1. Introduction

International air freight, once the exclusive domain of heavy regulation, is now a global market fraught with intense competition by for-profit firms. One feature of this competition is that the organizational form of carriers frequently differs. For an example, consider documents and parcels exported by the Japanese international air courier and small package (IC&SP) industry. Some carriers are vertically integrated, which is to say that a carrier owns domestic freight forwarding and trucking operations, international air, and foreign freight forwarding and trucking operations. Federal Express, which owns both domestic and foreign trucking as well as international air operations, typifies a fully integrated organizational form for IC&SP service. In contrast, other carriers employ a more disaggregated organizational form outsourcing one or more of these operations. Overseas Courier Service Co., Ltd., for instance, typifies a freight forwarder that owns a foreign freight forwarder but contracts for some of its domestic trucking services, for international air operations, and for foreign trucking services—an organizational form sometimes referred to as a network organization. Between these two extremes can be found a variety of ownership structures with firms owning some, but not all of these activities. Moreover, carriers may vertically integrate transportation segments for one destination, yet contract out for another. What accounts for this organizational heterogeneity? Why do some firms vertically integrate into some

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1 The authors would like thank Sid Chib and the participants of the Sixth Conference on Postal and Delivery Economics for comments and assistance that greatly improved the paper. Additionally, the authors wish to thank Yuzo Fujimoto for research assistance.
segments of IC&SP service while other firms rely on network organizations?

This paper explores the determinants of vertical integration in the Japanese IC&SP industry. Based on a transaction cost economics (TCE) analysis of the Japanese IC&SP industry, the paper investigates the integration decision for freight forwarders and posits that vertical integration in each transportation segment (i.e., domestic trucking, international air, and foreign trucking) can be interpreted as a response to specificity of investments in proprietary information networks used to track parcels in real-time. Due to competition and customer heterogeneity, we assume that some carriers choose to make specific investments in their information network in order to provide superior levels of service. The greater the specific investment in a real-time and proprietary information network for a particular transportation segment, the greater the likelihood of vertical integration in that segment. To explore this hypothesis, we surveyed firms providing IC&SP service in Japan to identify their organizational and information network choices. Particularly, we collected data on 995 individual parcels shipped from Japan through 14 IC&SP carriers. Probit analyses investigate the choice of vertical integration in each transportation segment of IC&SP service as a function of asset specificity (Williamson 1985) associated with real-time proprietary information networks. The empirical findings provide support for our theory.

The paper proceeds as follows. The next section briefly describes the Japanese IC&SP industry. Section 3 reviews TCE research on logistics industry, and section 4 uses this theory to develop a specific hypothesis about the relationship between idiosyncratic package-tracking information systems and organizational choice. Section 5 describes the data, the method of data collection, and the econometric method. Section 6 presents and discusses econometric results. Section 7 summarizes and concludes.

2. International Courier and Small Package Service in Japan

The primary domain of our study is international courier and small package service in Japan. Twenty-seven member firms (see table 1) are registered in the International Courier and Small Package Service Subgroup in the Japanese Air Cargo Forwarders Association (JAFA). Of these, 24 firms are actively competing in the Japanese market, which covers virtually all firms offering IC&SP service in Japan.2

Generally, IC&SP service is comprised of five separate activities, which include three separate transportation segments. (See figure 1.) A shipper contacts a freight forwarder whose responsibility is to coordinate a domestic truck picking up the package from the shipper and transporting it to an airport. The freight forwarder advances the freight through domestic customs and consolidates it for air transit. An international air carrier transports the consolidated package to a foreign airport. A foreign freight forwarder advances the freight through customs, separates the

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2 Three forwarders, “K” Line Air Service, Ltd., Keihin Air Service, and Tokyu Air Cargo, Co., Ltd., report to us that they do not currently provide IC&SP services.
packages, and coordinates delivery. Finally, a foreign truck delivers the package.

Empirically, we find that domestic and foreign freight forwarding activities in most cases are jointly owned or organized through some type of equity relations. Thus, we focus on the freight forwarder’s organizational choice for the three different transportation segments—domestic trucking, international air, and foreign trucking—for which we observe substantial heterogeneity of organizational configurations. We investigate from a transaction cost perspective why freight forwarders vertically integrate into one or more of these transportation segments.

<table>
<thead>
<tr>
<th>Table 1. JAF IC&amp;SP Subgroup Member Firms</th>
</tr>
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<tbody>
<tr>
<td>Airborne Express Japan, Inc.*</td>
</tr>
<tr>
<td>BAX Global Japan K.K.*</td>
</tr>
<tr>
<td>DHL Japan, Inc.*</td>
</tr>
<tr>
<td>Emery Air Freight Japan Corp.</td>
</tr>
<tr>
<td>Federal Express Japan K.K.*</td>
</tr>
<tr>
<td>TNT Express Worldwide (Japan) Inc.*</td>
</tr>
<tr>
<td>UPS Yamato Co., Ltd.*</td>
</tr>
<tr>
<td>Fukuyama Transporting Co., Ltd.*</td>
</tr>
<tr>
<td>Hankyu Express International Co. Ltd.*</td>
</tr>
<tr>
<td>Japan Schenker Co. Ltd.*</td>
</tr>
<tr>
<td>JNE Corporation</td>
</tr>
<tr>
<td>Keihin Air Service</td>
</tr>
<tr>
<td>Kintetsu World Express, Inc.</td>
</tr>
<tr>
<td>“K” Line Air Service, Ltd.</td>
</tr>
</tbody>
</table>

*Firms with asterisk provided us package-level data, or for which we collect data by test package or from shippers.

Empirically, we find that domestic and foreign freight forwarding activities in most cases are jointly owned or organized through some type of equity relations. Thus, we focus on the freight forwarder’s organizational choice for the three different transportation segments—domestic trucking, international air, and foreign trucking—for which we observe substantial heterogeneity of organizational configurations. We investigate from a transaction cost perspective why freight forwarders vertically integrate into one or more of these transportation segments.

Figure 1. IC&SP Activity Chain and Integration Choices
Although the phrase “integrated carrier” often is used by most industry participants, not all segments of the “integrated” firms are integrated. Integration can occur in any of three transportation segments. For instance, a variety of integration patterns are found for domestic trucking operations. Among 16 firms interviewed, only one firm, Fukuyama Transporting Co. Ltd., fully internalizes all pickup/delivery trucking operations. More typically, freight forwarders vertically integrate some domestic trucking routes while contracting out for other trucking routes.

Similarly, only a few firms are integrated into international air transport out of Japan. While Federal Express, DHL, and UPS-Yamato can be classified as integrated, 3 all other freight forwarders contract for international air carriage. Many of the firms, such as Airborne Express, BAX Global, Emery Air Freight, and TNT Express Worldwide, do integrate into international air transport between some foreign cities or in the United States, but have not integrated into international air transport between Japan and foreign cities.

It is this multi-national and multi-transportation segment characteristic of IC&SP service that yields the greatest organizational variety. Among the 24 Japanese competitors, 21 firms have at least one foreign freight forwarding and trucking operation subsidiary or parent company. For instance, Hankyu Express International, Kintetsu World Express, Nippon Express, Nishi-Nippon Railroad, Nissin, Overseas Courier Services, Proco Air Service, Seino Transportation, and Yusen Sea and Air Service all own foreign subsidiaries. 4 Alternatively, firms like Maruzen Air Express International and World Courier are subsidiaries of foreign firms. Many of these firms have equity relations with freight forwarding and trucking operations in some countries but not other countries.

3. Prior Literature

To theoretically investigate the choice organizational in the Japanese IC&SP industry, we adopt from a variety of theories the governance lens of transaction cost economics (Williamson 1975; 1985; 1996). TCE argues that bounded rationality make contracts inherently incomplete. Such incompleteness is of little consequence without opportunism or in a spot market where switching to an alternative trading partner is low cost. However, transactions characterized by specific assets cause contract incompleteness to have important ramifications for organizing a transaction, especially when uncertainty of transactions is significant. Hierarchy, 3

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3 Federal Express operates 47 freighter flights per week to Japan. Similarly, UPS operates 14 freighter flights per week to Japan (“Suji de miru koku 1997” (Airline figures), Ministry of Transport, 1997), and UPS owns 50% of UPS-Yamato’s equity. On the other hand, DHL owns 209 aircraft worldwide (http://www.dhl.com/info/glopres.htm), but it does not currently operate aircraft to Japan. However, more than half of the DHL’s equity is owned by airlines servicing to Japan (Japan Airlines owns 25.001% and Lufthansa Cargo AG owns 25.001%), and DHL parcels are partly transported by those airlines. When DHL parcels are transported by those airlines, we define in this paper that the air transport is integrated at the package level.

4 In addition, Nippon Courier Service Co., Ltd., is a joint subsidiary of Nippon Express Co., Ltd., and Overseas Courier Service Co., Ltd., both of which own foreign subsidiaries.
the organizational mode of last resort, offers transaction cost economizing advantages over markets when the transaction is characterized by specific assets, uncertainty, and frequency—under these conditions fiat is more advantageous than markets in reducing ex post exchange and maladaptation problems.

This paper is not the first application of TCE to logistics industries. Palay (1984) explored determinants for market versus non-market governance mode choice in rail freight contracts. Specifically, he gathered information on formal contracts as well as informal agreements between rail carriers and their shippers and found that a more “hierarchical” governance structure was chosen the greater the amount of transaction-specific capital in the exchange. Similarly, Pirrong (1993) observed that increases in “temporally” specific capital shifts bulk shipping contracts from the short-term duration found in spot markets toward long-term contracts. Unlike previous studies, he showed that even when capital is not sunk, i.e., not specific to a particular transaction in the long-run, the capital can still be a specific asset in the short-run. For example, the market for a shipping contract becomes “thin” for a ship visiting a remote harbor. As a result, spot contracts can be prohibitively costly because of the haggling between the shipper and the sea carrier.

From a related perspective, Nickerson and Silverman (1997) argued that for-hire trucking carriers vertically integrate by owning the truck and hiring a company driver when the optimal tractor configuration for a particular haul incurs severe operating penalties should it be redeployed for non-optimal uses (e.g., independents own tractors with average configurations, while carriers own tractors with configurations optimized for short-haul and light-weight freight or for long-haul and heavy freight). Also, Nickerson and Silverman (1997) argued that hub-and-spoke logistics (less-than-truckload) create coordination problems, which are reduced by employing company drivers instead of independents. Integration reduces the incentives independents have to deliver freight unreliably, which, because a small delay in the arrival of one truck can cause system-wide delays, could impose large operating costs and could damage carrier reputation. A large-sample empirical analysis of United States interstate for-hire trucking carriers provided support for their theory.

Generally, TCE studies of logistics show that the contract hazards associated with specific physical assets, unavailability of timely shipping capacity, and coordination problems associated with hub-and-spoke logistics networks lead to vertical integration in logistics industries. While all of these contracting problems are likely to have ramifications for organization of IC&SP service, we focus, in part, on a different set of specific investments.

4. Hypothesis

Our primary investigation focuses on the relationship between specific investments in information networks and organizational choice. Information technology has had a dramatic organizational impact on logistics and on IC&SP service in particular. Information technology is critical for tracking freight, trucks, and airplanes and providing real-time information to carriers and customers. Such information is valuable to a wide variety of customers that need to know the precise location of
their packages while in transit. Moreover, information technology is indispensable for the fastest international courier service—collecting parcels from all over the world, sorting in a few hours, and delivering them on the next day depends critically on accurate and real-time information about each package. In addition to internal needs for information, carriers choosing to provide such information to customers need to collect and transmit data from each transportation segment: domestic trucking, international air, and foreign trucking.

Presently, information technology and the corresponding computer network in most courier firms are unique to each firm and represent specific investments in both hardware and software. Several firms invest in unique portable electronic devices to record and code data about packages on both pick-up and delivery. UPS, for example, provides its 125,000 drivers with firm-specific hand-held computer systems to capture and transmit signatures and package data. Additionally, general purpose computers become specific to the firm once installed because of rapid price declines in computing equipment, which makes selling used equipment much less valuable than their continued use. More importantly, software is either partially or completely customized for each firm and for each piece of information a carrier tracks. Specific investments in the information network must be made in each transportation segment the freight forwarder wants to collect information from. These investments have little value if redeployed in an alternative, second-best use. For example, software written for UPS’s information system is unlikely to work on Federal Express’ information system without substantial and costly modification.

Moreover, information technology investments can be substantial. UPS and Federal Express together employ 4,000 information technology staff and spent approximately $2.5 billion in 1995 and 1996 to maintain and enhance their information networks. UPS alone is approaching annual expenditures of $1.5 billion on information technology (Bicknell 1996). Our interviews disclosed that other Japanese freight forwarders actively invest in proprietary information networks, though the investment levels vary in terms of percentage of annual expenditures (0.3% to 5%).

Large and firm-specific investments in information technology give rise to contracting hazards (i.e., hold-up and maladaptation hazards). Firm-specific investments by one trading partner could be exploited by the other partner in ex post negotiations or in an opportunistic response to changing conditions, or could impose substantial costs should the partners fail to adapt in a coordinated way in

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5 Interconnectivity of information networks is constantly improving, thanks to the development of TCP/IP. Also, some hardware and software manufacturers promote the scalability of computer systems, especially in small-scale systems. However, real-time and large-scale transaction systems, for which package-tracking systems and online banking systems are typical examples, have substantial proprietary elements compared to small-scale systems. One reason is that a system built on a publicly shared network does not provide sufficient transmission reliability for at least some carriers. Also, stringent demand of information processing in large online systems is currently beyond the capability of a cluster of PCs or workstations.
response to changing circumstances (Williamson 1985). In IC&SP service, information technology investments could be made in each transportation segment: domestic trucking, international air, and foreign trucking. Transaction cost economics maintains that hierarchy, although a costly form of organization, offers efficiency advantages of markets for minimizing these contracting hazards. Conflicts can be resolved by fiat instead of appealing to the courts. Therefore, even if courier service requires few idiosyncratic physical assets such as containers, trucks, or airplanes, the information network is transaction-specific, which, according to TCE, calls for vertical integration to safeguard against opportunistic actions that could expropriate or devalue specific investments. Thus, we predict that vertical integration in each transportation segment is a response to specificity of investments in information technology in each segment:

**Hypothesis:** The greater the specific investments in information technology in any particular segment of IC&SP transportation, the greater the likelihood of integration between freight forwarding and that segment of IC&SP transportation. 6

5. Data and Econometric Method

The number of IC&SP carriers in Japan is too small in number for a detailed econometric study using the firm as the unit of analysis. Moreover, such an analysis is complicated by the fact that the carrier may be vertically integrated in some cities and countries and contract for transportation services in other cities and countries. Therefore, we chose the parcel as our unit of analysis, which allows us to investigate both inter-firm and intra-firm organizational heterogeneity. Also, because of difficulty in tracking parcels originating in other countries and shipped into Japan, we chose to focus on individual parcels shipped from Japan.

We collected data on a total of 995 sample parcels shipped from 37 different origin cities in Japan to 160 destination cities in 42 countries during February and March 1998. Parcels were distributed among 14 IC&SP carriers. (See table 1.) Information network tracking data was either self-reported by the carriers, recorded

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6 It deserves to be noted that large investment per se does not necessarily create a contractual problem. Even if a substantial investment is needed to capture technological economies of scope, the party that makes the investment can always switch to an alternative partner without sacrificing value, provided the investment is not relationship-specific. Opportunism does not pose a contractual hazard in this case. However, when the investment at risk is relation-specific, incompleteness of contracts creates significant hazards. Hierarchy acts to safeguard investments that are specific. Given that specific investments create contracting hazards and hierarchy is a costly organizational form, why would any firm choose to employ specific investments? Underlying our analysis is the assumption that customers are heterogeneous in their preference for quality of service. We note that some firms focus on customers that are best served by specific investments and the firms are rewarded in the market place for these investments. Other firms focus on customers requiring lower levels of service, for which tracking information is not essential. However, our analysis does not explore why firms make particular investment decisions. Rather, we focus on the organizational implications of these investments.
directly based on test parcels sent by researchers, or reported by shippers who assisted us in our research. After omitting observations with missing data, we have between 815 and 903 observations depending on the dependent variable analyzed. Since the market share of IC&SP carriers was unavailable, we attempted to distribute the parcels evenly among carriers, though the number of packages per carrier ultimately varied from 49 to 200 per carrier. The variables for which we collected data are described below.

**Dependent Variables:** Since the customer contacts a carrier that performs the function of a freight forwarder in all cases, our analysis investigates whether the freight forwarder vertically integrates into any of the three transportation segments. DomTrk quantifies whether or not domestic trucking for picking up parcels is vertically integrated (coded 1) or contracted out (coded 0). IntAir quantifies whether or not international air service is vertically integrated (coded 1) or contracted out (coded 0). ForTrk quantifies whether or not foreign trucking is vertically integrated (coded 1) or contracted out (coded 0).

Data for these variables was collected by interviewing each of the participating IC&SP carriers and then mapping its organizational choices for domestic trucking, international air, and foreign trucking on a parcel by parcel basis according to the parcel’s origination and destination cities. All types of equity relationships were coded as vertically integrated. The absence of an equity relation was coded as contracting out.

**Independent Variables:** Our principal hypothesis is that integration is positively correlated with investments in the firm-specific information network for each transportation segment. Unfortunately, we were unable to obtain data on each firm’s investment in its proprietary information network. As a proxy for such investments, we developed a survey that collected data on the type and availability of real-time parcel information tracked by a carrier’s information network for each transportation segment. (The survey is displayed in the Appendix.) We then created an index for each transportation segment that counts the pieces of information available to the freight forwarder (which contracted with the shipper to transport the individual package) from each transportation segment. These indices, described below, assume that the level of proprietary information network investment is positively correlated with the amount of real-time information available from each transportation segment, except where noted. Thus, we assume that the

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7 In cases where test parcels or shippers’ packages are used, we asked the carriers for all the information that the carrier could obtain on the package based on the carrier’s information network, even when some of the information is not provided through internet tracking service offered to customers.

8 We also collected data on information pertaining to domestic and foreign customs clearance. The data included (Q8) whether or not customs has been cleared and (Q9) the time of clearing customs. Also, (Q18) whether or not customs in destination country has been cleared and (Q19) the time of clearing customs were collected. However, freight forwarders typically act as and are approved customs brokers. Since we are primarily interested in the specific investment in transportation segment and its effect on organizational form, the relationship on the integration between freight forwarding and customs brokerage is not theoretically clear.
amount of parcel tracking information is a proxy for the level of specific investment.

The variable \( k_{\text{DomTrk}} \) is an index which increases with the amount of parcel data available from domestic trucking, questions 1 through 7 on the survey. Data includes: (Q1) whether or not the package has been picked up, (Q2) name of the pick-up driver, (Q3) time of pick-up, (Q4) place of pick-up, (Q5) whether or not the package arrives at the local terminal, (Q6) time of local terminal arrival, and (Q7) name of local terminal. For each piece of information available on the information network, we add one to the index. Thus, the index ranges between 0, which indicates no data is available on the carrier’s information network, and 7, which indicates all of the information is available on the carrier’s information network. We expect vertical integration in domestic trucking is more likely with higher levels of \( k_{\text{DomTrk}} \) and thus predict a positive coefficient.

The variable \( k_{\text{IntAir}} \) is an index which increases with the amount of parcel data available from international air carriage, questions 10 through 17 on the survey. Data includes: (Q10) whether or not the parcel was loaded onto an airplane, (Q11) the loading time, (Q12) whether or not the airplane departed, (Q13) the departure time, (Q14) the city the airplane departed from, (Q15) the cities that package visits during air transit, (Q16) whether or not the airplane landed at the destination airport, and (Q17) time of arrival. The index ranges between 0 and 8. We expect vertical integration in international air service is more likely with higher levels of \( k_{\text{IntAir}} \) and thus predict a positive coefficient.

The variable \( k_{\text{ForTrk}} \) is an index which increases with the amount of parcel data available from foreign trucking, questions 20 through 26 on the survey. Data includes: (Q20) whether or not the delivery truck departed from the local terminal, (Q21) the time the delivery truck departed from the local terminal, (Q22) name of the local delivery terminal, (Q23) whether or not the parcel has been delivered, (Q24) time of delivery, (Q25) location of delivery, and (Q26) name of recipient. The index ranges between 0 and 7. We expect vertical integration in foreign trucking is more likely with higher levels of \( k_{\text{ForTrk}} \) and thus predict a positive coefficient.

**Control Variables:** We employ different control variables depending on the dependent variable. \( \text{Doc} \) is a binary variable and coded 1 for parcel containing documents only, and coded 0 otherwise. Parcels containing documents typically are more time sensitive than small packages. Moreover, documents are lighter in weight and larger in number than other air freight.\(^9\) Thus, following the theoretical prediction developed by Nickerson and Silverman (1997) that time-sensitive and complex flows of freight introduce contractual hazards most efficiently organized

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\(^9\) The total number of document couriers shipped from Japan in fiscal year 1995 was 6.93 million, which was about 5 times more than small packages (1.39 million). The total weight of those two were approximately the same (7,119 tons and 7,853 tons, respectively) (“Suji de miru butsuryu 1997,” Ministry of Transport, Japan).
via hierarchy, we predict a positive with respect to each of the dependent variables.

*JCities* is a dummy variable that is coded 1 for parcel origin cities of Tokyo, Osaka, and Nagoya, else coded 0. IC&SP Interviewees state that these cities, the largest in Japan, are responsible for much of IC&SP demand. Indeed, that more than 90% of our parcel level data originated from these cities reflects this fact. If economies of scale are present for domestic trucking and determine the organizational form, it would lead to a positive coefficient. However, the fact that the market for domestic trucking in these cities is substantial provides for a “thick” market of independent domestic trucking carriers that would lessen the need for vertical integration, which would lead to a negative coefficient.

*FinCities* is a dummy variable that is coded 1 for parcel destination cities of Chicago, Hong Kong, London, Los Angeles, New York, San Francisco, and Singapore. These cities are financial centers and are destination cities for many IC&SP parcels. More than 60% our parcels were delivered to these cities. We expect economies of scale, if present for either international air or foreign trucking, would lead to positive coefficients. Alternatively, the fact that the market for international air or foreign trucking to these cities is substantial again would provide for a “thick” market of independent airlines and foreign trucking carrier that would lessen the need for vertical integration into both transportation segments, which would lead to negative coefficients.

*MarkSize* is a variable that measures cumulative annual weight (in billions of kilograms) of international air freight, a freight segment including parcels larger than courier and small packages, from Japan to each destination country in the most recent year for which we have data, 1995. We employ this data as our best available proxy for country specific volume. If economies of scale in either international air or foreign trucking to a particular country are present, then we would expect coefficients for this variable to be positive.

**Method:** As described above, our model has three dependent variables: whether freight forwarding is vertically integrated or not into domestic trucking, international air, or foreign trucking. We employ a Probit estimation procedure for each dependent variable independently. This method assumes that error terms are uncorrelated.\(^1\) We model the benefit (inverse cost differential) of internal governance as unobserved variables *DomTrk*, *IntAir*, and *ForTrk* such that:

\[
DomTrk^* = \beta_{10} + \beta_{11} k_{DomTrk} + \beta_{12} Doc + \beta_{13} JCities + e_1
\]

\[
IntAir^* = \beta_{20} + \beta_{21} k_{IntAir} + \beta_{22} Doc + \beta_{23} FinCities + \beta_{24} MarkSize + e_2
\]

\[
ForTrk^* = \beta_{30} + \beta_{31} k_{ForTrk} + \beta_{32} Doc + \beta_{33} FinCities + \beta_{34} MarkSize + e_3
\]

where \(e_1 = N(0,s_1)\), \(e_2 = N(0,s_2)\), and \(e_3 = N(0,s_3)\) and \(\text{Cov}(e_1,e_2) = 0\), \(\text{Cov}(e_1,e_3) = 0\), and \(\text{Cov}(e_2,e_3) = 0\). The variables *DomTrk*, *IntAir*, and *ForTrk*

\(^1\) Future research will investigate alternative methods to correct for the possibility of correlated errors among the dependent variables.
take the value of one if DomTrk*, IntAir*, and ForTrk* is greater than zero, respectively, since internal governance has transaction cost advantage in each case. Thus, the econometric model takes the form:

\[
\text{Prob}(\text{DomTrk} = 1) = F(\beta_{10} + \beta_{11} \text{DomTrk} + \beta_{12} \text{Doc} + \beta_{13} \text{JCities})
\]

\[
\text{Prob}(\text{IntAir} = 1) = F(\beta_{20} + \beta_{21} \text{IntAir} + \beta_{22} \text{Doc} + \beta_{23} \text{FinCities} + \beta_{24} \text{MarkSize})
\]

\[
\text{Prob}(\text{ForTrk} = 1) = F(\beta_{30} + \beta_{31} \text{ForTrk} + \beta_{32} \text{Doc} + \beta_{33} \text{FinCities} + \beta_{34} \text{MarkSize})
\]

where \(F(\cdot)\) denotes the normal distribution function.

Table 2 displays descriptive statistics for all variables. The correlation coefficients are generally small to moderate in magnitude, which suggests that multicollinearity does not raise a problem for our estimation.

6. Results and Discussion

Table 3 reports the Probit results for two sets of estimations: baseline models with only control variables and fully specified models with control and independent variables. First, consider the result with control variables only. Both constant and coefficient for \(\text{Doc}\) and \(\text{JCities}\) are statistically significant with respect to DomTrk. The positive sign for \(\text{Doc}\) indicates the parcels containing documents are more likely to be shipped by an integrated carrier. The negative sign for \(\text{JCities}\) supports that interpretation that the market for domestic trucking services is thick in Japan’s financial centers, which reduces the need for freight forwarders to vertically integrate. With 903 usable observations, the model correctly predicts organizational choice 67.7% of the time but provides little explanatory power (\(R^2 = 0.062\)).

The constant and coefficients for \(\text{Doc}\) and \(\text{FinCities}\) are statistically significant with respect to IntAir, while MarkSize is insignificant. The positive sign for \(\text{Doc}\) indicates that integration is the more likely organizational form when parcels contain documents. The negative sign for \(\text{FinCities}\) supports the interpretation that the market for international air services between Japan and foreign financial centers is sufficiently thick so as to reduce the need for freight forwarders to vertically integrate. With 902 usable observations, the model correctly predicts organizational choice 68.7% of the time but provides only modest explanatory power (\(R^2 = 0.169\)).

Finally, the constant and \(\text{Doc}\) are statistically significant with respect to ForTrk, while \(\text{FinCities}\) and MarkSize are insignificant. Again, the positive sign for \(\text{Doc}\) indicates that integration is the more likely organizational form when parcels contain documents. With 822 usable observations, the model correctly predicts organizational choice 69.0% of the time but provides little explanatory power (\(R^2 = 0.090\)).
### Table 2. Descriptive Statistics*

<table>
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<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min.</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<tr>
<td>DomTrk</td>
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<td></td>
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<td>KForTrk</td>
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<td>7</td>
<td>-0.029</td>
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<tr>
<td>Doc</td>
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<td>0.466</td>
<td>0</td>
<td>1</td>
<td>0.060</td>
<td>0.305</td>
<td>0.305</td>
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<tr>
<td>JCities</td>
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<td>0.258</td>
<td>0</td>
<td>1</td>
<td>-0.099</td>
<td>0.209</td>
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<tr>
<td>FinCities</td>
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<td>0.485</td>
<td>0</td>
<td>1</td>
<td>-0.074</td>
<td>-0.082</td>
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<tr>
<td>MarkSize</td>
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<td>0.079</td>
<td>0.001</td>
<td>0.198</td>
<td>-0.119</td>
<td>-0.005</td>
<td>-0.005</td>
<td>-0.005</td>
<td>-0.005</td>
<td>-0.005</td>
<td>-0.005</td>
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</table>

*Correlations greater than 0.071 are significant at the 0.05 level; N = 742

### Table 3. Probit Results

<table>
<thead>
<tr>
<th></th>
<th>Control Variables</th>
<th>Control and Independent Variables</th>
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<td></td>
<td>DomTrk</td>
<td>IntAir</td>
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<td>C</td>
<td>0.973**</td>
<td>-1.044**</td>
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<td>KDomTrk</td>
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<td>0.709**</td>
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<tr>
<td>KIntAir</td>
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<td>-1.032**</td>
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<td>KForTrk</td>
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<td>0.531</td>
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<tr>
<td>Doc</td>
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<td>-493.46</td>
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<tr>
<td>JCities</td>
<td>67.7%</td>
<td>68.7%</td>
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<tr>
<td>FinCities</td>
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<td>0.169</td>
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<tr>
<td>MarkSize</td>
<td>903</td>
<td>902</td>
</tr>
</tbody>
</table>

*99% one-tail confidence interval.
The addition of independent variables improves the models’ predictive power especially for domestic and foreign trucking segments. For DomTrk, we find as predicted that the coefficient for \( k_{DomTrk} \) is positive and significant; the greater the amount of real-time parcel information available from domestic trucking the greater the likelihood of vertical integration. Coefficients for the constant, Doc, and JCities retain the same sign as in the baseline model and remain significant. With 896 usable observations, the model correctly predicts organizational choice 72.3% of the time and provides explanatory power \( R^2 = 0.201 \)—a substantial improvement over the baseline model.

For IntAir, we find as predicted that the coefficient for \( k_{IntAir} \) is positive and significant; the greater the amount of real-time parcel information available from international air service the greater the likelihood of vertical integration. Coefficients for the constant, Doc, and FinCities retain the same sign as in the baseline model and remain significant. With 893 usable observations, the model correctly predicts organizational choice 64.0% of the time and provides only modest explanatory power \( R^2 = 0.147 \). Although \( k_{IntAir} \) is statistically significant, the loss of a degree of freedom and a reduction in the number of data lead to no improvement in the model’s explanatory power compared to the baseline model.

For ForTrk, we find as predicted that the coefficient for \( k_{ForTrk} \) is positive and significant; the greater the amount of real-time parcel information available from foreign trucking the greater the likelihood of vertical integration. Coefficients for the constant, Doc, FinCities, and MarkSize retain the same sign and level of significance as in the baseline model. With 815 usable observations, the model correctly predicts organizational choice 69.4% of the time—a minor improvement over the baseline model—and provides explanatory power \( R^2 = 0.157 \)—a substantial improvement over the baseline model.

The empirical results provide support for our theory. The greater the amount of real-time information available in each transportation segment—our proxy for the level of specific investment in a proprietary information network—the greater the likelihood that a freight forwarder integrates into that segment. Indeed, specific investment in an information network appears to be critically important for the organizational choice of domestic and foreign trucking services and at least somewhat important for international air services. Integration reduces the cost of hold-up and maladapation hazards that may emerge when specific investments are made in a dynamic and changing environment.

This finding is important given the fact that we have controlled for the effect of temporal specificity (Pirrong 1993; Nickerson and Silverman 1997) found in other TCE studies of logistics. Following Nickerson and Silverman (1997), we expect that the choice of logistics technology—hub-and-spoke versus point-to-point—introduces additional contracting hazards. In addition, documents, a highly time-sensitive freight which also requires the most complex coordination of pick-up and delivery operations, are found to correspond a greater likelihood of integration in each segment, as is shown by the Doc variable. This finding is consistent with Nickerson and Silverman’s (1997) conclusion that integration is more likely for hub and spoke logistics technology when freight is highly time-sensitive and on-time delivery is important.
Other control variables, while not perfect measures, do have currency. The control variable of total market size of air freight suggests that economies of scale (and possibly scope) are not available in the transportation segments—none of the empirical findings suggest vertical integration hinges on such economies. On the contrary, thick markets, at least in some instances, lead to contracting out transportation segments, ceteris paribus. Thus, high-volume geographic markets by themselves either have no effect on the integration decision or increases the likelihood of contracting out.

We note that our analysis is limited in a number of ways. A binary integration variable for each transportation segment was constructed even though more than two organizational alternatives are observed. In our paper, integration includes ownership, partial equity positions, and equity joint ventures. Additional variation in organizational choice might be explained if each organizational alternative was treated separately. Importantly, our analysis does not encompass any performance measures. Organizational choices are likely to have performance implications such as lower governance cost and/or higher service (i.e., shorter or more reliably delivery). In future research, we plan to investigate the performance implications of organizational choice for IC&SP service. We also note that our analysis, which controls for financial centers, does not control for nation-level institutional factors for destination countries. Williamson (1991) has argued that such factors may act as shift parameters that influence the choice of organization. In future research, we plan to incorporate variation in country-specific institutional factors in our analysis to control for such influences. Finally, the econometric method employed assumes errors between dependent variables are uncorrelated, which may not be an accurate assumption. In future research, we plan to explore the use of alternative econometric methods to correct for correlated errors (Chib and Greenberg 1996a; 1996b).

7. Conclusion

The information network assets for real-time data acquisition in the transportation segments of IC&SP service and the transmission of parcel information to the originating freight forwarder are important components for international courier firms. Because of competition and customer heterogeneity, some carriers choose to make specific and nonredeployable investments in their information networks. Our study supports the proposition that the greater the specific investment in an information network in each transportation segment, as proxied by the amount of real-time information available from each segment, the greater the likelihood of vertical integration in each segment. This result suggests that the multinational and multi-transportation segment integration is the governance structure chosen in response to the nature of investments in an information network. The analyses also show that integration in each transportation segment is more likely for parcels containing documents because they are lighter in weight, larger in number, and typically most time sensitive than small packages and other air freight.

Our paper extends TCE analysis of the logistics industry in several ways. First, the organization of international courier and small package service and investment in complementary information networks have received little academic attention.
Our paper not only is one of the first to investigate this topic but also provides an empirical analysis of a contractual hazard not previously studied by TCE research of logistics—investment in information networks. Second, unlike most TCE studies that analyze a single transaction, this paper analyzed a constellation of transactions involved the value chain of parcel delivery. Finally, no prior TCE study has analyzed freight-level data. This unit of analysis allows us to investigate why one firm may choose different organizational forms depending on the transportation routes.

Appendix

<table>
<thead>
<tr>
<th>Variable</th>
<th>Questions</th>
</tr>
</thead>
</table>
| $k_{DomTrk}$ | Q1  Whether not the package has been picked up  
Q2  Name of the pick-up driver  
Q3  Time of pick-up  
Q4  Place of pick-up  
Q5  Whether or not the package arrives at the local terminal  
Q6  Time of local terminal arrival  
Q7  Name of local terminal |
| $k_{IntAir}$ | Q8  Whether or not customs are cleared  
Q9  The time of customs clearance  
Q10 Whether not the package was loaded onto an airplane  
Q11 The loading time  
Q12 Whether or not the airplane departed  
Q13 The departure time  
Q14 The city the airplane departed from  
Q15 The cities that the package visits during the airline transit  
Q16 Whether or not the airplane landed at the destination airport  
Q17 Time of arrival |
| $k_{ForTrk}$ | Q18 Whether or not customs in the destination country has been cleared  
Q19 The time of customs clearance  
Q20 Whether or not the delivery truck departed from the local terminal  
Q21 The time the delivery truck departed from the local terminal  
Q22 Name of the local delivery terminal  
Q23 Whether or not the parcel has been delivered  
Q24 Time of delivery  
Q25 Location of delivery  
Q26 Name of receipt |
References


