

KIEP Working Paper 09-08

## Trade Openness and Vertical Integration: Evidence from Korean Firm-Level Data

Hea-Jung Hyun and Jung Hur

Using firm-level data on vertical integration of Korean manufacturers, the paper tests whether trade liberalization is an important determinant of firm's decision on vertical integration. We develop an empirical framework incorporating trade openness into industrial organization models; transaction costs theory and theory of internal costs of management. The empirical results of the paper suggest that trade openness is negatively related with vertical integration. A further analysis on firm's decision among four types of organizational forms in international contexts, however, reveals that trade liberalization has positive impact on cross-border vertical integration while it is negatively correlated with domestic vertical integration.

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FOR

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INTERNATIONAL  
ECONOMIC POLICY

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Economic Policy



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## **Executive Summary**

Using firm-level data on vertical integration of Korean manufacturers, the paper tests whether trade liberalization is an important determinant of firm's decision on vertical integration. We develop an empirical framework incorporating trade openness into industrial organization models; transaction costs theory and theory of internal costs of management. The empirical results of the paper suggest that trade openness is negatively related with vertical integration. A further analysis on firm's decision among four types of organizational forms in international contexts, however, reveals that trade liberalization has positive impact on cross-border vertical integration while it is negatively correlated with domestic vertical integration.

**Keywords: Vertical Integration, Trade Liberalization, Transaction Costs, Internal Cost of Management**

**JEL Classification: D23, L22, F23**

## 국문요약

최근 전세계적으로 기업의 수직적 분업이 급증하면서 이를 설명하기 위한 이론적 연구도 활발해지고 있다. 그러나 이론적 연구에 비해 이를 뒷받침할 수 있는 실증분석의 성과는 미미한 실정이다. 이에 본 논문에서는 한국 제조기업 데이터를 분석하여 무역자유화가 기업의 수직적 통합 의사결정에 영향을 미칠 수 있는 결정 변수인지에 대해 살펴보았다. 연구 결과 무역개방도는 기업의 수직적 통합에 부(負)의 영향을 미치는 것으로 드러났다. 그러나 기업의 조직형태에 지리적 요인을 추가로 고려하여 네 가지 조직형태 결정요인을 분석한 결과, 무역자유화는 국내 수직적 통합에는 부(負)의 효과를, 국경간 수직적 통합에는 양(陽)의 효과를 가져오는 것으로 입증되었다. 본 논문은 무역자유화 이외에도 거래비용이론이나 경영내부비용이론과 같은 전통적인 기업조직이론도 한국기업데이터 분석을 통해 뒷받침될 수 있음을 밝혔다.

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“Outsourcing types, relative wages, and the demand for skilled workers: New evidence from US manufacturing” (with Aekapol Chongvilaivan and Yohanes Eko Riyanto, *Economic Inquiry*, Vol. 47, No. 1, pp. 18-33, 2009) 외



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# Trade Openness and Vertical Integration: Evidence from Korean Firm-Level Data

Hea-Jung Hyun\* and Jung Hur\*\*

## I. Introduction

Vertical integration, the degree to which a firm owns its upstream suppliers and its downstream buyers had long been believed to be a stereotype of firm's management control. For past few decades, however, instances of vertical disintegration have been increasing rapidly. This trend is indeed facilitated by rising international production sharing - so-called "international fragmentation", "foreign outsourcing", or "international vertical specialization"- as one of the most remarkable phenomena of globalization. It is based on the belief that vertical disintegration can enhance the efficiency of production process, through reduction of costs or improving access to frontiers of technology.

A downstream firm is likely to integrate with an upstream firm

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when facing *ex-ante* high transaction costs. When the transaction cost can be saved for a certain reason, the need for integration is reduced and firms may increase vertical disintegration to take advantage of reduced transaction costs and gains from specialization. International trade can substantially lower transaction costs. McLaren (2000) points out that international trade may thicken the input market, mitigates the hold-up problem, reduces the transaction costs and ultimately allows a firm to downsize its organizational structure. Grossman and Helpman (2004) examine the implications of falling trade costs for the relative prevalence of the different organizational modes. Their model proves that trade liberalization may promote mostly foreign direct investment or outsourcing depending on the characteristics of a specific industry.

There is a dearth of empirical evidence in the relevant field. Using six-digit NAICS U.S. manufacturing data, Chongvilaivan and Hur (2009) find that trade openness measured as import penetration has negative impact on domestic vertical integration. However, they do not consider locational dimension of vertical integration, silent on the effect of trade on cross-border vertical integration and foreign outsourcing. By analyzing firm-level data on offshoring of Korean manufacturers, Hyun (2010) suggests that firm's global sourcing decision depends on firm characteristics. However, she does not take into consideration trade openness as a determinant of offshoring in the model.

Since hold-up problems in cross-border transactions are not uncommon, recent theoretical studies combine international trade with the model of hold-up problem to capture home vs. foreign outsourcing decision. Ornelas and Turner (2008) theoretically show that trade libe-

ralization through a lower trade costs induce vertical multinational integration more than cross-border arm's length transactions. In contrast, Antràs and Helpman (2004), considers a model of a firm heterogeneity and finds that trade liberalization is more likely to increase foreign outsourcing than cross-border vertical integration.

That is, to the best of our knowledge, unlike the theoretical developments, the empirical studies on how trade openness affects firms' decision on vertical integration in both domestic and international contexts remain unexplored at the level of firm data. The purpose of this paper is to attempt to fill this gap in the literature by testing whether trade liberalization indeed affects firms' decisions on vertical integration in the international market.

The main contribution of this paper is as follows. First, if our memory serves us correctly, this is the first study that uses Korean manufacturers' firm-level data to explore the role of trade liberalization in the choice of vertical integration. Vertical integration has been a particularly important issue in Korea. Korean *chaebol* were often regulated under the competition law because they could exercise dominant market power over small and medium sized firms in the market through vertical integration. The empirical results of the present paper can provide useful policy implications for Korea. Second, our empirical model builds upon conventional wisdom in industrial organization literature, incorporating trade openness as modeled in new international trade literature (Ornelas and Turner 2008; Antràs and Helpman 2004). Third, in addition to study on the degree of vertical integration measured as value added per sales, we further break down the type of vertical inte-

gration capturing the locational dimension into four categories: domestic vertical integration, cross-border vertical integration, foreign outsourcing, and domestic outsourcing. This enables us to detect the way trade openness, with other explanatory variables, influences different types of firm's organizational structure.

The remainder of this paper is organized as follows. Section 2 provides a review of the theoretical and empirical literature to identify the determinants of vertical integration in domestic and international context. Section 3 outlines empirical framework and describes data. Section 4 reports the empirical results of baseline model and robustness check. Section 5 provides the conclusion.

---

## II. Determinants of Vertical Integration: Literature Review

### 1. Transaction Costs

According to traditional theories of transaction costs (Williamson, 1975, 1986; and Klein *et al.* 1978), upstream and downstream firms in an industry may have an incentive for vertical integration in order to mitigate the lock-in effect as follows. Suppose that the upstream firm pays relationship-specific investments before it produces customized inputs for its downstream partner. It may then be infeasible to conduct an arm's-length transaction through the market, because the relationship-specific investments of the upstream firm risk their returns of being appropriated by the downstream partner. Hence, the downstream firm may incur a cost of commitment technology, such as a merger, in order to internalize input production. This theory predicts a positive correlation between vertical integration and investments in an industry.

Empirical studies have shown that a positive correlation does indeed exist. MacDonald (1985) used 79 two-digit U.S. manufacturing data to show that as the capital intensity of an industry is larger, it is more likely to be vertically integrated. Caves and Bradburd (1988) confirmed this finding using 83 four-digit levels of U.S. manufacturing data. Qualitatively similar results had been put forwarded by Levy (1985) with a sample of 65 firms and Lieberman (1991) with a data of Ameri-

can producers in chemical industries. Interestingly, Masten *et al.* (1989) showed that in U.S. auto industry human-capital intensive manufacturers are more vertically integrated rather than physical-capital intensive manufacturers. From these findings, it seems that the types of transaction costs may matter for the determinants of vertical integration. For this reason, we will consider different types of investments such as capital, R&D and information technology in our regression model.

## 2. Internal Costs of Management

Williamson (1970) and Penrose (1959) provide another explanation for vertical integration by internal costs of management. As the size of a firm becoming larger, it would incur larger internal costs such as assessment and monitoring costs for employees, longer decision processes, and greater information dissemination costs within a firm, etc. So, in order to reduce inefficiency arising from firm size, a larger firm may opt for division into smaller parts or downsize its plant, and outsource necessary inputs for final production. This theory predicts a negative correlation between vertical integration and internal costs of management. Frank and Henderson (1992) show that the degree of vertical coordination is negatively correlated with a firm's scale of activities in the U.S. food industry. We may need a variety of managing activities in order to consider various types of internal costs of managements. However, given the limitation of data availability, we will use firm size and ICT (Information and Communications Technology) as



proxies for internal costs of management.

### 3. Trade Liberalization

Literature on international economics incorporating contractual incompleteness also found that more integrated international markets may influence decisions for vertical integration. McLaren (2000) extends the transaction costs theories to examine the relations between trade liberalization and incentives for vertical integration. The idea is that, as the extent of openness of international trade becomes deeper and trade costs between nations are reduced, it would increase the so-called “thickness” in input markets. The “thickness” implies an input producing firm’s ability to find an alternative downstream partner. The increased opportunity in a larger market will eventually reduce the hold-up problem in their domestic market and undermine motives for vertical integration. This theory predicts a negative correlation between domestic vertical integration and trade openness.

If trade openness deters the incentive for domestic vertical integration, it may lead domestic firms to integrate with foreign firms in other countries. While McLaren (2000) considers the impact of free trade on reorganization of domestic industry whether to integrate or buy from its domestic upstream firm, Ornelas and Turner (2008) remove the choice of domestic industrial organization and instead consider a domestic downstream firm’s choice whether to integrate or outsource inputs from a foreign upstream supplier. As a result complementary to McLaren (2000), they show the theoretical possibility that lower tariffs

may indeed prompt multinational vertical integration. The intuition process in the study is as follows. As trade costs are reduced, the foreign supplier has more room to make a relationship-specific investment that lowers the cost of producing the inputs. So, it is more likely that the benefit from the internalization of investment decision outweighs the cost of merging. Hence, as trade is liberalized and trade costs are reduced, cross-border vertical integration outperforms foreign outsourcing. The empirical implication is that there will be a positive correlation between multinational vertical integration and trade openness. However, the earlier work by Antràs and Helpman (2004) employed a more general setting where a firm has four different choices such as domestic integration, domestic outsourcing, foreign integration and foreign outsourcing. They found that lower trade costs would lead firms to choose more often foreign outsourcing than foreign integration. Lower trade costs in their model play a role in decreasing firms' transaction costs between nations. Due to lower costs in international trade of intermediate goods, firms previously domestically insourced are more likely to engage in foreign outsourcing activities. As a result, they predict that trade liberalization (i.e. trade cost reduction) raises the percentage of firms that outsource in each respective country. This implies that trade openness is negatively correlated with domestic integration, positively correlated with domestic outsourcing, negatively correlated with foreign integration and positively correlated with foreign outsourcing. The two former relations are consistent with McLaren (2000), while the two latter relations are opposed to that of Ornelas and Turner (2008).

In the present paper, we will differentiate decisions taken by firms for domestic vertical integration, cross-border vertical integration, and foreign outsourcing so that we can test different predictions implied by the trade theories. In doing so, we simultaneously test alternative hypotheses such as transaction costs theories and international costs of management as well.

---

## III. Empirical Methodology

### 1. Empirical Model

Based on the discussion on theoretical background in section 2, our empirical model takes following form:

$$VI_{i,t} = a_0 + a_1 \text{Foreign\_owned}_{i,t} + a_2 K/L_{i,t} + a_3 R\&D_{i,t} + a_4 ICT_{i,t} + a_5 \text{Size}_{i,t} + a_6 \text{Trade}_{i,t} + a_7 \text{IND}_{i,t} + \varepsilon_{i,t}$$

where  $VI$  is vertical integration of firm  $i$  at time  $t$ . It is calculated as the ratio of value added to total sales, following the conventional way of measuring vertical integration (Adelman 1955; Gort 1962; Tucker and Wilder 1977 and Levy 1985). Since the range of  $VI$  is from zero to one, it is bounded below and above by random number, which makes it impossible to be nonstationary. Thus, we transform the ratio using logit function to allow it to vary without limit. For the robustness check, we used the binomial value representing a discrete decision on whether to integrate considering production location.

*Foreign\_Owned* is a dummy variable on whether a firm is foreign invested or not. The decision on foreign ownership conforms to *Foreign Investment Promotion Act* that defines as a 'foreign invested firm' a company with 10% or more of its shares taken up by investments from foreigners. Our data on foreign ownership was provided by KOTRA (Korea Trade and Investment Promotion Agency). Gorg *et al.* (2008) finds different characteristics between domestic firms and foreign

owned firms in outsourcing behavior. Host countries, meaning FDI recipient countries, usually expect positive effect of FDI on domestic economy through outsourcing to local suppliers. Foreign owned firms may also be more active in global sourcing using networks of foreign affiliates in the third country. In the regression, we examine whether foreign ownership matters in the choice of a firm's organizational form.

*K/L* is the ratio of capital assets divided by the number of workers. According to the transaction costs theories, when an upstream firm incurs a huge amount of sunk costs such as capital asset purchases and R&D investment in order to provide its input to downstream firms, it is less feasible for them to be independent and thus to have more incentive for integration, due to the fear of the risk of being appropriated by the downstream firm. More capital-intensive firms may prefer in-house production rather than outsourcing, as capital-intensive firms usually have production structures too complicated to depend on external procurement. Thus, the predicted sign of the effect of capital intensity is positive.

*R&D* stands for R&D intensity measured as R&D expenditure divided by total sales.

Antràs and Helpman (2006) suggest that R&D intensive firms tend to choose cross-border vertical integration rather than foreign outsourcing, as contracting is more difficult for technologically complex or advanced inputs. This logic may also be applied to domestic vertical integration and outsourcing. We expect positive signs for the effect of R&D on vertical integration.

*ICT* is the firm's level of internet use. The firm with a higher level of

internet use is likely to increase the efficiency of internal communications and to have smaller internal costs of management. This causes the firm to have less cost of transaction and thus more incentive for vertical integration. The role of ICT may be particularly important for transactions between firms. Harris, R. (2001) suggests that the rapid improvements and extensions in communications networks may substantially lower the coordination costs among related suppliers and customer firms in cross-border transactions. Our ICT data is constructed based on the survey results. The survey questionnaire classifies firms into the level of internet use. At stage 1, the lowest level, internet use is only for checking personal e-mail and searching for documents. At stage 2, brochure ware, building web sites and invoicing are available. Firms use e-commerce and on-line sales at stage 3. At stage 4, transactions between companies, invoicing, and connecting to the shipping system via internet occur. Stage 5 represents e-enterprise. All the business processes are re-engineered through combination of off-line and on-line activities, and the firm's internal organization and external partners are connected on-line. As ICT is indicated as a composite number, we create dummy variables for each stage and regress them on vertical integration. The cut-off point for ICT level affecting the degree of vertical integration is stage 3; e-commerce. Dummy variable of e-commerce is used to represent whether a firm has at least reached the ICT level of e-commerce.

*Size* is the sales of a firm. The idea is that the transaction costs tend to be larger as the firm size increases, due to inefficiency of internal management arising from cumulative loss of control (Williamson 1970) and the fixed nature of managerial capital (Penrose 1959). By 'Internal

controls', we mean the ability of a company to assess and monitor employees and ability to disseminate information within a firm. Thus, the larger firm is less likely to choose vertical integration. Negative sign is expected in the regression.

*Trade* is trade openness or trade liberalization. To investigate the role of trade openness as a determinant of vertical integration, we consider two measures of trade openness of firms. One is trade intensity measured as trade volume divided by firm size. The source of trade effect is examined by comparing the role of export and import. An alternative way of measuring integrated international market, as suggested in the theory of incomplete contract, is to consider trade liberalization at the industry level. This measurement, used for robustness check, is firm-adjusted industry export intensity, which is the export volume of industry excluding the firm's own export sales divided by total sales of industry less sales of the firm. The advantage of using the latter is that it enables one to estimate the effect of open environment of the industry to the foreign market on firm's choice of vertical integration. Also we can avoid potential endogeneity problems between trade openness and vertical integration by employing firm-adjusted export intensity.

*IND* is 23 industry dummy variable.

## 2. Data Description

For our empirical analysis, we merge two firm-level databases. Our data on the extent to which firms are engaged in vertical integration, capital intensity, sales and R&D are taken from 'KISVALUE'. KISVA-

LUE, Korean firm-level database provided by the Korea Information Service, contains detailed financial data based on financial statements of individual firms. The source of data for firms' decisions on four types of organizational form, ICT level, and trade variables is 'The survey on the international outsourcing by Korean manufacturers (2007)' undertaken by the survey institute Gallup Korea. Our dataset includes 814 firms covering year 2001 and 2006.

<Table 1> describes the structure of Korean manufacturing industry and mean value of vertical integration controlled by firm size. The second column presents industry distribution of 7662 manufacturing firms listed in KOSPI (Korea Composite Stock Price Index), KOSDAQ (Korean Securities Dealers Automated Quotations) and statutory audited firms. The third column presents industry distribution of 814 firms in our dataset. The correlation coefficient between industry share of two datasets is 0.904. Thus, the distribution of industry in our firm-level data seems to be close to the true distribution of the firms in manufacturing industries.

The level of vertical integration of 23 manufacturing industries, of which the measure is calculated as value added per sales, are shown in the fourth and the fifth columns. 13 out of 23 manufacturing industries experienced decreases in the average level of vertical integration between 2001 and 2006 while only 6 industries saw increase in vertical integration for 5 years. Publishing, printing and copying documents is the industry in which vertical integration is the most prevalent among whole industry. The average of vertical integration of auto and trailer sector is 0.34, ranking second in the list in 2001, but it is decreased to 0.22, dropping to fifth in 2006.



**Table1. Distribution of Industry and Vertical Integration**

	Share (KISVALUE)	Share (sample)	VI(VA/Sales) 2001	VI(VA/Sales) 2006
Food Manufacturing	5.3	4.55	0.19	0.20
Tobacco	0.07	0	N/A	N/A
Textile	3.42	3.19	0.23	0.18
Apparel & Fur Product	3.03	1.72	0.20	0.21
Leather, Bags & Shoes	0.87	0.98	0.08	0.14
Timber & Wooden Product	0.67	0.25	N/A	0.39
Pulp, Paper & Paper Product	2.02	2.09	0.19	0.19
Publishing, Printing & Copying Documents	2.75	1.35	0.41	0.40
Cokes, Petroleum & Nuclear Fuel	0.38	0.61	0.22	0.27
Compound & Chemical Products	9.48	13.76	0.24	0.23
Lubber & Plastic	5.13	4.91	0.29	0.23
Nonmetallic Minerals	4.23	4.18	0.22	0.14
Ferrous Metal Products	7.57	6.76	0.22	0.14
Nonferrous Metal Products	6.34	3.19	0.30	0.35
Miscellaneous Machinery & Equipment	12.89	10.07	0.29	0.21
Computer & Office Instrument	1.25	1.47	0.27	0.23
Electric Machinery & Electric Con- verter	5.02	5.28	0.28	0.23
Electronic Parts, Video, Sound & Telecommunication Facilities	11.59	17.44	0.26	0.22
Medical appliances, Precision & Optical Instrument	3.09	2.58	0.29	0.32
Auto & Trailer	9.63	7.49	0.34	0.22
Miscellaneous Transportation Equipment	3.07	0.98	0.26	0.20
Furniture	1.61	1.11	0.31	0.24
Recycling Processing Raw Materials	0.59	0.12	N/A	N/A

Source: KISVALUE (2009).

<Table 2> reports the percent share of each type of vertical integration by industry, based on the idea that a firm's characteristics may differ depending on the location as well as its pattern of vertical integration.

Table 2. Type of Vertical Integration

(Unit: % share)

	Domes- tic VI	Cross- border VI	FO	DO	Domes- tic VI	Cross- border VI	FO	DO
	2001				2006			
Food Manufacturing	50	5.3	5.3	39.5	44.7	2.6	7.9	44.7
Tobacco	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Textile	33.3	3.7	18.5	44.4	21.4	10.7	21.4	46.4
Apparel & Fur Product	6.7	13.3	40	40	0	31.3	43.8	25
Leather, Bags & Shoes	37.5	12.5	12.5	37.5	12.5	25	12.5	50
Timber & Wooden Product	50	0	0	50	50	0	0	50
Pulp, Paper & Paper Product	58.8	0	5.9	35.3	52.9	0	5.9	41.2
Publishing, Printing & Copy- ing Documents	40	0	0	60	40	0	0	60
Cokes, Petroleum & Nuclear Fuel	40	0	0	60	40	0	0	60
Compound & Chemical Products	52.6	2.6	4.4	40.4	41.2	2.6	8.8	47.4
Lubber & Plastic	62.5	10	5	22.5	42.5	10	5	42.5
Nonmetallic Minerals	51.4	5.7	2.9	40	38.9	8.3	5.6	47.2
Ferrous Metal Products	46.4	3.6	3.6	46.4	42.1	5.3	5.3	47.4
Nonferrous Metal Products	30	6.7	16.7	46.7	10	13.3	16.7	60
Miscellaneous Machinery & Equipment	25	7.1	15.5	52.4	18.8	12.9	20	48.2
Computer & Office Instrument	30.8	15.4	23.1	30.8	23.1	15.4	23.1	38.5
Electric Machinery & Electric Converter	35.7	7.1	11.9	45.2	23.3	11.6	20.9	44.2
Electronic Parts, Video, Sound & Telecommunication Facilities	30.2	11.4	13.4	45	21.9	18.7	23.2	36.1
Medical appliances, Precision & Optical Instrument	38.1	9.5	9.5	42.9	30.4	13.0	21.7	34.8
Auto & Trailer	28.1	4.7	14.1	53.1	11.9	14.9	22.4	50.7
Miscellaneous Transportation Equipment	9.1	18.2	27.3	45.5	0	33.3	25	41.7
Furniture	44.4	0	22.2	33.3	11.1	0	33.3	55.6
Recycling Processing Raw Materials	50	0	0	50	100	0	0	0

Source: Gallup Korea (2007).

Although the main implications should be similar, there may be a slight incongruency in the ranking of industrial choice on organizational form when we compare the index for vertical integration re-

ported in <Table 1> and <Table 2> because vertical integration is measured in different ways. Vertical integration of <Table 2> is measured as a binomial decision variable on the choice of organizational form while the level of vertical integration is measured as intensity of value added in <Table 1>. Furthermore, the numbers reported in <Table 1> are mean value of vertical integration for each industry, but numbers shown in <Table 2> are percentage shares of each type of organizational form within the industry.

Our dataset from Gallup Korea (2007) includes detailed information on the choice of a firm's organizational forms. It contains information on whether a firm is involved in domestic vertical integration, cross-border vertical integration between headquarter and foreign subsidiaries, foreign outsourcing, or domestic outsourcing. Some of these four types are not mutually exclusive, but many firms rather choose a mixed type as their optimal strategy. For example, firms can outsource to domestic suppliers and insource to its own foreign affiliates at the same time. Thus, we reclassify the organizational choices into four types that are mutually exclusive; domestic vertical integration only (DVI), cross-border vertical integration (CBVI), foreign outsourcing (FO), and domestic outsourcing only (DO). CBVI refers to a situation in which cross-border vertical integration is chosen as either the only type or one of multiple choices. FO includes foreign outsourcing, but not DVI or CBVI. Only domestic outsourcing corresponds to DO.

<Table 2> portrays a noticeable change of pattern in organizational form between 2001 and 2006. The majority of manufacturing industries (18 out of 22 except the tobacco industry, which was not subject to ob-

servations) experience decreases in domestic vertical integration. This decreasing trend of domestic vertical integration is offset by increasing cross-border vertical integration during the same period. CBVI either increases or remains the same at least in 21 out of 22 industries between 2001 and 2006. This trend also applies to the case of foreign outsourcing. The share of foreign outsourcing either increases or remains unchanged in most industries except transportation equipment. The changing pattern of domestic outsourcing is not clear. DO decreases in 8 industries while it increases for 11 industries.

<Appendix 2> shows correlation coefficients between main variables. Most variables are not highly correlated.

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## IV. Empirical Results

### 1. Main Results

We employ three estimation methods to estimate the empirical model presented in Section 3: pooled OLS, random effects and multinomial logit estimations. Random effect estimation was chosen as a result of the Hausman test for model selection between random effects and fixed effects. Multinomial logit estimation is employed to test for the determinants of four types of organizational choices: the domestic vertical integration, cross-border vertical integration, foreign outsourcing, and domestic outsourcing.

Our empirical results are reported from <Table 3> to <Table 7>. <Table 3> reports the pooled OLS estimators of the effects of independent variables on the pattern of vertical integration. The results of the Hausman test are in favor of pooled OLS estimation compared to fixed effect estimation. Column (1) and (2) present the model with trade intensity. Column (3) and (4) show estimated results of the model with export intensity, while column (5) and (6) report the results of the model with import intensity. The coefficients of the effects of capital intensity show significant and positive sign from column (1) through column (6). The result supports the transaction cost theory, which argues that firms have more incentive for vertical integration when they face higher transaction costs. However, R&D intensity, another variable representing

**Table 3. Determinants of Vertical Integration: Pooled OLS**

	(1)	(2)	(3)	(4)	(5)	(6)
Foreign_owned	0.195** (0.080)	0.183** (0.089)	0.183** (0.078)	0.164* (0.085)	0.163** (0.081)	0.145* (0.088)
ICT	-0.026 (0.062)	-0.022 (0.063)	-0.021 (0.061)	-0.019 (0.061)	-0.0002 (0.060)	-0.001 (0.061)
K/L	0.041** (0.020)	0.046** (0.022)	0.044** (0.020)	0.048** (0.021)	0.039** (0.019)	0.046** (0.022)
R&D	0.031* (0.018)	0.018 (0.020)	0.033* (0.018)	0.018 (0.020)	0.028 (0.018)	0.019 (0.020)
Size	-0.092*** (0.026)	-0.097*** (0.027)	-0.093*** (0.026)	-0.097*** (0.027)	-0.113*** (0.025)	-0.122*** (0.027)
Trade	-0.052** (0.022)	-0.053** (0.023)				
Export			-0.054*** (0.019)	-0.051*** (0.020)		
Import					-0.013 (0.018)	-0.017 (0.019)
_cons	0.469 (0.582)	0.207 (0.722)	0.423 (0.583)	0.125 (0.712)	0.892 (0.573)	0.881 (0.695)
Industry dummies	No	Yes	No	Yes	No	Yes
R-sq.	0.082	0.145	0.086	0.146	0.078	0.143
Hausman	2.27	1.84	2.46	1.9	2.38	1.97
Number of Obs.	654	654	654	654	697	697

Notes: The heteroskedasticity-robust standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at 1%, 5%, and 10% respectively.

transaction cost, shows significant positive effect on vertical integration only in column (1) and column (3). The firm size is negatively related

to vertical integration. This result is in line with the conventional theory of internal costs of management implying that increasing inefficiency in internal cost of management such as monitoring cost due to the large size of the firm may lead firms to choose disintegration rather than integration. The effects of ICT level, however, are found to be insignificant in all six columns. Trade openness seems to have significant and negative impact on the degree of vertical integration. This result supports the arguments made by McLaren (2000). When the effect of trade is divided into that of exports and imports, the coefficients of both effects are shown to be negative. But only export intensity has a significant impact on vertical integration while the significance of the coefficient of import intensity disappears.<sup>1</sup>

<Table 4> shows the results of random effect panel estimates. Hausman tests to determine the appropriate empirical model between random effect estimation and fixed effect estimation show that there is no significant difference between the two methods. Thus, we have chosen random effect estimators. The main results are similar with pooled OLS estimators except some discrepancies in the size of coefficients and insignificance of the coefficients of R&D impact in all six specifications.

These results are partly consistent with the theoretical prediction. The theory of transaction costs is supported by consistently positive effect of capital intensity on vertical integration across various model specifications. The negative effect of firm size on the degree of vertical

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<sup>1</sup> We tested for the role of import penetration, but the coefficient of the effect of import penetration on vertical integration was insignificant. This result seems to be partly due to the problem of inconsistency in Korean industry classification standard between trade data and product data.

integration supports the theory of internal costs of management. The insignificance of the effects of ICT level on vertical integration may be

**Table 4. Determinants of Vertical Integration:  
Random Effect panel estimates**

	(1)	(2)	(3)	(4)	(5)	(6)
Foreign_owned	0.217** (0.090)	0.210** (0.099)	0.206** (0.088)	0.192** (0.097)	0.186** (0.091)	0.173* (0.099)
ICT	-0.003 (0.070)	0.003 (0.070)	0.001 (0.070)	0.005 (0.070)	0.018 (0.069)	0.020 (0.068)
K/L	0.037* (0.021)	0.039* (0.023)	0.040* (0.021)	0.041* (0.023)	0.037* (0.021)	0.042* (0.023)
R&D	0.016 (0.018)	0.005 (0.020)	0.018 (0.018)	0.004 (0.020)	0.015 (0.018)	0.006 (0.020)
Size	-0.103*** (0.028)	-0.109*** (0.029)	-0.104*** (0.028)	-0.11*** (0.030)	-0.122*** (0.028)	-0.13*** (0.029)
Trade	-0.046* (0.024)	-0.049* (0.025)				
Export			-0.048** (0.021)	-0.045** (0.022)		
Import					-0.012 (0.020)	-0.018 (0.021)
_cons	0.790 (0.634)	0.549 (0.767)	0.755 (0.635)	0.494 (0.774)	1.126 (0.625)	1.076 (0.743)
Industry dummies	No	Yes	No	Yes	No	Yes
R-sq.	0.081	0.144	0.084	0.145	0.077	0.141
Wald Chi-sq.	77.86	871.07	79.65	870.21	81.57	934.68
Hausman	1.69	1.37	3.97	3.09	4.02	3.22
Number of Obs.	654	654	654	654	697	697

Notes: The heteroskedasticity-robust standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at 1%, 5%, and 10% respectively.



the result of two mixed effects. ICT may have two different aspects. First, as the theory of internal costs of management predicts, ICT level can substantially reduce the cost of internal communications, specifically for intra-firm trade. Second, however, ICT level of a firm can also reduce cost of external communication between firms in arm's length transactions, positively affecting outsourcing while negatively related to vertical integration. Thus, possibly the effect of ICT on vertical integration may be insignificant due to two opposite forces. The consistently positive effect of foreign ownership seems to imply the different patterns of the choice of organizational form between Korean domestic firms and foreign firms; foreign invested firms are less likely to outsource to domestic suppliers. While some results are not fully supportive of transaction cost theory and theory of internal cost of management, our main prediction of the negative role of trade openness on the firm's level of vertical integration is justified by the empirical results.

## 2. Robustness Checks

To check for the robustness of the results, we employ multinomial logit estimates to examine the determinants of the choice for a firm's organizational form. As described in <Table 2>, we classify the organizational form into four types by taking into account both organizational and location dimensions: domestic vertical integration only, cross-border vertical integration, foreign outsourcing, and domestic outsourcing only. <Table 5> shows the estimation result without industry dummy variables. The main variables of interest seem to have different impact on vertical inte-

gration depending on organizational types. Foreign ownership has positive impact on domestic VI and the coefficient is significant at 1% level. The ICT level, while reporting that insignificant coefficient has a positive impact on cross-border vertical integration, does not seem to affect significantly domestic VI and foreign outsourcing. Capital intensity is positively correlated with domestic vertical integration having no effect on cross-border VI. R&D intensity also reveals different pattern of impact on organizational choices. The effect of R&D intensity is negatively related with domestic VI, while it enters positively as a determinant of the choice of cross-border VI and foreign outsourcing. The previous results in <Table 3> and <Table 4> reporting insignificant effect of R&D on vertical integration may be due to the mixed effect of two opposite forces between domestic VI and cross-border VI. Firm size is negatively related with the choice for domestic VI while it has insignificant effect on cross-border VI and foreign outsourcing. Thus, it can be inferred that consistently negative sign of the coefficients on the size effect on vertical integration comes mainly from impact of firm size on domestic VI. The effect of trade on a firm's organizational choice may differ according to firm location. Openness to trade has a negative relationship with domestic VI, which is consistent with McLaren (2000) and Antràs and Helpman (2004). The sign of the coefficients of trade openness become positive for the choice of cross-border VI and foreign outsourcing. The former relation is in line with Ornelas and Turner (2008) and the latter is consistent with Antràs and Helpman (2004). Column (4) through column (6) report the multinomial logit estimation result when trade is replaced by adjusted industry export to resolve potential endogeneity problem between firm trade and the choice

of organizational structure. The main implication is consistent with the estimates represented in column (1) through column (3) except the effect of R&D intensity on domestic VI. The negative effect of R&D on the choice of domestic VI disappears in column (4). The highly significant and negative sign of the coefficient of firm adjusted industry export on domestic VI confirms the result portrayed in column (1), supporting our prediction on the role of trade on VI, while it is not applied to the case of cross-border VI.

**Table 5. Multinomial Logit Estimates (without industry dummies)**

	(1)Domestic VI	(2)Cross- border VI	(3)Foreign Outsourcing	(4)Domesti c VI	(5)Cross- border VI	(6)Foreign Outsourc- ing
Foreign_owned	0.586*** (0.206)	-0.623 (0.501)	-0.107 (0.284)	0.553*** (0.200)	-0.695 (0.500)	-0.054 (0.281)
ICT	-0.233 (0.186)	0.716** (0.321)	0.103 (0.222)	-0.269 (0.185)	0.755** (0.316)	0.191 (0.218)
K/L	0.195** (0.076)	-0.182 (0.155)	-0.145 (0.112)	0.265*** (0.079)	-0.227 (0.154)	-0.113 (0.109)
R&D	-0.252*** (0.060)	0.209* (0.108)	0.162** (0.070)	-0.465 (0.479)	0.916** (0.358)	0.747*** (0.270)
Size	-0.122** (0.061)	-0.013 (0.110)	0.017 (0.089)	-0.184*** (0.060)	0.185 (0.118)	0.121 (0.086)
Trade	-0.105* (0.054)	0.518*** (0.187)	0.213** (0.090)			
adj-Export				-1.266*** (0.422)	1.861*** (0.717)	1.497*** (0.485)
_cons	-0.338 (1.637)	-1.249 (2.587)	-0.223 (2.054)	-0.622 (1.705)	-3.398 (2.714)	-2.603 (2.065)
Log pseudo likelihood		-1455.52			-1412.01	
Pseudo R-sq.		0.067			0.050	
Number of Obs.		1347			1278	

Notes: The robust standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at 1%, 5%, and 10% respectively.

<Table 6> reports the multinomial logit estimates with industry dummies. Main results remain consistent with results presented in <Table 5> except the significant size effect on cross-border VI and foreign outsourcing.

**Table 6. Multinomial Logit Estimates (with industry dummies)**

	(1)Domestic VI	(2)Cross-border VI	(3)Foreign Outsourcing	(4)Domestic VI	(5)Cross-border VI	(6)Foreign Outsourcing
Foreign_owned	0.621*** (0.213)	-0.607 (0.535)	-0.049 (0.300)	0.587*** (0.209)	-0.701 (0.514)	0.028 (0.295)
ICT	-0.311 (0.194)	0.799** (0.335)	0.194 (0.232)	-0.346* (0.194)	0.824** (0.329)	0.280 (0.229)
K/L	0.162*** (0.082)	0.028 (0.171)	-0.069 (0.129)	0.173** (0.083)	-0.023 (0.168)	-0.005 (0.125)
R&D	-0.213*** (0.066)	0.122 (0.125)	0.108 (0.077)	-0.271 (0.484)	0.697* (0.387)	0.632** (0.295)
Size	-0.167** (0.067)	0.020 (0.120)	0.065 (0.101)	-0.222*** (0.065)	0.259** (0.115)	0.17* (0.096)
Trade	-0.107* (0.059)	0.466** (0.184)	0.193** (0.096)			
adj-Export				-1.602*** (0.386)	2.205*** (0.825)	1.699*** (0.578)
_cons	1.479 (1.837)	-4.598 (3.321)	-4.496 (2.762)	2.027 (1.895)	-7.948** (3.318)	-7.434*** (2.822)
Log pseudo likelihood		-1350.81			-1317.98	
Pseudo R-sq.		0.135			0.113	
Number of Obs.		1347			1278	

Notes: The robust standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at 1%, 5%, and 10% respectively.

To further confirm the significant role of exporting environment on a firm's level of vertical integration, we implement pooled OLS and

random effect estimation including firm-adjusted export of industry instead of trade intensity of individual firms. As posted in <Table 7>, the main implications of the empirical result remain unchanged.

**Table 7. Determinants of Vertical Integration**

	(1)Pooled OLS	(2)Random Effect
Foreign_owned	0.133 (0.089)	0.158* (0.097)
ICT	-0.013 (0.066)	0.008 (0.072)
K/L	0.042* (0.023)	0.038* (0.024)
R&D	0.018 (0.022)	0.002 (0.022)
Size	-0.133*** (0.030)	-0.141*** (0.032)
adj-Export	-0.062*** (0.019)	-0.062*** (0.018)
_cons	1.049 (0.866)	1.383 (0.867)
R-sq.	0.14	0.14
Wald Chi-sq.		928.83
Number of Obs.	614	614

Notes: The heteroskedasticity robust standard errors are in parentheses. \*\*\*, \*\* and \* indicate significance at 1%, 5%, and 10% respectively. 23 industry dummy variables are included.

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## V. Conclusions

In this paper, we have tested whether trade liberalization is an important determinant of a firm's organizational form. The empirical tests on Korean manufacturing firms show that trade openness may adversely affect a firm's vertical integration. It supports the extended theory of transaction costs suggesting that decreased costs of transaction due to trade openness will contribute to mitigating the hold-up problem and will ultimately reduce the incentive for vertical integration in the domestic market. This relation, however, can differ depending on production location. The empirical results from robustness check show that the negative effect of trade openness still holds for domestic vertical integration while the effect becomes positive for the choice of cross-border vertical integration. This result is in line with Ornelas and Turner (2008), which proves that multinational vertical integration is increased because, as trade is liberalized and trade costs are reduced, the foreign supplier has more room to make a relationship-specific investment that lowers the cost of producing the inputs, which makes cross-border vertical integration more attractive than foreign outsourcing. Even though the positive sign of the effect of trade openness on foreign outsourcing is not consistent with Ornelas and Turner (2008), the larger size of the coefficient on cross-border vertical integration than foreign outsourcing can be interpreted as the outperformance of the effect of trade on cross-border VI compared to foreign outsourcing.

The main findings of this paper have important policy implications. The conclusions of our paper suggest that as trade openness, either at the firm level or industry level, is crucial for vertical disintegration in the domestic market, policies should be designed to promote trade, and exporting in particular, to induce downsizing of organizational structure of manufacturing firms. It will also help foster overseas investment by Korean manufacturers to participate in the international production network.

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# Appendix

## Appendix 1. Summary Statistics

Variable	Observation	Mean	Standard deviation
Foreign_owned	1628	0.202	0.402
VI	1039	0.229	0.299
ICT	1628	0.363	0.481
K/L	1460	4.E+07	8.34E+07
R&D/Sales	1033	3.951	12.944
Sales	1559	2.E+11	7.E+11
Export/Sales	1538	0.282	0.308
Import/Sales	1628	0.262	0.288

Source: KISVALUE (2009); Gallup Korea (2007).

## 2. Correlation Matrix

	Foreign_owned	ICT	VI	K/L	R&D	Size	Export
Foreign_owned							
ICT	0.065						
VI	0.045	-0.084					
K/L	0.034	-0.016	0.090				
R&D	-0.035	0.067	0.041	-0.214			
Size	-0.040	-0.201	0.264	0.425	-0.338		
Export	0.015	0.126	0.090	0.151	0.069	0.160	
Import	0.122	-0.068	0.003	0.039	0.073	0.106	0.294

Source: KISVALUE (2009); Gallup Korea (2007).

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