KIEP Working Paper 09-03

Firm Heterogeneity in the Choice of Offshoring: Evidence from Korean Manufacturing Firms

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Executive Summary

Using firm-level data on offshoring of Korean manufacturers, the paper examines the relationship between firm heterogeneity and the probability of adopting offshoring. The results of the paper suggest that firm productivity may not be an important determinant for Korean firms' offshoring decision. Firm's global sourcing decision may rather depend on other characteristics such as factor intensity, R&D intensity, ICT level, and affiliation with foreign markets, when industry specificity is controlled for.

JEL Classification: F23, L23, D21
Keywords: Offshoring, Outsourcing, Insourcing, Firm Heterogeneity.

국문요약

최근 전세계적으로 생산단계의 일부를 해외에서 수행하여 국내 기업에 조달하는 오프쇼어링은 급속도록 증가해 왔다. 그러나 한국기업의 오프쇼어링 행태에 대해서는 축적된 데이터가 없기 때문에 연구가 매우 제한적이었다. 이에 본 논문에서는 직접 설문을 바탕으로 구축된 한국 제조기업들의 2006년 오프쇼어링 데이터를 분석하여 기업의 특성과 오프쇼어링의 도입 확률의 관계를 살펴보았다. 연구 결과 이론의 가설과는 달리 한국 기업의 생산성은 오프쇼어링 의사결정에 유의미한 영향을 미치지 않는 것으로 드러났다. 오히려 자본집약도, R&D 집약도, ICT 수준, 해외투자를 통한 해외시장과의 연계성 등 기업의 다른 특성이 오프쇼어링에 더 중요한 요인임이 입증되었다. 이러한 결과는 한국기업이 국제 생산네트워크에 편입하기 위한 해외투자 활성화, ICT 수준 향상을 위한 세제 혜택 등 관련 정책적 시사점을 도출하는 데 기초자료로 활용될 수 있다는 점에서 의의를 찾을 수 있다.

Hea-Jung Hyun is an associate research fellow at Korea Institute for International Economic Policy (KIEP). She received her Ph.D. in Economics at Indiana University, Bloomington. Her areas of interest include FDI, fragmentation, and cross-border M&As. Her recent publication is "The Determinants of Cross-border M&As: the Role of Institutions and Financial Development in Gravity Model".

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저서 및 논문

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Hea-Jung Hyun*

I. Introduction

Offshoring is one of the most rapidly growing components of international trade. Hummels *et al.* (2001) find that growth in vertical specialization can account for 30 percent of the growth in exports of 10 Organisation for Economic Co-Operation and Development (OECD) countries and 4 emerging market countries between 1970 and 1990. Between 1992 and 2006, intermediate input trade was reported to have grown by around 11.9 percent a year (See Figure 1). This rapid expansion has triggered much research into the factors underlying the sourcing behavior of multinational enterprises. The remarkable increase in international production sharing that is reflected in unusually high growth rates for the exchange of components or partially assembled manufactured goods is documented in published studies. (Ng and Yeats 2001)

[1)] I am very grateful for helpful comments from Arianto Patunru, Iris Claus, Jung Hur, June-dong Kim, and participants in Asian Economic Panel held in Jakarta, March 2009.

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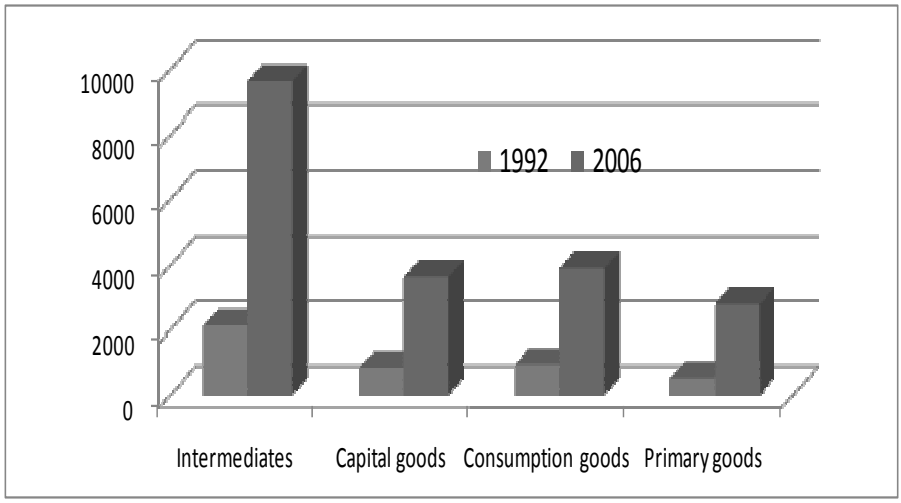
Figure 1. Intermediate Input Trade

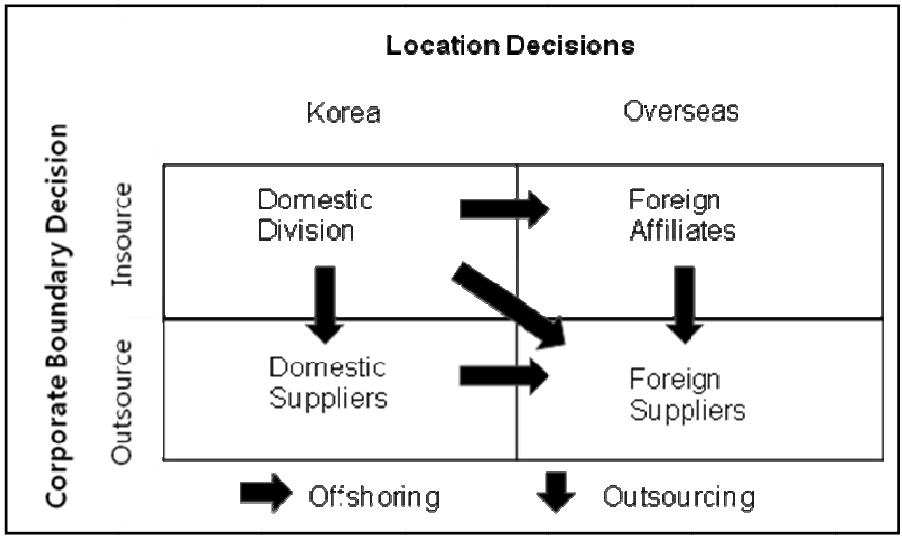
(Unit: 1bill. USD)



Sources: UNCTAD Database; Bang (2008).

Offshoring is defined as the relocation by a firm of a production stages - both manufacturing and services - from one country to another. It is contrasted to outsourcing though two terms are closely related. Outsourcing refers to subcontracting business processes out to the third party. Thus, foreign outsourcing means by relocation of business processes to an external supplier in another country. In contrast, the scope of the term "offshoring" can include internal sourcing via multi-national enterprises' (MNE's) own foreign affiliates as well as foreign outsourcing to the third party.

Figure 2. Boundary of Offshoring



Source: Abramovsky and Griffith (2007).

Although the potential adverse effect on employment of offshoring which can lead to hollowing-out effect is still ongoing political debate, offshoring is widely accepted by many firms based on the belief that offshoring can be productivity enhancing through cost saving and access to more advanced technology in business processes.

One of the main driving forces behind the rapid expansion of offshoring is the development of information and communication technology (ICT) in the 1990s. Production systems involving design, production, delivery, and installation consist of a number of complex components all of which require coordination technologies. And these

communication technologies are major limitation on coordination across production network (Harris 2000). Furthermore, offshoring itself incurs additional costs which are unnecessary for in-house production; adjustment costs, transaction costs, and search costs. The advanced technology in services, represented by internet-based communications network, contributes to lowering these costs and facilitating offshoring.

From firm-level perspectives, a critical issue concerning offshoring is which type of firm engages in offshoring. The new international trade literature is motivated by empirical evidence that firm differences within sectors may be more pronounced than differences between sector averages (Baldwin and Okubo 2006). Firm heterogeneity in productivity is introduced by Antras and Helpman (2004) as a key element of the choice of ownership structure and supplier locations. Antras (2005) incorporates incomplete international outsourcing contracts with a dynamic general equilibrium model of trade so as to explain the development of product cycles and production sharing between the North and the South. Pioneered by Melitz (2003), Helpman *et al*. (2004) show that high-productivity firms engage in FDI and less productive firms export, whereas lowest productive firms serve only the domestic market.

Antras *et al*. (2006) show that the level of communication costs and the size of the skill overlap are two key parameters in explaining the type of firms engaging in offshoring. From the general equilibrium model, they prove that when the skill overlap is large and communication costs are high, only the most productive and large firms will engage in offshoring, while, when the skill-overlap is small and commu-

nication costs are low, the least productive firms engage in offshoring. This study has embedded contracting models into the standard general equilibrium models that explain trade based on differences in endowments of factors across countries and monopolistic competition arising from 'love for variety.'

Jones *et al*. (2005) show the empirical evidence supporting the prevalence of disagglomeration. The data used for empirical tests is on trade in parts and components during the period of 1990-2000, according to SITC Rev.2 system. Their results support the hypotheses that growth of the world economy and technological improvements in service link activities contribute to raising the degree of fragmentation by lowering the business connection charges.

There is a dearth of empirical studies on offshoring at firm-level, while the vast majority of literature in this area has been at the aggregate level. Abramovsky and Griffith (2007), Tomiura (2005), Gorg and Hanley (2003), and Swenson (2000) are those of few studies at the plant or firm-level. Using ONS database on UK establishment, Abramovsky and Griffith (2006) find that more information and communication technology (ICT) intensive firms are more likely to purchase offshore than less ICT intensive firms. Their analysis, however, only includes offshoring of business services, not manufacturing. Although service outsourcing is rapidly growing, the majority of offshoring occurs in manufacturing sectors and it is hard to extend the implication of the empirical tests of service offshoring to the general cases. Our data set covers offshoring of both manufacturing and services.

Due to the data constraint, firm-level studies often use indirect way

of defining offshoring. Abramovsky and Griffith (2007) employ expenditure on a number of specific services as a measure of outsourcing of business services. Gorg and Hanley (2003) use imports of general intermediates as a proxy for international outsourcing. However, this indirect way of definition may include purchases of standardized inputs from marketplace. Swenson (2000) examines a set of firms located in U.S foreign trade zones, in which firms may tend to engage more in offshoring compared to other firms outside the foreign trade zones. He also uses foreign input usage to measure outsourcing.

Tomiura (2005) first attempted to resolve this problem. He used the distinguishable data set covering all manufacturing firms in Japan. The term 'outsourcing' in his paper is defined as purchasing goods or services via contract excluding purchasing of goods in the market without a contract. It seems quite close to 'offshoring' in our paper, which covers both contracting-out to own subsidiaries (foreign insourcing) and to the third party (foreign outsourcing). However, the survey result used in Tomiura (2005) contains the data for 1998, which may not exactly reflect the recent trend of Japanese firms' offshoring. We use dataset from the result of recent survey in year 2006, whereas the number of observation is much smaller than that in Tomiura (2005).

The purpose of this paper is to investigate the following questions: 1) which firm heterogeneity can affect the offshoring decision: and 2) which firm-level characteristics are associated with the level of offshoring. In each test, we compare the firm characteristics as a determinant of other type of sourcing; domestic outsourcing, foreign insourcing, foreign outsourcing, and offshoring. Using 698 firm-level data on off-

shoring of Korean manufacturing firms, based on the survey result in which the measurement of offshoring is more direct and comprehensive compared to previous literature, we examine the determinants of international production sharing.

This paper contributes to the literature in several ways. First, to the best of our knowledge, this is the first study that uses Korean manufacturers' firm-level data to explore the role of firm characteristics in the choice of offshoring. The new 'Heterogeneous Firm Trade model' [HFT model named by Baldwin and Okubo (2006) developed by Helpman *et al.* (2004)] in which the exposure to foreign market is associated with high productivity of firms. However, firm heterogeneity in our model stems from other firm aspects such as ICT, firm size, affiliation with foreign markets, capital intensity, and R&D intensity, as well as labor productivity. Second, we examine the effect of firm heterogeneity on the extent of offshoring as well as offshoring decision in order to investigate whether the firm characteristics are related with the level of international fragmentation. Third, we employ the use of Internet skills to measure the firm's ICT level. In Tomiura (2005), the number of computers is considered, which seems to be an indirect way of estimating the effect of ICT. To measure an establishment's ICT intensity, Abramovsky and Griffith (2006) use data on investment in software and dummy variable of internet use in ordering goods and services. Since the internet is now a public good and most firms have access to the internet in ordering somehow, the data on whether a firm uses the internet may not capture the true level of ICT. Fourth, the outsourcing of non-production overhead services is covered in the definition of out-

sourcing in our data set, which is not included in Tomiura (2005). Services sector is the fastest growing sector to which firms are involved in offshoring, though the level of offshoring to services is still much lower than that of manufacturing sector.

The remainder of this paper is organized as follows: Section II illustrates the pattern of offshoring by Korean manufacturers. Section III outlines the econometric frameworks and describes data. Section IV reports the empirical results. Section V concludes.

II. Data Description

The main variable of interest is offshoring. Our offshoring data is taken from the 'The survey on the international outsourcing by Korean manufacturers' undertaken by Gallup Korea, a survey research institute in 2007. The offshoring data includes 689 firms covering year 2001 and 2006. The survey provides rich information on both domestic and international outsourcing, R&D intensity, exports by foreign subsidiaries, Internet use, etc. at the firm-level.

Around 24 percent of firms are reported to engage in offshoring in 2006 while the majority of firms are not involved in offshoring (See Table 1). Among firms, 43.7 percent of them are outsourcing to the domestic market only and 32.3 percent do not outsource at all. However, the growth rate of offshoring between 2001 and 2006 is 55.7 percent, reflecting the rapid expansion of international fragmentation by Korean manufacturers.

Table 1. Offshoring Trends

Year	**2001**		**2006**	
Offshoring	Yes	No	Yes	No
Share of firms	16.2%	83.8%	24.2%	75.8%

Table 2 shows the share of offshoring by industry. The second column reports the share of firms included in each industry. The share of

Table2. Distribution of Industry (2006)

Industry	Industry share	Choice of offshoring (% share)	Average offshoring intensity (% share)
Food Manufacturing	5.16	10.0	3.25
Textile	5.87	30.5	25.61
Apparel & Fur Product	1.15	38.5	57.00
Leather, Bags & Shoes	1.58	26.7	22.50
Timber & Wooden Product	0.57	0	0
Pulp, Paper & Paper Product	2.01	6.7	20.00
Publishing, Printing & Copying Documents	1.15	0	0
Cokes, Petroleum & Nuclear Fuel	0.29	0	0
Compound & Chemical Products	11.89	8.8	10.75
Lubber & Plastic	3.72	18.8	16.67
Nonmetallic Minerals	5.73	14.9	21.00
Ferrous Metal Products	8.02	6.7	30.00
Nonferrous Metal Products	5.73	21.6	18.55
Miscellaneous Machinery & Equipment	6.30	25.4	22.80
Computer & Office Instrument	1.29	25.0	20.00
Electric Machinery & Electric Converter	4.01	12.5	34.25
Electronic Parts, Video, Sound & Telecommunication Facilities	18.05	27.2	39.53
Medical appliances, Precision & Optical Instrument	2.87	16.7	12.75
Auto & Trailer	6.30	25.4	34.00
Miscellaneous Transportation Equipment	2.01	22.2	25.25
Furniture	0.86	33.3	17.00
Miscellaneous Manufacturing	5.44	13.6	26.67

offshoring firms are reported in the third column. The fourth column reports the average value of offshoring as a percentage share of total input purchases. Apparel and fur product industries are the sectors in

which firms are most actively involved in offshoring. Furniture and textile rank second and third respectively in the frequency of offshoring. Electronic parts, video, sound, and telecommunication facilities come next.

More than 80 percent of offshoring take place in manufacturing industries. During 5 years, however, offshoring services has been growing more rapidly than the manufacturing. The growth rates of offshoring metallic pattern, parts and components, and final good assembly and processing are 58.1 percent, 54.8 percent, and 70.6 percent respectively, whereas, those in services sector, R&D services, customer support, law & accounting, and miscellaneous business are 75 percent, 100 percent, 83.3 percent, and 76.5 percent respectively.

III. Model

Based on the idea that important sources of offshoring decision could exist within firm heterogeneity, we employ probit model to capture the effects of firm-level variables of interest on binomial decision on whether to introduce offshoring or not. Offshoring decision is again divided by decision on foreign insourcing (offshoring to its own subsidiaries) and foreign outsourcing (cross-border arm's length transactions). For comparison reason, we also test for the role of firm characteristics in the choice of domestic outsourcing. Our model is in line with Abramovsky and Griffith (2006) and Tomiura (2005), but as aforementioned, we use the technology variable which seems to be a more useful instrument to measure the true level of information and communications technology of a firm than the number of computer used in Tomiura (2005). Taking various factors into account, we carry out regressions to examine what determines the offshoring choice by Korean manufacturers. A reduced-form specification of offshoring choice by firm i in industry j is as follows.

$$Y_i = \beta_0 + Z_i'\beta_1 + \mu_j + \varepsilon_i$$

where Y_i is the ratio of offshore outsourced goods and services to total input purchases of firm i. Also, it can be a probability estimated in logit and probit model representing a discrete decision on whether to offshore. By using the two measures of offshoring, we are able to inves-

tigate whether both extensive and intensive margin of offshoring can be explained.

Z_i is a vector of firm-level explanatory variables which are likely to influence a firm's offshoring decision. These variables are *ICT, Productivity, Size, K/L, R&D,* and *FDI.*

ICT is firm's ICT level. Harris, R. (2001) suggests that the process of global production can be attributed in part to the search for gains from specialization among developed countries. However, the existence of global and industry-wide coordination costs can be obstacles to specialization. He argues that the rapid improvements and extensions in communications networks may substantially lower these coordination costs among related suppliers and customer firms in manufacturing industries. His model, however, analyzes the macroeconomic equilibrium and emphasizes the role of economy-wide network costs as a limit to international fragmentation. To contrast, we focus on the differences in communication technology across firms in production sharing. Offshoring incurs higher transaction costs for searching partner, making contracts, ordering, and shipping internationally, compared to in-house production or domestic outsourcing. Firms with high level of communication technology may lower these costs and benefits from offshoring. Our data is based on the survey results. The survey questionnaire classifies firms into the level of internet use. At stage 1, the lowest level, internet is utilized only for checking personal e-mail and searching for documents. **Brochure ware**, building web sites and invoicing are available at stage 2. At stage 3, firms use **e-commerce** and on-line sales are available. At stage 4, transactions between companies,

invoicing, and connecting to shipping system via internet occur. Stage 5 is for **e-enterprise**. All the business processes are re-engineered through combination of off-line and on-line activities. Also firm's internal organization and external partners are connected on-line. Since ICT variable is in composite number, we create dummy variables for each stage and regress them on offshoring decision. The cut-off point of ICT level affecting offshoring decision is found to be stage 3; e-commerce. (See Table 4) Thus, we use the dummy variable $E-Commerce$ to represent whether a firm has, at least, an ICT level of e-commerce.

Productivity is measured by a firm's labor productivity. Antras and Helpman (2004) show that provided that headquarters' service intensity is low, more productive firms are more likely to serve foreign market via offshoring. This is because these firms are those which are able to overcome the fixed costs of offshoring. Using the data on offshoring performed by 3,723 Japanese *keiratsu* in 1994, however, Kimura (2002) found no relationship between profit per sales and outsourcing contract.

Size, the sales of a firm, controls for the effect of firm size on offshoring decision. Large firms may take advantage of exercising dominant market power over both domestic and foreign outsourcing suppliers in offshoring contracts, which could raise the tendency of participation in offshoring compared to small or medium firms.

K/L represents capital intensity measured as capital-labor ratio. Theoretically, more capital intensive firms prefer in-house production rather than international outsourcing, as capital intensive firms usually have more complicated structure of production to depend on external

procurement. Since offshoring has both aspects of intra-firm trade between headquarter and foreign affiliates and external sourcing, the predicted sign of the effect of capital intensity on offshoring is not clear; if more firms offshore through FDI than outsourcing, it can be positive. Otherwise, the sign can be negative.

$R\&D$ stands for firm's R&D intensity measured as the value of R&D expenditure per sales. Glass and Saggi (2001) found that firms can raise the ratio of offshoring through cost reduction and profit increase accomplished by increase in R&D investment. R&D expenditure is also regarded as ideal proxy for expected technological change. Bartel *et al.* (2008) show that firms engaging in R&D are 11-12 percent more likely to outsource some part of their production. They interpret the result as the demand for outsourcing increasing with the probability of technological change. To constrast, Antras and Helpman (2006) suggest that R&D intensive firms tend to choose FDI rather than foreign outsourcing as contracting is more difficult for technologically complex or advanced inputs. To sum, the predicted sign of the impact of R&D is positive for the choice of foreign insourcing, but obscure for foreign outsourcing.

Affiliation with foreign markets is also considered as one of the important firm characteristics that can affect offshoring decision. We test for the impact of foreign market affiliation via FDI. FDI is a dummy variable on whether a firm has foreign subsidiaries or not. Firms exposed to foreign markets through FDI may benefit from access to foreign production network in searching for offshoring partners.

μ_j, industry dummies control for the industry-specific effects in the

choice of offshoring, for example, and labor intensive sectors such as apparel and fur product industry may have high demand for outsourcing intermediate inputs to a region where cheap labor is abundant. We include 41 industry dummy variables in all the regression. Since many firms have multiple subsidiaries across countries and majority of firms outsource to China, we do not test for region-specific fixed effects for host region to which firm i outsources. The constant term β_0 and error term ε_i include factors not captured in the offshoring function, as well as any other unobserved factors. We control for heteroskedasticity of error term.

Table 3. Summary Statistics

Variable	Observation	Mean	Std.	Min	Max
Domestic outsourcing	689	0.466	0.499	0	1
Foreign insourcing	689	0.131	0.337	0	1
Foreign outsourcing	689	0.110	0.315	0	1
Offshoring	689	0.241	0.428	0	1
ICT1	689	0.065	0.247	0	1
ICT_2	689	0.935	0.247	0	1
ICT_3	689	0.363	0.481	0	1
ICT_4	689	0.279	0.449	0	1
ICT5	689	0.093	0.290	0	1
Productivity	672	5.843	0.883	2.577	9.449
Size	682	17.861	1.359	13.422	23.721
K/L	671	6.073	2.838	1.009	15.643
R&D	689	1.341	1.063	0	4.394
FDI	689	0.406	0.492	0	1

Notes: Natural log is taken for all variables with positive values except for dummy variables. ICT1 and ICT5 are ICT level at 1 and 5 respectively. ICT_2, ICT_3, and ICT_4 represent an ICT level of at least stage 2, stage 3, and stage4 respectively.

Table 3 shows the summary statistics of variables. Correlation matrix of variables is reported in Appendix 1. Most explanatory variables are not highly correlated.

IV. Empirical Results

Our empirical results are reported from Table 5 to Table 8. Table 5 reports the marginal effects of independent variables on sourcing dummy variable in probit estimation. Column (1) reports the estimates of the equation in which only the decision of outsourcing in domestic market is used for dependent variable. The results of regression on outsourcing to own subsidiaries, cross-border arm's length transactions, and offshoring are shown in column (2), (3) and (4) respectively. Labor productivity shows a negative sign for domestic outsourcing and foreign insourcing decision. The firm size is positively related with the probability of adopting domestic outsourcing while the coefficient of FDI shows significant and negative sign. From column (2), firms that offshore to own subsidiaries seem to be those with high ICT level, large firm size, low capital intensity, and high R&D intensity. Column (3), however, shows that the deterministic firm characteristics can be different between the case of foreign outsourcing to the third party and that of the foreign insourcing. The effect of ICT level and firm size are found to be insignificant in column (3). This result is somewhat puzzling as increasing the use of ICT level is expected to lead to more outsourcing rather than vertical integration. R&D intensity and labor intensity, however, are still significantly positive. In our dataset, the impact of ICT supports more FDI rather than foreign outsourcing through substantially lowering the internal costs of communication. Column (4)

shows the result when binomial offshoring decision is taken as dependent variable. The coefficient on ICT level has a significantly positive sign at 5 percent level. Also firms with high R&D intensity are more likely to engage in offshoring. A 1 percent increase in firm's ICT level and R&D intensity may raise the probability of offshoring by 0.088 percent point and 0.034 percent respectively.

This result is consistent with theoretical prediction by Glass and Saggi (2001). It also reflects the fact that firms tend to opt for offshore procurement under highly changing technological environment. FDI dummy variable is positively related with the choice of offshoring, which supports the hypothesis that firms having foreign affiliates are more prone to introduce offshoring. Capital intensity is negatively associated with offshoring decision. Firm size and productivity do not seem to be significant factors in offshoring decision.

Table 6 reports the estimation result on equations in which share of offshoring out of total input purchase is dependent variable. Since many firms do not offshore at all, a substantial portion of the observations cluster at zero. To correct the censoring bias that may be caused by zero value of offshoring, we estimate a tobit model (censored regression model). The main implication is similar to the results from Table 5 in which binary offshoring decision is dependent variable, though there are gaps in the value of coefficients and elasticity. The level of ICT above e-commerce, R&D intensity, and foreign market access could be positively related with the amount of offshoring, while capital-labor ratio is negatively related. Labor productivity does not seem to be a significant factor on sourcing strategy. The large firm size

is positively associated with domestic outsourcing and foreign insourcing.

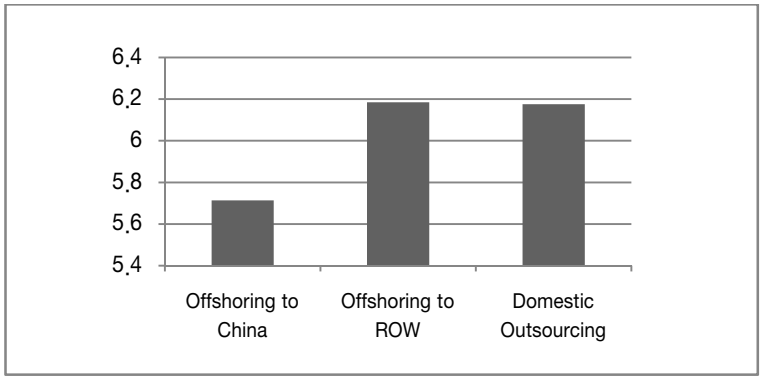
One of the major concerns is that sourcing decision may be endogenously determined. For instance, firms that anticipate offshoring may invest more in R&D as there can be more room for investment as a result of future cost savings from offshoring. To resolve the potential endogeneity problem, we employ probit and tobit model with endogenous regressors. R&D intensity and productivity are instrumented by lagged variables of year 2001.

Table 7 shows the results of probit IV estimation on offshoring decision. From column (1), FDI is adversely related with domestic outsourcing. The coefficient of firm size is positive, but not statistically significant which is different from the previous results in which endogeneity problem is not considered. The firms procuring to their own subsidiaries are likely to be those with high ICT level, high R&D intensity, low capital intensity, and large size. This result is consistent with the previous ones. For firms outsourcing to the third party in foreign countries, however, none of the firm characteristics are significantly relevant. Combining foreign outsourcing and insourcing, offshoring decision may be determined by high R&D intensity and foreign market access via subsidiaries. Interestingly, the significance of the coefficient of ICT level on the choice of offshoring disappears when endogeneity is considered. The result suggests that firms may intentionally raise the ICT level so as to increase the effectiveness of offshoring. This result is consistent with tobit IV model reported in Table 9.

Over all, the probit model estimation finds that the firm productivi-

ty[2] may not be an important source for offshoring decision by Korean manufacturing firms. This does not support the theoretical prediction by Helpman *et al*. (2004) that firms with higher productivity are the only ones that can overcome the higher fixed cost entailed by serving foreign market than domestic firms. Also the result is not consistent with Tomiura (2005) where firms tend to outsource more of their activities overseas when their productivity – when measured by both labor productivity and quasi TFP – is higher. This may be due to the fact that a majority (about 80 percent) of Korean firms operate in China and these firms' performances are relatively low compared to firms offshoring to the rest of the world or to domestic firms, though the differences may not be significant. (See Figure 3 and Appendix 2: Figure 5)

Figure 3. Productivity by Host Region of Offshoring



Source: Gallup Korea (2007).

[2] The effects of firm productivity remain insignificant when labor productivity is replaced by total factor productivity.

Rather, other firms' heterogeneity may be a more relevant factor regarding sourcing decision. The empirical results show that ICT level is positively related with the offshoring decision, particularly for the case of offshoring to their own affiliates. This makes sense in that higher ICT level can facilitate the cross-border transactions between firms and can contribute to lowering monitoring costs. However, the estimation result of probit IV suggests that it is highly possible that ICT level and offshoring decision are endogenously determined. Also, the insignificant coefficients of ICT on decision of cross-border arm's length transactions shown in Table 5 through Table 8 seem puzzling. The implication from the positive impact of R&D intensity is in line with the prediction by Glass and Saggi (2001). However, both probit IV and tobit IV show that the coefficient of R&D for foreign outsourcing is insignificant while it is positive, and significant for offshoring via FDI. This result is in line with Antras and Helpman (2006) that R&D sales ratio tends to be higher for foreign internal sourcing compared with foreign outsourcing. The negative relationship between capital intensity and the probability of offshoring also supports the prediction of theory. However, the results from probit and tobit model with endogenous covariates suggest that labor intensive firms are more likely to choose foreign insourcing while factor intensity may not significantly impact on foreign outsourcing, and this does not support the prediction by Antras (2003) in that labor intensive goods may be traded at arm's length, while capital intensive goods are transacted within firm boundaries. The consistently positive and statistically significant coefficients of FDI reveal the role of foreign market affiliation in saving search cost of input suppliers in offshoring market.

V. Conclusions

Offshoring is chosen by many manufacturers as a response to a highly competitive global environment, although the overall impact of offshoring on firm performance is still under debate.[3] This paper examines the firm characteristics as one of the main driving forces behind the sourcing decisions. The empirical tests on Korean manufacturing firms do not seem to support the new 'Heterogeneous Firm Trade model.' Firm productivity fails to explain offshoring decision. The result may imply that sourcing decision of Korean manufacturers could be made irrespective of the firm performances. Rather, development of information technology to reduce the cost of communication, factor intensity, investment in R&D, and foreign market experiences to lower the search costs may be more important elements than productivity in making sourcing decisions. High R&D intensity and FDI, specifically play significant roles in adopting offshoring and the main implication is robust to sensitivity analyses using alternative proxy to offshoring decision with endogenous regressors.

The findings of this paper have important policy implications for Korea. Since the access to foreign market is crucial for offshorig deci-

[3] Kotabe *et al.* (2008) argue that the outsourcing performance relationship takes on an inverted-U shape, implying that if firms insource or outsource too much, their performance will suffer, though there is a positive relationship between outsourcing and performance under optimum degree of outsourcing.

sion, policies should be designed to strengthen consulting to encourage firms to actively search for intermediate input suppliers and to participate in an international production network. Since, however, offshoring decision should be made by firms, government consulting should be confined to providing information based on databases of foreign suppliers. The proportionate increase of intra-firm trade to ICT level suggests that to facilitate offshoring via FDI abroad, infrastructure should be provided. An incentive system such as tax credit for investments in ICT may be a useful instrument.

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Tables

Table 4. ICT level and Offshoring Decision (Probit Model)

	(1) ICT_2	(2) ICT_3	(3) ICT_4	(4) ICT_5
ICT_2	0.129	0.554**	0.329	0.839**
	(0.482)	(0.26)	(0.250)	(0.237)
Productivity	-0.048	-0.02	-0.035	-0.009
	(0.53)	(0.193)	(0.176)	(0.152)
Size	0.054	-0.01	0.018	-0.001
	(0.103)	(0.12)	(0.138)	(0.106)
K/L	-0.175***	-0.18***	-0.177***	-0.175***
	(0.048)	(0.066)	(0.057)	(0.048)
R&D	0.268**	0.248**	0.254**	0.253**
	(0.116)	(0.136)	(0.142)	(0.116)
FDI	1.669***	1.66***	1.66***	1.691***
	(0.244)	(0.245)	(0.308)	(0.245)
Observation	652	637	637	637
Log likelihood	-425.33	-270.67	-268.92	-268.74
Pseudo R^2	0.055	0.243	0.249	0.249

Notes: The heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. Forty-one industry dummy variables are included. We do not report the results of the effects of industry characteristics and constant term.

Table 5. Sourcing Decision (Probit Model-Marginal Effects)

	(1) Domestic	(2) Subsidiary	(3) Arm's length	(4) Offshoring
E-commerce	0.011	0.061**	0.028	0.088**
	(0.044)	(0.028)	(0.027)	(0.038)
Productivity	-0.041	-0.034*	0.010	-0.001
	(0.030)	(0.019)	(0.016)	(0.023)
Size	0.067***	0.035***	-0.005	-0.001
	(0.021)	(0.012)	(0.012)	(0.016)
K/L	0.004	-0.018***	-0.014***	-0.028***
	(0.008)	(0.006)	(0.005)	(0.007)
R&D	0.005	0.023*	0.021*	0.034*
	(0.020)	(0.013)	(0.012)	(0.017)
FDI	-0.236***		0.007	0.265***
	(0.043)		(0.027)	(0.038)
Observation	668	671	616	637
Log likelihood	-437.568	-203.656	-205.226	-269.028
Pseudo R^2	0.051	0.159	0.1	0.248

Notes: The heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. Forty-one industry dummy variables are included. We do not report the results of the effects of industry characteristics and constant term.

Table 6. Amount of Sourcing (Tobit Model)

	(1)Domestic	(2)Subsidiary	(3)Arm's length	(4)Offshoring
E-commerce	0.142	1.394**	0.814	0.921**
	(0.276)	(0.645)	(0.685)	(0.395)
Productivity	-0.097	-0.323	0.234	0.153
	(0.189)	(0.441)	(0.498)	(0.282)
Size	0.231*	0.486*	-0.083	-0.123
	(0.131)	(0.292)	(0.342)	(0.186)
K/L	0.001	-0.459***	-0.336**	-0.302***
	(0.050)	(0.145)	(0.147)	(0.086)
R&D	0.158	0.836***	0.707**	0.607***
	(0.135)	(0.316)	(0.321)	(0.189)
FDI	-1.407***		0.147	2.919***
	(0.290)		(0.690)	(0.427)
Observation	671	671	671	671
Log likelihood	-955.334	-355.457	-338.161	-560.427
Pseudo R^2	0.026	0.130	0.078	0.149
Censored	381	590	600	518

Notes: The heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. Forty-one industry dummy variables are included. We do not report the results of the effects of industry characteristics and constant term.

Table 7. Sourcing Decision (Probit IV Model)

	(1)Domestic	(2)Subsidiary	(3)Arm's length	(4)Offshoring
E-commerce	-0.040	0.289*	0.042	0.045
	(0.149)	(0.167)	(0.172)	(0.226)
Productivity	-0.164	0.051	-0.173	-0.832
	(0.223)	(0.304)	(0.175)	(0.698)
Size	0.168	0.036	-0.013	0.313
	(0.112)	(0.137)	(0.096)	(0.334)
K/L	0.014	-0.116*	-0.074	-0.065
	(0.035)	(0.064)	(0.047)	(0.068)
R&D	-0.074	0.234**	0.041	0.257*
	(0.083)	(0.098)	(0.100)	(0.150)
FDI	-0.718***		0.047	0.807**
	(0.142)		(0.162)	(0.353)
Observation	372	372	372	374
Log likelihood	-696.673	-607.708	-596.960	-717.891
Wald stat for exogeneity	2.43	3.8	5.05	1.99

Notes: The heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. Forty-one industry dummy variables are included. We do not report the results of the effects of industry characteristics and constant term.

Table 8. Amount of Sourcing (Tobit IV Model)

	(1)Domestic	(2)Subsidiary	(3)Arm's length	(4)Offshoring
E-commerce	-0.151	1.345*	0.390	0.775
	(0.332)	(0.833)	(0.882)	(0.490)
Productivity	-0.538	0.247	-0.945	0.051
	(0.469)	(1.148)	(1.029)	(0.657)
Size	0.389*	0.129	-0.047	-0.289
	(0.240)	(0.595)	(0.508)	(0.349)
K/L	0.005	-0.532**	-0.352	-0.374***
	(0.071)	(0.254)	(0.251)	(0.144)
R&D	-0.082	1.157***	0.406	0.464*
	(0.189)	(0.410)	(0.481)	(0.286)
FDI	-1.573***		0.251	3.460***
	(0.318)		(0.862)	(0.477)
Observation	372	372	372	372
Log likelihood	-1019.84	-717.14	-684.79	-840.60
Wald stat for exogeneity	4.46	3.45	4.4	0.77
Censored	190	316	326	270

Notes: The heteroskedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. Forty-one industry dummy variables are included. We do not report the results of the effects of industry characteristics and constant term.

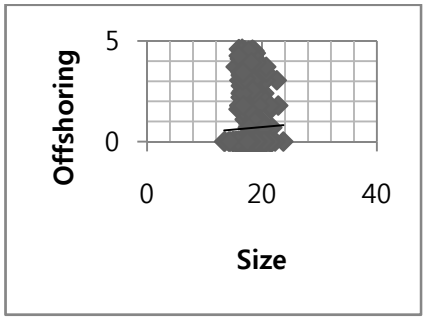
Appendix

Appendix 1. Correlation Matrix

	Domestic	Subsidiary	Arm's length	Offshoring dummy	Offshoring value	E-commerce	Productivity	Size	K/L	R&D
Domestic										
Subsidiary	-0.3557									
Arm's length	-0.3307	-0.1387								
Offshoring dummy	-0.5281	0.6801	0.6262							
Offshoring value	-0.4621	0.6013	0.5507	0.882						
E-commerce	0.0249	0.135	0.0476	0.1372	0.1013					
Productivity	0.0214	-0.033	-0.0229	-0.0415	-0.0279	0.449				
Size	0.0817	0.12	-0.0173	0.0746	0.0303	0.2608	0.5583			
K/L	0.0032	-0.1516	-0.1053	-0.1955	-0.1764	-0.1181	0.0532	-0.2039		
R&D	-0.0149	0.1173	0.1195	0.1778	0.2246	0.1126	-0.2129	-0.1128	-0.1639	
FDI	-0.1699	0.4543	0.0528	0.3939	0.3794	0.1334	0.0082	0.2229	-0.2124	0.1629

Appendix 2

<Figure 4>



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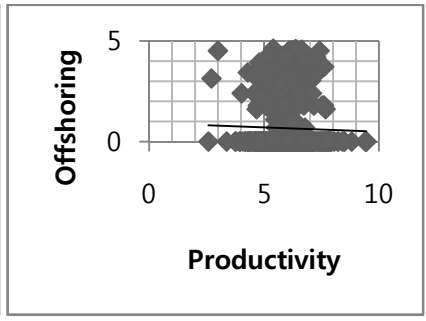

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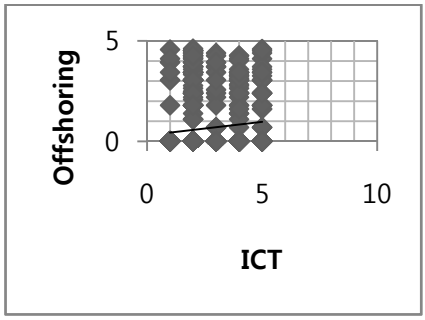

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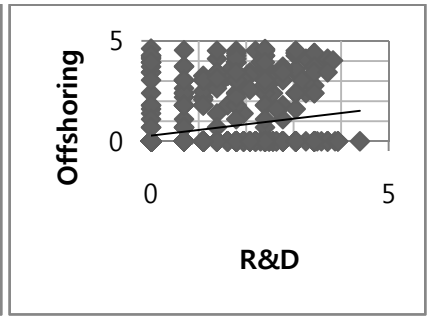

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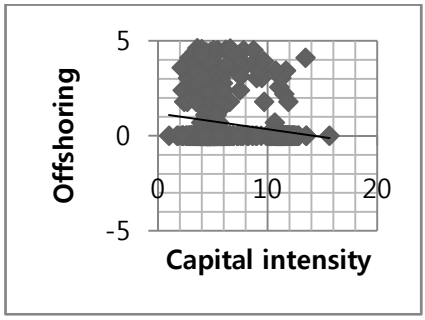

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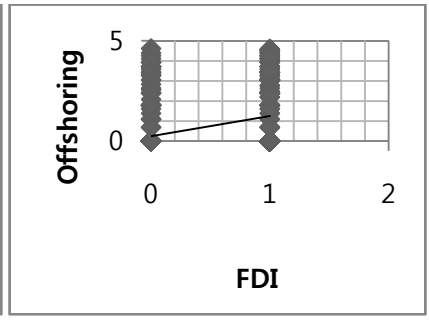

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Firm Heterogeneity in the Choice of Offshoring: Evidence from Korean Manufacturing Firms

Hea-Jung Hyun

Using firm-level data on offshoring of Korean manufacturers, the paper examines the relationship between firm heterogeneity and the probability of adopting offshoring. The results of the paper suggest that firm productivity may not be an important determinant for Korean firms' offshoring decision. Firm's global sourcing decision may rather depend on other characteristics such as factor intensity, R&D intensity, ICT level, and affiliation with foreign markets, when industry specificity is controlled for.

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