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EMPIRICAL ARTICLE

The moderating effect of innovation protection mechanisms on the competitiveness of service firms

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Abstract This empirical study examines the effectiveness of innovation protection mechanisms (IPMs) in capturing returns from innovation in service firms. To identify their effects, we set five types of IPMs (patents, other intellectual property rights, speed to market, secrecy, and complementary resources) as a moderator of the relationships between the innovation and firm competitiveness. Through a sample of service firms from the Korean Innovation Survey, the results of this study indicated that firm competitiveness cannot be influenced by service innovation alone but rather it is influenced by service innovation used in conjunction with IPMs other than patents. The results contribute to understanding innovation protection strategies for better competitiveness of service firms.

Keywords Innovation protection mechanism · Service and process innovation · Firm competitiveness · Korean Innovation Survey

1 Introduction

Since the service business contributes substantially to national economic development, the importance of service innovations (SI) has received increased attention during recent years (Cho et al. 2011). Despite the fact that many service firms develop innovations, profiting from them can be quite challenging. It is not only a

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question of pricing and marketing the services appropriately, but also about preventing competitors from imitating such services (Hurmelinna-Laukkanen et al. 2008). For example, LivingSocial, a social commerce firm in the US, provided new services such as LivingSocial Escapes (travel) and LivingSocial Instants (food delivery) to its customers; however, its competitor, Groupon, immediately provided a clone service to customers which prevented LivingSocial from having first-mover advantage (Mangalindan 2011).

Groupon's strategy was possible for the following reasons. First, innovations in the service industry only consider technology as an auxiliary for a new service rather than stress the importance of pure technological advancement, resulting in the employment of low-technology compared to the manufacturing industry (Hipp and Grupp 2005). Furthermore, innovations are dependent on customer needs and market trends, causing the sharing of information and ideas among competitors to be inevitable (Maklan et al. 2008). These factors allow innovations in the service industry to be easily imitated having a lower entry barrier for potential competitors (Sundbo 1997).

Since return from innovations is an important incentive for continuous innovation activity (Levin et al. 1987), it is important for service firms, whose intangible assets are core competences, to protect their innovation for maintaining and improving their competitiveness (Hurmelinna-Laukkanen et al. 2008). For innovation in service firms to be recognized by customers and attain competitiveness, attention to the firm's innovation protection mechanism (IPM) is needed.

Much research indicates that patents, secrecy, complementary resources, and speed to market are the most important IPMs in protecting innovation returns (Leiponen and Byma 2009). However, empirical analyses are mostly done for manufacturing firms as they are generally perceived more innovative (Allred and Park 2007; Brouwer and Kleinknecht 1999; Cohen et al. 2000). In the Korean Innovation Survey (KIS) of 2006 reported by the Science and Technology Policy Institute, only about 20 % of service firms were using more than one type of IPM. The use of IPMs is not only overlooked in research but is also overlooked by service firms.

Also, most previous research focused on the effectiveness of utilizing IPMs as dependent variables that were affected by firm-specific, industry-specific, and innovation environment-specific characteristics rather than analyzing how IPMs actually influence firm competitiveness (Arundel 2001; Blind et al. 2006). This type of research thus overlooks the fact that IPM is not merely the final aim but is a method to boost firm competitiveness. Therefore, this study discusses the importance and effectiveness of IPMs for firm competitiveness in service business.

This study provides new insights that can help both researchers and practitioners identify relevant issues regarding innovation protection within the area of the service industry. In the following section, we discuss previous research about innovation in service firms and IPMs. Section 3 develops the research model and hypotheses. In sect. 4, we describe the sample data, variable definitions, and measures used in this study. Section 5 presents the testing results, and the final section discusses the study implications before suggesting a direction for future study.

2 Literature review

2.1 Innovation in service firms

Innovation has been considered to be a core factor for firm competitiveness. However, most research has concentrated on innovation in the manufacturing industry or for technologically advanced products (Tether 2005). The importance of innovation has not been fully acknowledged in the service industry (Crevani et al. 2011).

Recently, much research has begun to focus on innovation in service firms, showing the difference between innovations from service firms and manufacturing firms. First, service firms usually develop concept and procedure oriented innovations, whereas manufacturing firms develop core technology oriented innovations (Nijssen et al. 2006). These differences occur because service firms' innovation is customer driven while manufacturing firms' innovation is science and technology driven (Howells 2000). Next, innovation in service firms is relatively easy to imitate and usually protected by copyrights and trademarks, but innovation in manufacturing firms is primarily protected by patents (Howells 2000). Finally, for innovation in service firms, the fit between new services and existing business activities is more important than in manufacturing firms (Johne and Storey 1998). Therefore, innovation in service firms should be organically linked between the front and back office (Nijssen et al. 2006).

Despite previous research, many difficulties have occurred in controlling and evaluating SI because such innovations tend to change frequently and also have ambiguous forms (Tether 2005). This is the result of the very nature of service. In general, service has four characteristics: (1) simultaneity (production and consumption occur at the same time), (2) perishability (service cannot be stored or produced beforehand to meet its demand), (3) heterogeneity (service cannot be identical among customers), and (4) intangibility (service cannot be touched or seen) (Coombs and Miles 2000; Hipp and Grupp 2005; Nijssen et al. 2006). These characteristics function distinctively depending on the type of service and influence SI in many different ways (Jaw et al. 2010).

2.2 Previous research on IPMs

Due to the drastic changes in advanced technology and increased competition in the service industry, it has become increasingly important to protect innovation to improve competitiveness (Narayanan 2000). The faster the innovation is imitated by competitors, the less time firms have to acquire adequate innovation output (Reed and DeFillippi 1990). This results in a loss of competitive advantage over competitors. Therefore, firms should focus on appropriability, which is the ability to capture the innovation output (Teece 1986). Appropriability is influenced by such exogenous factors as the structure of the industry, the legal system, and market trends, as well as endogenous factors such as IPMs used by the firm (Nieto and Pérez-Cano 2004). IPMs as endogenous factors refer to methods or strategies that

allow firms to benefit from an innovation by delaying or preventing imitation by competitors (Hurmelinna-Laukkanen et al. 2008).

According to Nieto and Pérez-Cano (2004), IPMs can generally be divided into two groups. First, formal IPMs grant innovators an exclusive right to utilize legal protection by the system of intellectual property rights (IPRs), such as patents, trademarks, and copyrights, for a limited period of time only. Second, informal IPMs include various measures for firms to prevent spillovers of their own innovation efforts and thus to safeguard the appropriation of firms' innovation returns. Typical forms of informal IPMs are secrecy, speed to market, and complementary resources.

Some research has noted that due to the characteristics of SI, the utilization of IPMs differs between service and manufacturing firms (Miles and Boden 2000). For example, Tether and Massini (2007) show that British service firms are overall less likely to use formal and informal IPMs than manufacturing firms. Finnish and British knowledge intensive service businesses typically utilize informal IPMs, as the formal IPM system is biased toward manufacturing goods and not necessarily protect innovation in a service context (Päällysaho and Kuusisto 2008).

Next, we discuss how each IPM operates in terms of innovation. First, the concept of a patent is what most people think of when considering the idea of protecting an innovation. Patent grants property rights to the innovator, providing rights to exclude others from making, selling, and importing the innovation (Garmon 2002). In other words, a patent helps generate profit by allowing innovators to enjoy a temporary monopoly or by selling their rights to imitators for royalties (Nieto and Pérez-Cano 2004). Patents usually commercialize high intelligent/technology innovation through the use of legal mechanisms (Gans et al. 2002). In this process, the innovator is required to fully disclose information about the innovation.

However, some research has raised questions about the effectiveness of patents (Levin et al. 1987; Nieto and Pérez-Cano 2004). First, registering an innovation for a patent is expensive and very time consuming. These demerits make patenting very inefficient because patenting is meaningless where market trends change quickly. Also, if competitors are able to find a way to imitate around the patent, it is especially difficult to prove that the competitors have made an imitation in the service industry (Blind et al. 2006).

Other than patents, trademarks and copyrights are IPRs that are used widely in research related to innovation. Like patents, trademarks and copyrights are also formal mechanisms for appropriation by legally protecting the innovation (Schmoch 2003). However, trademarks and copyrights give rights to innovations with limited technological elements, have more simplistic registration and certification processes, and are intended mostly for intangible goods compared to patents.

Trademarks, which include words, logos, 3D marks, and sounds, are used to represent original designs or symbols to differentiate a service from other firms' services, implying that there is a one-to-one relationship between a new service and a trademark (Mendonça et al. 2004). When compared to patents, trademarks apply more to commercialization and cover a broader range of activities from manufacturing to service industries (Mendonça et al. 2004). In other words, new

trademarks are commercially critical instruments that help position an innovation to reinforce the differentiation of a firm's services in the market (Lavey 1982).

Meanwhile, copyrights are mostly used in software, advertisement, publication, and movie industries and they have become more important in the digital network environment. Unlike patents, copyrights prevent others from copying a specific innovation but they do not prevent others from using the idea (David 1993). Copyrights give firms the exclusive right to an innovation to receive royalties from the subject using the innovation (Garmon 2002).

Besides legally protecting innovation, to minimize the weakness of formal protective mechanisms, other informal mechanisms can be used to protect innovation. Secrecy is applied in protecting an innovation by preventing core knowledge from leaking outside the firm (Nieto and Pérez-Cano 2004). The mechanism is highly desirable because unlike formal mechanisms, no information and knowledge must be disclosed to the public. In other words, as long as the knowledge in question is kept secret, the return from an innovation will be exclusive to the firm (Nieto and Pérez-Cano 2004). Therefore, secrecy is mostly used in process innovation (PI) where knowledge is accumulated and kept away from public view; it can also be used in SI where protection by IPR is not suitable (Leiponen and Byma 2009; Tidd et al. 2005). In addition, for secrecy to be effective in protecting a service, the innovation must be well hidden or placed where it may be overlooked by the competitors (Arundel 2001).

Despite the great effort to use secrecy as a protective mechanism, the innovation will eventually be acquired by the competitors. If the information is found by competitors too soon, there will be no protection for the innovation from being exploited and used by others, resulting in innovators failing to generate a profit from their work. In addition, if firms become overly preoccupied with keeping their innovations a secret, they may fail to provide the service as they intended because an unintentional barrier between the firm and the customers may arise (Hurmelinna-Laukkanen et al. 2008). Hence, innovators could use secrecy to gain a lead-time advantage over competitors by applying secrecy in the early stages of market development (Arundel 2001).

In today's market, where numerous innovations are introduced to the market, taking the first action may be crucial for success. Speed to market is a mechanism in which a firm gets into the market before the competitors imitate the innovation (Nieto and Pérez-Cano 2004). Several empirical studies indicate that speed to market is highly attractive because it may be a crucial factor in market share development (Kalyanaram et al. 1995; Kardes and Kalyanaram 1992; VanderWerf and Mahon 1997).

Speed to market can be analogous with the term "first-mover," in the sense that they refer to the pioneering firm with an innovation. First-mover advantage occurs when the innovating firms generate economic profit by being the first-mover (Lieberman and Montgomery 1988). Thus, speed to market will grant several competitive advantages. For instance, it forms lead time for SI to create output that will be advantageous in market competition and allows the firms to gain experience and knowledge to quickly go down the learning curve (Gilbert and Birnbaum-More 1996; Lieberman and Montgomery 1988).

Speed to market may also raise the switching cost since customers have a tendency to adapt to the characteristics of a firm's service becoming reluctant to change to another service (Wernerfelt 1986). Therefore, firms that are late into the market must invest additional time and money to attract customers that are already using the first-mover firm's services (Lieberman and Montgomery 1988). However, even with these advantages, firms may not always be successful with this mechanism. Many disadvantages of being a first-mover in the market can be explained by free-rider effects, market uncertainty, shifts in customer needs, and incumbent inertia (Lieberman and Montgomery 1988).

Since firms in the market are so linked with each other, it is inevitable for no firm to initiate a profit-generating innovation on its own (Nieto and Pérez-Cano 2004). Complementary resources are assets that firms must possess to maintain an adequate supply of its innovation to the market, such as specialized producing capability, access to distribution channels, service networks, and complementary technology (Teece 1986). The nature of this mechanism is also supported by what is known as the resource-based view (RBV). According to RBV, resource heterogeneity is the most basic condition for this theory to work (Barney 1991). This condition shows that resources and capabilities vary among firms and a competitive advantage is acquired through these differences (Barney 1991).

Complementary resources may be especially useful for innovations in the service industry where intense competition or numerous competitors exist differentiating the firm's services from that of competitors and impeding the competitors from entering the market (Levin et al. 1987; Nieto and Pérez-Cano 2004; Teece 1986). To use this mechanism, large firms with sufficient resources and abilities can utilize their own resources, while small- and medium-sized firms can use outsourcing as a method to overcome their limitations (King et al. 2003). However, regardless of whether the firm achieves heterogeneity of their resources, preserving the heterogeneity is essential for sustaining competitive advantage (Peteraf 1993). If the resource heterogeneity is not maintained, the advantages acquired from it will dissipate (Alvarez and Barney 2000).

Each IPM obviously has positive effects on innovation but simultaneously has some limitations. Therefore, in the following section, we investigate the empirical effectiveness pertaining to each IPM in Korean service firms through a research model.

3 Research model and hypotheses development

Driven by intelligent and demanding customers, global competition, and a fast changing market environments, many firms search for new ways to achieve and retain a competitive edge (Lee and Olson 2010). The major source for this edge in service firms likely would be customer satisfaction through superior customer value delivery, which translates into increased repeat purchases, cross-selling of related services, and recommendations to others (Roofthooft 2010). Customer satisfaction is influenced by price competitiveness and service differentiation (Athanassopoulos

et al. 2001); therefore, service firms try to develop various SIs and PIs to deliver superior customer values (Mas-Verdú 2007; McGrath et al. 1996).

A question that may arise is in what way will SIs and PIs influence firm competitiveness? First, SI occurs in the front office where value is provided through direct contact with customers (Chase 1978). SI is an intentional change in service to provide a new or substantially improved benefit and value by changing the method through which customers use the service in the market (Tether 2005). Thus, SI focuses on the market and is primarily customer-driven (Damanpour and Gopalakrishnan 2001). Examples might include new types of bank accounts, insurance products, or applications for mobile devices to interact directly with customers (Edvardsson and Olsson 1996). Since innovative services create new markets or increase market shares through customer satisfaction, firm competitiveness is directly influenced. Therefore, the following hypothesis is proposed:

Hypothesis 1a (H1a) service innovation positively influences firm competitiveness.

Since SI occurs in the front office, it must be released to the market. This means that SI can be readily exposed to competitors, making it difficult to protect against imitation, which shortens the time for the innovating firm to be the sole beneficiary of the created innovations (Hurmelinna-Laukkanen et al. 2008). Therefore, to have a greater return through an extended time of appropriation, use of an IPM is needed. Thus, the following hypotheses are suggested to effectively examine IPMs.

Hypothesis 1b (H1b) The relationship between service innovation and firm competitiveness will be moderated by patents.

Hypothesis 1c (H1c) The relationship between service innovation and firm competitiveness will be moderated by other IPRs.

Hypothesis 1d (H1d) The relationship between service innovation and firm competitiveness will be moderated by speed to market.

Hypothesis 1e (H1e) The relationship between service innovation and firm competitiveness will be moderated by secrecy.

Hypothesis 1f (H1f) The relationship between service innovation and firm competitiveness will be moderated by complementary resources.

Process innovation occurs in the back office where the service is prepared before being offered to the customers. Therefore, PI is usually developed in supply, transportation, or labor (Chase 1978). Generally speaking, PI is rethinking and restructuring the fundamental process to achieve a dramatic improvement in the firm's key factors, such as cost and quality (Hammer and Champy 1994). Hipp et al. (2000) defined PI as new and improved work methods that seek to achieve the long-term efficiency of the service provider. It is a concept that can be applied to service firms. In other words, PIs are internally focused and primarily efficiency driven (Damanpour and Gopalakrishnan 2001).

In service firms, the following activities are key examples of PI. Introduction of new information technology (IT) allows for efficiency in information processing (Clark and Stoddard 1996; Jiménez-Zarco et al. 2011). Moreover, to improve the

business process for service provision, new methods such as process optimization and organizational restructuring are implemented (Harkness et al. 1996; Jones 2002). These PIs lead to greater efficiency in production with savings in labor and/or capital; they also have the potential to reduce cost (Pianta 2005). In other words, firm competitiveness is affected by PI because it can differentiate service quality and creates price competitiveness later in the market (Li et al. 2007; Roth and Jackson III 1995). Therefore, the following hypothesis is suggested:

Hypothesis 2a (H2a) Process innovation positively affects firm competitiveness.

A PI tends to be more effectively maintained within a firm and protected by secrecy, while SI must be released to the market. For PIs, the legal protection offered by patents may not be worth the disclosure of information required by a patent application (Leiponen and Byma 2009). However, as the IPR market becomes vitalized through introduction of open innovation, PI can be another source of firm competitiveness like patent premium (Arora et al. 2008; Chesbrough 2006). Therefore, the following hypotheses are proposed to understand which IPM effectively uses innovation to influence firm competitiveness.

Hypothesis 2b (H2b) The relationship between process innovation and firm competitiveness will be moderated by patents.

Hypothesis 2c (H2c) The relationship between process innovation and firm competitiveness will be moderated by other IPRs.

Hypothesis 2d (H2d) The relationship between process innovation and firm competitiveness will be moderated by speed to market.

Hypothesis 2e (H2e) The relationship between process innovation and firm competitiveness will be moderated by secrecy.

Hypothesis 2f (H2f) The relationship between process innovation and firm competitiveness will be moderated by complementary resources.

By integrating the hypotheses mentioned above, we propose the research model shown in Fig. 1.

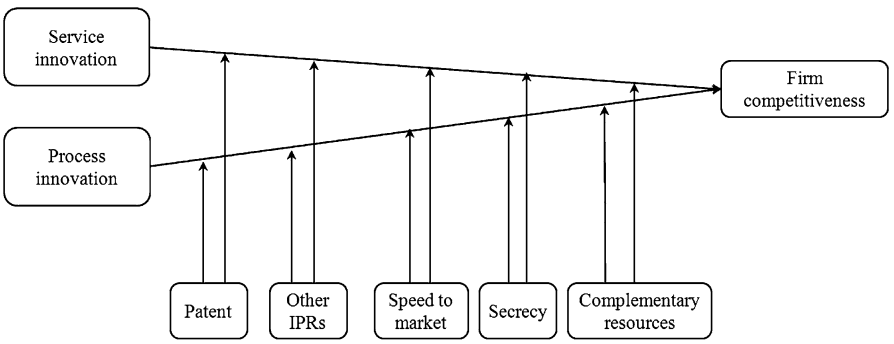

Fig. 1 Research model

In Fig. 1, the dependent variable is firm competitiveness, and the independent variables are SI and PI. In addition, five IPMs were selected as moderators to be analyzed through the effects of interaction between the independent variables and IPMs.

4 Methodology

4.1 Sample

This study used the results of the "Korean Innovation Survey 2006 (KIS)" conducted by the Science and Technology Policy Institute in Korea from 2003 to 2005. The definition and methodology of the survey is based on the revised edition of the Oslo Manual (OECD) (OECD 2005). KIS makes it possible to analyze the underlying factors that influence firm competitiveness. KIS is particularly informative as it surveyed each IPM, such as patent, secrecy, speed to market, etc. for individual firms; therefore, it makes possible the interpretation of the importance of IPMs as proxy measures of the effectiveness assessed by individual firms. Data from 243 service firms from among a total of 2,498 service firms that were classified as actively innovating and utilizing more than one type of IPM were used.

4.2 Measures

This section includes descriptions of the variables and how they were measured for this study. The definitions of the variables and measurement method were based on KIS (Table 1).

4.3 Dependent variable

Firm competitiveness is generally related to added value for customers in the service market (Tsai and Wang 2007). Enhancing added value can be estimated by sales growth, correlated positively with service advantage and market acceptance (Grant 2002). Logically, a firm's sales growth was used as a proxy measure for firm competitiveness in this study. It is expressed as a logarithm of the sales difference between 2003 and 2005.

4.4 Independent variable

Service innovation (SI) refers to the introduction of new or significantly improved services and products. It is measured as the sum of the number of new or significantly improved services and products in terms of quality and usage in applying new knowledge or technology into the market by a service firm during 2003–2005.

Process innovation (PI) is defined as the application of new or significantly improved methods of producing, supplying, and delivering a service. Following this definition, it is measured by the number of introductions of (1) significantly

Table 1 Description of variables used in this study

Variable	Empirical measurement	Value (range)
Dependent variable		
Firm competitiveness (firm's sales growth)	Logarithm of the sales difference during 2003–2005	Metric
Independent variable		
Service innovation (SI)	Sum of the number of new or significantly improved services and products in terms of quality and usage in applying new knowledge or technology into the market during 2003–2005	Metric
Process innovation (PI)	Sum of the number of introductions of (1) significantly improved technological methods of producing, purchasing, supplying, and delivering; (2) new customer contact points; and (3) organizational change in producing/delivering processes in service firms during 2003–2005	Metric
Moderating variable		
Patent (formal IPM)	0: unused, 1: used during 2003–2005	Nominal
Other IPRs (formal IPM)	0: unused, 1: used during 2003–2005	Nominal
Speed to market (informal IPM)	0: unused, 1: used during 2003–2005	Nominal
Secrecy (informal IPM)	0: unused, 1: used during 2003–2005	Nominal
Complementary resources (informal IPM)	0: unused, 1: used during 2003–2005	Nominal
Control variable		
Industry type	Choice of one among three types of industries (low-technology, knowledge-intensive business, and telecommunications and software)	Nominal
Firm size	1: small-sized firm, 2: medium-sized firm, and 3: large-sized firm	Ordinal

improved methods of producing, purchasing, supplying, and delivering services technologically; (2) new customer contact points; and (3) organizational change in producing/delivering processes.

4.5 Moderating variable

In this study, five different types of IPMs, patents, other intellectual properties rights (other IPRs), speed to market, complimentary resources, and secrecy were used. Section 2.2 discusses the concept and purpose of each IPM. To summarize briefly, a patent is a formal mechanism that protects innovative outcomes by claiming exclusive right of the innovation by making it illegal to be imitated. However, detailed information of the innovation must be disclosed to the public. Second, other

IPRs are also formal IPMs, such as trademarks and copyrights, which achieve service differentiation and loyalty by giving service firms the legal rights to an innovation. Third, service firms use speed to market to achieve appropriability within a given period of time by gaining lead time and quickly going down the learning curve through an early introduction of the innovation to the market. Fourth, complimentary resources are an informal mechanism that allows the firm to achieve a competitive edge by being distinguished among competitors in the market, releasing innovation with a variety of complimentary resources to the market. Finally, secrecy is used by service firms to keep essential knowledge confidential, therefore profiting from the innovation exclusively.

In this research, the nominal variable was used to measure on a yes or no basis whether a service firm had used each IPM for innovation during 2003–2005.

4.6 Control variable

4.6.1 Firm size

Characteristics of the service industry come from the fact that most service firms are medium or small in size (Hipp and Grupp 2005). However, larger firms can have a greater influence on sales growth due to an economy of scale. A measure of firm size is included to test whether there are inherent advantages associated with firm size (Hanel 2008). In this study, firms were divided by size; large-sized firms, medium-sized firms, and small-sized firms were assigned 3, 2, and 1 point, respectively, to control the influence based on firm size.

4.6.2 Industry type

Depending on the industry type, market size, and service trend may be different. This can have a major influence on sales growth for a firm in a certain industry. To control for service industry differences, this study formed industry dummies based on a study by Leiponen and Byma (2009). Thus, the two industry dummies represented three types of industries that involved low-technology services including utilities, transportation, and wholesale trade; knowledge-intensive business services including R&D services and consulting services; and telecommunications and software services. Table 1 presents descriptions of variables used in this study.

5 Result

Before testing the hypotheses, sample characteristics were analyzed shown in Table 2. During the 2003–2005 periods, 4.98 SI occurred on average over a 3-year period, which is twice the number of PIs, and 2.53 on average over the same time period. This result indicates that firms in the service industry focused more on SI.

Next, from the analysis on firm size, our sample was oriented toward small- and medium-sized firms, accounting for over 80 % of the total. For industry types,

Table 2 Descriptive analysis

Variable	Data
Innovation	
Service	Average of 4.98 case
Process	Average of 2.53 case
Firm size	
Small	98 (40 %)
Medium	101 (41.6 %)
Large	44 (18.1 %)
Industry type	
Low-technology (Low_ Ind)	39 (16 %)
Knowledge-intensive (Know_Ind)	89 (36.6 %)
Telecommunications and software	115 (47.4 %)
IPM in SI	
Patent	94 (38.7 %)
Other IPRs	92 (37.9 %)
Secrecy	148 (60.9 %)
Complimentary	112 (46.1 %)
Speed to market	133 (54.7 %)
IPM in PI	
Patent	43 (17.7 %)
Other IPRs	54 (22.2 %)
Secrecy	100 (41.2 %)
Complimentary	73 (30 %)
Speed to market	77 (31.7 %)

telecommunication and software service was 47 %, knowledge-intensive industry was 36 %, and low technology was 16 % of the sample, having the sample high-tech and knowledge service orientation.

Finally, IPMs were more frequently used in SI than PI. In addition, informal IPMs, such as secrecy, utilization of complimentary resources, and speed to market, were more frequently used than formal IPMs, such as patent and other IPRs in both service and PI.

This research estimated the main effects and moderating effects using generalized least squares regression. Table 3 presents the results of the hierarchical regression analyses. First, in testing for the main effects, hypotheses H1a and H2a were rejected shown in Model 1 with an explanatory power of 43.7 %. Service and PI did not have a significant influence on firms' sales growth.

The moderating effects of IPM in SI were tested in Model 2 through Model 6. First, the addition of the moderating variables was significant in the research model because the majority of these models, Models 3 to 6, had an increased adjusted R^2 value greater than the main model (Model 1). In Models 2 to 6, H1c, H1d, H1e, and H1f hypotheses were supported by showing the interaction effects of the IPMs and SI. IPMs other than patents were positive moderators for SI to influence sales

Table 3 Regression results for the research models

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Service innovation (SI)	.030	−.009	−.043	−.154	−.105	−.166
Process innovation (PI)	.056	.060	.073	.124	.092	.100
Firm size	.634***	.626***	.631***	.643***	.625***	.641***
Low_Ind	.023	.027	.027	.033	.027	.033
Know_Ind	−.052	−.053	−.057	−.046	−.053	−.047
Patent in SI	.017	−.022	.006	.018	.017	.022
Other IPRs in SI	.021	.012	−.033	.032	.026	.029
Secrecy in SI	−.005	−.001	.003	−.034	.012	.006
Complimentary in SI	.099	.098	.097	.091	.033	.081
Speed to market in SI	.047	.048	.046	.033	.029	−.006
Patents in PI	−.014	−.019	.006	−.003	.005	−.011
Other IPRs in PI	−.018	−.017	−.035	−.024	−.033	−.023
Secrecy in PI	−.076	−.070	−.074	−.069	−.073	−.085
Complimentary in PI	.008	−.010	−.015	−.003	−.012	.010
Speed to market in PI	.032	.036	.045	.038	.057	.038
Patent × SI		.088				
Patent × PI		.009				
Other IPRs × SI			.137**			
Other IPRs × PI			−.010			
Secrecy × SI				.222*		
Secrecy × PI				−.100		
Complimentary × SI					.215***	
Complimentary × PI					−.080	
Speed to M × SI						.236*
Speed to M × PI						−.068
Adjusted R^2	43.7 %	43.7 %	44.3 %	44.1 %	45 %	44.2 %
F value	13.53	12.06	12.31	12.24	12.65	12.27

Two-tailed test

* $p < .10$, ** $p < .05$, *** $p < .01$

growth. Among informal IPMs, speed to market in particular had the largest moderating effect of 0.236, followed by secrecy with 0.222, and complementary resources with 0.215. Finally, formal IPMs such as other IPRs had a control effect of 0.137.

Hypotheses H2b–f were all not supported as they had insignificant interaction effects with the IPMs and PI in Models 2–6. The IPMs did not have any moderating effects on the relationship between PI and sales growth. Finally, among the control variables, firm size had a considerable influence on sales growth for all models, whereas industry type was not significant for sales growth. The larger the firm size, the higher the sales growth, but there was no effect caused by the industry characteristics on sales growth.

The following section discusses the hypothesis results mentioned above.

6 Discussion and conclusion

Firms consistently innovate to gain competitive advantage but our findings showed that innovation alone cannot achieve competitive advantage. Thus, we investigated the role of IPMs to understand how innovation can have a significant effect on firm competitiveness.

Nieto and Pérez-Cano (2004) suggested that an informal IPM is effective for innovations mainly consisting of tacit knowledge and that a formal IPM is effective for innovations mostly consisting of codified knowledge. Especially, as SI is related to the intangibility of service and skills of frontline employees that are hardly described by text, SIs are more based on tacit knowledge than product innovations (Hipp and Grupp 2005; Nijssen et al. 2006).

Our findings also provide many new insights. In the case of SI, our results showed a significant moderating effect of informal IPMs. Speed to market, secrecy, and complementary resources positively moderated firms' sales growth figures when the SI contained tacit knowledge. Therefore, speed to market has the ability to command a higher price and larger market share for a leading firm compared to its competitors (Makadok 1998).

Secrecy can be used with speed to market to maintain an early edge in the market. For the case of tacit knowledge, keeping the core knowledge and information of an innovation through secrecy may be easier to protect innovation, and this is an attractive mechanism to maintain firm competitiveness. This result is consistent with previous research which indicated that secrecy has a greater value than a formal mechanism for SIs (Arundel 2001).

Complementary resources were used for differentiation. According to the tenets of RBV, firms that have established effective control over certain complementary resources, such as the distribution channels, marketing, and complementary technologies, are able to appropriate the results of SI to a greater extent than their competitors (Teece 1986; Tripsas 1997). Since our sample consisted of mainly higher value-added businesses such as knowledge-intensive and telecommunications and software businesses, more resources supplementing SIs to differentiate these businesses from their competitors are needed.

However, our empirical results showed that patents did not have any moderating effect on firms' sales growth and other IPRs had a weaker contribution on sales growth compared to informal IPMs. In the case of patents in the service industry, it is difficult to prove the novelty of SI that is based on tacit knowledge. It is difficult for small-and medium-sized firms, which were the majority of our sample, to continuously monitor the market for imitators who find their way around the patent (Kingston 2001).

Other IPRs, such as copyrights and trademarks, are more efficient than patents because the registration time is shorter and the expense is lower. In addition, for SI that requires repeated usage due to its perishable characteristic, forming a brand image through trademarks may provide a difference from imitations (Mendonça

et al. 2004; Nijssen et al. 2006). However, it is difficult to identify the extent of the rights of a firm's innovation with these other IPRs due to the complicated legal rights and distribution structures of a SI (Madison 2000). Therefore, unlike patents, other IPRs show moderating effects but are not very effective.

The testing results of hypotheses H2a–f showed that PI and all types of IPMs did not have a significant effect on firms' sales growth. This was partially inconsistent with previous research, which indicated that informal IPMs are necessary for PI (Hanel 2008; Harabi 1995). PIs are usually developed for future sales growth from a long-term perspective (Hipp et al. 2000). PI, occurring in the back office, may increase work flow efficiency by changing the necessary procedure for services to be offered in firms. This efficiency may positively influence the value of the service as perceived by customers through diverse forms, thereby finally increasing the firm's sales (Grant 2002). However, in this study, PI might not have shown a significant impact on a firm's sales growth since our data did not contain sufficient longitudinal figures to find a causal relationship between PI and sales growth.

The more similar the sample size is across moderator-based subgroups, the more significant the moderating effect will be (Aguinis 1995). In our sample, there was a disproportion between the subgroups using IPMs and those who did not in their PI efforts since each IPM was generally used less for PI. This may be the reason for having insignificant moderating effects.

Our findings offer several implications and contributions to researchers in the area of innovation management in service businesses. First, this study analyzed the characteristics of innovation in the service industry and gathered all IPMs used in the area of innovation from previous research. Unlike conceptual or case studies, this study provided an empirical analysis of firm competitiveness through the effects of the interaction between innovation and IPMs. Second, we reinterpreted the role of each IPM, which was customarily used in the manufacturing industry, to a service industry point-of-view. We discussed how IPMs are used to create SIs to achieve sales growth.

The results of this study also offer suggestions to practitioners. In this study, we provided a practical guideline for commercializing and protecting an innovation by discussing the utilization of IPMs. IPMs in SI may be implemented based on the knowledge attribution in innovation. Furthermore, service firms that do not consider the protection of an innovation as important may be interested in IPMs as a part of an innovation management strategy. This will play an important role for firms to continually sustain a competitive advantage in this rapidly changing environment.

Despite the implications reflecting the current service business environment and characteristics of IPMs, this study is not free from limitations. First, we did not consider the fact that sales growth resulting from using IPMs for an innovation may come with a time lag to some extent. Second, from the advancement in technology and diversification of customer needs, numerous products accompanying services are being provided (Hipp and Grupp 2005). Therefore, future studies should not only consider appropriating innovation output in pure service firms but also consider service firms with a product-service convergence trend (Lee and Olson 2010).

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