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Abstract

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Keywords: Transport mode, Logistics, Multinational firms, Multinomial logit

JEL classification: F15, F23, R41

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Transport Modal Choice by Multinational Firms: Firm-level Evidence from Southeast Asia[§]

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1. Introduction

Multinationals are different from non-multinationals in terms of their superior tangible assets such as the products and the production processes (Dunning, 1973). Also, multinationals may possess superior intangible assets, including innovative capacity, corporate reputation, and management practices (Markusen, 1995; 2002).[1] More recently, a large number of studies have used firm-level micro data to statistically document that multinationals surpass non-multinationals for their productivity, R&D expenditure, capital-labor ratio, sales, and employment (Davide, 2002; Arnold and Hussinger, 2005; Bernard et al., 2005).[2] These differences have provided an important insight for understanding the mechanics of foreign investment at the firm level. For example, the larger production and productivity by multinationals may indicate the existence of a non-negligible amount of fixed costs in making direct investment (Helpman et al., 2004). As multinational firms could yield positive spillover effects on indigenous firms and improve their own performance at home, analysis on differences between multinationals and non-multinationals has also attracted much interest from policymakers.[3]

In this paper, we shed new light on *logistics* management in accounting for the difference between multinationals and non-multinationals. In particular, we argue that multinationals have superior logistics management skills compared to non-multinationals. Multinational firms have developed extensive international supply chains in which production and distribution networks are intricately linked around the globe. As a result, they face considerable logistical problems for the operation of their global supply chains, including long lead times, uncertain arrival times, high inventory levels, and volatile demand (Levy, 1997; Meixell and Gargey, 2005; Prater et al., 2001). A frequent adjustment in global logistics could add substantially to coordination costs between suppliers and freight transporters (Prater et al., 2001). In order to tackle these problems in global supply chains, multinationals need to adopt advanced logistics

[1] Fosfuri and Motta (1999) shows that multinationals arise without firm-specific assets for a motive of technology acquisition. See Blonigen (2005) for empirical literature on multinationals.
[2] See Greenaway and Kneller (2007) for a survey on the role of firm heterogeneity in exporting and FDI.
[3] For instance, Navaretti and Castellani (2004) examines the impact of FDI on firm performance at home for Italian multinationals.

management. For example, they may make efforts to implement lean production systems in which just-in-time (JIT) delivery, and low inventories improve the quality of inputs, coordination of shipment scheduling, and the responsiveness to demand fluctuations (Levy, 1997).[4] Also, they may need to take advantage of a wide range of fast and reliable transport modes to reduce costs arising from delays in freight transport across and within countries (Hummels and Schaur, 2010). Therefore, multinationals should have better knowledge of logistics management than non-multinationals.

In particular, this paper empirically examines the difference in transport modal choice between multinationals and non-multinationals. Since it is difficult to directly measure managerial skills over logistics at the firm level, we instead conduct an indirect analysis of the argument by exploring the distinction between domestic and multinational firms in the decision over freight transport modes. Specifically, we investigate firms' transport modal choice: air, sea, and truck shipping. Firms face a variety of complex logistical problems in using sea and air transportation. Lengthy shipping time by sea requires a manager to make a careful plan on the synchronization between production and logistics. Expensive transport costs by air imply the need to carefully manage production and logistics costs. Additionally, manufacturers who use air or sea shipping also need to ship by truck from their factory gate to airport or seaport. In this sense, the requirement of logistical procedures and managerial knowledge is more significant for the use of sea and air transportation than that of truck transportation, holding other factors constant. In other words, the use of sea and air transportation requires firms to have better managerial knowledge. Therefore, the more significant use of sea/air transportation in multinationals could be taken as evidence of multinationals' superior logistics management.

In the empirical analysis, we use a data set on transport modes from the Establishment Survey on Innovation and Production Network by the Economic

[4] JIT delivery and low inventories are made possible by the introduction of advanced information technology that facilitates the rapid flow of goods and information and coordinates the shipment of components and final goods between distant manufacturing plants. Computer-based logistics management reduces substantial information costs to track the flow of goods delivered across borders, leading to a decline in inventory-carrying costs due to the international fragmentation of production. In this respect, Keane and Feinberg (2007) provide evidence that advanced information technology improved logistics management for U.S. multinationals, which contributed to the growth of intra-firm trade between parent firms and their Canadian affiliates.

Research Institute for ASEAN and East Asia (ERIA). The data set is novel in that it provides information on freight modes used by manufacturing firms to supply their main product as well as to source their primary intermediate inputs. Also, we can identify the ownership status of establishments by the capital share owned by foreign firms. Then, a multinomial logit model is specified to analyze firm's freight modes between air, sea, and truck transportation. By assigning truck transportation as a benchmark, we estimate the effect of foreign ownership on the probability that air and sea transport is chosen relative to truck transport. The results indicate that foreign ownership has a significant effect on the probability that air and sea shipping is chosen as compared to truck. These results are robust to controlling for the transportation distance of freight goods, distance to nearest airport and sea port, and fixed industry effects. Based on the empirical analysis, we conclude that multinationals are different from non-multinationals in terms of logistics management.

Although logistics management has attracted little attention in the literature, its analysis has important policy implications. If superior logistics management can be observed for multinationals, this will provide new insights for policymakers to encourage foreign investment. In particular, multinationals' superior management indicates the need for sufficient knowledge for firms to make direct investment. This insight justifies policy measures being taken to support potential investors to acquire techniques and knowledge on logistics management. For example, it will be helpful to give seminars on the above-mentioned advanced logistics techniques or provide consulting services on logistics for potential investors. However, these policy implications must be based on formal evidence. Therefore, it is important from the policy viewpoint to analyze differences in logistics management between multinationals and non-multinationals. Also, such analysis contributes to the previous literature in adding new findings on differences between multinational and non-multinationals.

The rest of this paper is organized as follows. Section 2 sets up our empirical framework to examine alternative transportation mode choices, followed by data description on transportation choices by manufacturing establishments in Southeast Asia. Section 3 shows estimation results by a multinomial logit model to discuss the effect of foreign ownership, with sensitivity analysis. Section 4 concludes the paper.

2. Empirical Framework

This section presents our empirical specification to examine multinationals' superior logistics management. Next, the data sources for our estimation are provided. Lastly, summary statistics of our dataset are presented.

2.1 Empirical Specification

As mentioned in the introductory section, we indirectly examine multinationals' superior logistics management skills by analyzing transport modal choice: air, sea, and truck shipping. Our empirical equation on seller *i*'s modal choice over mode M in transporting its products to buyer *j* is specified as follows:

$$V(M)_{ij} \equiv U(M)_{ij} + \varepsilon(M)_{ij} = \delta_1^M FO_i + \delta_2^M D_{ij} + \mathbf{Z_{ij}\gamma'} + \varepsilon(M)_{ij} \quad (1)$$

FO_i indicates a foreign ownership of seller *i*, which takes unity if seller *i* is owned by a multinational company and zero otherwise. Our interest lies in whether this coefficient δ_1^{M} is estimated to be significantly positive. D_{ij} is the log of the geographical distance between seller *i* and buyer *j*. $\mathbf{Z_{ij}}$ is a vector of other independent variables including industry and year dummy variables. It includes the size of the seller and buyer (over 200 employees or not) to control for the scale effect on transport modes. Also, because air/sea shipping is likely to be used for international shipments, we control for cross-border transactions. $\varepsilon(M)$ denotes unobservable mode characteristics. As explained in Wooldridge (2002), when $\varepsilon(M)$ is independently distributed and follows identical type I extreme value distribution across modes, the probability that the firm chooses mode *M* is given by:

$$\Pr\left(Y_{ij}^f = M | \boldsymbol{X}_{ij}^f\right) = \frac{\exp\left(U(M)_{ij}\right)}{1+\sum_k \exp\left(U(k)_{ij}\right)} \quad (2)$$

Y_{ij}^f is a random variable that indicates the choice made by transaction *f* between seller *i* and buyer *j*. $\boldsymbol{X}_{ij}^f$ is a vector of independent variables, including foreign ownership, distance, and $\mathbf{Z}$. The coefficients are estimated by a maximum likelihood procedure. Specifically, a multinomial logit (MNL) model is used to estimate the probability that a firm chooses one of the three transportation modes, air, sea, and truck. In the following, truck is a base mode.

The geographical distance affects firms' modal choice through not only a per-unit physical charge for shipments but also shipping time costs due to the nature of

demand for shipments. Transportation time has a larger influence on the price of products that decay rapidly over time; for example, time-sensitive products include perishable goods (fresh vegetables), new information goods (newspapers), and specialized intermediate inputs (parts for JIT production). A lengthy shipping time may lead to a complete loss of commercial opportunity for products and their components. An opportunity cost is more likely to be significant for goods with a rapid product life cycle and high demand volatility (Hummels, 2001; Djankov et al., 2010). Given the value of timeliness in selling a product, time costs are small for timely shipments (short transport time). In other words, the time costs will be highest in sea and be lowest in air. On the other hand, the physical transportation charge will be highest in air and be lowest in sea. Truck transport will have a medium level in these two kinds of costs between air and sea transports. These expectations are generally consistent with the findings in the transportation literature (Jiang et al., 1999). As a result, a coefficient for the geographical distance represents the *average* difference in the sum of those two kinds of transport costs per distance between truck and air/sea.

2.2 Data

The main data source is the Establishment Survey on Innovation and Production Network for selected manufacturing firms in four Southeast Asian countries for 2008 and 2009: Indonesia, the Philippines, Thailand, and Vietnam. While this dataset is previously used to investigate the effect of between-firm linkages on innovation, modal choices are not explicitly studied (Machikita and Ueki, 2011). To analyze the situation in which firms face alternative transport modes across truck, sea, and air for shipment, the sample population is restricted to selected manufacturing hubs in each country. The location includes JABODETABEK area in Indonesia (Jakarta, Bogor, Depok, Tangerang, and Bekasi), CALABARZON area in the Philippines (Cavite, Laguna, Batangas, Rizal, and Quezon), Greater Bangkok area in Thailand, and Hanoi area and Ho Chi Minh City in Vietnam. This data set is novel in that it has information on transport modes actually chosen by firms in supplying its main product and sourcing its main intermediate inputs. Exploiting the information on the origin and destination of shipments, we can identify international flows of goods within and across countries,

which are delivered by one of three alternative freight modes.

There are several noteworthy points in our dataset. First, the sample is restricted to freight shipments between locations that are accessible by land transportation. The restricted sample assures consistency with our empirical model in which firms face alternative shipping modes among air, sea, and truck transportations. Second, we adopt the following definition to identify alternative transport modes used by firms. A truck mode is defined as freight shipments in which firms use only truck transportation during the whole shipping route. On the other hand, air/sea transport mode is defined as freight shipments in which firms use air/sea shipping at least once in the whole process of transportation. Based on these definitions, the sample by air/sea transport indicates that firms deliver their products by truck from the factory gate to ports.[5] Finally, the nature of the survey data makes it difficult to clearly distinguish between alternative transport modes in some cases; for instance, firms may perceive each freight mode not as mutually distinctive choices, but as combinational choices. To address the extent of a possible deviation between the sample and a multinomial logit model, we conduct the Wald test to examine the determinants of the probability that air and sea shipping is jointly chosen relative to truck transportation.

Table 1 presents the number of actual transport modes by industry and ownership status. The total number of freight modes used by foreign-owned firms is 7 for air, 23 for sea, and 110 for truck transportation. The corresponding figure of domestic firms is 8 for air, 7 for sea, and 334 for truck delivery. It is evident that truck transportation plays a key role in delivering freight shipments. As compared to domestic firms, foreign-owned firms are more likely to use air/sea transport relative to truck transport. The relative importance of air and sea shipping is consistent with the idea that multinationals take advantage of fast shipping and low-cost shipping modes for their freight shipments.

=== Table 1 ===

In Table 2, we show summary statistics of the main sample used in regression.

[5] We specify truck transportation as a benchmark transport mode in a multinomial logit model.

There are 489 observations in the sample. Foreign ownership is the dummy variable that takes on unity if the majority of capital is owned by the foreign business enterprise, and zero otherwise. Among 489 firms, 30% of them are identified as foreign owned ones. Survey information on the number of employees is used to determine whether exporting/importing firms are relatively large (over 200 workers). The sample shows that 30% of firms are large exporters as measured above. Exploiting similar information on trading partners, we find that 36% of importing firms are relatively large in the sample. Foreign freight indicates whether shipments are sent abroad, showing that only 4% of them cross over national borders. Finally, the dataset includes the geographic distance defined in logs: distance from sending firms to their trading partners, nearest airport, and nearest sea port.

=== Table 2 ===

3. Estimation Results

This section reports the estimation results on transport mode choices by manufacturing firms from the multinomial logit technique. After presenting the baseline results, we examine the robustness of the key results by controlling for the distance to the nearest airport and marine port. Finally, we explore whether importers make similar decisions as to the transport mode.

3.1 Baseline Results

Table 3 presents the estimation results of Equation (2) for the probability that firms choose air/sea transportation relative to truck transportation in Columns (1) and (2), respectively. The estimated coefficients represent the effect of explanatory variables on the likelihood of choosing air/sea shipping. Parentheses under the coefficients report robust standard errors.

=== Table 3 ===

Foreign ownership has significantly positive coefficients at the 10% significance level in Column (1) and at the 1% level in Column (2), implying that foreign-owned firms are more likely to use air or sea transportation relative to truck transportation. We also conduct a Wald test to check whether each variable is jointly significant in the two equations. Column (3) reports χ^2 statistics with p-values in the parentheses for each variable. As shown by the low p-value, foreign ownership is jointly significant at the 1% level in the equations for air and sea transport. Thus, these results lead us to conclude that foreign-owned firms have a higher likelihood of employing air and sea transport relative to truck transport than domestically-owned firms do. The evidence is consistent with the hypothesis that multinationals with advanced logistics management tend to exploit air and ocean shipping to send their freight in international operations.

It is of interest to further examine other determinants of freight mode choice. The dummy variables for large exporter and importer have insignificant coefficients in Columns (1) and (2). The size of a firm sending and receiving freight does not affect the probability of transport modal decisions. Note that we do not study the effect of the shipment size in determining modal choices for the lack of shipment-level data in the survey. Intuitively, the size of shipments, rather than firms, could be more influential in determining transportation mode.

The variable for foreign freight is related to the concern that foreign ownership may simply reflect the likelihood of cross-border transactions under multinational production networks. To address this issue, we include a dummy variable indicating whether main trading partners are located abroad. The results show that foreign freight has a significantly positive impact on the probability of firms choosing air shipping, but not sea shipping; Wald test shows the joint significance at 5%. We find that international freight is likely to be transported by air, but cross-border freight by itself has little effect on the significance of foreign ownership. Finally, the coefficients of distance are insignificant in air transportation, but significantly positive in sea transportation. The results imply that long-distant shipments are likely to be delivered by marine transportation.

In sum, we find that transport mode choices depend significantly on foreign ownership of manufacturing firms and the location of trading partners. Specifically, foreign-owned firms tend to use air transportation relative to truck transportation for

international freight whereas they are likely to use sea transportation relative to truck transportation for long-distance shipments.

The statistical significance of foreign ownership raises a question on the economic magnitude of the effects in accounting for freight mode choices. While it is easy to compute marginal effects in a linear model, we need to carefully evaluate the size of the marginal effects for a multinomial logit model. A meaningful practice is to explore the relative extent to which a change in each variable, holding other variables constant, affects the probability that a firm chooses air/sea transportation relative to truck transportation. To this end, we compute a change in odds ratios for unit increase in each explanatory variable; unit increase, rather than standard deviation increase, is chosen to focus on the effect of foreign ownership (Long and Freese, 2006).

Changes in the odds ratio are reported in Column (4) for the likelihood of choosing air relative to truck transportation, and in Column (5) for the probability of using sea relative to truck shipping. If ownership status were to change from domestic to foreign, the odds of air versus truck are expected to increase by a factor of 3.38. On the other hand, the odds of sea versus truck would increase by a factor of 9.66, suggesting that foreign ownership has a nearly three-fold impact on sea relative to air transportation. A possible explanation is that advanced logistics technology allows multinationals to mitigate long lead times and uncertainty in arrival time of marine shipping, so that they can make full use of low-cost, but slow, mode of transportation in order to meet delivery scheduling of components and final products

Although the magnitude of odds ratio has little substantive meaning, we can compare between odds ratios for each variable. If a firm delivers a shipment abroad, the odds ratio of air versus truck would increase by a factor of 10.25, which is three times larger than that for foreign ownership. This implies that the effect of foreign freight on air shipping is important in magnitude. Finally, it is evident that distance has a substantial impact on the likelihood of choosing sea relative to truck transport.

3.2 Sensitivity Analysis

The discussions up to this point have demonstrated that foreign ownership plays a statistically significant and quantitatively large role in accounting for a variation in

air/sea transport modes. The results are robust to a series of control variables, including international freight, distance to trading partners, and industry and year fixed effects. However, our results could be interpreted as showing that multinationals would locate their offshore production in a location that is conducive to air/sea transportation. Possibly, foreign affiliates are more likely to be positioned with good access to transport infrastructure than domestic firms. In this case, the estimated coefficient of foreign ownership could simply reflect a self-selection effect by multinationals.

To investigate the sensitivity of the previous results to transport infrastructure, we include the distance from manufacturing firms to airport and sea port. Table 4 presents the results using a multinomial logit technique. Additional control variables, however, have insignificant coefficients across the equations, indicating that the proximity of foreign affiliates with air/sea transport infrastructure plays little role in transport modal choices. In contrast, we find that foreign ownership remains significantly positive in Columns (1) and (2). Wald test supports the joint significance of ownership status in determining transport mode choices. In addition, a change in odds ratio for unit increase in the foreign ownership variable is almost unchanged in size. These results lend considerable support to the hypothesis that foreign-owned firms are more likely to employ air/sea transport modes even after accounting for a self-selection effect of multinationals with respect to transport infrastructure.

=== Table 4 ===

Next, we examine transport modal choices by importing firms. The previous analysis focused on the role of foreign ownership in explaining transport mode choices made by firms to *send* their freight. The evidence is consistent with the hypothesis that multinationals with advanced logistics management exploit advanced transport modes. However, we have not considered that logistics management could also influence transport modes by firms to *receive* freight shipments. In the context of international trade, we have analyzed exporting firms, but not importing firms.

To further explore transport mode choices by multinationals, we create a similar data set for transport modes by importing firms. As compared to the prior analysis, we estimate the probability that air/sea transport is used relative to truck transport when

foreign-owned firms receive freight shipments. Such analysis matters for the possible distinction that exporting firms would make influential decisions as to transport modes, but importing firms may not have substantial influence in the transport mode that are actually chosen. Intuitively, we are interested in whether multinationals have an influence on transport modal choices by sending firms.

Table 5 shows the results estimated by a multinomial logit model for importer firms. Foreign ownership has significantly positive coefficients for air and sea transportation in Columns (1) and (2). The Wald test in Column (3) also indicates the joint significance of the foreign ownership variable. As was the case for exporting firms, air and sea transportation is more likely to be employed for foreign-owned firms when they are receivers. To discuss the size of the effect, we compute the change in odds ratio for unit increase in each variable. Column (4) indicates that, if the status of an importing firm changes from domestic to foreign ownership, odds of air versus truck would increase by a factor of 6.18. In Column (5), odds of sea versus truck are expected to increase by a factor of 2.11. These figures imply that foreign ownership has a three-fold impact on air shipping relative to marine transport.

=== Table 5 ===

The relative magnitude of foreign-ownership impacts is in stark contrast with the results for exporting firms; foreign ownership has a greater influence on sea transportation. These results can be understood from transport-mode characteristics; air shipping has expensive freight charges with fast delivery, and sea transportation is a low-cost freight mode with slow delivery. From an exporter's point of view, it is the cost-minimizing choice to exploit sea transport for freight shipments. From an importer's point of view, it is an advantage to receive delivered goods in a timely manner. Given that a balance in the bargaining power between exporters and importers affects actual transport modes, our results suggest that multinationals may take advantage of their superior bargaining power with respect to the transport modes.

4. Concluding Remarks

This paper examines transport modal choices by multinational firms to shed light on the role of logistics management in multinational activities. Based on previous studies on multinational enterprises and supply chains, we develop the hypothesis that multinationals should have superior managerial skills over global logistics. Using a firm-level survey in Southeast Asia, we provide evidence that foreign ownership of sellers has a significantly positive and large impact on the likelihood that air/sea transportation being chosen relative to truck freight. This result is robust to the shipping distance, international freight, and transportation infrastructure. In addition, we find that both exporters and importers owned by foreign firms tend to use air/sea transportation. Thus, our analysis provides considerable evidence that foreign-owned firms tend to use freight modes with relatively serious requirements of logistical procedures and managerial knowledge. We interpret these results as suggesting that superior managerial skills in logistics allow multinational firms to exploit air and sea transport modes.

The analysis in this paper improves our understanding of a distinctive feature of multinational activity. As there has been little attention on the role of global logistics operations in accounting for multinational production, we focus on accounting for differences between multinational and domestic firms at a point in time. However, it remains to investigate how multinationals develop global logistics operations to take advantage of production networks across borders. In other words, multinationals could acquire advanced logistics management *ex post*, rather than *ex an*te. For instance, firms may become multinationals to exploit firm-specific assets such as innovative products and production processes. After extending their production to a foreign market, they start to improve managerial skills over international logistics. This implies that a difference in logistics management may not be a strong predictor of which firms self-select to invest abroad and become multinationals. A complex interaction between an improvement in logistics management and a development of offshore production is a challenging, but important issue for further understanding a link between logistics management and multinational activity.

References

Anderson, James E; van Wincoop, Eric, 2004, Trade Costs, *Journal of Economic Literature*, 42 (3), 691-751.

Arnold, Jens M.; Hussinger, Katrin, 2005, Export Behavior and Firm Productivity in German Manufacturing: A Firm-Level Analysis, *Review of World Economics/Weltwirtschaftliches Archiv*, 141 (2), 219-43.

Blonigen, Bruce A, 2005, A Review of the Empirical Literature on FDI Determinants, *Atlantic Economic Journal*, 33 (4), 383-403.

Bernard, Andrew B; Jensen, J Bradford; Schott, Peter K, 2005, Importers, Exporters, and Multinationals: A Portrait of Firms in the U.S. that Trade Goods, *NBER Working Papers* 11404.

Castellani, Davide, 2002, Export Behavior and Productivity Growth: Evidence from Italian Manufacturing Firms, *Review of World Economics/Weltwirtschaftliches Archiv*, 138 (4), 605-28.

Djankov, Simeon; Freund, Caroline; Pham, Cong S., 2010, Trading on Time, *Review of Economics and Statistics*, 92 (1), 166-73.

Dunning, John H, 1973, The Determinants of International Production, *Oxford Economic Papers*, 25 (3), 289-336.

Feinberg, Susan E; Keane, Michael P, 2006, Accounting for the Growth of MNC-Based Trade Using a Structural Model of U.S. MNCs, *American Economic Review*, 96 (5), 1515-58.

Fosfuri, Andrea; Motta, Massimo, 1999, Multinationals without Advantages, *Scandinavian Journal of Economics*, 101 (4), 617-30.

Greenaway, David; Kneller, Richard, 2007, Firm Heterogeneity, Exporting and Foreign Direct Investment, *Economic Journal*, 117 (517): 134-61.

Helpman, E., Melitz, M., and Yeaple, S., 2004, Export versus FDI with Heterogeneous Firms, *American Economic Review*, 94(1): 300-316.

Hummels, David L, 2001, Time as a Trade Barrier, GTAP Working Papers 1162.

Hummels, David L; Schaur, Georg, 2010, Hedging Price Volatility Using Fast Transport, *Journal of International Economics*, 82(1), 15-25.

Jiang, Fei; Johnson, Paul; Calzada, Christian, 1999, Freight Demand Characteristics and Mode Choice: An Analysis of the Results of Modeling with Disaggregate Revealed Preference Data, *Journal of Transportation and Statistics*, 2 (2), 149-58.

Keane, Michael P; Feinberg, Susan E, 2007, Advances in Logistics and the Growth of Intra-firm Trade: The Case of Canadian Affiliates of U.S. Multinationals, 1984-1995, *Journal of Industrial Economics*, 55 (4), 571-632.

Levy, David L., 1997, Lean Production in an International Supply Chain, *Sloan Management Review*, 38 (2), 94-102.

Long, J. Scott; Freese, Jeremy, 2006, Regression models for categorical dependent variables using Stata, 2nd ed., Stata Press.

Machikita, Tomohiko. and Ueki, Yasushi, 2011, Innovation in Linked and Non-linked Firms: Effects of Variety of Linkages in East Asia, *International Journal of Institutions and Economies*, 3(1), 77-102.

Markusen, James R, 1995, The Boundaries of Multinational Enterprises and the Theory of International Trade, *Journal of Economic Perspectives*, 9 (2), 169-89.

Markusen, James R, 2002, Multinational firms and the theory of international trade, Cambridge and London: MIT Press.

Meixell, Mary J.; Gargeya, Vidyaranya B., 2005, Global Supply Chain Design: A Literature Review and Critique, *Transportation Research Part E*, 41, 531-50.

Navaretti, Barba G. and Castellani, Davide., 2004, Investments Abroad and Performance at Home: Evidence from Italian Multinationals, CEPR Discussion Paper 4284.

Prater, Edmund; Biehl, Markus; Smith, Michael A., 2001, International Supply Chain Agility: Tradeoffs between Flexibility and Uncertainty, *International Journal of Operations & Production Management*, 21 (5/6), 823-39.

Wooldridge, Jeffrey M., 2002, Econometric analysis of cross section and panel data, Cambridge and London: MIT Press.

Table 1. Transport Mode by Industry and Ownership Status

Industry	Foreign			Domestic		
	air	sea	truck	Air	sea	truck
1	0	3	11	1	0	55
2	1	1	3	1	2	38
3	2	5	40	1	1	119
4	3	10	24	1	0	64
5	1	2	15	3	0	16
6	0	2	17	1	4	42
Total	7	23	110	8	7	334

Notes: Foreign and Domestic indicates foreign-owned and domestically-owned firms, respectively; industry 1 is food, beverages, tobacco, textiles, apparel, and leather; industry 2 is wood, wood products, paper, paper products, printing; industry 3 is coal, petroleum products, chemicals, chemical and plastic products, rubber, other non-metallic mineral products, iron, steel, non-ferrous metals, metal products; industry 4 is machinery, equipment tools, computers, computer parts, other electronics, electronic components; industry 5 is automobile, auto parts, other transportation equipment and parts; industry 6 is precision instruments and others.

Table 2. Summary Statistics

Variable	Obs.	Mean	S.D.	Min	Max
Foreign ownership, = 1 if foreign owned	489	0.29	0.45	0	1
Large exporter, = 1 if exporter's labor over 200	489	0.30	0.46	0	1
Large importer, = 1 if importer's labor over 200	489	0.36	0.48	0	1
Foreign freight, = 1 if freight shipped abroad	489	0.04	0.19	0	1
Distance to trading partner, log in km	489	4.47	1.35	1.61	6.91
Distance to nearest airport, log in km	489	3.65	0.87	1.61	5.99
Distance to nearest sea port, log in km	489	4.16	0.91	1.61	5.99

Table 3. Multinomial Logit Model of Transport Mode Choice

Variable	(1) Air	(2) Sea	(3) Wald test	(4) Change in odds for unit increase: Air relative to truck	(5) Change in odds for unit increase: Sea relative to truck
Foreign ownership	1.22*	2.27***	16.48***	3.38	9.66
	(0.74)	(0.60)	(0.00)		
Large exporter	-1.04	-0.31	2.37	0.35	0.74
	(0.70)	(0.56)	(0.31)		
Large importer	-0.24	-0.43	0.78	0.78	0.65
	(0.59)	(0.56)	(0.68)		
Foreign freight	2.33**	1.23	6.79**	10.25	3.43
	(0.99)	(0.77)	(0.03)		
Distance	0.29	2.37***	21.65***	1.34	10.68
	(0.30)	(0.53)	(0.00)		
Industry fixed effect	Y	Y			
Year fixed effect	Y	Y			
Sample	489				
Pseudo R2	0.42				
Log pseudolikelihood	-103.5				

Notes: Robust standard errors are in parentheses; Y indicates the inclusion of fixed effects; Wald test shows χ^2 statistics with *P*-values in parentheses for the null hypothesis that coefficients are zero in estimating equations.

*: significant at 10%

**: significant at 5%

***: significant at 1%

Table 4. Multinomial Logit Model with Additional Control Variables

Variable	(1) Air	(2) Sea	(3) Wald test	(4) Change in odds for unit increase: Air relative to truck	(5) Change in odds for unit increase: Sea relative to truck
Foreign ownership	1.19*	2.14***	15.37***	3.30	8.50
	(0.71)	(0.59)	(0.00)		
Large exporter	-1.16*	-0.16	2.74	0.31	0.85
	(0.70)	(0.53)	(0.25)		
Large importer	-0.32	-0.48	1.03	0.73	0.62
	(0.61)	(0.56)	(0.60)		
Foreign freight	2.41**	1.17	6.84**	11.08	3.21
	(0.97)	(0.83)	(0.03)		
Distance	0.28	2.40***	20.86***	1.32	11.03
	(0.28)	(0.55)	(0.00)		
Distance to airport	0.54	-0.13	2.58	1.71	0.88
	(0.36)	(0.26)	(0.28)		
Distance to sea port	-0.03	-0.24	0.59	0.97	0.79
	(0.33)	(0.32)	(0.74)		
Industry fixed effect	Y	Y			
Year fixed effect	Y	Y			
Sample	489				
Pseudo R2	0.43				
Log pseudolikelihood	-102.1				

Notes: Robust standard errors are in parentheses; Y indicates the inclusion of fixed effects; Wald test shows χ^2 statistics with p-values in parentheses for the null hypothesis that coefficients are zero in estimating equations.

*: significant at 10%

**: significant at 5%

***: significant at 1%

Table 5. Multinomial Logit Model for Importing Firms

Variable	(1) Air	(2) Sea	(3) Wald test	(4) Change in odds for unit increase: Air relative to truck	(5) Change in odds for unit increase: Sea relative to truck
Foreign ownership	1.82***	0.75*	10.39***	6.18	2.11
	(0.63)	(0.41)	(0.01)		
Large exporter	-0.25	-0.34	0.58	0.78	0.71
	(0.83)	(0.48)	(0.75)		
Large importer	0.10	-0.12	0.10	1.10	0.89
	(0.73)	(0.41)	(0.95)		
Foreign freight	1.20	1.49***	9.68***	3.33	4.45
	(0.78)	(0.52)	(0.01)		
Distance	0.60*	2.48***	13.71***	1.83	11.93
	(0.35)	(0.73)	(0.00)		
Distance to airport	0.37	0.06	1.42	1.45	1.06
	(0.31)	(0.19)	(0.49)		
Distance to sea port	0.53*	-0.42	5.39*	1.69	0.66
	(0.30)	(0.32)	(0.07)		
Industry fixed effect	Y	Y			
Year fixed effect	Y	Y			
Sample	478				
Pseudo R2	0.46				
Log pseudolikelihood	-134.1				

Notes: Robust standard errors are in parentheses; Y indicates the inclusion of fixed effects; Wald test shows χ^2 statistics with p-values in parentheses for the null hypothesis that coefficients are zero in estimating equations.

*: significant at 10%

**: significant at 5%

***: significant at 1%