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Service Regime and Sectoral Patterns of Innovation in Services: a Reinvestigation using Miozzo & Soete Taxonomy

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Abstract

This paper develops a notion of the service regime and uses this service regime to empirically reconsider the sectoral patterns of innovation in Miozzo and Soete service taxonomy. Taking a synthesis approach to service innovation, this paper develops the service regime derived from the technological regime and incorporating service trajectory, and non-legal appropriable mechanisms into the framework. Four research hypotheses are proposed to elaborate the sectoral patterns of innovation in four service sectors. A dataset of 5,711 service firms is collected from the Taiwan Innovation Survey 2004-2006. The results indicate that the service regime across four service sectors is not so obviously sector-specific than the paper expects. This paper confirms that the sectoral patterns of innovation in service are generally still equivocal, resulting from their loosely coupled systems in nature. The paper concludes that the service regime provides a novel framework to re-examine service innovation.

1. Introduction

Although most economies have increasingly become more service-based, there is little understanding about how service sectors innovate, since the previous studies on sectoral patterns of innovation mainly have focused on the technological paradigm/regime/trajectory to examine manufacturing sectors (Malerba, 2002; Malerba & Orsenigo, 1997; Nelson & Winter, 1977; Pavitt, 1984). Nevertheless, three approaches to sectoral patterns of innovation in services have emerged in recent years (Coombs & Miles, 2000; Gallouj, 2002; Gallouj & Windrum, 2009). One is the *assimilation approach* (Castellacci, 2008; Evangelista, 2000; Miozzo & Soete, 2001; Peneder, 2010; Sirilli & Evangelista, 1998). The assimilation approach tends to use a technological perspective to analyze innovative patterns in services. An other is the *demarcation approach* to service innovation, whose theoretical roots originated from service industry studies (Gadrey, Gallouj, & Weinstein, 1995; Sundbo, 2000) and service marketing (Alam, 2002; Bendapudi & Leone, 2003; Vargo & Lusch, 2004). These authors claim that innovations in services are quite different from those in manufacturing in terms of innovation paradigm (e.g., service dominant logic), trajectory (e.g., organizational innovation), and customer co-production. The third is the *synthesis approach* to service innovation, which integrates technological innovation and service innovation as a whole. The classical synthesis approach to service innovation includes manufacturing-service convergences (Coombs & Miles, 2000) and the general technology-service characteristics-based model (Gallouj & Weinstein, 1997).

The Miozzo and Soete (2001) service taxonomy was a pioneering study on the sectoral pattern of innovation in services, directly using the technological regime and types of Schumpeterian innovation proposed by Pavitt (1984). However, the borrowing from the *assimilation approach* causes some criticisms. The current paper argues that there are two major drawbacks in the existing Miozzo and Soete service taxonomy. First of all, as Gallouj (2002) argued, services themselves follow different trajectories and they belong to different types of taxonomy. According to Gallouj (2002) critics, most of the criticism of the Miozzo and Soete service taxonomy considers the notion of technological trajectory, since Miozzo and Soete directly extended the Pavitt manufacturing taxonomy by including product innovation and process innovation. In contrast, other innovation trajectories in the services are particularly important but have been ignored, such as organizational innovation (Armbruster, Bikfalvi, Kinkel, & Lay, 2008; Djellal & Gallouj, 2001; Heidenreich, 2009; Tether & Tajar, 2008b) and business model innovation (Chesbrough, 2010; Teece, 2010).

Second, the scope of its appropriable mechanism is also limited. Miozzo and Soete taxonomy tends to draw on *legal* intellectual property protection such as patents, trademarks, and copyrights, but the *non-legal* appropriable mechanisms such as know-how, lead time, lock-in strategy and design complexity usually important for service firms are neglected (Bader, 2008; Miles, Andersen, Boden, & Howells, 2000).

To resolve these drawbacks of the Miozzo and Soete service taxonomy, this paper proposes the notion of the service regime as the *synthesis approach* to analyze sectoral patterns of innovation in services. The service regime combines the assimilation approach and the demarcation approach, which is not only modified from technological regime (the assimilation approach) but also incorporates the demarcation perspective by including service trajectory, and non-legal appropriable mechanisms. By synthesizing the assimilation approach and the demarcation approach, the service regime might provide a fruitful avenue to advance the study of service taxonomy.

2. Literature Review

2.1 Patterns of sectoral innovation in services: three approaches

In a pioneering article on manufacturing taxonomy, Pavitt (1984) proposed a manufacturing taxonomy characterized by technological regimes and trajectories. He suggested that there were four categories of manufacturing sectors: (1) the supplier-dominated, (2) the scale-intensive, (3) the specialized suppliers, and (4) the science-based sectors. These classifications were based on distinct characteristics, including sources of technology, type of users, means of appropriation, and technological cumulateness. These characteristics are the so-called technological regime (Nelson & Winter, 1982), which can shape and differentiate the patterns of innovation across sectors. Malerba & Orsenigo (1997) argued that technological regime represents important properties of technologies but Nelson & Winter (1977) thought the notion of technological regime is a cognitive concept forced the firm's beliefs and brings the constraint of firm's behavior and bounds them what can do and can't do. The Pavittian manufacturing taxonomy accurately makes a forward understanding that provide a critical framework as patterns of innovation for other studies. Many following studies have addressed distinctive sectoral patterns of innovation that cover not only manufacturing but also service sectors. These prior studies have a variety of approaches to measure the different sectors. Accordingly, there are three recent approaches to study service innovation (Coombs & Miles, 2000; Gallouj, 2002; Gallouj & Windrum, 2009), namely, the assimilation, demarcation, and synthesis approaches. The paper elaborates three approaches below.

2.1.1 Assimilation approach

The basic concept of the assimilation approach addresses that measuring service innovation is the same as meaning of technological innovation (Coombs & Miles, 2000). The innovation methods and investigating viewpoint of the assimilation approach were originally developed by technological innovation and introduced by technical systems (Gallouj, 2002).

Miozzo & Soete (2001) initially proposed a service taxonomy, which directly extended the Paivittian approach into services. This was also one of few studies that explored the sectoral patterns of innovation in services by using technological regime. The Miozzo and Soete service taxonomy proposed four categories of service firms: (1) the supplier-dominated, (2) the scale-intensive physical networks, (3) the information networks, and (4) the specialized suppliers and science based. However, although Miozzo and Soete formulated their taxonomy mainly in terms of the technological regime, they successfully explored a further understanding of the supplier-dominated classification, which included personal services and public social services (Gallouj, 2002). Consequently, the Miozzo and Soete study is a symbolic assimilation approach for studying sectoral patterns of innovation in services.

Castellacci (2008) adopted the technological paradigm-regime-trajectory interaction to examine sectoral patterns of innovation in Italian manufacturing and service sectors. In his taxonomy, the two kinds of paradigms, the ICT paradigm and the Fordist paradigm, are applied to categorize four types of manufacturing-service sectors: (1) advanced knowledge providers, (2) mass production goods, (3) supporting infrastructure services, and (4) personal goods and services. Similarly, Evangelista (2000) also used the technological regime to classify four types of services : (1) technology users, (2) S&T-based, (3) interactive and IT based, (4) technical consultancy.

2.1.2 Demarcation approach

The opposite approach of the assimilation perspective is the demarcation one, which is the basis for carrying out specialized studies of innovation in services (Drejer, 2004). Its advocators have proposed that service-based economy is so idiosyncratic that studying service innovation necessarily requires novel theories and analytical instruments (Sundbo, 1997; Sundbo & Gallouj, 2000).

Three main service-specific points have attracted much attention in the demarcation approach. First, service firms introduce organizational innovation as well as technological innovation (Armbruster et al., 2008; Sundbo, 2000). Service sectors tend to adopt more organizational innovations than manufacturing sectors do. Sundbo (1997) built up three types of organizational innovation to explain the collaborative

relationship with outside companies, including top-strategic organization, network organization, and professional organization. Second argument discussing about co-production between producers and users is the center of the service innovation process. The importance of producer-user production is emphasized by knowledge intensive business service firms (Bettencourt, Ostrom, Brown, & Roundtree, 2002). Since clients play an active role in service production, in order to customize innovative solutions to customers, service firms showed co-produce with their clients closely (Firat, Dholakia, & Venkatesh, 1995; Howells, 2006). Third, a service innovation paradigm in contrast to the technological regime is emerging, called service-dominated logic (S-D logic)(Vargo & Lusch, 2004). S-D logic differs from good-dominant thinking in that presents a novel service innovation focused on the co-creation of customer value and reciprocal relationships (Vargo & Lusch, 2004). It emphasizes that service innovation is to create a network composed of heterogeneous actors, such as customers, suppliers and partners. The S-D logic is becoming a service paradigm to exploit the nature and dynamic of service practices, including exchange behavior, roles of customers, value definition, and firm-customer interaction, in contrast to the traditional good-dominated logic (Vargo & Lusch, 2008).

2.1.3 Synthesis approach

The synthesis approach presents an integrative approach which integrates the assimilation approach and the demarcation approach. The synthesis approach has become increasingly appropriate since the boundary between manufacturing sectors and service sectors is blurring (Miles & Boden, 2000).

Gallouj & Weinstein (1997) proposed a characteristics-based model that combines different sets of technical and service characteristics. It was a pioneering synthesis approach to examine the novel combination of technology and service to deliver new products and services. In addition, prior studies have used the synthesis approach to examine service taxonomy (de Jong & Marsili, 2006; Hollenstein, 2003; Souitaris, 2002). Souitaris (2002) attempted to verify Pavitt's taxonomy empirically, but he used a synthesis perspective to explore innovative activities, not only combining the existing assimilation oriented variables in technological innovation but also involving the demarcation oriented indicators in organizational innovation. In the Swiss context, Hollenstein (2003) identified five innovation models for service sectors: (1) science-based high-tech firms with full network integration, (2) IT-oriented network-integrated developers, (3) market-oriented incremental innovators with weak external links, (4) cost-oriented process innovators with strong external links along the value chain, (5) low-profile innovators with hardly any external links. Additionally, Sundbo & Gallouj (2000) established a general model to

classify the innovation patterns and concluded that sectoral patterns of innovation in services as a loosely coupled system, which is shown lack of coherences and less a series of relationship between different sources through which knowledge and idea are diffused.

2.2 Developing the notion of service regime

To resolve these drawbacks of the Miozzo and Soete service taxonomy, this paper proposes a notion of service regime, a synthesis approach, to analyze the sectoral pattern of innovation in services with three dimensions, namely, sources of innovation, service trajectory, and appropriability.

2.2.1 Sources of innovation

Sources of innovation consider the probability of innovation based on the amount of resources invested in research (Malerba & Orsenigo, 1993). Evolutionary theory scholars argue that innovative sources remain endogenous factors, which intend the certain extent generated and recreated by a firm's innovative activities (Breschi & Malerba, 1997; Nelson, 1992; Rosenberg, 1982).

von Hippel (1988) claimed that different functional sources of innovation affect potential innovation performance. This paper considers two main strands for the sources of innovation in the development of innovative activities: in-house R&D and external sources. In-house R&D includes a firm's own innovation generation. Prior studies verified that in-house R&D investment is used to enhance the degree of innovation performance (Crepon, Duguet, & Mairesse, 1998; Frenz & Ietto-Gillies, 2009). In-house R&D activities contribute to the creation of knowledge and increase the firm's absorption capacities (Cohen & Levinthal, 1990). The development of in-house R&D helps accumulate absorptive capabilities and influence the innovation performance.

The opposite innovative sources of firm's own generation are external sources via a variety of channels. Prior studies have confirmed that the external sources of innovation increasingly impact innovation performance that firms use to develop or improve their products and services (Amara & Landry, 2005; Chang, 2003). However, this paper only emphasizes the five different forms of external sources of suppliers, customers, competitors, public research institutes and government, and consultancies. For example, Napolitano (1991) argued that external sources, such as suppliers and customers, were better able to design and evaluate prototypes for innovative products and processes. Segarra-Blasco & Arauzo-Carod (2008) found that firms' cooperation activities were closely linked to suppliers, customers, competitors and public institutes that affect the propensity of innovative activities and innovation performance. Firms

acquire knowledge via cooperative activities, where innovation efforts are made jointly with public institutes and universities (Frenz & Ietto-Gillies, 2009). Muller & Zenker (2001) claimed that knowledge-intensive business service firms (KIBS) play significant roles in the innovation systems and networks, creating and diffusing new knowledge to develop the new innovations. Tether & Tajar (2008a) indicated that KIBS providers tend to complement firms' internal innovation activities and firms' external sources of innovation.

2.2.2 Service trajectory

The concept of trajectory represents innovation cumulateness, implying that future innovative activities are based on current innovations, and that innovative firms are more likely to innovate in specific technologies along specific tracks (Malerba & Orsenigo, 1993, 1997; Nelson & Winter, 1977). Evolutionary theory assumes that firms accumulate know-how and tacit knowledge in the course of their prior experiences (Nelson & Winter, 1982). Those firms maintain unique skills that are often difficult to transfer and then becoming the sources of inertias (Lewin & Volberda, 1999). Specifically, when firms face a new opportunity or a new variation emerging, they tend to select a specific option, which depends to the firms' previous path and experiences (Dosi, 1982).

The technological trajectory provides a path whereby firms innovate within a specific technology in an attempt to improve the functional performance of that technology (Dosi, 1982). The technological trajectory as an institutional constraint drives the directions of the firm's development and also directs the industry development (Andersen, 1998; Klevorick, Levin, Nelson, & Winter, 1995). However, this paper develops the synthesis trajectories to characterize wider forms of innovation in combination with technological innovation and service innovation. Four distinction service trajectories are identified: *product innovation*, *process innovation*, *organizational innovation*, and *business model innovation*. Firstly, an established product innovation is to introduce a good or service that is new or a significant improvement with respect to its characteristics (OECD, 2005). Its not only brings consistently discontinuous but also accompanies introduction of radical innovations (Utterback, 1996). A second trajectory describes process innovation, which is the implementation of a new or significantly improved production method (OECD, 2005). Process innovation mainly emphasizes the re-innovation or improvement of existing innovations (Rothwell & Gardiner, 1988).

Thirdly, organizational innovation addresses innovation for administrative processes and organizational structures relating to the basic work activities of an organization and its management (Damanpour, 1991). It can be differentiated into

structural innovations and procedural innovations (Armbruster et al., 2008). However, some studies have verified that organizational structures facilitate the creation of new products and process (Hobday, 1998). The organization designs reconfigure the abilities to facilitate sustained products and process innovations (Damanpour, 2001).

A business model innovation is characterized its revenue generation mechanisms and relatively articulates the value network linking suppliers and customers (Chesbrough, 2010). Teece (2010) proposed a framework for profiting from innovation (PFI) to explain the concept of business model innovation. This framework describes how to capture value from innovations where being bundle in the complementary assets. Shafer, Smith, & Linder (2005) defined a business model as a representation of firm's underlying strategic choices for creating and capturing value within a value network.

2.2.3 Appropriability

The appropriability summarizes the possibilities of protecting innovations from imitation and of extracting profits from monopolistic innovative activities (Breschi & Malerba, 1997; Hanel, 2006). Firms utilize a variety of methods to protect innovation and control complementary assets through patents, secrecy, and copyrights(Teece, 1986).

This paper distinguishes two main strands of intellectual property protection methods: *legal* and *non-legal* appropriable mechanisms. Firstly, with respect of legal IPR mechanisms, patents, trademarks, copyrights and trade secrecy are often classified according as legal policies that belonged to a private regime. The legal IP mechanisms were also applied to services, although there were originated from the manufacturing systems related to physical artifacts(Miles et al., 2000). As a legal one of patent, the European financial service firms, like Swiss Re and UBS were used patent strategies for protection(Bader, 2008). The trademarks also as a useful legal IPR mechanism, a prior study indicated that trademarks were the outcomes of establishing recognizable symbols and identities for goods and services, and played a crucial role in the process of marketing innovation(Srinivasan, Lilien, & Rangaswamy, 2008). The trademarks are viewed a complementary indicator to help capture relevant aspects of innovation phenomena and processes of industrial change(Mendonca, Pereira, & Godinho, 2004; Schmoch, 2003). In contrast, copyrights often develop protections for literary works and creative results, and give creators all the rights for protection and distribution of the products. Software products are involved a range of objects such as source codes, algorithms and commands, which are preferred to pursue trade secrecy and copyrights as means of protecting intellectual assets (de Laat, 2005).

Currently, prior studies have verified that non-legal appropriable mechanisms are useful strategies to manage innovation process in services (Blind et al., 2003; Miles et al., 2000). This paper includes five main models of non-legal intellectual property mechanisms in terms of lead time strategy, design complexity, luck-in strategy, chain joining, and know-how strategy. Lead time strategy means that firms create shorter innovation cycles and update new version quickly to reduce the risk of copying and imitation by rivals (Miles et al., 2000). Prior studies have suggested that lead time strategies are the alternative means to protect the competitive advantages of new products and processes (Lopez & Roberts, 2002). The concept of design complexity addresses the variety of methods for restricting imitation. For example, software firms bundle packages with software and hardware to prevent copying (Miles et al., 2000). In order to prevent copying by later entrants, adding complexity design to products effectively delays in product imitated by competitors (Morone & Berg, 1993). The PFI model is a typical luck-in strategy to facilitate how complementary assets generated for firms (Teece, 1986). These strategies offer codified products in a package, combined with marketing or after-sales support to make the complete services difficult to imitate. In addition, building business groups or franchising is an indicator of entry barrier (Mahmood & Lee, 2004). This is a strategy occupying a very huge market share, preventing new rivals from entering the same sectors. Know-how strategies involve key recipes and confidential elements. Service firms often use know-how strategies from away valued knowledge (Miles et al., 2000).

2.3 Reconsideration of Miozzo and Soete service taxonomy: the service regime perspective

With the notion of the service regime, this paper reconsiders the sectoral patterns of innovation of Miozzo and Soete. The Miozzo and Soete service taxonomy is selected for the empirical test because it produces three drawbacks: limited sorts of service trajectory, constraint of appropriable mechanisms, and criticism of user roles. This study reviews four distinctive categories of Miozzo and Soete and develops five hypotheses based on service regime perspective.

2.3.1 Diversified sources of innovation in services

The various sources of innovation are likely to have positive influenced to innovation performance including in-house R&D and external sources via outside firms (Frenz & Ietto-Gillies, 2009). A prior study identified that the different sources of innovation in innovative activities varies across service sectors (Evangelista, 2000). According to survey of (Sirilli & Evangelista, 1998), they claimed that most sectors in services rely on in-house R&D activities. The service sectors for which in-house

R&D plays an important role are mainly the scale-intensive physical networks, information networks, and specialized supplier and science based sectors. However, Miles (2007) argued in-house R&D activities vary across services of different sorts, even though most services sectors appear to be low R&D investors. The R&D activities should be broadened the scope which is acknowledged research in the social sciences and humanities on the grounds (Djellal, Francoz, Gallouj, Gallouj, & Jacquin, 2003). Based on the assumption, OECD (2002) posited several instances to illustrate service activities of in-house R&D, for example, development of new survey methods and instruments, tracking and launch of prototype, etc. Thus, this study proposes that the supplier-dominated sectors also employ a bulk of in-house R&D activities even if these firms highly underpin the professional skills and capabilities (Miozzo & Soete, 2001). Moreover, referring competitors as another source of innovation disseminates into service sectors of Miozzo and Soete taxonomy. Tether (2002) argued two reasons why service firms co-operate with their competitors, namely collaborating and solving a common problem. Firms seek to collaborate with competitors to learn their rivals' competencies (Hamel, Doz, & Prahalad, 1989). A prior study identified that firm's absorptive capacity determines the extent of competitor interdependence and technology opportunity (Cohen & Levinthal, 1990). Therefore, this study proposes that four sectors of Miozzo and Soete service taxonomy often refer sources of innovation from in-house R&D and competitors. Thus the preceding discussion suggests the following hypothesis:

H1a: Using in-house R&D and competitors as sources of innovation is not different among four sectors

On the contrary, service sectors also engage in other different sources of innovation for innovation in terms of suppliers, customers, public research institutes and consultants (Segarra-Blasco & Arauzo-Carod, 2008; von Hippel, 1988). Many prior studies verified that the supplier-dominated firms recognize that customer needs and preferences are main core innovative sources to develop competitive advantage (Djellal & Gallouj, 2005; Fliess & Becker, 2006; Nasution & Mavoddo, 2008). The scale-intensive physical networks comprise major firms such as wholesale, retailing, transport, and logistics services. Those sectors follow supplier-driven patterns and they rely heavily on suppliers' provisions as a main source for innovation (Evangelista & Sirilli, 1998; Sirilli & Evangelista, 1998). A prior study suggested that new technology updating was quite important for efficiently providing opportunities to grow businesses (Soha, Power, & Terziovski, 2002). Moreover, the information networks as well as the specialized suppliers and sciences based sectors not only rely on internal R&D activities but also need to collaborate with outside channels in order

to facilitate innovation such as public research institutes and consultants (Hollenstein, 2003; Tether, 2002; Tether & Tajar, 2008a, 2008b). Therefore, this study proposes that four sectors of Miozzo and Soete service taxonomy are sector-specific to refer sources of innovation from suppliers, customers, public research institutes and consultants. Thus, the preceding discussion suggests the following hypothesis:

H1b: Using suppliers, customers and others as sources of innovation is different among four sectors

2.3.2 Constellation of service trajectories in services

The classical concept of technological trajectory, which is a sort of institutional boundary establishes that firms may be constrained by their technologies (Dosi, 1982; Nelson & Winter, 1982). Alternatively, they may be constrained by their services, strategies, or business models (Teece, 2010). However, the traditional view of services is assumed to be a residual sector and productivity laggards but with emerging of information and communication technology (ICT) development, technological innovation is to pay an attention in the service process of economic change (Miles & Boden, 2000). Using the ICT has represented a major driving force which has led most service sectors to close productivity gap (OECD, 1996). A prior study had identified that the diffusion of ICT are key factors behind the growth of services (OECD, 1997). The centrality of ICT in most service sectors implies that data on the generation and diffusion of information technologies should be collected on a systematic basis (Evangelista, 2000). The ICT emerging may seriously influence the introduction of new or improved ways of producing and delivering services (Barras, 1986; Sirilli & Evangelista, 1998). Moreover, a business model innovation also diffuses into all the services sectors because it offers a reciprocal mechanism which makes easier generate revenues and link with firms' strategies (Chesbrough, 2010; Teece, 2010). A prior study indicated that innovation of business model designed can be expected to improve their ability to capture a greater share of value (Gambardella & McGahan, 2010). Therefore, this study proposes that four sectors of Miozzo and Soete service taxonomy often utilize process and business model innovation from service trajectories. Thus the preceding discussion suggests the following hypothesis:

H2a: Using process innovation and business model innovation as service trajectories is not different among four sectors

Similarity, a prior study claimed that the supplier-dominated sectors are mainly dependent on process innovation with implementing technologies to increase the efficiency of production process and service quality (Castellacci, 2008). These firms

grow to create the new business models linking innovative activities and strategies (Briggs, Sutherland, & Drummond, 2007). The scale-intensive physical networks sectors depend on suppliers as a main innovative source. This is much clearly followed by innovation accumulated from process innovation. The result is line with Castellacci (2008) study, which indicated that the scale-intensive physical networks sectors tend to a mixed innovation including to process and organizational innovation (Miles, 2008). Moreover, the information networks sectors have highly commitment to product innovation (Gupta, Pawar, & Smart, 2007; Miller, 1986). Those firms are included a bulk of bank and insurance industries which recognize the need to increase new product development with considerable sequence of signal processing, strategic concepts and product launch (Tidd & Bessant, 2009; Vermeulen, 2004). The specialized suppliers and science based sectors primarily pursue the innovative activities through product innovation (Hollenstein, 2003). These sectors tend to include small-size firms that develop their innovative activities in close cooperation with their customers for the new products and services they create (Quinn, 1992). Therefore, this study proposes that four sectors of Miozzo and Soete service taxonomy are sector-specific to utilize product and organizational innovation from service trajectory. Thus the preceding discussion suggests the following hypothesis:

H2b: Using product innovation and organizational innovation as service trajectories is different among four sectors

2.3.3 Jointly appropriable mechanisms in services

The service characteristics are heterogeneous and the service content provided is also diverse, which is not easy to protect with formal intellectual property methods such as patent mechanisms (Blind et al., 2003). Services are associated with intangible know-how and output which are one of the attributes of service innovations that make easier to imitate by rival competitors. However, according to (Howells, Blind, Elder, & Evangelista, 2003), they proposed a “knowledge regime” theory to explain the propensity of service firms to protect their innovations. The knowledge regime theory identifies that appropriable mechanisms applied in service sectors relies on two main accounts, namely, the degree of codification of knowledge and the degree of tangibility of service outputs. A prior study suggested that service sectors vary across different degree of codified knowledge and tangible output, which are beneficial using jointly appropriable mechanisms (Amara, Landry, & Traore, 2008).

Intellectual property protection methods that are appropriable to utilize in services in terms of legal and non-legal appropriable mechanisms (Miles et al., 2000). The supplier-dominated sectors are mainly small-sized firms that are weakly R&D capabilities and they often appropriate on basis on their professional skills and design

(Miozzo & Soete, 2001). A prior study proposed that the supplier-dominated sectors rely on jointly appropriable mechanisms to developing protection innovation such as trademark, know-how and design complexity (Castellacci, 2008). Schmoch (2003) suggested that a trademark as a good method to benefit protection innovation for these sectors because it plays a special role to increase customer trust and reduces perceived risks to facilitate the linkage with service qualities. In contrast, the scale-intensive physical networks sectors depend on building confidential quality standards to lock customer loyalty (Blind & Hipp, 2003). A quality standard is tended to be an advanced strategy that locks customer in especially in markets with homogeneous products and average quality (Tether, Hipp, & Miles, 2001). Castellacci (2008) argued that the scale-intensive physical networks sectors utilize complementary appropriable mechanisms for protection innovation. The information networks are typical sectors to have joint legal and non-legal appropriable mechanisms to protect innovation from rivals (Bader, 2007, 2008). Prior studies identified that a financial company had carried out a legal strategy to block imitation by competitors (Bader, 2008; Hanel, 2006). Lopez & Roberts (2002) took an opposite argument to point that early entry strategy was useful to protection market share advantages in financial services. The first mover advantage ensures that a firm can enjoy a sustained market share advantage (Usero & Fernandez, 2009). Moreover, the specialized suppliers and science based sectors are mainly small-sized firms with closely linking R&D activities, which often employ the legal intellectual property rights to protect innovation (Castellacci, 2008). Prior studies have suggested that these sectors enjoy strong formal appropriable mechanism protections in the forms of trade secrecy, copyrights and patents (Maurer & Zugelder, 2000; West, 2003). Therefore, this study proposes that four sectors of Miozzo and Soete service taxonomy are sector-specific to use jointly appropriable mechanisms to protect innovation. The preceding discussion suggests the following hypothesis:

Hypothesis 3: Using appropriable mechanisms to protect innovation is different among four sectors.

3. Methodology

3.1 Data collection

The dataset examined in this study is from the Taiwan Innovation Survey 2004-2006. This survey was undertaken by public university, and sponsored by the National Science Council of Taiwan. The Taiwan CIS survey contains information on the innovative activities of firms and the factors that influence their innovation obstacles. These surveys are based on the OECD's "Oslo Manual" guidelines for the survey design, data collection and interpretation of technological innovation. The data in the survey refer to the period 2004-2006 and include firm-level analysis in both manufacturing and services. The representative sample includes 10,017 firms. This study excludes the manufacturing firms from the data and obtains 5,711 innovative service firms.

Based on the Miozzo & Soete classification, 293 firms (5.1%) are found in the category of supplier-dominated sectors, including a variety of traditional sectors such as personal services, restaurants, hotels, beauty and laundry, public/ social services and education and health. The main body 3,627 firms (63.5%) are scale-intensive physical networks sectors in Taiwan (Table 1), included firms from bulk material sectors such as wholesale, retailing, logistics and transportation. In addition, 411 firms (7.2%) are in the information networks sectors, coming from finance, insurance, and telecommunications sectors. Finally, there are 1,380 firms (24.2%) belonging to specialized suppliers and science based sectors, such as publishing services, waste disposal, computer system design services, real estate, legal and accounting, business and technical consultancy, advertising and specialized services.

TABLE 1

The sample by sector

Category of firm	Typical core sectors	No. of sample	Sample (%)
Supplier dominated	Personal services	23	0.40
	Hotel	57	1.00
	Restaurant	154	2.70
	Beauty and laundry	36	0.60
	Public and social services	14	0.20
	Education and health	9	0.20
	Sub-total	293	5.10
Scale-intensive physical networks	Wholesale	2579	45.20
	Retailing	828	14.50
	Transport	99	1.70
	Transport supported services	97	1.70
	Logistics	24	0.40
	Sub-total	3627	63.50
Information networks	Finance	160	2.80
	Insurance	111	1.90
	Telecommunications	13	0.20
	Other financial services	127	2.20
	Sub-total	411	7.20
Specialized suppliers/ science based	Publishing services	342	6.00
	Waste disposal	35	0.60
	Legal and accounting	7	0.10
	Computer and software	130	2.30
	Real estate	356	6.20
	Business consultancy	82	1.40
	Technical consultancy	51	0.90
	Advertising	93	1.60
	Specialized services	148	2.40
	Other business services	215	3.80
	Sub-total	1380	24.20
Total		5711	100.00

3.2 Analytical tool

The analysis of this study consists of two steps. In the first phase of analysis, one-way ANOVA testing is used to verify the whether there are different mean values between different sectoral patterns of innovation in the dataset. The second phase of analysis identifies inter-sector mean comparisons, applying post-hoc analysis to compare the mean scores of significant differences among four classifications. If a variable of post-hoc analysis presents a significant difference, it implies that the new notion of service regime provides a good reason to reconsider the Miozzo and Soete study, but otherwise the existing service taxonomy should be accepted. These variables are measured by a four-point Likert-scale of high, medium, low and not used.

4. Results

4.1 Descriptive statistics

This study conducts the descriptive statistics of service regime variables by the Taiwan Innovation Survey 2004-2006. Table 2 indicates the research result of one-way ANOVA test and post-hoc analysis for four different sectors in this study. Specifically, variables of inter-sector comparison are shown. The table shows that all variables in the one-way ANOVA test are statistically significant among the four sectors, except four variables: in-house R&D and competitors in the sources of innovation, and process innovation and business model innovation in the service trajectory. Specifically, the results show that customers (mean=1.81) and in-house R&D (mean=1.59) are considered to be more important sources of innovation than competitors (mean=1.48), suppliers (mean=1.17), consultants (mean=0.78) and public research institutes and government (mean=0.50). The competitors are ranked as third place for sources of innovation and suppliers have fairly low place. In contrast, public research institutes and government and consultants display less important for service sectors in the sources of innovation.

In comparison to service trajectory, the results show that business model innovation (mean=1.32) is considered to be much critical for service sectors. The product innovation is ranked as second place with considerable more important (mean=1.19). The process innovation is fairly less important (mean=1.16) and organizational innovation displays the lowest ranking in this dimension (mean=1.09). In addition, most sectors show jointly appropriable mechanisms in terms of legal and non-legal appropriable mechanisms. The results show that trade secrecy (mean=1.18), patents (mean=1.00), lead time (mean=0.98), know-how (mean=0.97) and luck-in (mean=0.95) are considered to be much critical variables which often jointly be used in all sectors. The variables of trademarks (mean=0.88), copyrights (mean=0.63), design complexity (mean=0.79) and chain joining (mean=0.62) are shown less important for service sectors.

4.2 Hypothesis testing

This study obtains the one-way ANOVA and post-hoc analysis to test the research hypotheses which is summarized in Table 2. The hypotheses testing in this study are inter-sector comparisons that empirically verify the observed sectoral patterns of innovation of Miozzo and Soete. The hypothesis 1a predicts that using in-house R&D and competitors as sources of innovation is not different among four sectors. As shown in Table 2, the coefficients for in-house R&D and competitors are not statistically significant ($p > 0.05$). The non-significant signs suggest that in-house

R&D and competitors as sources of innovation are critical variables which use across all service sectors, thereby supporting the argument for Hypothesis 1a. The hypothesis 1b predicts that using suppliers, customers, public research institutes and government, and consultants as sources of innovation is different among four sectors. As also shown in Table 2, the coefficients for suppliers ($F=3.783$, $p<0.01$), customers ($F=2.971$, $p<0.05$), public research institute and government ($F=6.111$, $p<0.001$), and consultants ($F=4.26$, $p<0.01$) are all statistically significant. The post-hoc test indicates that the information networks and scale-intensive physical networks sector outperform other sectors. The significant signs suggest that suppliers, customers, public research institutes and government, and consultants as sources of innovation are sector-specific variables which are specifically referred by four sectors, thereby supporting the argument for Hypothesis 1b.

The hypothesis 2a predicts that using process innovation and business model innovation as service trajectories is not different among four sectors. As shown in Table 2, the coefficients for process innovation and business model innovation are not statistically significant ($p>0.05$). The non-significant signs reveal that process innovation and business model innovation as service trajectories are critical variables which utilize across all service sectors, thereby supporting the argument for Hypothesis 2a. On the other side, the hypothesis 2b predicts that using product innovation and organizational innovation as service trajectories is different among four sectors. As shown in Table 2, the coefficients for product innovation ($F=6.488$, $p<0.001$) and organizational innovation ($F=8.062$, $p<0.001$) are all statistically significant. The post-hoc test indicates that the information networks sectors outperform other three sectors. The significant signs reveal that product innovation and organizational innovation as service trajectories are sector-specific variables which are specifically utilized by four sectors, thereby supporting the argument for Hypothesis 2b.

The hypothesis 3 predicts that using appropriable mechanisms to protect innovation is different among four sectors. As shown in Table 2, the coefficients for legal appropriability in terms of patents ($F=2.996$, $p<0.05$), trademarks ($F=10.574$, $p<0.001$), copyrights ($F=13.29$, $p<0.001$), trade secrecy ($F=11.834$, $p<0.001$), and non-legal appropriability in terms of lead time ($F=3.712$, $p<0.05$), design complexity ($F=9.475$, $p<0.001$), luck-in strategy ($F=5.67$, $p<0.01$), chain joining ($F=8.95$, $p<0.001$), know-how ($F=10.228$, $p<0.001$) are all statistically significant. The post-hoc test constantly indicates that the information networks sector outperform other three sectors. The significant signs suggest that appropriable mechanisms to protect innovation are sector-specific variables which are mutually reinforced by four sectors, thereby supporting the argument for Hypothesis 3.

TABLE 2

Analysis of variance test

Service regime	Variables	All sectors Mean	The new taxonomy				F-value	Post- hoc test
			Supplier dominated (1) N=89	Scale-intensive physical network (2) N=1101	Information network (3) N=232	Specialized supplier/ science based (4) N=396		
Sources of innovation	In-house	1.59	1.57	1.59	1.74	1.52	1.394	n.a.
	Suppliers	1.17	0.99	1.12	1.39	1.19	3.783**	(3)>(2),(4),(1)
	Customers	1.81	1.45	1.85	1.85	1.75	2.971*	(2),(3)>(1),(4)
	Competitors	1.48	1.66	1.46	1.59	1.45	1.314	n.a.
	Public research institutes and Government	0.50	0.35	0.49	0.68	0.46	6.111***	(3)>(2),(4),(1)
	Consultants	0.78	0.66	0.75	1.00	0.75	4.260**	(3)>(2),(4),(1)
Service trajectory	Product innovation	1.19	1.13	1.17	1.41	1.13	6.488***	(3)>(2),(4),(1)
	Process innovation	1.16	1.24	1.16	1.22	1.09	1.243	n.a.
	Organizational innovation	1.09	1.02	1.08	1.32	1.00	8.062***	(3)>(2),(1),(4)
	Business model innovation	1.32	1.37	1.31	1.42	1.26	1.315	n.a.
Appropriability	Patents	1.00	0.88	1.02	1.13	0.90	2.996*	(3)>(2),(4),(1)
	Trademarks	0.88	0.84	0.83	1.28	0.77	10.574***	(3)>(2),(1),(4)
	Copyrights	0.63	0.55	0.61	1.02	0.48	13.290***	(3)>(2),(1),(4)
	Trade secrecy	1.18	0.93	1.14	1.63	1.07	11.834***	(3)>(2),(4),(1)
	Lead time	0.98	0.80	0.97	1.17	0.94	3.712*	(3)>(2),(4),(1)
	Design complexity	0.79	0.60	0.79	1.13	0.65	9.475***	(3)>(2),(4),(1)
	Luck-in strategy	0.95	0.96	0.95	1.22	0.82	5.670**	(3)>(2),(1),(4)
	Chain joining	0.62	0.61	0.58	0.94	0.54	8.950***	(3)>(2),(1),(4)
Know-how	0.97	0.88	0.95	1.29	0.84	10.228***	(3)>(2),(1),(4)	

* p< 0.05, **p<0.01, ***p<0.001

TABLE 3

Juxtaposition of differences between new service taxonomy and the Miozzo and Soete taxonomy

Category of firm	New service taxonomy versus Miozzo and Soete taxonomy					
	Sources of innovation		Service trajectory		Appropriability	
	New Taxonomy	M&S Taxonomy	New Taxonomy	M&S Taxonomy	New Taxonomy	M&S Taxonomy
Supplier dominated	Competitors, in-house R&D	Suppliers	Business model innovation, process innovation	Product innovation/ process innovation	Luck-in, trade secrecy	Non-technical
Scale-intensive physical networks	Customers*	In-house, suppliers	Business model innovation, product innovation	Process innovation	Trade secrecy, patent	Standards, norms
Information networks	Customers*, suppliers*, consultants*, government or public research institutes*	In-house, suppliers	Product innovation*, organizational innovation*	Process innovation	Legal*, non-legal*	Standards, norms
Specialized suppliers/ science based	Customers, in-house R&D	In-house, customers, suppliers	Business model innovation, product innovation	Product innovation	Trade secrecy, lead-time	R&D, know-how, skills, copyright, product differentiation

* : The variable presents statistically different among four sectors .

5. Discussions

From the empirical results, this study proposes the service regime derived from a synthesis approach to reconsider the existing service taxonomy of Miozzo and Soete. Specifically, this study confirms that the sectoral patterns of innovation in services are sector-specific due to mostly loosely coupled system with various patterns of innovative activities in service sectors. Since the hypotheses in this study are supported, there are two sectors that are statistically significant across four sectors, especially for the information networks and scale-intensive physical networks sectors. These indicate that the notion of service regime provides an effective framework to reconsider the Miozzo and Soete service taxonomy.

We obtain the juxtaposition of differences between this study and the Miozzo and Soete service taxonomy which is summarized in Table 3. Overall, Table 3 summarizes the service patterns of innovation which have statistically different and high coefficient variables beyond average in each of sectors. This table indicates that in-house R&D and competitors as sources of innovation and process innovation and business model innovation as service trajectory are widely employed by all service sectors. In line with prior studies, in-house R&D activities and competitors play important roles in services (Sirilli & Evangelista, 1998; Tether, 2002). In particular, in-house R&D activities are varied across service sectors which are acknowledged researches in the social sciences and humanity activities (Djellal et al., 2003). This means that the low R&D capability sector such as the supplier-dominated sectors also employ a bulk of in-house R&D activities even if these firms are high underpinned professional skills and abilities. Moreover, ICT development also influence the introduction of new methods or improved ways of producing and delivering services (Barras, 1986; Sirilli & Evangelista, 1998). This identifies that process innovation in service trajectory was utilized by all service sectors (Evangelista, 2000; OECD, 1996, 1997). It is noteworthy that business model innovation is also widely used by all service sectors. There are two possible explanations for why this sort of innovative cumulativeness is necessary. First, business model innovation is a reciprocal mechanism generating revenues that provide an efficiency to improve the firms' performance within a value network (Teece, 2010). A successful business model certainly brings a new innovation combined with core competences and firm's strategies, which is suitable for service firms (Gambardella & McGahan, 2010). Secondly, the S-D logic also provides a good explanation (Vargo & Lusch, 2004, 2008). The S-D logic is similar to rules of the game, which are tied to standard patterns of behavior (Nelson & Sampat, 2001) and assumes reciprocal skills for each of the firms in the value chain. It proposes that specialization is more efficient for

services, where the knowledge and skills must be complementary. This suggests that building reciprocal relationships is useful to combine complementary assets to support firms' revenues (Chesbrough & Rosenbloom, 2002; Teece, 1986).

The Table 3 indicates that trade secrecy, patents, lead time and luck-in strategy constitute legal and non-legal intellectual property rights protection methods that are used jointly. The complementary mechanisms suggest that intellectual property mechanisms are interdependent and reinforce each other to protect innovations from rival firms (Amara et al., 2008). The joint use of appropriability mechanisms are important strategies for innovative firms because the speed of imitation has a bearing on the durability of firms' competitive advantages (Porter, 1996). Howells et al. (2003) suggested a knowledge regime theory to explain complementarities. They argued that service firms often use the joint intellectual property mechanisms because they operate under a wider variety of knowledge regimes. The legal appropriability are better suited for capturing profits from innovations when knowledge regimes are characterized by a high degree of knowledge codification and tangible output, such as patents, copyrights, trade secrecy, and trademarks. In contrast, if service firms are based on tacit knowledge and intangible output, the protection of innovations from imitation can be obtained by non-legal appropriable mechanisms. In particular, the codified knowledge combined with intangible output or tacit knowledge is coupled with tangible outputs. This suggests the jointly appropriability, where legal and non-legal intellectual property protections are most applicable mechanisms (Howells et al., 2003).

Roughly, this study also confirms service sectors as sector-specific which may be caused by a mostly loosely coupled system. We speculate that this is a possible reason why Miozzo and Soete service taxonomy focused on sector-lever analysis, though they examined firm-level data. Miozzo and Soete found many common patterns among firms in the same sectors so that they concluded a specific sectoral pattern of innovation. The sector level data cover a wide range of firms which are much diversity. These multiple composite firms are showed various innovative activities which are likely sector-specific. In line with prior studies, they verified that the taxonomy of the innovative patterns was taken by firm-level data analysis (de Jong & Marsili, 2006; Souitaris, 2002). For example, Table 1 indicates the sample of typical sectors. The specialized suppliers and science based sectors comprise various firms including waste disposal, legal and accounting, computer and software, business and technical consultants, advertising services, real estate, specialized services and other business services. These firms are presenting various innovative behaviors which cause sector-specific patterns. On the other way, sectoral patterns of innovation in services is as loosely coupled system (Sundbo & Gallouj, 2000). The causal

ambiguity refers to unclear means-ends connections which are main factors to cause loose coupling (Orton & Weick, 1990). The prior studies have verified that measuring innovation output in services is difficult because of bulky external innovative sources (Miles, 2007; Sirilli & Evangelista, 1998). These various innovation inputs partially influence output performances (Sirilli & Evangelista, 1998). The Table 2 indicates that all sectors rely on such diversified sources of innovation to develop that those may facilitate an unclear causal determinacy and loose coupling.

6. Conclusions

Despite the rise of service-based economies, we have little knowledge about different sectoral patterns of innovation in services. By deploying the synthesis approach to study service innovation, this paper proposes a new notion of the service regime to analyze sectoral patterns of innovation in services. The service regime is elaborated into three dimensions: sources of innovation, service trajectory and appropriability. This study reconsiders the existing sectoral patterns of innovation of Miozzo and Soete throughout the service regime perspective. Data from Taiwan innovation survey 2004-2006 is used to empirically test these sectoral patterns of innovation of Miozzo and Soete taxonomy. The results confirm that the sectoral patterns of innovation in services are less sector-specific than we expected due to service system as a loosely coupled system. Moreover, compared to Miozzo and Soete taxonomy, the service regime has the potential to contribute more insights to understand the sectoral patterns of innovation in services.

This study concludes that sectoral patterns of innovation in services are mostly a loosely coupled system in which specific patterns with the service regime perspective are more obvious. A loosely coupled system is comprised of certain diversity of innovative sources, service trajectories and intellectual property rights protection like joint IPR appropriable mechanisms. The evidences have shown that diversified sources of innovation, constellation of service trajectories, and jointly appropriable mechanisms are developed by all sectors. These common patterns are clearly found and can be said a loosely coupled system in which all elements and non-fixed behavioral patterns and traditions are intertwined. The sectoral patterns of innovation in services are less tightly interaction which characterize by a large variety of relations among sources of innovation, service trajectory and appropriability than those in manufacturing sectors.

However, the focus on service regime draws attention on the variety of patterns of innovation in services and the main findings are explored: sectoral patterns of innovation in services remain sector-specific which is comprised for certain diversified sources of innovation, constellation of service trajectories and jointly appropriable mechanisms. Specifically, the specific sectoral patterns of innovation in this study are developed: the *supplier-dominated sectors* present in-house R&D and competitors as the main sources of innovation, and they prefer both accumulated process innovation and business model innovation, and they jointly employ appropriable mechanisms in the forms of trade secrecy and luck-in strategy. The *scale-intensive physical networks sectors* utilize sources of innovation from customers and in-house R&D, and their innovative cumulativeness is fostered by product

innovation and business model innovation, and their appropriability employs trade secrecy and patents. The *information networks sectors* rely on customers and in-house R&D as sources of innovation. These sectors are used to both product innovation and business model innovation, and their joint appropriable mechanisms are including trade secrecy and know-how strategies. Furthermore, the *specialized suppliers and science based sectors* are mainly the sources of innovation for customers and in-house R&D, while the accumulated innovative activities are by product innovation and business model innovation. These sectors often utilize both legal and non-legal appropriable mechanisms of trade secrecy and lead time strategies.

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