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On the Probabilities and Determinants of Global Sourcing in Korean Industry : An Empirical Analysis Using a New Firm-Level Dataset

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Abstract

Based on a recently constructed firm-level panel dataset, *Survey of Business Activities*, 2006~08, from the National Statistics Office (NSO), we empirically analyzed probabilities and determinants of global sourcing in Korean industry by setting up a panel logit model and a panel tobit model.

This paper is likely the first attempt to utilize firm-level panel dataset in the study of global sourcing, which can be regarded as an important step forward in this field in the sense that the dataset could correct the chronic distortion that conventional Input-Output data causes, which has been taken to substantially overestimate global sourcing since, besides global sourcing, it also includes ordinary trade not classified to global sourcing.

The results show that a larger firm that invests more in R&D, exports more, and is more informatized appeared more likely to engage in and expand global sourcing significantly. According to industry, the effect of lagging returns on invest, capital-labor ratio, and number of patents derived from global sourcing appears mixed. We might arguably obtain a more rigorous result than existing studies that rely only on cross-sectional or IO data by taking the endogeneity problem and industry/firm characteristics into consideration. A set of research topics for subsequent study/analysis was presented with the conclusion.

Ⅰ. Introduction

The world economic environment has changed substantially over the past decades, as have business strategies responding to these environmental changes.

Among them, one remarkable phenomenon is a widening trend in production sharing between–and within–domestic and international firms. The trend has something to do with the twin forces of increasing integration of the global economy and a disintegration of production processes. Due to the considerable fall in transaction costs due to ICT development and the enhanced international flows of resources, this unprecedented trend has prevailed so quickly worldwide.

Figure 1. An Illustration of Sourcing, Location, and Global Sourcing

		Location	
		Domestic (Within countries)	International (Between countries)
Sourcing	Outsourcing (Between firms)	Domestic Outsourcing	International Outsourcing
	Insourcing (Within firms)	Domestic Supply	International Insourcing

Sources : Olsen(2006).

Though as yet there is no definite consensus on an explanation of this trend, probably the most widely accepted categorization[1] is Olsen's(2006), which is depicted in <Figure 1>. To wit: a firm can choose to procure intermediate inputs in four ways that correspond to the best combination of sourcing and location.

OECD(2007) added another description of offshoring to the aforementioned categories, which was intended to explicitly distinguish internal and external[2] production sourcing:

> In other words, production abroad of an enterprise's activities could be carried on internally(*offshore in-house sourcing*), or externally(*offshore outsourcing*), which corresponds to *subcontracting abroad*.

The recent trend, in particular, seems to be strengthening more rapidly in the area of international production sharing, for both outsourcing and insourcing (the shaded areas in <Figure 1>), which we will hereafter name "global sourcing", following Antras and Helpman(2004).[3]

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1) Alternatively, The Offshoring Research Network(ORN) of Duke University refers offshoring to the process of sourcing business functions or processes supporting home-based or global operations from a foreign country, either through wholly-owned organizational units(captive offshoring/shared services) or external service providers(offshore outsourcing), which we might say is not very different from OECD's categorization in general.

2) See OECD(2007) Chapter I for more of the definition of offshoring.

3) In many other studies the term "offshoring" is widely used interchangeably or in lieu of "global sourcing." It tends conventionally to put more emphasis on offshore relocation of employment. Not interested in the employment feature, we would stick to global sourcing throughout this paper.

Now that firms have more options regarding sourcing and location in their production process than any time in the past, organizational choices among conventional exports/imports, vertical integration, foreign direct investment, licensing, onshore outsourcing, offshore outsourcing, and so forth has become an endogenized factor. What factors then, would affect any endogenous organizational choice?

Global sourcing depends on uncertain contracts with firms outside the border where operational risks arise due to differences in custom, law, institution, incomplete information, incentive conflicts, etc. which by nature brings about transaction cost and property-rights problems.

On the one hand, according to the 'transaction cost theory', firms weigh the benefits from concentrating only on core processes in production against the costs caused by an international search for such uncertain contracts. Abraham and Taylor(1996) asserted that firms tended to apply the tenets of global sourcing in order to defend themselves from issues such as unforeseen volatility in product demand, to promote acquisition of high technology, and to realize potential economies of scale. Diaz-Mora(2007) placed great emphasis above all on reductions in labor costs.

On the other hand, according to the 'property right theory', firms make an organizational choice between vertical integration and global sourcing to effectively avoid the hold?up problem.[4] Grossman and Helpman(2002, 2005) showed that a firm chose its organizational form in consideration of search cost, bargaining power, market size, and substitutability of products. Antras and Helpman(2004)

4) For more of the hold-up problem, see Holmström and Roberts(1998), for instance.

considered ownership of a corporation and location of producers as the key factors of production activity in a firm's behavior and examined how the firm's characteristics in the production process affected organizational choice. Taking the cost of communication and duplication of technologies as critical criteria, Antras, Garicano, and Rossi-Hansberg(2006) found that the higher the cost, the bigger their size, and the higher their productivity, the more likely firms were to choose global sourcing.

Amiti and Wei(2009) related global sourcing to familiar trade theories:

> The fragmentation of production stages has been widely studied within a trade-theoretic framework by Dixit and Grossman(1982), Jones and Kierzkowski(1990, 1999, 2001), Cordella and Grilo(1998), Deardorff(1998, 2001), Amiti(2005) and others. This same phenomenon has also been referred to in the literature as international production sharing, globalised production, de-localisation, slicing up the value chain and offshoring. Some authors go on to distinguish between who owns the production stage abroad: when it is owned by the same firm it is referred to as vertical FDI or intra-firm trade; and when it is owned by a foreign firm it is referred to as arms-length trade or international outsourcing. Antras and Helpman(2004) distinguish between domestic and international outsourcing.

Recently, based on a wide range of survey analysis, the Offshoring Research Network(2007) provided a new perspective which stated that a growing and intensifying global race for international talent(highly qualified personnel) would soon become a major driving force for global sourcing.

Data and empirical studies based on Input?Output Tables seemingly support the growing trend to global sourcing. De Backer and Yamano(2007) produced evidence of global sourcing from the OECD International Input–Output Database during 1995~2000 to show that it has been rising in most countries in both manufacturing industries and market services. Using the U.S. Input–Output Tables, Amiti and Wei(2009) also reported that during 1992~2000, material offshoring increased at an annual average rate of 4.4% while service offshoring at 6.3%, although the share of offshoring to total input in 2000 exhibited quite a big gap between 17.3% for material and 0.3% for service. Utilizing a similar methodology to that of Amiti and Wei (2005)'s, Kim (2006) obtained an analogous pattern of offshoring in the Korean manufacturing industry to that of the U.S. case cited. Park(2009), employing the latest Input–Output data, confirmed a comparable picture for Korean industry as a whole.

Input–Output data clearly have advantages as a data source to study global sourcing in that they are formal, dependable, easy to access, viable to analyze, etc. However, they also have disadvantages, one of which is critical in the sense that Input–Output data

Table 1. Trends in Material and Service Offshoring

Unit : trillion won, %

	Total Amount		Share to Total Input	
	1995	2005	1995	2005
Material Offshoring	67.2	191.0	27.2	28.8
Service Offshoring	0.5	5.6	0.2	0.8

Source : Park(2009).

could overestimate the amount of global sourcing because not only does this include global sourcing, but also the standard trade of intermediates. That is, global sourcing based on Input−Output data might have a fundamental measurement error and henceforth it could miss the mark leading to loose or wrong conclusions.[5)]

A measurement problem can be checked by comparing Input−Output with firm−level survey data(as an alternative data source). In De Backer and Yamano(2007) where Input−Output data were used, the share of global sourcing to total input was 8% for Japan and 60~75% for Ireland; where firm−level data were used, the figures showed 1.2~1.8% for Japan in Hijzen, Inui, and Yasuyuki(2010) and 0.8~3.2% for Ireland in McCann(2009). As can be easily noticed, there exists a substantial discrepancy, evidence of such a measurement error lying in Input−Output data.

We would prefer firm−level data to Input−Output data since this is far less likely to cause a measurement problem. Also, when it comes to the number of samples in a micro−level analysis, it is well known that more observation is better. Practically, however, it is not easy to obtain formal and dependable firm−level data. Such data did not become available until the National Statistics Office(NSO) issued its *Survey of Business Activities*(*Survey* hereafter) after 2006 which contained a variety of key business factors and information about 10,786 firms(68,202 establishments) across all industries as of 2006. In particular, for the first time it formally included a series including both international outsourcing and international insourcing that matched to "global sourcing" figures, which satisfied our earnest

5) For more on issues in measurement of global sourcing(or offshoring) using Input−Output data, see De Backer and Yamano(2007) and OECD(2007).

demand for firm-level data in this study of the topic.[6] [7]

Taking advantage of the *Survey* data, we examined two main questions on global sourcing in this paper: First, what factors would make global sourcing more likely to happen? Second, what factors would prompt firms to engage in global sourcing in reality? To analyze the two questions we used the panel logit method and the panel tobit method, respectively.

The rest of the paper is organized as follows. Chapter II describes the data. In Chapter III we set up models and estimation strategies. Chapter IV provides estimation results and interpretation. Finally, Chapter V concludes with some policy implications and future research topics.

6) For more in detail on survey items, see Statistics Research Institute(2009).

7) To our knowledge, a notable exception was the cross-section data used in Hyun et al(2007) and Hyun(2010). However, the data contained 698 firms for 2006 only, which could not avoid the endogeneity problem between dependent and explanatory variables.

Ⅱ. Trends in Global Sourcing : What the *Survey* Shows

As of the end of 2010, only the three-year period from 2006~08 of a firm-level survey on global sourcing is available in the *Survey*. The limited time series of the data prevented the construction of a panel data sizable enough for a dynamic analysis. Though short of time series analysis, it still has enough observations to handle the endogeneity problem and examine on cross-sectional characteristics of global sourcing. We leave it for a future study to explore the dynamic characteristics of global sourcing until more time series data will become available.

<Table 2> summarizes the trend of the number of firms engaging in global sourcing by industry that the *Survey* data provided. Accordingly, the absolute number of firms in global sourcing is rather small in that not more than five percent of total firms on annual average utilized this business strategy during those three years, and the number declined.[8] Among industries, manufacturing and services lay atop the list followed by construction. In services, Wholesale and Retail, Publishing, and Business Services, etc., had some involvement. In the meantime, three industries — Agriculture, Electricity, Financial Intermediation — did not take advantage of global sourcing during the time span.

8) Precisely, from 523/10,786 in 2006 to 471/10,748 in 2007 to 440/10,928 in 2008 which are equivalent to 4.85, 4.38, and 4.03, respectively.

Table 2. The Number of Firms in Global Sourcing by Industry

Unit : firm

Industries	Total Firms			Firms in GS		
	2006	2007	2008	2006	2007	2008
Agriculture, Forestry, Fishing, Mining and Quarrying	41	36	32	0	0	0
Manufacturing	6,082	5,927	5,807	393	343	312
Electricity, Gas and Water Supply	97	105	105	0	0	0
Construction	653	633	638	33	36	36
Services	3,913	4,047	4,346	97	92	92
Wholesale and Retail Trade, Restaurants and Hotels	1,020	1,042	1,086	35	30	22
Transport and Storage	666	675	650	8	5	5
Publishing, Broadcasting, Movie, Information and Communication	756	771	865	26	20	24
Real Estate and Renting	214	228	253	3	5	5
Financial Intermediation	145	159	161	0	0	0
Business Services	870	928	1,073	22	29	32
Other Services	242	244	258	3	3	4

Source : National Statistics Office.

In terms of sales share by industry <Table 3> shows a similar pattern to what <Table 2> shows in the number of firms. It appears in <Table 3> that firms procured far less amount of intermediates through global sourcing than Input−Output data implied. Remember, the two datasets have quite different measurements. The sales share of global sourcing to total sales, when the total number of firms is considered, does not exceed 1% in each industry, while the share varies from 0.87 to 18.76 when only firms engaging in global

Table 3. The Sales Share of Firms in Global Sourcing by Industry

Unit : %

Industries	Total Firms			Firms in GS		
	2006	2007	2008	2006	2007	2008
Agriculture, Forestry, Fishing, Mining and Quarrying	0	0	0	0	0	0
Manufacturing	0.51	0.47	0.52	7.94	8.11	9.61
Electricity, Gas and Water Supply	0	0	0	0	0	0
Construction	0.13	0.19	0.25	2.64	3.43	4.45
Services	0.26	0.16	0.17	10.72	7.32	8.13
Wholesale and Retail Trade, Restaurants and Hotels	0.54	0.28	0.23	15.85	9.81	11.23
Transport and Storage	0.23	0.13	0.12	18.76	17.26	15.27
Publishing, Broadcasting, Movie, Information and Communication	0.25	0.11	0.21	7.31	4.02	7.51
Real Estate and Renting	0	0	0	0	0	0
Financial Intermediation	0.02	0.12	0.02	1.54	5.38	0.87
Business Services	0.14	0.17	0.21	5.51	5.58	6.91
Other Services	0.08	0.10	0.07	6.36	7.96	4.78

Source : National Statistics Office.

sourcing are considered. In services, it is most noticeable that financial intermediation is the poorest in global sourcing, and not up to expectations.

Combining <Table 2> and <Table 3>, we can recognize through the *Survey*, a new and rare firm–level dataset, an indication that global sourcing has been a rather uncommon business activity among Korean industries up to this stage, contrary to what the Input–Output data told in the IO–based studies. It could mean that when we explore global sourcing for which a particular excessive data problem exists, we should be careful to choose relevant data and then handle them appropriately. Furthermore, Korean industries and firms need to find ways to take advantage of production–sharing as an industrial as well as business strategy in both present and future scenarios; this approach could prospectively turn out to be very useful in enhancing firms' business performance.

Ⅲ. Models and Data

1. Estimation Models

There are simply too many variables potentially affecting global sourcing for us to consider them all. Therefore, we selected several widely accepted explanatory variables to estimate their effects on global sourcing: especially those which we expect to complement existing studies and reflect the specific characteristics of our dataset, the *Survey*.

The basic equation is given in (1), where global sourcing is accounted for by various factors such as business performance, a set of control variables, time and firm dummies, and an error term.

$$y_{it} = \beta_o + R_{it-1}\beta_1 + X_{it}\beta_2 + T_t\beta_3 + u_i + \varepsilon_{it} \qquad (1)$$

where y_{it} is the dependent variable representing either possibility (log of odds or logit) or share (global sourcing to sales) of global sourcing; R_{it-1} means a firm's business performance and here we use a lagged return of investment (ROI) as a proxy[9] for business performance; X_{it} is a vector of control variables which manifest firm characteristics — total employment, R&D expenditure per the

9) When there exists a two-way causality between global sourcing and business performance (ROI), simultaneity could lead to an endogeneity problem. A lagged ROI is chosen to avoid this problem.

employed, exports−sales ratio, capital−labor ratio, number of patents a firm holding, introduction of e−business system, and so forth. T_t and u_i are time and firm dummies, respectively. T_t purports to capture general fluctuation of each year while u_i individual firm's fixed effects. ε_{it} is an error term. In particular, the e−business system, a crucial tool for modern international exchange of goods, services, information, and knowledge based on evolving networks, is employed to stand as a proxy variable for whether the firm utilizes ICT on its business activities and global sourcing.

The possibility of global sourcing is analyzed with panel logit method, in that it seeks to determine whether a firm's choice to engage in global sourcing($\Psi_{it}=1$) depends on its probability $P(\Psi_{it}=1)$ as follows in (2) as a usual logit model suggests.

$$P(\Psi_{it}=1)=\frac{e^{y_{it}}}{1+e^{y_{it}}} \tag{2}$$

Since a logit is defined as a log of odds, that is, probability of an event occurring to not occurring, (3) holds.

$$\text{In}\left(\frac{P}{1-P}\right)=y_{it} \tag{3}$$

Hence the observed dependent variable y_{it} will have a binary choice, either 1 (global sourcing) or 0 (no global sourcing).

Combining (1), (2) and (3), we can set up an estimation model using the logit model as shown in (4) and are ready to examine what factors could affect the introduction of global souring into business activities based on panel data constructed from the *Survey*. The

Survey is tailored to fit the purpose of our empirical investigation and to build a panel dataset which consists of more than four thousand individual data points.

$$\text{In}\left(\frac{P}{1-P}\right) = y_{it} = \beta_0 + R_{it-1}\beta_1 + X_{it}\beta_2 + T_t\beta_3 + u_i + \varepsilon_{it} \qquad (4)$$

In the meantime, for the determinants of global sourcing, we use a panel tobit method since, according to the *Survey*, a majority of firms do not engage in global sourcing in that many observations are censored from below, i.e., zero. The basic panel tobit model which we will use here is given in (5) where the share of global sourcing to total sales(y_{it}) becomes equal to its true value(y^*_{it}) when global sourcing is observed as nonzero, and zero otherwise.

$$y_{it} = \begin{cases} y^*_{it}, \text{ if } y^*_{it} > 0 \\ 0, \text{ otherwise} \end{cases} \qquad (5)$$

where $y_{it}^* = \beta_0 + R_{it-1}\beta_1 + X_{it}\beta_2 + T_t\beta_3 + u_i + \varepsilon_{it}$. Like a usual tobit model, if a firm's individual heterogeneity is not controlled in a panel dataset (if there is no u_i above), an omitted variable bias will take place and its pooled OLS estimator will be inconsistent. To control the heterogeneity problem, here we design a panel tobit model equipped with random effects[10] (u_i) which will separate individual

10) We take and use u_i as random effects in (5), not fixed effects as in (4). Random effects are known to produce a consistent and efficient estimator only if u_i is orthogonal(mutually independent) to other explanatory variables. Otherwise, fixed effects would be a better choice conventionally. However, like the case of ours that has only short time series along with

heterogeneity, avoid an omitted variable bias, and consequently, produce a consistent estimator. That is, random effects u_i play an important role in improving estimation results.

2. Data

As mentioned earlier, we constructed a panel dataset from National Statistics Office's *Survey of Business Activities*, 2006~08 and use it to our estimation. The Survey covered by far more than 10,000 firms across all industries. Subject firms were limited to those in which number of employees exceeded 50 workers and amount of capital 0.3 billion won. In terms of sales total, the firms represented about 70% of all firms.

<Table 4> provides summary statistics of total industry. Statistics in <Table 4> include the total number of samples (N=15,764) used in the panel logit estimation. Due to the existence of a lagged variable (R_{it-1}), we lost a year and 2007 and 2008 only could be used. Among all industries, three of which lack global sourcing or other needed data were excluded – Agriculture, Electricity, Financial Intermediation.

Global sourcing dummy (*gsdum*) and global sourcing share (*gs_sales*) are the dependent variables used in estimating a probability of global sourcing in (4) and determinants of global sourcing in (5), respectively. From those figures we see only 4% of firms expend a marginal 0.3% of total sales on average between

long cross-sections, random effect, to the contrary, can be a better choice than fixed effects. See Cameron and Trivedi (2005).

Table 4. *Summary Statistics : Total Industry*

Variables	Definition	Measurement	mean	std. dev.
gsdum	global sourcing dummy	firms engaging in global sourcing = 1	0.04	0.2
gs_sales	global sourcing share	share of global sourcing to total sales	0.3	2.6
R_{it-1}	return on investment (ROI)	profit to asset, lagged	35.9	1,006.0
emp	total employment	sum of all type of employment	341.3	1,663.1
rnd_emp	R&D expenditure per employment	all type of total R&D to total employment	3.6	9.4
ex_sales	export−sales ratio	exports to total sales	11.2	22.8
k_emp	capital−labor ratio	total tangible asset to total employment	121.3	1,842.0
patent	number of patents	number of patents paying registration fees regardless of patent development	31.2	1,222.1
ebizdum	e−business system dummy	firms introducing e−biz system = 1	0.6	0.5
N of obs.			15,764	

2007 and 2008. Return on investment represents a firm's profitability. Of all firms in the data, the average was 35.9%. Total employment measures the size of a firm and averages about 341 persons employed per firm. R&D expenditure per employment is taken as a level of technology and innovation activity, which turned out to be 3.59 million won on average. An 11% Export−sales ratio indicates the average degree of openness to foreign markets.

Capital-labor ratio suggests a structural type of firm integration, 121 million won on average. The average number of patents, 31, that a typical firm holds *de jure* shows accumulated technologies. An e-business system[11] is related to the extent of utilization of ICT, and 60% of firms appear to utilize it.

Figures shown regarding return on investment and number of patents have especially high standard deviations compared with other variables, which means that firms disperse widely in those categories.

<Table 5> provides comparable summary statistics with <Table 4> for manufacturing and services separately. The two sectors reveal common as well as distinctive characteristics for some variables, both dependent and explanatory. Comparing the dependent variables, *gsdum* and *gs_sales*, we can notice that global sourcing is more likely to take place and its share to sales per firm tends to be bigger in manufacturing than in services; from these statistics we may well infer global sourcing to take place more often in the former than in the latter. Specifically, both *gsdum* and *gs_sales* in manufacturing are twice as high as in services: 5% vs. 2% for *gsdum* and 0.45% vs. 0.19% for *gs_sales*. This gap seems to reflect manufacturing's characteristics to consign longer-term production sharing. We will verify what actually drives global sourcing in the following chapter.

11) E-business refers the business activities such as enterprise resource planning(ERP), learning management system(LMS), knowledge management system(KMS), human resource management system (HRMS), customer relationship management(CRM), supply chain management(SCM), etc. Simple computer softwares for personnel management, accounting, etc. are not counted in.

Table 5. Summary Statistics: Manufacturing vs. Services

Variables	Manufacturing		Services	
	mean	std. dev.	mean	std. dev.
gsdum	0.05	0.23	0.02	0.15
gs_sales	0.45	2.98	0.19	2.11
R_{it-1}	22.57	273.50	60.87	1,648.21
emp	308.82	1,965.90	367.13	1,152.98
rnd_emp	4.48	9.54	2.20	9.24
ex_sales	17.44	26.41	2.97	13.31
k_emp	106.44	142.80	160.45	3,078.69
patent	50.38	1,609.50	5.50	100.85
ebizdum	0.63	0.48	0.53	0.50
N of obs.	9,063		5,621	

In the meantime, whereas they have similar figures in *emp*, *k_emp*, and *ebizdum*, there is quite a difference in R_{it-1}, *rnd_emp*, *ex_sales*, and *patent*. Except R_{it-1}, the other figures(*rnd_emp*, *ex_sales*, and *patent*) in manufacturing are all bigger than in services.

Ⅳ. Estimation Results

1. Probabilities of Global Sourcing

In this section, we estimated the probabilities of global sourcing using the panel logit model as shown in (4). We regress a binary choice on business performance, control variables which exhibit various firm characteristics, a time dummy, random effects, and error term.

<Table 6> provides the variables included, coefficients estimated, standard errors, and corresponding significance level of estimates for total industry, manufacturing, and services.

For total industry, the estimation result has shown that the return on investment(R_{it-1}), number of employees(*emp*), R&D expenditure per employment(*rnd_emp*), export−sales ratio(*ex_sales*), and e−business system(*ebizdum*) appear to be significant, while the capital−labor ratio(*k_emp*) and number of patents(*patent*) appear as insignificant. That is, in general, a high performance, bigger−sized firm with active investment in R&D and a large portion of export to sales is most likely to engage in global sourcing, which coincides with the result of existing studies such as Glass and Saggi(2001) and Hyun et al(2007).

Considering that different sectors may have different effects from explanatory variables on probabilities and determinants of global sourcing, we divide total industry into manufacturing and services,

Table 6. Probabilities of Global Sourcing: A Panel Logit Model

$$\ln\left(\frac{P}{1-P}\right) = y_{it} = \beta_0 + R_{it-1}\beta_1 + X_{it}\beta_2 + T_t\beta_3 + u_i + \varepsilon_{it}$$

Variables	Whether firms engage in Global Sourcing (*gsdum*)		
	Total Industry	Manufacturing	Services
R_{it-1}	0.142** (0.072)	0.046 (0.083)	0.288 (0.205)
emp	0.622*** (0.085)	0.530*** (0.114)	0.497* (0.257)
rnd_emp	0.092*** (0.019)	0.070** (0.024)	0.179*** (0.054)
ex_sales	0.032*** (0.002)	0.031*** (0.003)	0.075*** (0.017)
k_emp	−0.071 (0.06)	−0.438*** (0.003)	0.040 (0.112)
patent	−0.002 (0.015)	−0.025 (0.187)	0.123** (0.051)
ebizdum	0.510*** (0.191)	0.566** (0.231)	0.937* (0.529)
T_t(2008=1)	−0.129 (0.125)	−0.050 (0.149)	−0.304 (0.338)
constant	−12.018*** (0.639)	−9.032*** (0.703)	−17.620*** (1.597)
N of obs.	15,764	9,063	5,621

Notes : 1) ***, **, * show significance level 1, 5, 10%, respectively.
2) Standard errors are in parentheses.
3) Total industry regression includes industry dummies, though not reported.

and then estimate each to see if there is any notable discrepancy between them. The estimation results say that from the perspective of global sourcing manufacturing differs from services most remarkably in two aspects: capital-labor ratio and number of patents.

The capital-labor ratio shows a *negatively* significant effect on global sourcing in manufacturing, while there is an insignificant relationship in the service sector. This outcome appears to result from the inclination that a firm with a high capital-labor ratio, highly likely in the manufacturing than service sector, would prefer internal vertical integration over global sourcing to fully utilize relatively abundant capital. Antras(2003) and Hyun et al(2007) also produced a similar result of a negative relationship between global sourcing and the capital-labor ratio.

In contrast, of the number of patents, manufacturing has a negative yet insignificant effect on global sourcing while there is a positive significant effect in services. On the one hand, patents in manufacturing have a tendency to do with production technology, which would make a firm concentrate more on internal production than production sharing. On the other hand, patents in services have tendency to do with non-technology, distribution, and marketing such as business models and management systems which would make a firm encourage more production sharing. A firm that holds such patents would have an incentive to focus on core activities i.e., business and marketing, by consigning peripheral activities to global sourcing. Consequently, global sourcing and patents could work as a substitute in the manufacturing sector, while a complement in the service sector. In our data and estimation, however, only the complementary nature of service patents proved statistically significant.

Besides capital-labor ratio and number of patents, other explanatory variables — number of employees, R&D expenditure per employment, export-sales ratio, and an e-business system— seem to be legitimately applicable to both manufacturing and services.

One interesting claim in the above estimation is that the significance of the coefficient of return on investment was valid only in term of total industry but not in manufacturing or services alone. It can be inferred from the standard errors that both sectors, manufacturing and services, are too widely dispersed to produce statistically significant coefficients. When we increase observations by taking both industries into consideration simultaneously, however, statistic significance for the total industry is obtained, which indicates that we can presume there exists a meaningful relationship between global sourcing and return on investment as long as observations are added and accumulated.

2. Determinants of Global Sourcing

Following the probabilities of global sourcing in the previous section, we try to identify determinants of global sourcing in this section using the panel tobit model given in (5). As is suggested in III.1, we relate the share of global sourcing to total sales to the explanatory variables listed earlier. The estimation results are provided in <Table 7>.

For total industry, basically the same variables that explained the probabilities of global sourcing significantly could also explain the share of global sourcing significantly. Distinctively, the return on

Table 7. Determinants of Global Sourcing: A Panel Tobit Model

$$y_{it} = \begin{cases} y_{it}^*, \text{ if } y_{it}^* > 0 \\ 0, \text{ otherwise} \end{cases}$$

$$y_{it}^* = \beta_0 + R_{it-1}\beta_1 + X_{it}\beta_2 + T_t\beta_3 + u_i + \varepsilon_{it}$$

Variables	Share of Global Sourcing to Total Sales (*gs_sales*)		
	Total Industry	Manufacturing	Services
R_{it-1}	0.524* (0.306)	0.167 (0.339)	1.234* (0.728)
emp	2.156*** (0.408)	1.764*** (0.503)	1.741** (0.814)
rnd_emp	0.380*** (0.09)	0.279*** (0.103)	0.645*** (0.188)
ex_sales	0.127*** (0.013)	0.121*** (0.14)	0.172*** (0.041)
k_emp	−0.334 (0.27)	−1.690*** (0.385)	0.092 (0.397)
patent	−0.012 (0.07)	−0.096 (0.08)	0.205 (0.175)
ebizdum	2.265*** (0.846)	2.045** (0.981)	3.945* (1.84)
T_t(2008=1)	−0.117 (0.463)	0.354 (0.541)	−1.074 (1.132)
constant	−48.073*** (3.442)	−36.920*** (3.228)	−54.730*** (5.763)
N of obs.	15,764	9,063	5,621

Notes : 1) ***, **, * show significance level 1, 5, 10%, respectively.
2) Standard errors are in parentheses.
3) Total industry regression includes industry dummies, though not reported.

investment (R_{it-1}), number of employees (*emp*), R&D expenditure per employment (*rnd_emp*), export-sales ratio (*ex_sales*), and e-business system (*ebizdum*) turn out to be valid determinants of global sourcing while, again this time, the capital-labor ratio (*k_emp*) and number of patents (*patent*) invalid.

A firm attaining a higher business return (ROI) in the past year could have room to apply financial buffers to additional investment, along with diversifying its business structure to enhance future returns as well as to provide against rainy days. In such cases, global sourcing could be a feasible option, and, as revealed in <Table 7>, lagged ROI has a positive marginal effect on it. According to the estimation, firm size appears to significantly matter to determine the degree of global sourcing. It is perhaps because a larger firm would have more bargaining power in the process of negotiation than a smaller firm, which offers bigger firms a relatively favorable environment with regard to global sourcing. Active R&D investment itself could also increase the volume of global sourcing by way of expanding production possibilities. Higher export potential could motivate a firm to search harder for an opportunity to source inputs and intermediates domestically as well as globally at a low cost of information collection. A better e-business system, representing a firm's proficiency of ICT and informatization, could also help a firm execute more global sourcing by reducing transaction costs.

In the previous section we already found that the selected variables worked relatively well to affect the probabilities of global sourcing. When we added the result in <Table 7> to <Table 6> we could infer that a firm of larger size, with bigger R&D investment, higher export portions, and a better e-business system reaping higher returns was more likely not only to engage in global sourcing in the first place, but also to engage in even more global sourcing. That is, once a firm starts global sourcing it tends to keep utilizing and increasing it. However, as the logit estimation showed, the capital−labor ratio(*k_emp*) and number of patents(*patent*) did not appear to affect global sourcing, which implied that total industry as a whole had little to do with a determination of global sourcing particularly for capital intensity or patents.

We divided total industry into manufacturing and services as we did in the previous section and estimated each using the panel tobit model. The result is reported in the second and third columns in <Table 7>.

In manufacturing, basically the same explanatory variables valid in the probabilities have proven to be significant — number of employees, R&D expenditure per employment, export−sales ratio, capital−labor ratio(negative), and e−business system. In the service sector, however, the capital−labor ratio was excluded but return on investment included as a valid determinant. The capital−labor ratio plays a more important role in manufacturing while return on investment is a more appropriate yardstick for services, which may reflect each sector's distinctive characteristics. Global sourcing in manufacturing depends negatively on the capital−labor ratio probably because a higher capital−labor ratio could make it a better option for manufacturing firms to construct vertical integration than to manage global sourcing. In the meantime, in services, global sourcing has a more positive role crucially depending on business performance, perhaps because services may need less capital equipment, which could encourage service firms to rely more on returns to access global sourcing.

V. Summary and Conclusion

Based on a new firm-level dataset from the National Statistics Office's *Survey of Business Activities* from 2006 to 2008, we analyzed what factors would make global sourcing more likely to happen(probabilities) and what factors would determine the volume of global sourcing(determinants) in this paper. For the empirical methods required to achieve these purposes, we utilized panel logit model for probabilities and panel tobit model for determinants of global sourcing, respectively. We split the estimation into total industry, manufacturing, and services. The results are summarized in <Table 8>.

Table 8. Summary of Empirical Analyses on Global Sourcing

Variables	Probabilities			Determinants		
	Total	Mftg.	Services	Total	Mftg.	Services
R_{it-1}	0.142**	0.046	0.288	0.524*	0.167	1.234*
emp	0.622***	0.530***	0.497*	2.156***	1.764***	1.741**
rnd_emp	0.092***	0.070**	0.179***	0.380***	0.279***	0.645***
ex_sales	0.032***	0.031***	0.075***	0.127***	0.121***	0.172***
k_emp	−0.071	−0.438***	0.040	−0.334	−1.690***	0.092
patent	−0.002	−0.025	0.123**	−0.012	0.096	0.205
ebizdum	0.510***	0.566**	0.937*	2.265***	2.045**	3.945*

Sources : <Table 6> and <Table 7>.

First, for the probabilities of global sourcing, the common significant factors in total industry, manufacturing, and services were number of employees, R&D expenditure per employment, export-sales ratio, and e-business system. Return on investment was valid only in total industry; capital-labor ratio only in manufacturing; and number of patents only in services.

Second, for the determinants in global sourcing, the valid factors in the previous analysis are commonly significant in total industry, manufacturing, and services. However, return on investment is invalid in manufacturing; capital-labor ratio only in manufacturing; and number of patents invalid in both.

In short, putting the two analyses together, we can briefly say that large, R&D-oriented, exporting, informatized firms turn out to be more likely to engage in and expand global sourcing.

The contributions of this paper can be summarized as follows: First, we utilized a recently built new firm-level dataset, the *Survey*, arguably not contaminated, to examine global sourcing, which had not been done before. Problematic data itself has been a major impediment to rigorous analyses because of appropriate dataset being rare or hard to collect in this field. Hence, it was the pivotal point that we could access quality data. The *Survey* can be regarded as a different, yet better, source for studying global sourcing than the conventional Input-Output data, since this panel dataset consists of a large amount of firm-level cross-sectional observations, despite of relatively short time series, with a variety of factors that can control many firm characteristics. The key difference between the two datasets is that Input-Output data overestimates global sourcing by adding other ordinary trade to global sourcing as in Olsen(2006), which would cause for sure serious measurement errors and distort estimation results. Input–Output data may be an alternative good proxy for global sourcing if only it moves along with the real global sourcing, which seems not the case. According to the *Survey*, however, global sourcing is not prevalent yet in most of Korean industry and much smaller than previous studies based on IO data suggested so that IO data by its nature is not preferred for analyzing global sourcing. In any future study, firm–level data needs to be used more widely and intensively to escape from the limitations of IO data. The *Survey* is young and expected to add substantially more observations to the current dataset and also much more detailed information in years to come, so that we anticipate better researches in the near future to come out based on data improvement.

Second, thanks to the *Survey*, we could construct a panel and plainly avoid the potential endogeneity problem between global sourcing and business performance: The model is designed for lagged return on investment to affect present global sourcing but not the other way around. The previous studies on global sourcing that used cross–section or IO data could not free themselves from the inevitable criticism on endogeneity.

Third, because of the *Survey*, we should be better able to control various industry and firm characteristics, which can provide us with a clearer understanding on probabilities and determinants of global sourcing. A dataset with poor characteristic variables available could not separate marginal effects by factor or produce concrete results in a richer and finer context.[12)]

12) In <Table A> in appendix, we illustrated an example of an extra estimation result of a tobit panel model in which industry/firm characteristics *were not*

Fourth, in this paper, some results were newly found while others confirmed existing results from previous studies. In a nutshell, we can say there is not a big qualitative difference between this paper and earlier ones. However, it is important to note and should not be overlooked that we obtained the same results via better dataset and more rigorous methods.

There exist some questions worth considering: First, if global sourcing offers such a good alternative to enhance a firm's business performance, then why has it been not so popular among Korean industries and firms? Why more firms not at least try? Judging from the analysis presented by this paper, it appears to be that low marginal effects or absolute levels of explanatory variables is not an adequate prime suspect of uncommon global sourcing, since we do not have a smoking gun saying they are exceptionally low in terms of a reasonably acceptable criterion. Instead, one plausible guess is that low global sourcing may be related to a Korean business structure that is already inclined too much to exports rather than other alternatives like global sourcing; or it is some insufficient institutional policy support that we could not take into account in the analysis.

Second, now that we have examined the one side of the effect of business performance on global sourcing, what would be the opposite side, say, an effect of global sourcing on business performance?

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controlled. When compared with <Table 7> where industry/firm characteristics *were* controlled, noticeable differences took place, which necessarily requires that individual/firm characteristics should be controlled. Otherwise, the estimation result and conclusion would be biased.

Third, if global sourcing is one of a number of viable business strategies available to improve business potential, and firms will eventually be interested in maximizing their profits, to what extent should firms take advantage of global sourcing as an effective strategy and how can we find the optimal degree in its usage?[13] How and how far should government help?

Fourth, by nature, global sourcing can be better understood as a dynamic choice. However, a dynamic analysis has yet to be undertaken for want of time series.

Fifth, is there any possibility that because of lack of adequate policies we are missing latent industry/firm growth opportunities that global sourcing otherwise could bring us?

All the above questions remain to be answered in future researches as more appropriate data and estimation methods become available

13) For more on global sourcing as a business strategy, see Offshoring Research Network(2007).

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Appendix

Table A. ***Determinants of Global Sourcing : A Panel Tobit Model without Industry/Firm Characteristics Considered***

$$y_{it} = \begin{cases} y_{it}^{*}, \text{ if } y_{it}^{*} > 0 \\ 0, \text{ otherwise} \end{cases} \qquad y_{it}^{*} = \beta_0 + R_{it-1}\beta_1 + X_{it}\beta_2 + T_t\beta_3 + u_i + \varepsilon_{it}$$

Variables	Share of Global Sourcing to Total Sales (*gs_sales*)		
	Total Industry	Manufacturing	Services
R_{it-1}	0.629*** (0.324)	−0.001 (0.382)	2.158*** (0.737)
emp	2.325*** (0.314)	2.095*** (0.434)	2.278*** (0.687)
rnd_emp	0.377*** (0.093)	0.255** (0.11)	0.767** (0.224)
ex_sales	0.186*** (0.014)	0.188*** (0.016)	0.217*** (0.042)
k_emp	−0.549*** (0.235)	−2.483*** (0.384)	−0.086 (0.36)
patent	−0.064 (0.072)	−0.198** (0.084)	0.267 (0.196)
ebizdum	3.032*** (0.859)	3.204*** (1.039)	4.962** (2.129)
T_t(2008=1)	−0.164 (0.721)	0.318 (0.887)	−0.926 (1.756)
constant	−50.817*** (3.4)	−39.56*** (3.321)	−61.56** (8.879)
N of obs.	15,764	9,063	5,621

Notes : 1) ***, **, * show significance level 1, 5, 10%, respectively.
2) Standard errors are in parentheses.
3) Unlike <Table 7>, in this appendix, total industry excludes industry dummies and both manufacturing and services exclude random effects. That is, u_i drops out in the estimation so that industry or firm characteristics are not controlled.