf{T})$. Differentiating $\Pi_1^{MA}(\mathbf{B_1},\theta_2;\mathbf{T})$ with respect to β_{11} and β_{12}, and applying the envelope theorem, we obtain

$$\frac{\partial \Pi_1^{MA}}{\partial \beta_{11}} = \underbrace{-\beta_{11}\frac{\partial q_{11}}{\partial p_{11}}\frac{\partial p_{11}^{MA}}{\partial \beta_{11}}}_{\text{Strategic distortion effect}(+,-)} + \underbrace{p_{11}^{MA}\frac{\partial q_{11}}{\partial p_{21}}\frac{\partial p_{21}^{UA}}{\partial \beta_{11}}}_{\text{Rent-shifiting effect}(-)}, \tag{11}$$

$$\frac{\partial \Pi_1^{MA}}{\partial \beta_{12}} = \underbrace{-\beta_{12}\frac{\partial q_{12}}{\partial p_{12}}\frac{\partial p_{12}^{MA}}{\partial \beta_{12}}}_{\text{Strategic distortion effect}(+,-)} + \underbrace{(p_{12}^{MA}-T_{12})\frac{\partial q_{12}}{\partial p_{22}}\frac{\partial p_{22}^{UA}}{\partial \beta_{12}}}_{\text{Rent-shifiting effect}(-)}. \tag{12}$$

The right-hand side (RHD) of Eqs. (11) and (12) indicates effects of an increase in β_{ij} (i.e., encouraging sales by owner of firm *i*); the first term shows the profit change that occurs because firm owner offers non-profit maximization objective for his/her manager (i.e., strategic distortion effects) and the second term represents the effects that the sales promotion of firm *i* lowers the price of the rival's products in the corresponding market and hence a part of the firm *i*'s profit is shifted abroad (i.e., rent-shifting effects)[14].

Similarly, the derivative of the foreign firm's maximal profit with respect to θ_2 is obtained as follows:

$$\begin{aligned}\frac{\partial \Pi_2^{UA}}{\partial \theta_2} = & \underbrace{-\theta_2\Big(\frac{\partial q_{22}}{\partial p_{22}}\frac{\partial p_{22}^{UA}}{\partial \theta_2}+\frac{\partial q_{21}}{\partial p_{21}}\frac{\partial p_{21}^{UA}}{\partial \theta_2}\Big)}_{\text{Strategic distortion effect}(+,-)} \\ & + \underbrace{p_{22}^{UA}\frac{\partial q_{22}}{\partial p_{12}}\frac{\partial p_{12}^{MA}}{\partial \theta_2}}_{\text{Rent-shifiting effect in county 2}(-)} \\ & + \underbrace{(p_{21}^{UA}-T_{21})\frac{\partial q_{21}}{\partial p_{11}}\frac{\partial p_{11}^{MA}}{\partial \theta_2}}_{\text{Rent-shifiting effect in county 1}(-)},\end{aligned} \tag{13}$$

[14]As pointed out in Das (1997), whether with quantity or price competition, delegation to managers has rent-shifting effects.

where the first term on the RHS represents the strategic distortion effects, and the second (resp. last) term, which is negative, shows rent shifting effects from firm 2 (U-form) to firm 1 (M-form) in the market of foreign country (resp. home country). If we evaluate Eqs. (11), (12) and (13) at the value zero of the incentive parameter, we obtain $\frac{\partial \Pi_1^{MA}}{\partial \beta_{11}} |_{\beta_{11}=0} < 0$, $\frac{\partial \Pi_1^{MA}}{\partial \beta_{12}} |_{\beta_{12}=0} < 0$, and $\frac{\partial \Pi_2^{UA}}{\partial \theta_2} |_{\theta_2=0} < 0$, implying that the owner of firm *i* wants his/her manager to behave less aggressively in the corresponding market.

By solving $\frac{\partial \Pi_1^{MA}}{\partial \beta_{11}} = 0$, $\frac{\partial \Pi_1^{MA}}{\partial \beta_{12}} = 0$ and $\frac{\partial \Pi_2^{UA}}{\partial \theta_2} = 0$ simultaneously, we can obtain the equilibrium values in incentive parameters β_{11}^{MA}, β_{12}^{MA} and θ_2^{UA} as a function of T_{12} and T_{21}. Substituting these values into the market variables, we get the equilibrium values of output, firm's profits, and social welfare in the asymmetric organizational structure (see Table A2 of Appendix A).

To simplify the discussion, we assume that the freight rates are symmetric irrespective of the direction of trip, i.e., $T_{12} = T_{21} = T$. Then, the following Lemma is immediate:

Lemma 1. *Suppose that the round trip freight rates are symmetric (i.e., $T_{12} = T_{21} = T$). In an asymmetric organizational structure, where only one firm adopts M-form, the following relationship holds:*

$$(i)\beta_{ii}^{MA} < \theta_i^{UA}\left(= \frac{\beta_{ii}^{MA} + \beta_{ij}^{MA}}{2}\right) < \beta_{ij}^{MA} < 0,$$
$$(ii)Q_i^{MA} = Q_i^{UA}$$
$$(iii)q_{ij}^{UA} < q_{ij}^{MA} < q_{ii}^{MA} < q_{ii}^{UA}, (iv)\Pi_i^{UA} < \Pi_i^{MA}.$$

Proof. See Appendix A. □

As in Vickers (1985), Fershtman and Judd (1987) and Sklivas (1987), VFJS for short, the equilibrium values $\beta_{ii}^{MA}, \beta_{ij}^{MA}$, and θ_i^{UA} are negative, implying that in Bertrand competition profit oriented owners of firm offer their managers incentive contracts that make them behave less aggressively than they would do under the profit maximization. In addition, the equilibrium incentive parameter designed by the owner in the U-form is just the average of the incentive parameters that the owner of the M-form offers to the managers of each division, i.e., $\theta_i^{UA} = \frac{\beta_{ii}^{MA} + \beta_{ij}^{MA}}{2}$. As mentioned before, if the sum of the firm's incentive parameters is the same irrespective of the organizational structure, then the firm's total output is also the same irrespective of its organizational form. Considering this, $\theta_i^{UA} = \frac{\beta_{ii}^{MA} + \beta_{ij}^{MA}}{2}$ implies that the total output of the U-form is the same as that of the M-form as far as freight rates are symmetric, that is, $Q_i^{MA} = Q_i^{UA}$.

In Lemma 1(iii), we find two types of inequalities, that is, $q_{ij}^{MA} < q_{ii}^{MA}$ and $q_{ij}^{UA} < q_{ii}^{UA}$, and $q_{ij}^{UA} < q_{ij}^{MA}$ and $q_{ii}^{MA} < q_{ii}^{UA}$. The former (i.e., $q_{ij}^{MA} < q_{ii}^{MA}$ and $q_{ij}^{UA} < q_{ii}^{UA}$) implies that firm's supply to the domestic market is greater than the overseas supply that requires freight costs for shipping goods. The latter (i.e., $q_{ij}^{UA} < q_{ij}^{MA}$ and $q_{ii}^{MA} < q_{ii}^{UA}$) implies that U-form firm, compared to M-form firm, supplies more output to the domestic market but less to the overseas market. Managers in the U-form internalize the effects of transport costs for its exports; this effect would direct the U-form, compared to M-form, to reduce overseas supply that requires freight costs and to increase the domestic supply with no transportation costs. Therefore, being a U-form provides more (resp. less) incentives for a domestic (resp. overseas) market than being an M-form.

Lemma 1(iv) suggests that the profit of the M-form firm is greater than that of the U-form firm under the asymmetric organizational structure. This is straightforward considering if U-form brings higher profits than M-form, then the owner of M-form can achieve this by choosing the same incentives schemes for managers in each division, that is, $\beta_{ii}^{MA} = \beta_{ij}^{MA}$. Therefore, it is better for the owner of firms to choose M-form rather than the U-form in an asymmetric organizational structure because it gives greater flexibility with respect to profit maximization.

3.2. SYMMETRIC ORGANIZATIONAL STRUCTURE: MM AND UU REGIME

The procedure in previous subsection allows us to calculate the equilibrium market values when both firms have the same organization forms. First, we look at the case where both firms have the M-form. In this case, the equilibrium prices and quantities in the last stage of the game are given in Eqs. (6), (7) and (8) by replacing $\lambda_{ii} = \beta_{ii}$ and $\lambda_{ij} = \beta_{ij}$ for $i, j = 1, 2; i \neq j$. In stage 3 of the game, the owner of each firm chooses β_{ii} and β_{ij} to maximize its profit, $\max_{\beta_{ii},\beta_{ij}} \Pi_i^{MM}(\mathbf{B_i}, \mathbf{B_j}; \mathbf{T}) (\equiv \pi_{ii}^{MM}(\beta_{ii}, \beta_{ji}; T_{ji}) + \pi_{ij}^{MM}(\beta_{ij}, \beta_{jj}; T_{ij}))$[15], where $\mathbf{B_i} = (\beta_{ii}, \beta_{ij})$, $\mathbf{B_j} = (\beta_{jj}, \beta_{ji})$ and $\mathbf{T} = (T_{ij}, T_{ji})$. Superscript 'MM' denotes the case where both firms are in multi-divisional form (MM regime). By solving $\frac{\partial \Pi_{ii}^{MM}}{\partial \beta_{ii}} = 0$ and $\frac{\partial \Pi_{ji}^{MM}}{\partial \beta_{ji}} = 0$ for $i, j = 1, 2. i \neq j$, simultaneously, we obtain the equilibrium values in incentive parameters and market variables when both firms are in multidivisional forms (see Table A1 of Appendix A). As in the asymmetric case,

[15]Here, $\pi_{ii}^{MM}(\beta_{ii}, \beta_{ji}; T_{ji}) = p_{ii}^{MM}(\beta_{ii}, \beta_{ji}; T_{ji}) \times q_{ii}^{MM}[p_{ii}^{MM}(\beta_{ii}, \beta_{ji}; T_{ji}), p_{ji}^{MM}(\beta_{ii}, \beta_{ji}; T_{ji})]$ and $\pi_{ij}^{MM}(\beta_{ij}, \beta_{jj}; T_{ij}) = [p_{ij}^{MM}(\beta_{ij}, \beta_{jj}; T_{ij}) - T_{ij}] \times q_{ij}^{MM}[p_{ij}^{MM}(\beta_{ij}, \beta_{jj}; T_{ij}), p_{jj}^{MM}(\beta_{ij}, \beta_{jj}; T_{ij})]$, where $q_{ii}[\cdot]$ and $q_{ij}[\cdot]$ are demand function given in Eq. (1).

the equilibrium values β_{ii}^{MM} and β_{ij}^{MM} are negative. In addition, $\frac{\partial \beta_{ii}^{MM}}{\partial T_{ji}} < 0$ (resp. $\frac{\partial \beta_{ij}^{MM}}{\partial T_{ij}} > 0$) implies that, for the increase in T_{ji} (resp. T_{ij}), the owner of firm i reinforces (resp. weakens) penalizing for the domestic sales (resp. overseas sales), thereby directing each division's manager to behave more (resp. less) passively than otherwise.

Now, we examine the case where both firms are in U-form. The equilibrium prices and quantities in the last stage of the game are given in Eqs. (6), (7) and (8) by replacing $\lambda_{ii} = \lambda_{ij} = \theta_i$ for $i, j = 1, i \neq j$. In stage 3 of the game, given the rival firm's incentive parameter, the owner of firm i chooses θ_i to maximize its profit, that is, $\max_{\theta_i} \Pi_i^{UU}(\theta_i, \theta_j; \mathbf{T})$, where superscript 'UU' stands for the case where both firms are in unitary organizational structure (UU regime). The first order condition for this maximization problem gives the same form as Eq. (13). By solving $\frac{\partial \Pi_i^{UU}}{\partial \theta_i} = 0$ for $i = 1, 2$, simultaneously, we obtain the equilibrium values in incentive parameters and equilibrium values of market variables including firms' output, profits, and social welfare (see Table A1 of Appendix A).

4. THE CHOICE OF ORGANIZATIONAL FORM WITH EXOGENOUS FREIGHT RATES

To guarantee that all possible variables are positive in equilibrium, we assume the following sufficient condition under exogenous freight rates, which requires that the transport cost be sufficiently small when its cost is symmetric ($T_{12} = T_{21} = T$)[16].

Assumption A. $T < T^x \equiv \frac{8(1-d)(2-d^2)^2}{(4-3d^2)(8-4d-3d^2+d^3)}$.

4.1. COMPARISONS

By comparing the equilibrium incentive parameters under different organizational structure when freight rates are given exogenously (Appendix A), the following Lemma is obtained:

Lemma 2. *Suppose that the freight rates for shipping goods are symmetric irrespective of the direction of trip, i.e., $T_{ij} = T_{ji} = T$. With exogenous freight rates,*

[16] In the case of exogenous freight rates, the assumption of symmetric freight rates is to render the analysis more tractable; the extension to asymmetric freight rates does not alter the main results obtained here.

it holds that

$$\beta_{ii}^{MA} < \beta_{ii}^{MM} < \theta_i^{UU} (= \theta_i^{UA}) < \beta_{ij}^{MM} < \beta_{ij}^{MA} < 0,$$
$$\beta_{ii}^{MM} + \beta_{ij}^{MM} = \beta_{ii}^{MA} + \beta_{ij}^{MA} = 2\theta_i^{UA} = 2\theta_i^{UU}.$$

Proof. From equilibrium outcomes in Tables A1 and A2 of Appendix A with $T_{ij} = T_{ji} = T$, we obtain:

$$\beta_{ij}^{MA} - \beta_{ij}^{MM} = \beta_{ii}^{MM} - \beta_{ii}^{MA} = \frac{d^4(1+d)T}{8(2-d^2)\Delta_b} > 0,$$
$$\beta_{ij}^{MM} - \theta_i^{UU} = \theta_i^{UU} - \beta_{ii}^{MM} = \frac{d^2(1+d)T}{2\Delta_b} > 0; \quad \Delta_b = 4 + 2d - d^2. \qquad \square$$

Two points are noteworthy in Lemma 2. First, all the equilibrium incentive parameters in a different organizational form have negative values, implying that in Bertrand competition profit oriented owners offer their managers incentive contracts that make them behave less aggressively than they would do under the profit maximization. Second, the sum of firm's incentive parameters for the different division of the firm are the same across different organizational forms, implying that the total output of the firm is the same irrespective of its organizational form.

Next, we look at the output and profit ranking across different organizational forms. By comparing the equilibrium output and profit under different organizational forms presented in Table A1 and A2 of Appendix A, we obtain the following proposition.

Proposition 1. *Suppose that the freight rates are symmetric (i.e., $T_{12} = T_{21} = T$). Then, the following inequalities hold with respect to quantity, profits, and social welfare:*
(i) $q_{ii}^{MM} < q_{ii}^{MA} < q_{ii}^{UA} < q_{ii}^{UU} (= q_{ij}^{UU} < q_{ij}^{UA} < q_{ij}^{MA} < q_{ij}^{MM})$,
(ii) $\Pi_i^{UA} < \Pi_i^{MM} < \Pi_i^{UU} < \Pi_i^{MA}$, (iii) $SW_i^{MM} < SW_i^{UU}$ and $SW_i^{MA} < SW_i^{UA}$.

Proof. See Appendix A. $\square$

Two types of inequalities are found in Proposition 1(i), i.e., $q_{ii}^{MA} < q_{ii}^{UU}$ and $q_{ii}^{MM} < q_{ii}^{UA}$, and $q_{ii}^{MM} < q_{ii}^{MA}$ and $q_{ii}^{UA} < q_{ii}^{UU}$. The former case, $q_{ii}^{MA} < q_{ii}^{UU}$ and $q_{ii}^{MM} < q_{ii}^{UA}$, implies that a firm's supply to its own market is greater when it is in U-form than when it is in M-form irrespective of whether the rival firm is in U-form or not. Since managers in the U-form organization internalize the effects of transport costs on exports, they tend to reduce overseas supply that requires transport costs and increase domestic supply instead compared to M-form. Put differently, given the rival's organizational form, a change in organizational form M to U implies an increase in domestic supply and a decrease in export supply. The latter case, $q_{ii}^{MM} < q_{ii}^{MA}$ and $q_{ii}^{UA} < q_{ii}^{UU}$, implies that given the organizational form of firm i, a change from M-form to U-from organization of the rival firm makes firm i increase the domestic supply and reduce the overseas supply. This is quite straightforward considering that goods are substitutes. As suggested in Proposition 1(i), the rival firm tends to reduce export supply but increase domestic supply when it changes its organizational form from M to U. Since goods are substitutes in each market, this shift of rival firm's organizational form increases firm i's domestic supply and decreases its overseas supply. In addition, since firm's total output is the same irrespective of firm's organizational structure (i.e., $Q_i^{MM} = Q_i^{UU} = Q_i^{UA} = Q_i^{MA}$), $q_{ii}^{MM} < q_{ii}^{MA} < q_{ii}^{UA} < q_{ii}^{UU}$ implies $q_{ij}^{UU} < q_{ij}^{UA} < q_{ij}^{MA} < q_{ij}^{MM}$.

We now turn to the profit ranking. In Proposition 1 (ii), $\Pi_i^{UA} < \Pi_i^{MM}$ and $\Pi_i^{UU} < \Pi_i^{MA}$ imply that given the rival's organizational structure, firm i can increase its profit by changing its organizational structure from U to M-form. In our model, the organization of M-form coincides with the U-form if a constraint that all the managers of different divisions must have the same level of incentive scheme (i.e., $\beta_{ii} = \beta_{ij}$) is added. Therefore, it is better for the owner of firm to choose M-form rather than U-form as its organizational structure because M-form gives greater discretion with respect to profit maximization than U-form. In addition, it is noteworthy that $\Pi_i^{MM} < \Pi_i^{UU}$ holds in the profit ranking. As pointed out earlier, the total output is the same in both organizational forms if freight rates are exogenous. However, the U-form is more efficient than the M-form as far as both firms have the same organizational form because, compared with M-form, the manager of U-form considers the efficiency of overall production and hence internalizes the effect of one division on the other.

4.2. THE DETERMINATION OF ORGANIZATION FORM UNDER EXOGENOUS FREIGHT RATES

We now turn to the determination of firms' organizational structure in the first stage of the three-stage of the game. We still assume that the freight rates are exogenously given. By regarding firms' payoffs as their profits, Table 2 summarizes the potential choices in this stage, where both firms have two choices with respect to their organizational structure: M-form and U-form.

Table 2: General Form of Organization Decision Game

firm 1\ firm 2	U-form	M-form
U-form	Π_1^{UU}, Π_2^{UU}	Π_1^{UA}, Π_2^{MA}
M-form	Π_1^{MA}, Π_2^{UA}	Π_1^{MM}, Π_2^{MM}

In the first stage of the game, each firm's owner faces the game represented in Table 2 and must decide how to organize the firm. It can be checked, from Proposition 1, that when the products are substitutes, the dominant strategy is to organize the firm in M-form. The following proposition is immediate.

Proposition 2. *Suppose two-way trade market under Bertrand competition with exogenous freight rates. (i) Choosing an M-form (i.e., multidivisional incentives) organization is the dominant strategy for the owners of both firms. (ii) Firms are both better off if they choose U-form instead of M-form, i.e.,* $\Pi_i^{MM} < \Pi_i^{UU}$ *(prisoner's dilemma situation). (iii) Choosing U-form for both firms is socially desirable than both choosing M-form, i.e.,* $SW_i^{MM} < SW_i^{UU}$.

Proposition 2 can be explained as follows. It is well known that price competition is fiercer and closer to perfect competition than the quantity competition. In M-form organization, transport costs in international trade protects domestic sales from imports but works as a marginal cost for export sales. In Bertrand competition, an increase in the marginal cost (i.e., transport costs) makes firm's owner choose incentive contracts that induce manager for the export sales to behave more aggressively. On the other hand, protection to the domestic sales makes firm owner choose incentive contracts that induce manager to behave less aggressively. Firm's owner, by offering different optimal incentive schemes for each division, can get higher profits than in the U-form where the same incentive schemes are offered. In sum, firms' owners prefer M-form to U-form as they can enjoy greater discretion in terms of profit maximization. Though MM regime is a Nash equilibrium, but not the Pareto optimum. If both firms have the symmetric organization, then $\Pi_i^{MM} < \Pi_i^{UU}$ holds (Proposition 2(ii)). The U-form is more efficient than the M-form because the manager of U-form considers the efficiencies of overall product sales and hence internalize the effects of transportation costs in the export sales on the overall profits. Therefore, each owner pursuing rational self-interest chooses M-form instead of U-form as its organization even though both choosing U-form is collectively profitable and socially desirable. Proposition 2 contrasts sharply with Barcena-Ruiz and Espinosa (1999) which shows that, as an internal organization, the U-form organization emerges in equilibrium and is consistent with the firms' collective interests[17].

5. THE CHOICE OF ORGANIZATIONAL FORM WITH ENDOGENOUS FREIGHT RATES

So far, we have considered the case where freight rates for shipping goods are exogenous and symmetric between pairs of countries. We verified that both firms choose M-form organizational structure if freight rates are exogenously given. However, as addressed in the Introduction, freight rates on a given port pair show a significant difference (i.e., asymmetric freight rates) depending on the direction of shipment and one of the most important reasons for this directional imbalance in freight rates is the bilateral trade imbalance between the corresponding countries. To incorporate this, following the setting in **?**, we explicitly include transport sector with market power into the model and assume that the transport firm (firm S) sets the freight rates before the manufacturers' choice of delegation structure. Furthermore, the transport firm (firm S) is assumed to commit to the maximum capacity required for a round trip.

Now, we solve for the subgame for each three possible combinations of organizational forms. We start with the case of an asymmetric organizational form where firm 1 takes an M-form while firm 2 U-form. In this case, the transport firm S sets T_{12} and T_{21} to maximize its profits, that is,

$$\max_{T_{12},T_{21}} \Pi_s(\equiv T_{12}q_{12}^{MA} + T_{21}q_{21}^{UA} - (f + \gamma_s k_s)),$$

where f, γ_s, and k_s are, respectively, the fixed cost, the marginal cost (MC) of operating a means of transport such as vessels, and the capacity, i.e., $\max[q_{ij}, q_{ji}] = k_s$.

In the following analysis, we proceed with the analysis by assuming $q_{12}^{MA} \geq q_{21}^{UA}$ to reflect Proposition 1(i)[18]. Then, we have $\Pi_s \equiv (T_{12} - \gamma_s)q_{12}^{MA} + T_{21}q_{21}^{UA} - f$, where q_{12}^{MA} and q_{21}^{UA} are given in Tables A1 and A2 of Appendix A. To maximize

[17] This is because Barcena-Ruiz and Espinosa (1999) focus on the role of demand externalities between the different products by assuming multiproduct firm. In Barcena-Ruiz and Espinosa (1999), with substitute products, being a U firm provides incentives for a higher price (i.e., less aggressive behavior) than being an M firm, since managers in the U-form internalize the demand externalites arising among the different products. The interaction in terms of price competition with the rival firm of U-form organization results in lower sales and higher prices and profits. As a result, the U firm ends up earning higher profits than the M frim, which, in turn, coincide with firms' collective interests.

[18] For exogenous and symmetric freight rates, $q_{12}^{MA} \geq q_{21}^{UA}$ holds (see Proposition 1(i)).

its profits, firm S sets (Notation '$\sim$' represents equilibrium values of the above maximization problem and $\Delta_a \equiv 8 - 7d^2 + d^4 > 0$).

$$\tilde{T}_{12} = \frac{1}{2}\gamma_s + \frac{(1-d)(8+4d-3d^2-d^3)}{2\Delta_a},$$
$$\tilde{T}_{21} = \frac{(1-d)(2-d^2)(16+8d-12d^2-5d^2+d^4)}{2(4-3d^2)\Delta_a}.$$

However, by substituting $\tilde{T}_{12}$ and $\tilde{T}_{21}$ into q_{12}^{MA} and q_{21}^{UA} (Appendix A), we find that $q_{21}^{UA}[\tilde{T}_{12}, \tilde{T}_{21}] > q_{12}^{MA}[\tilde{T}_{12}, \tilde{T}_{21}]$[19], which is inconsistent with the assumption: $q_{12}^{MA} \geq q_{21}^{UA}$. Similarly, in the analysis assuming $q_{12}^{MA} < q_{21}^{UA}$, the resulting equilibrium value is also inconsistent with the assumption. In this context, firm S maximizes its profits subject to $q_{12}^{MA} = q_{21}^{UA}$, that is,

$$\max_{T_{12}, T_{21}} \Pi_s \left(\equiv T_{12} q_{12}^{MA}(T_{12}, T_{21}) + T_{21} q_{21}^{UA}(T_{12}, T_{21}) - (f + \gamma_s k_s) \right)$$
$$s.t. \quad q_{12}^{MA} = q_{21}^{UA} \Leftrightarrow T_{12} = T_{21} \frac{(4-3d^2)(8+4d-3d^2-d^3)}{(2-d^2)(16+8d-12d^2-5d^3+d^4)}$$

Then, we obtain the following equilibrium freight rate[20]:

$$T_{12}^{MA*} = (8+4d-3d^2-d^3)\left[\frac{1-d}{2\Delta_a} + \frac{4-3d^2}{2\Phi}\gamma_s\right], \tag{14}$$
$$T_{21}^{UA*} = \frac{(2-d^2)(16+8d-12d^2-5d^3+d^4)}{2}\left[\frac{1-d}{(4-3d^2)\Delta_a} + \frac{1}{\Phi}\gamma_s\right], \tag{15}$$

where $\Phi = 64 + 32d - 76d^2 - 34d^3 + 26d^4 + 8d^5 - d^6 > 0$. In order to ensure positive quantities in all organizational forms, we assume that the marginal cost of the transport firm is sufficiently small.

Assumption B. $\gamma_s < \Omega \equiv \frac{4(1-d)(2+d)(2-d^2)}{\Delta_a}$.

The following lemma is immediate from Eqs. (14) and (15) (superscript '$*$' denotes the equilibrium with endogenous freight rates).

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[19]We find $q_{21}^{UA}[\tilde{T}_{12}, \tilde{T}_{21}] - q_{12}^{MA}[\tilde{T}_{12}, \tilde{T}_{21}] = \frac{(16+8d-12d^2-5d^3+d^4)\gamma_s}{16(1-d^2)(4+2d-d^2)} > 0$, where $q_{21}^{UA}[\tilde{T}_{12}, \tilde{T}_{21}] = \frac{(2-d^2)[8(1-d)(4+2d-d^2)-(32-24d^2+d^4)\gamma_s]}{16(1-d^2)(16-12d+d^4)}$ and $q_{12}^{MA}[\tilde{T}_{12}, \tilde{T}_{21}] = \frac{8(2-d^2)(1-d)(4+2d-d^2)-d^3(4-3d^2)\gamma_s}{16(1-d^2)(16-12d+d^4)}$.

[20]$T_{12}^{MA*} - T_{21}^{UA*} = \frac{d^2(4+2d-5d^2-d^3+d^4)}{2(8-7d^2+d^4)(4-3d^2)\Phi}[(1-d)\Phi + (4-3d^2)(8-7d^2+d^4)\gamma_s] > 0$.

Lemma 3. *Suppose that a transport firm commits to a shipping capacity sufficient for a round trip with possible imbalance of shipping volumes in two directions and that only one firm takes M-form organization. In this case, transport firm S with a monopoly position charges the M-form firm a higher freight rates than the U-form firm, i.e.,* $T_{12}^{MA*} > T_{21}^{UA*}$ *such that* $q_{12}^{MA*} = q_{21}^{UA*}$ *holds.*

Proof. $T_{12}^{MA*} - T_{21}^{UA*} = \frac{d^2(4+2d-5d^2-d^3+d^4)}{2(8-7d^2+d^4)(4-3d^2)\Phi}[(1-d)\Phi+(4-3d^2)(8-7d^2+d^4)\gamma_s] > 0$. □

The above lemma is straightforward. As in Proposition 1(i), if freight rates are exogenous and symmetric, then $q_{12}^{MA} > q_{21}^{UA}$, implying that the export volume from country 1 to country 2 is greater than that in the opposite direction. A bilateral trade imbalance implies an underutilization of the available capacity that carriers have allocated to both bilateral transport markets, which leads to an increase in trade costs on a given round trip (the backhaul problem). Since the two markets are identical in our model, the demand gap between the two countries for the import cargo, which is caused by the difference in the firms' organizational structure, is relatively small. Firm S adjusts the freight rates (i.e., it charges a relatively higher freight rates for the export of M-form than for the export of U-form) to fill up the empty backhauls.

Using T_{12}^{MA*} and T_{21}^{UA*}, we can obtain equilibrium values of market variables when freight rates are determined endogenously (see Table A3 of Appendix B). From Equilibrium outcomes in Table A3 in Appendix B, we obtain the following Lemma 4.

Lemma 4. *Suppose only one firm takes M-form organization. With endogenous determination of freight rates, the following relationship holds: (i)* $q_{ii}^{UA*} > q_{ii}^{MA*}$*, (ii)* $Q_i^{UA*} > Q_i^{MA*}$.

Proof. From equilibrium outcomes in Table A3,
we have: $q_{ii}^{UA*} - q_{ii}^{MA*} = \frac{d^2(1+d)(2-d^2)[(1-d)\Phi+(4-3d^2)\Delta_a\gamma_s]}{2(4-3d^2)\Delta_a\Phi} > 0$. In addition, $Q_i^{UA*}(\equiv q_{ii}^{UA*} + q_{ij}^{UA*})$ is greater than $Q_i^{MA*}(\equiv q_{ii}^{MA*} + q_{ij}^{MA*})$ because $q_{ij}^{MA*} = q_{ij}^{UA*}$ in Lemma 3. □

Lemma 4 implies that even in the case of endogenous freight rates, as in the case of exogenous ones, domestic supply by U-form is greater than that by the M-form ($q_{ii}^{UA*} > q_{ii}^{MA*}$). Unlike exogenous freight rates, the total output by the U-form is greater than that by the M-form. Since transport firm adjusts freight rates to realize full load in both directions, so the total output of U-form firm with more domestic supply is greater than that of M-form firm, i.e., $Q_i^{UA*} > Q_i^{MA*}$.

However, $Q_i^{UA*} > Q_i^{MA*}$ does not lead to $\Pi_i^{UA*} > \Pi_i^{MA*}$. When freight rates are set by monopolistic transport firm, M-form would face higher freight rates than U-form (i.e., $T_{12}^{MA*} > T_{21}^{UA*}$), making M-form disadvantageous in terms of cost. And this cost disadvantage is greater as the marginal cost of the transport firm increases. Therefore, if the latter is large enough (i.e., γ_s is large), then the firm's profit in the U-form is larger than that in the M-form.

Next, we turn to the case where both firms take the symmetric organizational form, i.e., both M-form or both U-form. Using the same procedure as before, we can obtain the equilibrium freight rates under the MM (both M-form firms) regime or under the UU (both U-form firms) regime as follows:

$$T^{MM*} = \frac{1}{4}\gamma_s + \frac{(1-d)(4+2d-d^2)}{2(4-3d^2)} > \frac{1}{4}\gamma_s + \frac{(1-d)(2+d)(2-d^2)}{8-7d^2+d^4} = T^{UU*}, \tag{16}$$

where $T^{MM*}(= T_{12}^{MM*} = T_{21}^{MM*})$ (resp. T^{UU*}) denotes optimal freight rates set by transport firm S under the MM (resp. UU) organizational structure when shipping is constrained by the capacity.

In Eq. (16), $T^{MM*} > T^{UU*}$ can be explained as follows. If freight rates are exogenous and symmetry, then it holds from Proposition 1(i) that $q_{ij}^{UU} < q_{ij}^{MM}$, implying that the demand for import cargo is greater under the MM regime than under the UU regime. This, in turn, implies that the demand for import cargo is more elastic under the UU regime than under the MM regime. Considering that firm's price-cost margin is inversely related to the firm's price elasticity of demand, a transport firm S would charge M-form firms higher freight rates for shipping goods compared to U-form firms ($T^{MM*} > T^{UU*}$). Using T^{MM*} and T^{UU*}, we can obtain equilibrium values of market variables with endogenous freight rates when both firms are organized either in M-form or in U-form together (see Table A4 of Appendix B).

By comparing the equilibrium outcomes for each possible organizational forms given in equations of Tables A3 and A4 in Appendix B, we obtain the following Proposition with respect to output rankings:

Proposition 3. *Suppose that the freight rates for shipping goods across the two bilateral transport markets are determined endogenously. Then, the following inequalities hold:*
(i) $q_{ii}^{MM*} < q_{ii}^{MA*} < q_{ii}^{UA*} < q_{ii}^{UU*}$ *(ii)* $q_{ij}^{UU*} < q_{ij}^{UA*} = q_{ij}^{MA*} < q_{ij}^{MM*}$,

(iii) $Q_i^{MA*} < Q_i^{MM*} < Q_i^{UU*} < Q_i^{UA*}$

Proof. See Appendix C. □

Proposition 3(i) indicates that the ranking with respect to firm's domestic supply in the endogenous freight rates is the same as that in the exogenous freight rates (see Proposition 1(i)). The ranking with respect to firms' overseas supply in the endogenous freight rates is also the same as that in the exogenous freight rates except for $q_{ij}^{UA*} = q_{ij}^{MA*}$. However, the ranking of firm's total output under the endogenous freight rates is quite different from that under the exogenous freight rates. With endogenous freight rates, the firm with M-form organization faces higher freight rates than the U-form firm, making M-form be in a disadvantageous position in terms of cost. Since this is true for both symmetric and asymmetric organizational forms between firms (i.e., $T^{UU*} < T^{MM*}$ and $T^{UA*} < T^{MA*}$), resulting in $Q_i^{MM*} < Q_i^{UU*}$ and $Q_i^{MA*} < Q_i^{UA*}$. In addition, rival firm's organizational form also affects firm's total output. Given the organizational form of firm i, a change in organization form U to M of the rival firm makes firm increase the domestic supply and decrease the overseas supply. The increase in domestic supply exceeds the decrease in overseas supply, resulting in $Q_i^{MA*} < Q_i^{MM*}$ and $Q_i^{UU*} < Q_i^{UA*}$.

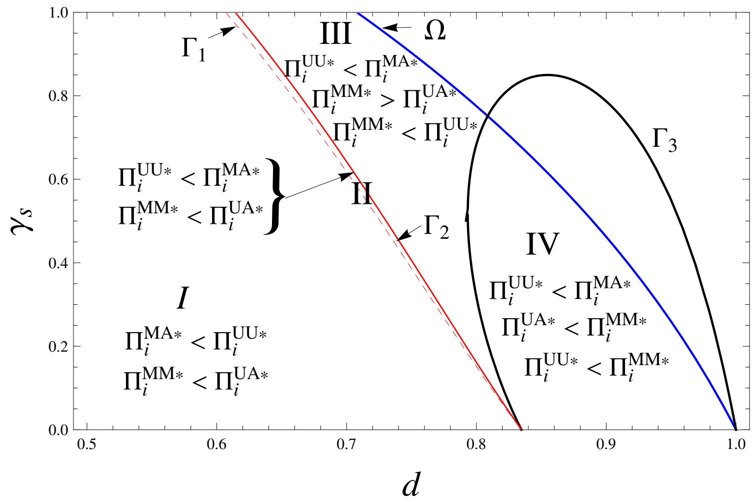
Comparing firm's profit, we obtain the following results:

$$\begin{cases} \Pi_i^{MA*} - \Pi_i^{UU*} \gtreqless 0 \Leftrightarrow \Gamma_1(d, \gamma_s) \gtreqless 0, \\ \Pi_i^{MM*} - \Pi_i^{UA*} \gtreqless 0 \Leftrightarrow \Gamma_2(d, \gamma_s) \gtreqless 0, \\ \Pi_i^{UU*} - \Pi_i^{MM*} \gtreqless 0 \Leftrightarrow \Gamma_3(d, \gamma_s) \gtreqless 0, \end{cases} \tag{17}$$

Figure 2. Endogenous Organizational Form

where Γ_1, Γ_2 and Γ_3 are the complicated functions of d and γ_s (see Appendix D). Figure 2 illustrates Γ_1, Γ_2, Γ_3 and Ω on the space of d and γ_s. Since the curve Ω represents the domain of (d, γ_s) ensuring positive output in the endogenous freightrates (see Assumption B), the domain (d, γ_s) is divided into four regions by curves Γ_1, Γ_2 and Γ_3; regions I, II, III, and IV.

Now, using Figure 2, we can examine firms' choice of internal organization, the first stage of the game, when freight rates are determined endogenously by the transport firm with market power. For the owners of two manufacturers, it is the dominant strategy to choose U-form (resp. M-form) organization if (d, γ_s) combination belongs to region I (resp. regions III and IV), where $\Pi_i^{MA*} < \Pi_i^{UU*}$



and $\Pi_i^{UA*} > \Pi_i^{MM*}$ (resp. $\Pi_i^{MA*} > \Pi_i^{UU*}$ and $\Pi_i^{UA*} > \Pi_i^{MM*}$) hold. On the other hand, since $\Pi_i^{MA*} > \Pi_i^{UU*}$ and $\Pi_i^{UA*} > \Pi_i^{MM*}$ hold in region II, asymmetric organizational form (i.e., only one firm adopts M-form) emerges at equilibrium if (d,γ_s) falls into this area. However, since region II is very small, the possibility of an asymmetric organizational form is negligible. More importantly, if the combination(d,γ_s) belongs to region III, where both firms choose M-form, prisoners' dilemma situation occurs. That is, firms 1 and 2 are both better off if they choose U-form instead of M-form (i.e., $\Pi_i^{UU*} > \Pi_i^{MM*}$).

We summarize these findings in Proposition 4.

Proposition 4. *Suppose that the freight rates for shipping goods are determined endogenously. Because of the curves Γ_1, Γ_2 and Γ_3, the domain of (d,γ_s) in Figure 2 is divided into four regions; regions I, II, III and IV.*
(i) Given γ_s, if d is sufficiently low (resp. high), i.e., the combination (d,γ_s) is in region I (resp. III and IV), then firms 1 and 2 both choose U-form (resp. M-form).
(ii) If d is intermediate level given γ_s, i.e., (d,γ_s) is in region II, then asymmetric organizational form between firms is Nash equilibrium.
(iii) If (d,γ_s) belongs to region III, then the prisoner's dilemma situation arises, implying that firms 1 and 2 are both better off if they choose U-form instead of M-form .
(iv) $SW_i^{MM*} < SW_i^{UU*}$.

Proof. Proposition 4 (i), (ii), and (iii) are obvious from the above discussion. For proof of Proposition 4 (iv), see Appendix D. □

The following economic intuitions can be given to the above proposition. If freight rates are given exogenously, firms' owners prefer M-form to U-form as its organizational form irrespective of rival's organization because the former gives more discretion with respect to firms' profit maximization behavior (see Proposition 2(i)).

When freight rates are endogenously determined, there are two factors operating in opposite directions in the choice of firms' organizational form by the owners. The first is the difference in freight rates for shipping goods depending on firm's organizational form. As shown in Eqs. (14) and (15), firm's owner can achieve lower freight costs by choosing U-form instead of M-form (i.e., freight costs reducing effect of U-from). The second is the profitability performance of M-form. Other things being equal, firms organized using M-form should be more profitable than firms organized using U-form because M-form organization gives firm's owner more discretionary power than the U-form with respect to firm's profit maximization behavior (i.e., profit enhancing effect of M-form).

Competitive pressures also come from substitute products. Considering this, the higher the substitutability between products (i.e., an increase in d), the greater the profitability performance of M-form compared to U-form. Therefore, if d is sufficiently low (resp. high) given γ_s, i.e., (d, γ_s) belongs to region I (resp. regions III and IV), then the former effect outweighs (resp. falls short of) the latter, resulting in both firms choosing U-form (resp. M-form). On the other hand, given γ_s if d is intermediate level, i.e., (d, γ_s) belongs to region II, then rival firm's organizational form matters in choosing own organizational form. If the rival firm is in M-form (resp. U-form), then the former (i.e., freight cost reducing effects of the U-form) dominates (resp. falls short of) the latter (i.e., profit enhancing effect of M-form), resulting in firm's choosing U-form (resp. M-form) as its organization.

More importantly, with endogenous freight rates, the prisoners' dilemma occurs in region III where γ_s is relatively high. In this region, MM regime (both firms choose M-form) is a Nash equilibrium but is not necessarily Pareto optimum. That is, firms 1 and 2 are both better off if they choose U-form organization instead of M-form when γ_s is relatively high. Intuitively, this can be explained as follows. As can be seen in Eq. (15), freight rates are an increasing functions in marginal cost of the transport firm. At low marginal cost (i.e., low level in γ_s), the profits of both symmetric manufacturers are high, so the role of carrier's marginal cost in the change of manufacturer's profit is relatively small, and vice versa. Therefore, if (d,γ_s) belongs to region III, where γ_s is relatively high, it is important for the owners to achieve efficiency in choosing firm's internal organization because the role of marginal cost in the change in firm's profits is relatively high. U-form is superior to M-form in terms of efficiency. This is because the manager of the U-form organization internalizes the impact of rising in the transport costs at the corporate level, whereas in the M-form organization, where decisions are made independently by each division unit, only the export division responds. Therefore, in region III, firms 1 and 2 are both better off if they choose U-form instead of M-form, since $T^{MM*} > T^{UU*}$ and γ_s is high.

Lastly, confining to symmetrical organization structure between firms, we look at the welfare implication of the owner's choice of organizational form when the freight rates are determined endogenously. Note that $SW_i^{UU*} > SW_i^{MM*}$ holds for all domain of (d,γ_s). Therefore, in region I where both firms choose U-form in equilibrium, each owner's behavior pursing rational self-interest is consistent with both collective and social interests. In regions III and IV, where both firms choose M-form organization, owner's behavior based on private incentive is inconsistent with social interests. In particular, in region III where prisoners' dilemma situation occurs, private incentive of firm's owner is in conflict with both collective and social interests.

6. CONCLUDING REMARKS

In this paper, focusing on the asymmetric transport costs associated with backhaul problem, we have examined firms' choice of internal organization. We specifically introduce transport sector with market power into the standard two-country reciprocal trade model, and assume that the transport firm needs to commit to shipping capacity required for a round trip. We have theoretically shown that the endogeneity of maritime transport costs does matter in determining firms' optimal organizational form. In particular, diverse types of firms' organizational forms can arise when the freight rates are asymmetric between pairwise directions of shipments. That is, if the freight rates for shipping goods are exogenous and symmetric between the two regions, then choosing the M-form organization is the dominant strategy for both firms although both choosing the U-form is collectively profitable (i.e., prisoners' dilemma) and socially desirable. If the freight rates are determined endogenously, however, different types of organizational structure such as both M-forms, both U-forms, and only one firm M-form may arise depending on the parameter values on product substitutability and cost condition of carrier. Even in the case of endogenous freight rates, a prisoners' dilemma situation might occur if marginal cost of transport firm is relatively high (i.e., high freight rates) and firms both choose M-form organization.

Our analysis contributes to a better understanding of the impact of endogenous determination of freight rates on firms' optimal organizational form in two-country reciprocal trade model. Furthermore, out analysis suggests that research on trade and trade-related policies in oligopolistic setting should be reexamined theoretically, taking into account the impact of "backhaul" on freight rates and its interaction with firms' organizational structure. Nevertheless, the conclusions of our paper rely heavily on critical assumptions to keep the model as simple and transparent as possible, including linear demand function, symmetric countries in terms of market size, ignorance of demand externalities among different products, a fixed number of firms, and exclusion of trade-related polices. Therefore, it is desirable that the extension of the study proceeds in the direction of relaxing the above-mentioned constraints. Especially the following two points are noteworthy as directions for extension.

First, the two countries in our model are assumed to be symmetric, so the impact of market size on the firms' optimal organizational decision is simply disregarded in the analysis. As is well known, imbalances in trade flows affect freight rates, because (some) carriers have to return without cargo from the low-demand region to the high-demand region. By introducing the market size into the model, we can include the issue of backhaul problem in firm's decision on organization form in a more explicit way. Another extension would be to examine whether our results are robust when incorporating import tariffs into the model with asymmetric transportation costs. Extension by introducing import tariffs provides implications for the effectiveness of tariff liberalization, because it might change the freight rates set by transport firm with market power. Finally, given that an efficient tax system has not been set up yet in many developing countries, tariff revenues will play a significant role in national budgets. Therefore, the tariff rate may be determined through revenue maximization (e.g. Collie, 1991; Clarke and Collie, 2006; Collie, 2020). The extension of our model in these directions remains on the agenda for future research.

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APPENDIX A

Notations	$\Delta_a = 8 - 7d^2 + d^4, \Delta_b = 4 + 2d - d^2$ $\Phi = 64 + 32d - 76d^2 - 34d^3 + 26d^4 + 8d^5 - d^6$

Table A1: Market Equilibrium under Symmetric Organizational Structure

$$\theta_i^{UU} = \frac{-d^2[(1-d)\Delta_b-(4-3d^2)T_{ij}+d(2-d^2)T_{ji}]}{2(16-12d^2+d^4)}$$
$$q_{ii}^{UU} = \frac{2(1-d)(4-d^2)(2-d^2)\Delta_b-2d^2(2-d^2)^2T_{ij}-d(32-32d^2+9d^4-d^6)T_{ji}}{2(16-12d^2+d^4)(4-5d^2+d^4)}$$
$$q_{ij}^{UU} = \frac{2(1-d)(4-d^2)(2-d^2)\Delta_b-4(2-d^2)\Phi T_{ij}-d^3\Delta_a T_{ji}}{2(16-12d^2+d^4)(4-5d^2+d^4)}$$
$$\Pi_i^{UU} = \frac{d^2(1-d^2)}{2-d^2}\left[(q_{ii}^{UU})^2+(q_{ij}^{UU})^2-\frac{d^2}{4}\left(q_{ii}^{UU}-q_{ij}^{UU}\right)^2\right]$$
$$SW_i^{UU} = \frac{W_1-4(2-d)(1-d)(2+d)^2(2-d^2)\Delta_b(W_2T_{ij}+W_3T_{ji})+W_4T_{ij}^2+W_5T_{ji}^2}{8(2-d)^2(1-d^2)(2+d)^2(16-12d^2+d^4)^2}$$

$$q_{ii}^{MM} = \frac{(2-d^2)[(1-d)\Delta_b+d(2-d^2)T_{ji}]}{(1-d^2)(16-12d^2+d^4)}$$
$$q_{ij}^{MM} = \frac{(2-d^2)[(1-d)\Delta_b-(4-3d^2)T_{ij}]}{2(16-12d^2+d^4)(4-5d^2+d^4)}$$
$$\beta_{ii}^{MM} = \frac{-d^2[(1-d)\Delta_b+d(2-d^2)T_{ji}]}{16-12d^2+d^4}$$
$$\beta_{ij}^{MM} = \frac{-d^2[(1-d)\Delta_b-(4-3d^2)T_{ij}]}{16-12d^2+d^4}$$
$$\Pi_i^{MM} = \frac{d^2(1-d^2)}{2-d^2}[(q_{ii}^{MM})^2+(q_{ij}^{MM})^2]$$
$$SW_i^{MM} = \frac{(2-d^2)[W_6-W_7T_{ij}-W_8T_{ji}+4(4-3d^2)^2T_{ij}^2+W_9T_{ji}^2]}{2(1-d^2)(16-12d^2+d^4)^2}$$

Table A2: Market Equilibrium under Asymmetric Organizational Structure

$$\beta_{ii}^{MA} = \frac{-d^2[8(1-d)(2-d^2)\Delta_b+d^4(2-d^2)T_{ij}+d(32-28d^2+5d^4)T_{ji}]}{8(2-d^2)(16-12d^2+d^4)}$$
$$\beta_{ij}^{MA} = \frac{-d^2[8(1-d)(2-d^2)\Delta_b-(2-d^2)(32-24d^2+d^4)T_{ij}+d^3(4-3d^2)T_{ji}]}{8(2-d^2)(16-12d^2+d^4)}$$
$$q_{ii}^{MA} = \frac{8(1-d)(2-d^2)\Delta_b-d^4(2-d^2)T_{ij}-d(4-d^2)(8-5d^2)T_{ji}]}{8(1-d^2)(16-12d^2+d^4)}$$
$$q_{ij}^{MA} = \frac{8(1-d)(2-d^2)\Delta_b-(2-d^2)(32-24d^2+d^4)T_{ij}-d^3(4-3d^2)T_{ji}]}{8(1-d^2)(16-12d^2+d^4)}$$
$$\Pi_i^{MA} = \frac{d^2(1-d^2)}{2-d^2}[(q_{ii}^{MA})^2+(q_{ij}^{MA})^2]$$
$$SW_i^{MA} = \frac{S_1-S_2T_{ij}+S_3T_{ij}^2-(2-d^2)(S_5T_{ij}+S_5T_{ji})+S_6T_{ji}^2}{128(1-d^2)(2-d^2)^2(16-12d^2+d^4)^2}$$

$$\theta_j^{UA} = \frac{-d^2[2(1-d)\Delta_b+d(2-d^2)T_{ij}-(4-3d^2)T_{ji}]}{2(16-12d^2+d^4)}$$
$$q_{jj}^{UA} = \frac{8(1-d)(2-d^2)\Delta_b-(2-d^2)(32-24d^2+d^4)T_{ij}-d^3(4-3d^2)T_{ji}}{8(1-d^2)(2-d^2)(16-12d^2+d^4)},$$
$$q_{ji}^{UA} = \frac{8(1-d)(2-d^2)\Delta_b-d^3(2-d^2)(4-3d^2)T_{ij}-d(4-d^2)(4-3d^2)(8-5d^2)T_{ji}}{8(1-d^2)(16-12d^2+d^4)},$$
$$\Pi_i^{UA} = \frac{d^2(1-d^2)}{2-d^2}\left[(q_{jj}^{UA})^2+(q_{ji}^{UA})^2-\frac{d^2}{4}\left(q_{jj}^{UA}-q_{ji}^{UA}\right)^2\right]$$
$$SW_j^{UA} = \frac{S_1-S_2T_{ij}+S_7T_{ij}^2-(S_8+S_9T_{ij})T_{ji}+S_{10}T_{ji}^2}{128(1-d^2)(2-d^2)^2(16-12d^2+d^4)^2}$$

$$W_1 = 8\Delta_b^2(4-d^2)^2(1-d)(2-d^2)(6-4d-d^2)$$
$$W_2 = 64-32d-52d^2+26d^3+3d^4-d^5$$
$$W_3 = 32-32d-12d^2+18d^3-3d^4-d^5$$
$$W_4 = 8192-20480d^2+19776d^4-9216d^6+2112d^8-215d^{10}+7d^{12}$$

$W_5 = 4096-8192d^2+6208d^4-2240d^6+384d^8-19d^{10}-d^{12}$
$W_6 = 2\Delta_b^2(1+d)(6-4d-d^2)$
$W_7 = 8\Delta_b(1-d)(4-3d^2)$
$W_8 = 2(1-d)(2-d^2)(16-12d^2+d^4)$
$W_9 = (2-d^2)(16-12d^2+d^4)$
$S_1 = 128\Delta_b^2(1-d)(2-d^2)^3(6-4d-d^2)$
$S_2 = 16\Delta_b(1-d)(2-d^2)^3(128-96d^2+4d^3+2d^4-d^5)$,
$S_3 = 4\Delta_b(2-d)(1-d)(2+d)^2(2-d^2)$
$S_4 = 8192-20480d^2+19776d^4-9216d^6+2112d^8-215d^{10}+7d^{12}$
$S_5 = 2d^3(1536-2880d^2+1824d^4-416d^6+17d^8)$
$S_6 = 16384-40960d^2+40192d^4-19392d^6+4608d^8-412d^{10}-11d^{12}$
$S_7 = (2-d^2)^2(4096-7168d^2+4352d^4-1072d^6+108d^8-7d^{10})$
$S_8 = 16\Delta_b(1-d)(2-d^2)^2(4-3d^2)(64-36d^2-2d^3+d^4)$,
$S_9 = 2d^5(2-d^2)(4-3d^2)(48-28d^2-d^4)$
$S_{10} = (4-d^2)^2(2048-3072d^2+1488d^4-244d^6+9d^8)$

Proof of Lemma 1
From equilibrium outcomes in Table A2 with $T = T_{12} = T_{21}$, we obtain that

$$\beta_{ij}^{MA}-\theta_i^{UA} = \theta_i^{UA}-\beta_{ii}^{MA} = \frac{(2-d)d^2(1+d)T}{8(2-d^2)} > 0,\ Q_i^{MA}-Q_i^{UA} = 0,$$
$$q_{ii}^{UA}-q_{ii}^{MA} = q_{ij}^{MA}-q_{ji}^{UA} = \frac{d^2T}{8(2-d^2)} > 0,\ q_{ii}^{MA}-q_{ij}^{UA} = \frac{(2-d)T}{4(1-d)} > 0,$$
$$\Pi_i^{MA}-\Pi_i^{UA} = \frac{d^3(1+d)(4-3d)T^2}{32(1-d)(2-d^2)^2} > 0. \quad \square$$

Proof of Proposition 1
From equations in Appendix A with $T = T_{12} = T_{21}$, we have

$$q_{ii}^{UU}-q_{ii}^{UA} = q_{ii}^{MA}-q_{ii}^{MM} = \frac{d^3T}{8(1-d)(2+d)(2-d^2)} > 0.$$

Since $q_{ii}^{MA} < q_{ii}^{UA}$ from Lemma 1, this implies $q_{ii}^{MM} < q_{ii}^{MA} < q_{ii}^{UA} < q_{ii}^{UU}$. Since total output is the same irrespective of organizational structure, ranking with regard to domestic supply (i.e., $q_{ii}^{MM} < q_{ii}^{MA} < q_{ii}^{UA} < q_{ii}^{UU}$) leads to $q_{ij}^{UU} < q_{ij}^{UA} < q_i^{MA} < q_{ij}^{MM}$.

With regard to profit ranking, from Appendix A, with have

$$\Pi_i^{MA} - \Pi_i^{UU} = \frac{d^4(1+d)T^2}{16(1-d)(2+d)^2(2-d^2)} > 0,$$
$$\Pi_i^{UU} - \Pi_i^{MM} = \frac{d^3(1+d)(4+3d)T^2}{2(1-d)(2+d)^2\Delta_b^2} > 0,$$
$$\Pi_i^{MM} - \Pi_i^{UA} = \frac{d^4(1+d)(16-8d^2-d^4)T^2}{32(1-d)(2-d^2)^2\Delta_b^2} > 0.$$

Rearranging welfare ranking, we have

$$SW_i^{UU} - SW_i^{MM} = \frac{d^2(1+d)^2(8+4d-d^2)T^2}{4(1-d)(2+d)^2\Delta_b^2} > 0,$$
$$SW_i^{UA} - SW_i^{MA} = \frac{d^2[8(1-d)(2-d^2)^2 - (16-20d^2-2d^3+9d^4-d^5)T]}{32(1-d)(2-d^2)^2\Delta_b^2} > 0.$$

Both are positive within the domain of $T < T^x$. □

APPENDIX B

Table A3: Market Outcomes with Endogenous Freight Rates (Asymmetric Organizational Structure)

$\beta_{ii}^{MA*} = \frac{-d^2[(1-d)(8+2d-6d^2-d^3)\Phi+d(2-d^2)(4-3d^2)\Delta_a\gamma_s]}{2(4-2d-d^2)\Phi}$,
$\beta_{ij}^{MA*} = \frac{-d^2[\Phi+(32-52d^2+25d^4-3d^6)\gamma_s]}{2(4-2d-d^2)\Phi}$,
$\theta_i^{UA*} = \frac{-d^2(1-d)[(12+2d-10d^2-d^3+d^4)\Phi+(2+d)(2-d^2)(4-3d^2)\Delta_a\gamma_s]}{2(4-2d-d^2)\Phi}$,
$q_{ii}^{MA*} = \frac{(2-d^2)[(1-d)(8+2d-6d^2+d^3)\Phi+d(2-d^2)(4-d^2)\Delta_a\gamma_s]}{2(1-d^2)(4-2d-d^2)(4-3d^2)\Phi}$,
$q_{ii}^{UA*} = \frac{(2-d^2)[(1-d)(16+4d-13d^2-2d^3+d^4)\Phi+d(4-3d^2)(4+d-2d^2-d^3)\Delta_a\gamma_s]}{2(1-d^2)(4-2d-d^2)\Delta_a\Phi}$,
$q_{ij}^{MA*} = q_{ij}^{UA*} = \frac{(2-d^2)[(1-d)\Phi-(4-3d^2)\Delta_a\gamma_s]}{2(1-d^2)(4-2d-d^2)\Phi}$
$\Pi_i^{MA*} = \frac{(2-d^2)[A_0(d)\Phi^2-2\gamma_s\Delta_a\Phi(1-d)A_1(d)+\gamma_s^2 A_2(d)]}{2(1-d^2)(4-3d^2)^2(4-2d-d^2)^2\Phi^2}$
$\Pi_i^{UA*} = \frac{(2-d^2)[2B_0(d)\Phi^2-2\gamma_s B_1(d)\Phi(4-3d^2)+\gamma_s^2 B_2(d)(4-3d^2)^2\Delta_a^2(2-d^2)]}{2(1-d^2)(4-2d-d^2)^2\Delta_a^2\Phi^2}$
$A_0(d) = 80+32d-116d^2-40d^3+41d^4+12d^5+d^6$
$A_1(d) = (4-3d^2)(16-16d-28d^2+20d^3+13d^4-6d^5-d^6)$
$A_2(d) = (2-d^2)(32-52d^2+25d^4-3d^6)^2(16-20d^2+5d^4+d^6)$
$B_0(d) = (1-d)^2(320+128d-528d^2-184d^3+270d^4+80d^5-41d^6-10d^7+d^8)$
$B_1(d) = \Delta_a(1-d)(2-d^2)(32-32d-48d^2+32d^3+21d^4-6d^5-3d^6)$
$B_2(d) = 32-40d^2-4d^3+15d^4+2d^5-d^6$

Table A4: Market Outcomes with Endogenous Freight Rates (Symmetric Organizational Structure)

$$q_{ii}^{MM*} = \frac{(2-d^2)[2(1-d)\Delta_b(8+2d-6d^2-d^3)+\gamma_s d(4-3d^2)]}{4(4-3d^2)(1-d^2)(16-12d^2+d^4)}$$

$$q_{ij}^{MM*} = q_{ji}^{MM*} = \frac{(2-d^2)[2(1-d)\Delta_b-\gamma_s(4-3d^2)]}{4(4-3d^2)(16-12d^2+d^4)}$$

$$\beta_{ii}^{MM*} = \frac{-d^2[2(1-d)(4+2d-d^2)(8+2d-6d^2-d^3)+\gamma_s d(2-d^2)(4-3d^2)]}{4(4-3d^2)(16-12d^2+d^4)}$$

$$\beta_{ij}^{MM*} = \frac{-d^2[2(1-d)(4+2d-d^2)-\gamma_s(4-3d^2)]}{4(16-12d^2+d^4)}$$

$$\Pi_i^{MM*} = \frac{4A_0(d)(1-d)^2\Delta_b^2-4\gamma_s A_1(d)(1-d)\Delta_b+\gamma_s^2 A_2(d)}{8(1-d)^2(16-12d^2+d^4)^2}$$

$$q_{ii}^{UU*} = \frac{4(1-d)(2+d)(2-d^2)(16+4d-13d^2-2d^3+d^4)+\gamma_s d(4+d-2d^2-d^3)\Delta_a}{8(1-d^2)(2+d)(4-2d-d^2)\Delta_a},$$

$$q_{ij}^{UU*} = q_{ji}^{UU} = \frac{4(1-d)(2+d)(2-d^2)-\gamma_s\Delta_a}{8(4-2d-d^2)(1-d^2)(2+d)},$$

$$\theta_i^{UU*} = \frac{-d^2(1-d)[4(12+2d-10d^2-d^3+d^4)-\gamma_s\Delta_a]}{8(4-2d-d^2)\Delta_a}$$

$$\Pi_i^{UU*} = \frac{16B_0(d)(2+d)^2(2-d^2)-8\gamma_s B_1(d)+\gamma_s^2\Delta_a^2 B_2(d)}{8(1-d)^2(16-12d^2+d^4)^2}$$

Note: $\Delta_a \equiv 8-7d^2+d^4$ and $\Delta_b \equiv 4+2d-d^2$.

APPENDIX C

Proof of Proposition 3

A straightforward comparison yields the following results

$$q_{ii}^{UU*} - q_{ii}^{UA*} = \frac{d^3(1+d)(4+d-2d^2+d^3)\gamma_s}{8(1-d)(2+d)\Phi} > 0,$$

$$q_{ii}^{UA*} - q_{ii}^{MA*} = \frac{d^2(1+d)(2-d^2)[(1-d)\Phi+(4-3d^2)\Delta_a]\gamma_s}{2(4-3d^2)\Delta_a\Phi} > 0,$$

$$q_{ii}^{MA*} - q_{ii}^{MM*} = \frac{d^3(1+d)(2-d^2)^2\gamma_s}{4(1-d)\Delta_b\Phi} > 0.$$

With respect to the ranking in overseas supply, we get the following relationship from equations in Tables A3 and A4 of Appendix B:

$$q_{ij}^{MM*} - q_{ij}^{MA*} = \frac{\gamma_s d^2(1+d)(2-d^2)(4-3d^2)}{4\Delta_b\Phi(1-d)} > 0,$$

$$q_{ij}^{MA*} - q_{ij}^{UU*} = \frac{\gamma_s d^2(1+d)\Delta_a}{8(1-d)(2+d)\Phi} > 0.$$

Since $q_{ij}^{MA*} = q_{ij}^{UA*}$ in Lemma 3, the relationship in Proposition 3(ii) holds. Regarding total output, we obtain

$$Q_i^{UA*} - Q_i^{UU*} = Q_i^{MM*} - Q_i^{MA*} = \frac{d^2(1+d)(2-d^2)\gamma_s}{4\Phi} < 0.$$

Considering $Q_i^{UU*} > Q_i^{MM*}$ due to $T^{UU*} < T^{MM*}$ in Eq. (16), above relationship leads to Proposition 3 (iii). □

APPENDIX D

On Functions of Γ_1, Γ_2 and Γ_3

$\Gamma_1(d,\gamma_s) = -4(4-2d-3d^2+d^3)^2\alpha_1\Phi^2 + 4(4-2d-3d^2+d^3)(4-3d^2)(8-7d^2+d^4)\times$
$(128-128d-176d^2+272d^3+36d^4-204d^5+35d^6+62d^7-14d^8-6d^9+d^{10})\Phi\gamma_s + (32-52d^2+25d^4-3d^6)^2(2048-1024d-5568d^2+2912d^3+5920d^4-3128d^5-3048d^6+1550d^7+747d^8-334d^9-66d^{10}+20d^{11}-d^{12})\gamma_s^2,$

$\Gamma_2(d,\gamma_s) = -16(2-d-d^2)^2(2-d^2)\alpha_1\Phi^2 + 8(1-d)(2+d)(2-d^2)(4-3d^2)(8-7d^2+d^4)(128-128d-128d^2+224d^3-12d^4-140d^5+37d^6+38d^7-7d^8-4d^9)\Phi\gamma_s + (32-52d^2+25d^4-3d^6)^2(4096-2048d-10880d^2+4672d^3+11584d^4-3968d^5-6252d^6+1546d^7+1775d^8-280d^9-250d^{10}+22d^{11}+15d^{12})\gamma_s^2,$

$\Gamma_3(d,\gamma_s) = 16(2-d^2)(8-8d^2-d^3+d^4)^2\alpha_1 - (1-d)(4+2d-d^2)(4-3d^2)(8-6d^2+d^4)(8-7d^2+d^4)(8-4d-8d^2+3d^3+2d^4)\gamma_s + d(4+3d)(4+2d-d^2)(32-52d^2+25d^4-3d^6)\gamma_s^2,$

where $\Phi = 64+32d-76d^2-34d^3+23d^4+8d^5-d^6 > 0$, and
$\alpha_1 = 64-64d-124d^2+114d^3+75d^4-60d^5-15d^6+8d^7+d^8$.

Proof of Proposition 4

From equilibrium outcomes, we obtain
$SW_i^{MM*} = \frac{(2-d^2)[C_0(d)-\gamma_s C_1(d)+\gamma_s^2 C_2(d)]}{32(1-d^2)(64-96d^2+40d^4-3d^6)^2}$, $\quad SW_i^{UU*} = \frac{D_0(d)-\gamma_s D_1(d)+\gamma_s^2 D_2(d)}{64(1-d^2)(2+d)^2(4-2d-d^2)^2\Delta_a^2}$;
$C_0(d) = 4(4-2d-d^2)^2(1-d)\alpha_2$, $\quad D_0(d) = 16(1-d)(2+d)^2(2-d^2)\alpha_3$,
$C_1(d) = 4(1-d)(4-2d-d^2)(4-3d^2)(96-32d-152d^2+40d^3+66d^4-12d^5-5d^6)$,
$C_2(d) = 4\alpha_2(4-2d-d^2)^2(1-d) + (4-3d^2)^2(96-136d^2+50d^4-d^6)$,

$D_1(d) = 8(1-d)(2+d)(2-d^2)\Delta_a(96-32d-136d^2+24d^3+57d^4+d^5-7d^6-d^7)$,
$D_2(d) = \Delta_a^2(96+128d^2+12d^3-51d^4-9d^5+5d^6+d^7)$,
where $\alpha_2 = 480-160d-904d^2+248d^3+522d^4-82d^5-85d^6-11d^7$, and
$\alpha_3 = 960-320d-1984d^2+568d^3+1414d^4-296d^5-407d^6+38d^7+44d^8-d^{10}$.

A straightforward comparison yields the following results

$$SW_i^{MM*} - SW_i^{UU*} = \frac{-d^2(1+d)[E_0(d)(2+d)^2(2-d^2)-\gamma_s E_1(d)+\gamma_s^2 E_2(d)]}{64\Delta_a^2\Delta_b^2(1-d)(2+d)^2(4-2d-d^2)(4-d^2)^2} < 0,$$

$E_0(d) = 8(1-d)^2\Delta_b^2(512-320d-968d^2+540d^3+606d^4-270d^5-141d^6+34d^7+11d^8)$,
$E_1(d) = 8\Delta_a(1-d)(4-d^2)(2-d^2)\Delta_b(4-3d^2)(8-4d-8d^2+3d^3+2d^4)$,
$E_2(d) = (1+d)(8+4d-d^2)(4-2d-d^2)(4-3d^2)^2\Delta_a^2$. □

APPENDIX E

Here, we consider the case where firms compete in terms of quantity (i.e., Cournot competition). When freight rates are exogenous, it is quite straightforward that choosing M-form organization for both firms is the dominant strategy. The intuition is the same as in the case of Bertrand competition. It is better for the owner of firm to choose M-form rather than the U-form because the former, M-form, gives greater discretionary power with respect to profit maximization. Therefore, as in Bertrand case, MM regime is the Nash equilibrium organization in the Cournot competition.

Furthermore, it holds in the Cournot competition that $\hat{\Pi}_i^{MM} > \hat{\Pi}_i^{UU}$ (Notation '$\wedge$' represents the equilibrium in the Cournot competition). This is related to the incentive contracts between firm's owner and managers. In Cournot competition, firm's owner in the M-form makes incentive contracts that induce manager for the export sales to behave more aggressively and manager for the domestic sales to behave less aggressively compared with the U-form. Consequently, M-form firm, compared with U-form firm, tends to supply more products to the domestic market and less to the overseas market that requires transport costs, which leads to $\hat{\Pi}_i^{MM} > \hat{\Pi}_i^{UU}$ due to the production efficiency in the M-form.

We now examine the case where freight rates are determined endogenously by the transport sector. When firms compete in quantities (à la Cournot), we can obtain the optimal freight rates under each organizational structure as follows:

$$\hat{T}^{MM} = \frac{1}{4}\gamma_s + \frac{4-2d-d^2}{2(4-d^2)},\ \hat{T}^{UU} = \frac{1}{4}\gamma_s + \frac{2(2-d)}{8-d^2},$$
$$\hat{T}_{ij}^{MA} = \frac{8-4d-d^2}{2(8-d^2)} + \frac{(4-d^2)(8-4d-d^2)}{2(64-32d-20+6d^3+d^4)}\gamma_s,$$
$$\hat{T}_{ij}^{UA} = \frac{16-8d-4d^2+d^3}{32-12d^2+d^4} + \frac{16-8d-4d^2+d^3}{64-32d-20d^2+6d^3+d^4}\gamma_s$$

In above equations, we find that (i) $\hat{T}^{MM} < \hat{T}_{ij}^{UA}$, and $\hat{T}_{ij}^{MA} < \hat{T}^{UU}$, (ii) $\hat{T}^{MM} < \hat{T}^{UU}$ hold, irrespective of the values of d and γ_s. Part (i) indicates that given the organizational structure of the other manufacturer, the transport firm S with monopoly power charges the M-form firm a lower freight rates than the U-form firm. This means that, compared to the case of exogenous freight rates, where choosing the M-form organization is the dominant strategy, each firm has a stronger motivation to choose the M-form organization as its dominant strategy even in the case of endogenous freight rates. Part (ii) reflects the fact that the demand for the import cargo is greater under the UU-regime than under the MM-regime in the Cournot competition when freight rates are exogenous.

Using the equilibrium values on freight rates given above, we can obtain equilibrium values of firm i's profits, for $i \in \{1,2\}$ and $R \in \{MM, UU, MA, UA\}$ a as in Table A5.

Table A5: Equilibrium Quantity and Profits of Firm in Cournot Competition

$$\hat{q}_{ii}^{MM} = \frac{2(4+d-d^2)(4-2d-d^2)+d(4-d^2)\gamma_s}{(4-d^2)(16-12d^2+d^4)},\ \hat{q}_{ij}^{MM} = \frac{2(4-2d-d^2)-d(4-d^2)\gamma_s}{2(16-12d^2+d^4)}$$
$$\hat{q}_{ii}^{MA} = \frac{2(4+d-d^2)(64-32d-20d^2+6d^3+d^4)+2d(4-d^2)(8-d^2)\gamma_s}{(4-d^2)(4+2d-d^2)}$$
$$\hat{q}_{ij}^{MA} = \frac{(64-32d-20d^2+6d^3+d^4)-(32-12d^2+d^4)\gamma_s}{(4+2d-d^2)(64-32d-20d^2+6d^3+d^4)}$$
$$\hat{\Pi}_i^R = \frac{2-d^2}{2}[(\hat{q}_{ii}^R)^2 + (\hat{q}_{ij}^R)^2] \text{ where } R = MM, MA$$

$$\hat{q}_{ii}^{UU} = \frac{8(2-d^2)(16+4d-3d^2)+d(4-d)(8-d^2)\gamma_s}{8(8-d^2)(8-4d^2+d^4)},\ \hat{q}_{ij}^{UU} = \frac{8(2-d)-(8-d^2)\gamma_s}{8(8-4d^2+d^4)}$$
$$\hat{q}_{ii}^{UA} = \frac{(16+4d-3d^2)(64-32d-20d^2+6d^3+d^4)+d(4-d)(4-d^2)(8-d^2)\gamma_s}{(8-d^2)(4+2d-d^2)(64-32d-20d^2+6d^3+d^4)}$$
$$\hat{q}_{ij}^{UA} = \frac{(64-32d-20d^2+6d^3+d^4)-(32-12d^2+d^4)\gamma_s}{(4+2d-d^2)(64-32d-20d^2+6d^3+d^4)}$$
$$\hat{\Pi}_i^R = (\hat{q}_{ii}^R)^2 + (\hat{q}_{ij}^R)^2 - \frac{d^2}{4}(\hat{q}_{ii}^R + \hat{q}_{ij}^R) \text{ where } R = UU, UA$$

From the equilibrium values on firm's profit in Table A5, we can confirm that $\hat{\Pi}_i^{MM} > \hat{\Pi}_i^{UM}$ and $\hat{\Pi}_i^{MA} > \hat{\Pi}_i^{UU}$ hold as long as positive exports are ensured, suggesting that MM regime the Nash equilibrium organization with endogenous freight rates in the Cournot competition. Furthermore, $\hat{\Pi}_i^{MM} > \hat{\Pi}_i^{UU}$ holds, indicating that M-form organization is in the collective, as well as individual, interests of two manufacturers.