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Do external knowledge sourcing methods matter in service innovation?: analysis of South Korean service firms

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TEMEP Discussion Paper No. 2009:08

서울대학교

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Editor: Almas Heshmati

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Do external knowledge sourcing methods matter in service innovation?: analysis of South Korean service firms

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This paper analyses the effects of different external knowledge sourcing methods on service innovation performance. We identify three external knowledge sourcing methods: informal information transfer, R&D collaboration, and technology outsourcing. Three hypotheses are established to examine the relationship between these three external knowledge sourcing methods and service innovation. Our result shows that the relationship between the extent of external knowledge sourcing and service innovation performance varies depending on the particular external knowledge sourcing method. This research grants important implication to firms in selecting an appropriate external knowledge sourcing strategy in service industry.

Keywords: service innovation; external knowledge sourcing method; informal information transfer; R&D collaboration; technology outsourcing

Introduction

Since service firms are facing rapid developing technology, fast changing customer needs, fierce competition, and short service life cycles, the importance of service innovation increases in regard to service firms' competitiveness and profitability (Bogner & Barr, 2000; Cainelli et al., 2004; D'Aveni, 1995; Elche & González, 2008). However, due to the acceleration of change in market and technology, firms cannot create service innovations depending only on internal knowledge base. Therefore, external knowledge – such as information, technology, and know-know from outside of firm boundaries – becomes to play a more crucial role in accelerating service innovation (Chesbrough, 2003; Keil, 2002; Leonard-barton, 1995).

Traditionally, innovation in services has been studied largely on the basis of theories of innovation in the manufacturing sector (Drejer 2004; Gallouj 2002), and previous research of innovation in the manufacturing sector identify external knowledge sourcing method as a crucial determinant of the relationship between external knowledge and product innovation (Kang & Kang, 2009). However, the effect of external knowledge sourcing method on service innovation has not been sufficiently explored. Therefore, in this research we analyse the effects of the external knowledge sourcing methods on service innovation.

There are various external knowledge sourcing methods that firms can utilize, such as informal information transfer (Kang & Kang, 2009), R&D cooperation (Brockhoff, 1992; Pisano, 1990; Shan et al., 1994), and technology outsourcing (Granstrand, 1982; Granstrand & Sjölander, 1990). Most firms do not use a single method but use a variety of methods simultaneously for external knowledge sourcing. The effect of external knowledge sourcing on innovation performance varies depending on external knowledge sourcing methods (Kang & Kang, 2009). Therefore, studying and comparing different effects of various external knowledge sourcing methods on service innovation performance is strongly required.

In this study, we examine the different effects of various external knowledge sourcing methods on service innovation by simultaneously incorporating three external knowledge sourcing methods within a single empirical model. We identify three external knowledge sourcing methods: informal information transfer, R&D cooperation, and technology outsourcing. Effects of these three external knowledge sourcing methods on service innovation performance are analysed empirically using the negative binomial regression model. We employ the 'Korea Innovation Survey 2006 (KIS 2006)' dataset covering 1) informal information transfer, 2) R&D cooperation, and 3)

technology outsourcing of corporations in the service sector in South Korea. The number of focal firm's service innovation in 2005 is used as the dependent variable to represent its service innovation performance.

The contribution of this study to the research of service innovation is twofold. First, the results show that the effect of external knowledge sourcing on service innovation performance varies depending on the external knowledge sourcing method. This gives significant implications for firms when selecting external knowledge sourcing methods and determining the appropriate utilization levels of external knowledge sourcing methods. Second, the finding reinforces the assimilation approach of service innovation research and gives an implication to the synthesis approach, and thus contributes to the service innovation research.

Conceptualization and Hypotheses

Since the change in technology and market is moving rapidly in most industries, firms cannot accomplish innovation successfully with using only internal knowledge base or capabilities. External sourcing of knowledge and capabilities for accelerating innovation is gaining more and more importance in accelerating innovation (Chesbrough, 2003; Hagedoorn & Duysters, 2002; Keil, 2002; Leonard-barton, 1995). Because firms in the service industry are exposed to radical developments in technology, fast change of customer needs, high competition, and short service lifetime (Bogner & Barr, 2000; D'Aveni, 1995), it is very important to accelerate the speed of innovation and to improve the probability of successful innovation. Nowadays, many service innovations are created by technological advance. However, the core competencies of service firms are not its technological development capability but its service capability. Therefore, service firms are more likely to depend on external knowledge and technologies for innovation than are manufacturing firms (Tether, 2005; Tether & Tajar, 2008).

Traditionally, innovation in services has been studied largely on the basis of theories of innovation in the manufacturing sector (Drejer 2004; Gallouj 2002). Previous research relating to factors affecting service innovation have been based on two conflicting approach: assimilation approach and demarcation approach (Cooms & Miles 2000). Assimilation approach asserts that innovation in the service sector is basically similar to innovation in the manufacturing sector (Gallouj 2002; Sirilli & Evangelista 1998), while the demarcation approach, on the other hand, asserts that

innovation in the service sector is different from innovation in the manufacturing sector and has its own unique characteristics (Coombs & Miles 2000; Drejer 2004; Gadrey et al. 1995; Gallouj 2000; Sundbo 2000; Sundbo & Gallouj 2000). These two approach stand in tight opposition to one another.

However, regardless of whether the research on service innovation has been studied on the basis of innovation theories in the manufacturing sector or not, and regardless of whether the research has been done based on assimilation approach or demarcation approach, most research agree that firms should actively utilize external knowledge for innovation in this fast changing environment. Particularly, external knowledge sourcing method can be major factor that affects service innovation in service industry, same as it is a major determinant of product innovation in the manufacturing industry. Therefore, this research analyses the effects of various external knowledge sourcing methods on service innovation performance based on the assimilation approach.

Most firms utilize various external knowledge sourcing methods simultaneously and the effect of using external knowledge on innovation performance varies depending on the type of external knowledge sourcing method (Hagedoorn & Hesen, 2007; Kang & Kang, 2009). There are various criteria in classifying external knowledge sourcing methods. Hagedoorn and Hesen (2007) categorize external knowledge sourcing methods by the type of agreement: joint-venture, non-equity partnership, and licensing. Research that categorizes external knowledge sourcing methods by formality of agreement also exists (Brockhoff, 1992; Hakansson & Johansson, 1992). Robertson and Gatignon (1998) classify the governance mode of R&D into three: internal R&D, market contracting, and alliance. Kang and Kang (2009) synthesize previous criteria and identify three external knowledge sourcing methods according to the properties of each method: informal information transfer, R&D cooperation, and technology outsourcing. Kang and Kang (2009) consider various aspects of external knowledge sourcing method, such as agreement, organisational interaction, and strength of relationship between firm and its external knowledge sources, to identify three external knowledge sourcing methods. Based on the assimilation approach to service innovation, we follow Kang and Kang (2009)'s method to categorize external knowledge sourcing methods in the service sector. Properties of three external knowledge sourcing methods are described in Table 1.

< Insert Table 1 about here >

Informal information transfer is acquiring information that has spilled over from external knowledge sources, without formal contracts or interactions. Relationships between focal firms and external knowledge sources can be classified as informal network when there are no particular contracts between focal firms and external knowledge sources (Hakansson & Johansson, 1992; Pyka, 1997). Also, relationship between a firm and external knowledge sources for informal information transfer can be categorized as a weak tie because it is not for sharing critical capability or organisational interaction but for sharing information (Granovetter, 1973; Hansen, 1999). Informal and weak relationship does not require large managerial, transactional, and maintenance costs. Because the cost is very low, firms can build larger networks for informal information transfer with abundant external knowledge sources. Because of this advantage, firms can access external information more readily, react faster to changes of environment, and innovate more efficiently.

Previous research has stressed that when a firm utilizes external information, there is an inverted-U shape relationship between the extent of external information sourcing and innovation due to lack of absorptive capacity, over-search problem, or dispersion of attention (Koput, 1997; Laursen & Salter, 2006). However, recent research (Kang & Kang, 2009) suggests that the efficiency of knowledge absorbing process has enhanced quickly and the searching cost of external information has decreased because of the fast development of information technologies and communication technologies. Firms can gain, keep, and utilize external information more efficiently for their innovation under the condition of limited resources. Kang and Kang (2009) find empirically a positive relationship between informal information transfer and innovation performance. Thus, this research proposes a hypothesis as follows.

H1: The extent of informal information transfer has a positive effect on service innovation performance.

Relationship between a firm and its R&D cooperation partner is a formal relationship because it is mostly constructed by formal agreement (Hakansson & Johansson, 1992; Pyka, 1997). Relationship between a firm and its R&D cooperation partner also has properties of strong tie because capability sharing and organisational interaction occurs through it (Granovetter, 1973; Hansen, 1999). A strong tie like R&D cooperation has the advantage of sharing critical capabilities and resources.

Through R&D cooperation, a firm can overcome the apparent limitations of

firm's resources and capabilities for innovation (Narula, 2004), R&D cooperation improves the efficiency of the innovation process by spreading the costs of technological development, decreasing risks (Das & Teng, 2000; Narula, 2004; Tyler & Steensma, 1995), and shortening the time of innovation cycle (Pisano, 1990). R&D cooperation also grants firms opportunities for monitoring technological advances, thus allowing rapid access to new technology (Dodgson, 1993; Hamel, 1991; Roberts & Berry, 1985). Firms cooperating with other organisations enjoy a scope of economy by widening the breadth of technological competence (Kogut, 1988; Das & Teng, 2000). Many of previous studies also support the positive effect of R&D cooperation on innovation (Aschhoff & Schmidt, 2008; Cincera et al., 2003; Teng, 2007). In particular, Love & Mansury (2007) also suggest that strategic alliance, a type of cooperation, has a positive effect on service innovation. Thus, it should stand to reason that R&D cooperation has a positive effect on a firm's service innovation performance.

However, immoderate dependency on R&D cooperation in innovation activity causes a negative effect on service innovation performance. R&D cooperation needs a large maintenance cost, thereby rendering it difficult for firms to build various and wide networks (Granovetter, 1973; Hansen, 1999). High coordination cost for profiting from complex linkage between cooperation partners also has a negative effect on performance (Narula, 2004). Also, partners may show opportunistic behaviors - such as asymmetric knowledge sharing and technology leakages - in R&D cooperation (Dodgson, 1993; Bruce et al., 1995; Pisano, 1990). Partners' opportunistic behaviors may lead to delays and failures of R&D activity, causing negative effects on firms' innovation (Bruce et al., 1995; Dodgson, 1993; Pisano, 1990). Firms utilizing R&D cooperation, therefore, need to build monitoring systems to prevent risks due to partners' opportunistic behaviors; however, building such systems would generate a dispersion of firms' energy and capability, thus hindering the firms from focusing on innovation activity. Also, monitoring systems increase the rigidity of R&D cooperation process, obstructing the efficiency of innovation activity. Many of previous studies support the negative effect of R&D cooperation on innovation (Janz et al., 2004; Okamuro, 2007; Teng, 2007). Therefore, it is possible that a firm's strong dependency on R&D cooperation have a negative effect on its service innovation performance. Based on the discussion above, we propose a hypothesis asserting that there is an inverted-U shape relationship between the extent of R&D cooperation and service innovation.

H2: The extent of R&D cooperation has an inverted-U shape relationship with service innovation performance.

These days, many service innovations are generated by technological improvements. However, the core competencies of service firms are especially its service ability. Internal development of a new technology for service innovation is difficult, requires longer time, and makes it hard for a firm to cope with the fast changing environment of service industry. Therefore technology outsourcing from external knowledge sources has a crucial effect on service innovation. Service firms can focus their capabilities on service innovation through external sourcing of technological elements that are necessary for service innovation and they can accomplish faster service innovation.

In short term perspective, the relationship between a firm and external technology provider can be identified as a formal relationship (Hakansson & Johansson, 1992; Pyka, 1997) and thus momentarily has properties of strong tie. However in a long-term perspective, the relationship for technology outsourcing has properties of a weak tie because technology outsourcing just causes a short-term organisational interaction for transferring technological knowledge and firms do not need to maintain a strong relationship with technology provider when the contract is over. It is less likely to generate rigidity of relationship between a firm and its technology provider. Therefore, firms can access adequate external technology more readily, react faster to changes of environment, and innovate more efficiently through technology outsourcing.

Concerning the open innovation perspective, Chesbrough (2003) emphasizes the importance of active technology outsourcing for innovation. Under condition of very high technological uncertainty, a firm is more likely to choose technology outsourcing rather than to pursue internal R&D (Balakrishnan & Wernerfelt, 1986; Harrigan, 1986; Walker & Weber, 1984). Because changes in business environment, knowledge, and technology are being accelerated, it becomes more difficult to maintain competitive advantage through internal R&D. When a firm has problems which cannot be solved by internal R&D, or when a firm is required to invent new technology very fast, technology outsourcing gives great advantage to the firm's innovation. Therefore, we hypothesize that technology outsourcing has a positive effect on the firm's service innovation performance.

H3: The extent of technology outsourcing has a positive effect on service innovation performance.

Data and Methods

Service industry in South Korea

Service industry of South Korea accounted for 56.3% of the growth domestic products (GDP) in 2006. The number is relatively low compared to that of other OECD member countries. However, for the past 15 years, the accounting rate of the service industry has increased from 40.6% in 1990 to 56.3% in 2005 (SERI 2006). Since innovation is observed more frequently in fast-growing industries (Eisenhardt & Tabrizi, 1995) and the service industry of South Korea is growing continuously, service innovations occur frequently in South Korea. Therefore, this provides an interesting environment to study service innovation in South Korea.

Moreover, because of recent progress in IT industry, South Korea becomes a more fitting site to study service innovation. IT has a significant effect on service innovation (Licht & Moch, 1999; Miles, 2005). IT is widely used in physical services, such as logistics, transport, and retailing. IT is also the key in information-processing which is the core of service providing activity, such as internet service, e-commerce, telecommunication service, and financial service (Miles, 2000). According to the OECD report (2007), the diffusion rate of internet in South Korea takes up to 78.3% in 2006 and come out at the top in the world. In addition, the diffusion rate of mobile phone takes up to 92.2%. Fast development and rapid diffusion of IT in South Korea gives service firms an advantage in service innovation and South Korean case should give a significant implication to other developing countries.

Sample

The data for analysis are taken out from the 'Korean Innovation Survey 2006: Service Sector' (KIS 2006) gathered by Science and Technology Policy Institute (STEPI) of South Korea. Survey method and questionnaire used in KIS 2006 are based on the third edition of Oslo Manual of the Organisation for Economic Cooperation and Development (OECD). KIS data are used extensively for research because of many reasons: many variables and large sample size. The questionnaire of KIS 2006 is made up of 16 pages describing important terminology prior to questions.

It includes several questions on the type and importance of informal information sources, R&D cooperation partners, sources for technology outsourcing, and other questions related to a firm's service innovation.

Population of KIS 2006 was created by 'Basic Statistical Survey 2004' of Korea National Statistical Office. STEPI chose 6,545 samples from this population according to the Neyman method. Samples were selected by second order stratification. First, STEPI stratified the population on 20 categories according to the Korea Standard Industrial Classification (KSIC). Most categories of Korean service sectors were included within the 20 categories. Second, STEPI stratified each category on 4 sub-categories according to the number of employees. The population was stratified on 80 sub-categories and STEPI selected 6,545 sample firms from 80 sub-categories by the difference of variance between each sub-categories.

The survey was sent to 4,898 firms in the service sector of South Korea in May 2006, with the exception of 1,647 firms who had quit their business or had refused answering the survey. STEPI got back 2,498 answers, amounting up to a response rate of 51%. After receiving the responses, STEPI called sample firms to ratify the result of the survey. In this study we use a sub-sample of the KIS 2006 which includes data from 454 firms that replied all the variables that this analysis examines.

Dependent variable

This study analyses the effects of different external knowledge sourcing methods on service innovation performance. Therefore, the central problem is defining the measure of service innovation performance. In previous studies, there are various methods to measure firm's innovation such as 'number of product innovation' (Kang & Kang, 2009), 'fraction of the firm's turnover relating to innovation' (Laursen & Salter, 2006), and 'whether or not the focal firm introduces a new or improved service' (Love & Mansury, 2007). Though Laursen and Salter (2006)'s method is useful in measuring the focal firm's innovativeness, it is not efficient for measuring the quantity of service innovation. And Love and Mansury (2007)'s method tends to oversimplify the firm's service innovation performance.

Based on assimilation approach, we use the number of service innovation in 2005 as the measurement of service innovation performance. This approach for measuring innovation is similar to Kang and Kang (2009). The quantity of service

innovation well represents the level of service innovation performance. KIS 2006 strictly defines service innovation as ‘a new service that is completely different from previous services, is commercialized successfully, and affects focal firm’s sales’.

Independent variables

The extent of external knowledge is determined by the variety of types of external knowledge sources used by focal firms and the strength of relationship between focal firms and each type of external knowledge source. (Kang & Kang, 2009; Katila & Ahuja, 2002; Laursen & Salter, 2006; Levinthal & March, 1993). In this study, we propose an alternative method to measure the extent of external knowledge that simultaneously considers the variety of external knowledge sources and the importance of each external knowledge source. The extent of external knowledge is measured by the sum total of importance of each type of external knowledge source

In this study, we identify three external knowledge sourcing methods. Thus, we suggest three independent variables reflecting the extent of external knowledge in each method: the extent of informal information transfer, the extent of R&D cooperation, and the extent of technology outsourcing. Types of external knowledge sources are introduced in table 2.

< Insert Table 2 about here >

The extent of informal information transfer (INFOR)

KIS introduces thirteen types of informal information sources and measures importance of each source to a firm’s service innovation by a six-point scale (0 to 5). The extent of informal information transfer (INFOR) is measured by the sum total of importance of thirteen types of information sources. Thus, INFOR has integer value of range 0 to 65.

The extent of R&D cooperation (COOPER)

KIS introduces nine types of R&D cooperation partners and measures the contribution of each partner to a firm’s service innovation by a six-point scale (0 to 5). In this study, we measure the extent of R&D cooperation (COOPER) by the sum total of contribution

of nine types of cooperation partners in innovation activity. COOPER has integer value of range 0 to 45.

The extent of technology outsourcing (OUTSOURCING)

KIS introduces nine types of sources for technology outsourcing and measures the contribution of each source to a firm's service innovation by a six-point scale (0 to 5). In present research, the extent of technology outsourcing (OUTSOURCING) is measured by the sum total of contribution of nine types of sources for technology outsourcing. Therefore, OUTSOURCING has integer value of range 0 to 45.

Control Variables

In this study, we employ five control variables: firm size, R&D intensity, start-up, market size, and participation of user. Firm size has an important effect on the firm's innovativeness, and therefore is frequently used as a control variable in many studies related to innovation. Firm size is measured by logarithm of the number of total employees who work in focal firms (LOGSIZE).

Firm's R&D intensity has been considered an important factor affecting innovation. R&D intensity (RDINT) is calculated by the firm's R&D expenditure divided by firm's sales. R&D intensity represents not only firm's internal effort for innovation but also firm's absorptive capacity (Cohen & Levinthal, 1990). Thus, we use R&D intensity to control effects of internal effort for innovation and absorptive capacity.

Start-up firms have a tendency to innovate more vigorously than incumbents. Therefore, we look whether or not the firm was a recent start-up (STARUP). If a firm started in the period 2001-2005, then the firm is considered a start-up. Simply the variable takes the value of 1 when the focal firm started up in the period 2001-2005, and 0 otherwise.

In addition, we control for the size of focal firm's market (GEOMARKET). A firm who operates in large areas has to upgrade its service suitable to the various needs of different regions (Altinay & Wang, 2006). Services competing in broad markets are more likely to be obsolete than services competing in small markets. So firms competing in broad markets make exert to innovate more intensively than firms

competing in small markets. In this research, GEOMARKET variable takes the value 1 when corresponding to the area within a radius of 50km, 2 when corresponding to the area within 100km, 3 when corresponding to the area within 200km, 4 when corresponding to whole country, and 5 when corresponding to international market.

Previous studies of innovation insist that the relatedness of customers to innovation has a significant effect on innovation (Kang & Kang, 2009; Laursen & Salter, 2006; Rothwell et al., 1974; von Hippel, 1988) and cooperation with customers has a positive effect on knowledge creation (Weck, 2006). Customers freely give the firm feedback on services that they have used. A previous literature suggests that customers significantly enhance service innovation (Love & Mansury, 2007). We include CUSTOMER variable to control for the effect of relatedness of customers to innovation. CUSTOMER variable is created based on the 'clients or customers' source of informal information for innovation. The variable takes the value of 1 when the firm indicates that it uses clients or customers to a degree of 4 to 5 as sources of knowledge for innovation activities, and 0 otherwise.

Method

In this study, we employ the number of service innovation in 2005 to measure service innovation. The number of service innovation is a countable integer value. When analyzing a dependent variable that is an integer value, researchers can employ regression models such as Poisson regression or negative binomial regression. Since the variance of our dependent variable is not equal to its mean and also greatly larger than its mean, our dependent variable has an over-dispersion problem and infringes on the basic conditions of Poisson distribution. Therefore negative binomial regression model which allows over-dispersion is chosen for analysis.

Results

Korea Innovation Survey 2006 (KIS) is a self-reported survey, and focal independent variables and dependent variable of this study were collected by using a single survey instrument and a single informant per firm. Therefore, there may be significant risks of common method bias and single informant bias in this study. To address potential concerns of common method bias and single informant bias, we undertook Harman's

(1967) one-factor test. According to Harman's (1967) one-factor test, if a substantial amount of common method bias exists in data, either a single factor will come out from the factor analysis, or one general factor that accounts for most of the covariance among the variables will emerge when all the variables are entered together (Podsakoff et al., 2003). We entered all the variables into an exploratory factor analysis. An unrotated principal components factor analysis on all variables revealed four factors with eigenvalues greater than 1.0, which together accounted for 58 percent of the total variance; also, the largest factor did not account for a majority of the variance (29%). Therefore, no general factor is apparent. This test left us confident that neither common method nor single informant bias was a serious problem in our study.

< Insert Table 3 about here >

In this research, we explore the relationship between three external knowledge sourcing methods and service innovation employing dataset from KIS 2006. Table 3 shows summary of descriptive statistics and correlations among variables. There are relatively high correlations between independent variables. Thus, we conducted variance inflation factor (VIF) analysis to examine whether there is a multicollinearity problem amongst independent variables. Table 4 shows the result of VIF analysis and INFOR variable shows the largest value of VIF (1.94). In general, it is accepted that there is no multicollinearity problem when the VIF value is below than ten. Therefore, relatively high correlations between independent variables just illustrate that a firm who has open attitude to external knowledge is likely to use a combination of various external knowledge sourcing methods. In other words, a firm who has high openness actively uses various external knowledge sourcing methods simultaneously.

< **Insert Table 4 about here** >

Table 5 contains results of three negative binomial regression models that analyse effects of the three external knowledge sourcing methods and the extent of external knowledge sourcing on service innovation. Each model contains control variables such as LOGSIZE, RDINT, STARTUP, GEOMARKET, USER, and industry dummies. Model 1 contains only the control variables. Model 2 analyses the effects of three external knowledge sourcing methods (INFOR, COOPER, and OUTSOURCING) on service innovation. Model3 contains additional square terms of INFOR, COOPER, and OUTSOURCING to analyse the curvilinear relationship

between three independent variables and service innovation.

< Insert Table 5 about here >

Model 2 shows that the parameter for INFOR is significant and positive. Thus, hypothesis 1 which asserts a positive relationship between the extent of informal information transfer and service innovation performance is supported. When a firm acquires information that is spilled over from external knowledge sources through informal information transfer, the more the firm uses informal information transfer, the more the firm gains service innovation performance.

Model 2 shows that the parameter for COLLAB is not significant. However, model 3 shows that the parameter for COLLAB is positive and significant and the parameter for COLLAB squared is negative and significant. Therefore, hypothesis 2 asserting that the extent of R&D collaboration takes an inverted-U shape relationship with service innovation performance is supported.

Model 2 shows that the parameter for ACQUI is not significant. Thus, hypothesis 3 which suggests a positive relationship between the extent of technology outsourcing and service innovation performance is not supported. However, model 3 shows that the parameter for ACQUI is negative and significant and that the parameter for ACQUI squared is positive and significant. This result presents a U-shape relationship between the extent of technology outsourcing and service innovation performance.

Discussion

We find that the effect of informal information transfer has a positive effect on service innovation. The result is similar to Kang and Kang (2009) that suggests a positive relationship between the extent of informal information transfer and product innovation. Over-search problem is diminished due to the reduction in searching cost and the improvement of knowledge absorption process through the fast development of information and communication technology. Also, since network for informal information transfer does not require high maintenance and coordination costs, the benefit of information transfer is greater than the cost. Therefore, service firms should develop large informal channels for transferring information with external knowledge sources more actively. This similar result reinforces the assimilation approach of

service innovation studies (Gallouj 2002; Sirilli & Evangelista 1998).

The finding shows that the extent of R&D collaboration has an inverted-U shape relationship with service innovation performance. This implies that firms have to utilize R&D collaboration to an optimal level. Firms should maintain the extent of R&D collaboration within a controllable scope and pay attention to technology leakage (Kaufman et al. 2000) and opportunistic behaviors of their collaboration partners (Williamson 1985). Firms can utilize repeated alliance to reduce the risk of partners' opportunistic behavior. Previous research of collaboration based on the transaction cost economics suggest that repeated alliance or collaboration with same partner decrease behavioral uncertainty and transaction costs and increase confidence level between partners (Granovetter 1973; Gulati 1995; Marsden 1981). Thus firms overcome the risk of R&D collaboration by repeated alliance. However, research based on the network view suggest opposite insight to the R&D collaboration. Non-redundant network has a positive effect on profit from network (Burt 1992; Granovetter 1973) and repeated alliance has negative effect on innovation performance (Goerzen 2007). Too broad exploration or too deep exploitation of R&D collaboration partner has negative effect on focal firm's innovation performance. Therefore, firms must keep in mind to utilize same partner moderately and also to update collaboration partners adequately.

The inverted-U shape relationship between the extent of R&D collaboration and service innovation performance can provide an explanation for the two conflicting results in R&D collaboration and innovation literature: the positive effect of R&D collaboration on innovation (Aschhoff & Schmidt 2006; Cincera et al., 2003), and the negative effect of R&D collaboration on innovation (Janz et al. 2003; Okamuro 2007; Teng, 2007). Since inverted-U relationship between the extent of R&D collaboration and service innovation performance is akin to the research of innovation in the manufacturing sector, this result also reinforces the assimilation approach of service innovation (Gallouj 2002; Sirilli & Evangelista 1998).

The relationship between the extent of technology outsourcing and service innovation performance does not precisely correspond with previous research, which asserts that the increase in the extent of technology outsourcing accelerates innovation and increases innovation performance (Kang & Kang 2009). The result presents that when the extent of technology outsourcing is below the threshold, service innovation performance decreases with the increase in the extent of technology outsourcing. On the other hand, this result shows that when the extent of technology outsourcing exceeds the threshold, service innovation performance increases with the increase in the extent of

technology outsourcing. This finding implies that service firms should use technology outsourcing actively or they should not use technology outsourcing at all to maximize service innovation performance.

There are several reasons for this different result. First, the different mainsprings of service innovation and product innovation have to be considered. Many service innovations often depend on non-technological factors rather than the technological, and there is a possibility that there exists no direct effect of technology outsourcing on service innovation. Second, it is possible that a newly acquired technology does not fit into the already existing systems or services. In this case, the service firm suffers a delay in the development of a new service that utilizes the newly acquired technology, and so the service innovation performance decreases. Third, the different purposes of technology outsourcing - for service innovation and for product innovation - must be considered. In the manufacturing sector, when the firm counters problems which cannot be solved by internal R&D, the firm can solve them through technology outsourcing and so achieve innovation immediately. However, technology outsourcing is just a method for acquiring new applications or equipments in service industry and cannot generate service innovation immediately. Fourth, when innovation strategy of the firm focuses is focused on both the internal R&D strategy and external sourcing strategy, rather than on a single strategy, shirking problem may occur which would cause firm's service innovation performance to decrease.

Contribution and limitation

The finding of this research enables a further understanding into the relationship between the utilization of external knowledge and service innovation performance. Firms tend to use various external knowledge sourcing methods such as informal information transfer, R&D collaboration, and technology outsourcing simultaneously. However, previous studies have only estimated separately the effect of a single method on innovation performance. Thus, previous research has less implication in selecting a particular external knowledge sourcing method and determining optimum levels of the extent of each method. We overcome this limitation by identifying three different external knowledge sourcing methods simultaneously and analyzing the effects of each method on the service innovation performance. This research highlights that firms have to consider various strategic alternatives of external knowledge sourcing methods.

This research shows that the extent of external knowledge sourcing is very

important factor that determines the innovation performance. Since the effect of external knowledge utilization varies depending on external knowledge sourcing methods, firms should consider their status and circumstances before selecting external knowledge sourcing method. For instance, firms who have sufficient internal R&D capability, but suffer technology leakage, who want to keep appropriability of leading technology, had better use informal information transfer and technology outsourcing, rather than use R&D collaboration. Firms might utilize R&D collaboration actively, though, when they select their parent firms or subsidiaries as partners to avoid opportunistic behaviors of partner. However, when collaborating with competitors or customers who have a low trust level and are in a position to compete, firms should control the level of depending R&D collaboration.

The results show both similarities and differences from Kang and Kang (2009), which is built on a similar theoretical framework but works with the manufacturing sector. The finding implies that innovation in the service sector shows both similarities and differences from that of manufacturing. This contributes to the synthesis approach to innovation (Gallouj & Weinstein 1997; Preissl 2000). Because the aim of the synthesis approach is to build both theoretical and empirical approaches to innovation that can explain all economic activities including manufacturing and services (Tether, 2005), synthesis approach should consider not only similarities but also differences between innovations in the service sector and those in the manufacturing sector.

Analyzing the KIS 2006 database has an advantage because it provides a large number of samples. However, it is hard to find variables which fit precisely to the object of this research. In this research, we use the 'number of service innovations in 2005' as a measure of service innovation. However, our measurement has limitations because each service innovation has different effects on the firm's innovation and different degrees of innovativeness. Also, perception of innovation varies with firms. Thus, in future research, if data fitting more precisely to the research purpose are available, a more meaningful result may be obtained.

Conclusion

Service firms cannot innovate successfully by just using internal knowledge in this fast-moving environment. Firms have to explore and exploit external knowledge for innovation and must collaborate with other organisations for survival. When service firms decide to use external knowledge, the external knowledge sourcing method they

chosen is very important. This research gives important implications for solving these questions. We have discussed the different effects of various methods of external knowledge sourcing. This study suggests that service firms should explore and exploit external information through informal network as much as possible, use R&D collaboration at a moderate level, and use technology acquisition carefully to maximize service innovation performance. This research is helpful to managers in selecting appropriate method of external knowledge sourcing and in determining the degree of using each method.

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Table 1. Three external knowledge sourcing methods for service innovation

Methods	Formal agreement	Organisational interaction	Strength of relationship	advantage	disadvantage
Informal information transfer	No	No	Weak	Low or no cost	Relatively invaluable knowledge transfer
R&D cooperation	Yes	Strong & long term	Strong	Effective Knowledge transfer, Risk sharing	High coordination cost
Technology outsourcing	Yes	Weak & Short term	weak	Fast acquisition of appropriate knowledge	Risk of failure of commercialization

Source: Kang, K. H., & Kang, J. 2009. How do firms source external knowledge?: Analyzing Effects of Different Knowledge Sourcing Methods, *International Journal of Innovation Management*, 13, 1-17.

Table 2. External knowledge sources categorized by sourcing method

Sourcing mode	External knowledge sources
Informal information transfer (13 types)	Subsidiaries of same headquarter
	Competitors in same industry
	Customers or clients
	Business service firms, e.g., consulting
	Suppliers of raw materials or equipments
	Private research institutes
	IT firms
	Universities
	Government research organisations
	Informal networks of CEO or CTO
	Reviewing patents
	Fairs, exhibitions
	Media & Information network, e.g., newspaper, TV
R&D Cooperation (9 types)	Subsidiaries of same headquarter
	Competitors in same industry
	Customers or clients
	Business service firms, e.g., consulting
	Suppliers of raw materials or equipments
	Private research institutes
	IT firms
	Universities
Technology outsourcing (9 types)	Government research organisations
	Subsidiaries of same headquarter
	Competitors in same industry
	Customers or clients
	Business service firms, e.g., consulting
	Suppliers of raw materials or equipments
	Private research institutes
	IT firms
	Universities
	Government research organisations

Table 3. Descriptive statistics and correlations

Variables	Mean	Std dev.	1	2	3	4	5	6	7
1. INFOR	26.41	18.15	1						
2. COOPER	4.18	7.66	0.460	1					
3. OUTSOURCING	3.01	7.21	0.362	0.469	1				
4. RDINT	0.13	0.84	0.002	-0.038	0.091	1			
5. LOGSIZE	4.15	1.43	0.294	0.197	0.180	-0.108	1		
6. STARTUP	0.05	0.22	-0.002	0.051	0.122	0.183	-0.126	1	
7. USER	0.09	0.29	0.031	0.014	-0.017	-0.015	0.049	0.070	1
8. GEOMARKET	3.52	1.05	0.121	0.024	0.077	0.058	0.138	-0.042	0.032

INFOR, COOPER, and OUTSOURCING stand for the extent of informal information transfer, the extent of R&D cooperation, and the extent of technology outsourcing

Table 4. VIF Test results

Variables	VIF
INFOR	1.94
COOPER	1.54
OUTSOURCING	1.4
LOGSIZE	1.24
RDINT	1.13
STARTUP	1.05
USER	1.46
GEOMARKET	1.03
Average	1.35

Table 5. Negative binomial regression, explaining relationship of three external knowledge sourcing methods and service innovation

Model	I		II		III	
Dep. variable	SERVICE INNOVATION		SERVICE INNOVATION		SERVICE INNOVATION	
Indep. variables	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
INFOR			0.0182***	0.0061	-0.0155	0.0180
INFOR^2					0.0006**	0.0003
COOPER			0.0203	0.0162	0.1752***	0.0367
COOPER^2					-0.0072***	0.0014
OUTSOURCING			0.0108	0.0142	-0.1372***	0.0380
OUTSOURCING^2					0.0059***	0.0015
RDINT	-0.1171	0.1546	-0.1117	0.1492	-0.1048	0.1474
LOGSIZE	0.4667***	0.0681	0.3356***	0.0713	0.2683	0.0703
STARTUP	-0.1992	0.4318	-0.2002	0.4141	0.0096	0.4011
USER	-0.4555	0.3343	-0.6168*	0.3258	-0.4501	0.3119
GEOMARKET	0.0232	0.0956	-0.0599	0.0969	-0.0142	0.0898
Industry dummies	Yes		Yes		Yes	
No. of obervation	454		454		454	
Log likelihood	-1231.13		-1220.31		-1205.11	
Chi-square	108.67***		130.32***		160.73***	

*p < 0.10; ** p < 0.05; *** p < 0.01

INFOR, COOPER, and OUTSOURCING stand for three independent variables: the extent of informal information transfer, the extent of R&D cooperation, and the extent of technology outsourcing.

INFOR^2, COOPER^2, and OUTSOURCING^2 stand for the square-terms of three independent variables.

S.E. stands for the standard error of coefficient.

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