RELATIONS BETWEEN TECHNOLOGICAL–NON-TECHNOLOGICAL INNOVATIONS IN THE SERVICE SECTOR

服务业技术创新与非技术创新的关系

Abstract

In the economic literature there is a debate on whether technological and nontechnological innovations share the same determinants. As a result of this debate two opposing views have emerged: the distinctive view argues that the determinants of both technologies are different; on the contrary, the integrative view considers that both types of technologies share determinants. The main objective that we pursue in this study is to test which of the two views is prevalent in the service sector of the Spanish economy. Analyses were performed using data from Spanish Technological Innovation Panel for the period 2008-2012. To perform hypothesis tests, the approach of complementarity was used. Our findings indicate that neither of the two approaches has been fully accredited, although the distinctive view is more prevalent. However, this radiography of relations tells us that companies can achieve further increases in productivity if technological innovation and non-technological innovation are implemented simultaneously.

摘要

在经济文献中，关于技术和非技术创新是否具有相同的决定因素存在争论。作为这场辩论的结果，出现了两种对立的观点：独特的观点认为这两种技术的决定因素是不同的；相反，综合的观点认为这两种技术共享决定因素。在这项研究中，我们追求的主要目标是测试这两种观点中哪一种在西班牙经济的服务部门是普遍的。分析采用了西班牙技术创新小组 2008 - 2012 年的数据。 为了进行假设检验，采用了互补性的方法。我们的研究结果表明，这两种方法都没有被完全认可，尽管独特的观点更普遍。然而，这种关系的放射线图告诉我们，如果技术创新和非技术创新同时实施，企业可以进一步提高生产力。

Keywords - Technological innovation, Organizational innovation, Marketing innovation, Complementarity approach, Service sector

关键词： 技术创新，组织创新，营销创新，互补性方法，服务业

Introduction

It is a fact that rapid economic and social development to which humanity has been subjected in recent decades is closely related to the innovative hatching that has simultaneously taken place. Consequently, the innovative capacity of firms has come to be seen as an essential factor, without which, such companies would have serious difficulties in accessing new markets, increasing their market share or sustaining competitive advantages in the long term (McAdam & Keogh, 2004).

However, until the late twentieth century, this budding interest in innovation was materialized in studies confined almost exclusively to its technological aspects and that primarily use data belonging to the industrial sector. (e.g., Freeman, 1982; Rothwell, 1994). However, the recent advent of studies that take into consideration non-technological innovation (e.g. Schmidt & Rammer, 2007; Mothe & Nguyen-Thi, 2012) or analyze the influence of innovation in the service sector (Gallouj & Weinstein, 1997; Masso & Vahter, 2011; Carlborg, Kindström, & Kowalkowski, 2014) has allowed us to develop a more-accurate idea of the real dimension of the concept innovation.

Accordingly, Innovations can be classified as technological, in case of product or process innovations, or as non-technological, in case of marketing or organizational innovations (OECD & Eurostat, 2005).

Historically, the study of such types of innovation has been raised, denying the possibility of interaction between them, presuming that each type is influenced by different variables (Fritsch & Meschede, 2001), and its impact on innovation performance is also different (Damanpour, Szabat, & Evan, 1989). This position, totally reluctant to any possibility of interaction between the different types of innovation, should be framed within the so-called distinctive view. However, against such a stance so far preponderant, some authors have begun to suggest the existence of interdependence between the various types of innovation, stating that a type of innovation cannot be understood without evaluating its relationship with the rest (Damanpour & Gopalakrishnam, 2001; Roberts & Amit, 2003). This new trend, known as integrative view, is supported by a growing number of academic papers that consider that the simultaneous use of different types of innovation benefit the company and improve its innovative results (e.g., Damanpour et al., 2009; Schmidt & Rammer, 2007; Walker, 2005).

In this paper, our interest lies in analysing if the relationship between different types of innovation in the services sector in Spain coincides with the prediction of the distinctive view or that of the integrative view. If relations between these types of innovation are essentially complementary, this would be support the reasoning of the

integrative view, which maintains that technological and non-technological activities support each other (Damanpour & Evan, 1984). Conversely, if relations are predominantly substitutive or there is no relationship established, the result would support those who defend the distinctive view, i.e., the combination of different types of innovation does not result in a synergistic effect, and therefore, it cannot be a source of competitive advantage.

To check which of the two visions prevails in the Spanish services sector, we use the complementarity approach (Topkis 1978, Milgrom & Roberts 1990). This approach allows the simultaneous exploration of the entire range of existing relationships (complementarity, substitutability or independence) between the different types of innovation analysed. The use of causality as research methodology (e.g., Gunday, Ulusoy, Kilic, & Alpkan, 2011) does not allow simultaneous analysis of the three possible relationships mentioned. Likewise, the use of correlation coefficients (e.g., Camison & Villar-Lopez, 2014) can lead to biased results, since a positive/negative correlation is not a sufficient condition to affirm the existence or inexistence of complementarity/substitutability (Athey & Stern, 1998). Therefore, the complementarity approach begins to be used increasingly to analyse the relationship between different types of innovation (e.g., Ballot, Fakhfakh, Galia, & Salter, 2015; Guisado-González, Wright, & Guisado-Tato, 2017).

On the other hand, it must be underlined that most of the studies that have analysed the relationships between different types of innovation have used cross-section data (e.g., Cassiman & Veugelers, 2006). However, as pointed out by Miravete and Pernías (2006), the analyses with cross-section data do not allow us to overcome the problems of unobservable heterogeneity. The use of panel data facilitates the control of this kind of problem. Therefore, in this study we use panel data, totalling 8,935 observations pertaining to the period 2008-2012.

The empirical research on the relationship between different innovation types remains scarce. In this sense, our paper contributes to extending the empirical investigation on this question, using the complementarity approach as an important research tool, since the literature on innovation emphasizes that the complementarity between technological and non-technological innovations is an important issue (Brynjolfsson & Hitt, 2003).

In the next section, we establish the theoretical framework and propose the corresponding hypotheses. The third section describes the source of the data being used, defines the variables and details the methodology employed. In the fourth section, the results are presented and discussed. Finally, we present the conclusions.

Framework for the analysis and hypothesis

It is evident that for a long time the concept of innovation has tended to equate technological innovation (Schmidt & Rammer, 2007). Such pro-technology bias has been supported by most of the literature (Edgerton, 1999), which has resulted in cataloging the service sector as a laggard sector in terms of innovative processes and productivity growth (Baumol, 1967), becoming a sector considered only able to adopt innovations developed in other sectors, i.e. a sector dominated by its suppliers (Pavitt, 1984).

The fact that each type of innovation is preferably associated with a sector – technological innovation in manufacturing and non-technological in services – has sparked a debate regarding the advisability of posing the innovation in the service sector differentially. Such discussion has resulted in the appearance of three distinct positions (Coombs & Miles, 2000; Vergori, 2014).

The technicist (or assimilation) approach reduces innovation in the service sector to the introduction of technological systems (e.g., communication systems). Therefore, this approach rejects any possibility that a technological innovation can be gestated within this sector, while it does not conceive the existence of non-technological innovation. This position fits in with the traditional view that the services sector is dominated by its suppliers that, despite being overtaken, has raised valuable theoretical and empirical contributions concerning the details of the spread of industrial innovations in the service sector (Barras, 1986).

The service-oriented (or demarcation) approach emphasizes the specificities of innovation in services and, therefore, understands that different theories are needed to address the innovative phenomenon in manufacturing and services. This claim is based on the differences between goods and services that are generally summarized as intangibility, inseparability, heterogeneity and perishability. The service-oriented approach pays special attention to non-technological forms of innovation, particularly important in the service sector and historically ignored by most of the investigations.

The integrative (or synthetic) approach has tried to find a definition of innovation that combines the innovation of goods and services, as the industrial and services sectors have more similarities than differences in relation to the basic dimensions of the innovation process (Evangelista, 2000).

In the present study, we work under the premise of an integrative (or synthetic) approach. The reason is that we believe that it would be unwise to circumscribe exclusively non-technological innovation to the service sector and technological

innovation to the manufacturing sector, especially when our interest is to investigate the possible relationship of complementarity/substitutability that both types of innovation might have in the services sector.

Over time, the specialized literature has agreed to a broader definition of innovation, where non-technological innovation is again accommodated as in the primitive conception enunciated by Schumpeter. This circumstance has generated an unusual interest in the study of non-technological innovation and, therefore, in the study of innovation in the service sector where it is more relevant (e.g., Evangelista, 2000; Tether & Tajar, 2008; Mothe, & Nguyen-Thi, 2012).

Likewise, it should be pointed out that in parallel with the growing interest in innovation in the services sector, greater attention has also been paid to obtain a better knowledge of the relationship between technological and non-technological innovations, as the coexistence of product, process and organizational innovations is more common in the services sector than in the manufacturing sector (Cainelli, Evangelista, & Savona, 2006; Asikainen, 2015). On these relations, we have already pointed out that there are two opposing visions: the distinctive view and the integrative view. Regarding these relations, we have already pointed out that there are two opposing visions: the distinctive view and the integrative view.

The distinctive view rests on the principles of analytical thinking, hence, it is considered that only through understanding the behaviour of the different parts of a phenomenon is it possible to reach understanding of the phenomenon itself (Ackoff, 1999). Based on this premise, the distinctive view leads us to consider the different types of innovation as distinct phenomena whose analysis should be undertaken separately, as each is subject to the influence of different determinants (Damanpour, 2010), and therefore, its influence on growth and competitiveness of the company will be uneven.

The results of distinctive view are multiple studies that have addressed in isolation each type of innovation and its determinants: product innovation (e.g., Li & Atuahene-Gima, 2001), process innovation (e.g., Knott, 2001), organizational innovation (e.g., Colombo & Delmastro, 2002) and marketing innovation (e.g., Moreira, Silva, Simões, & Sousa, 2012).

On the other hand, the integrative view rests on synthetic thinking, according to which the behaviour of a phenomenon must be understood in terms of interdependence with other parts that are included within a larger phenomenon that encompasses them all (Ackoff, 1999). Such an assumption comes from the presumption of complementarity between the different types of innovation (Damanpour, 2010), which, in turn, is connected

with a rising stream of thought that emphasizes better economic performance usually associated with the simultaneous use of multiple types of innovation (Gera & Gu, 2004), since such concurrency, among other benefits, results in a growing complexity of the competitive strategy of the company, preventing the imitation of the competitive advantages that the company could have achieved (Rivkin, 2000).

In turn, the integrative view also finds a powerful theoretical support in the resource-based view. The latter conceives the company as a unique and heterogeneous set of resources developed throughout its history and whose right combination will allow the company to build sustainable competitive advantages (Wernerfelt, 1984; Barney, 1991). The harmony between integrative view and resource-based view, becomes apparent, then, because in both cases, achieving competitive advantage lies in the right combination of multiple elements and not in the effect of any of them separately.

Despite having identified four types of innovation (product, process, organizational and marketing innovation), in this study, we conduct an analysis of complementarity using only three kinds of innovation, since, for that matter, product innovations and process will be subsumed into a single class called technological innovations. This is because the focus of this work is the service sector, so product and process differentiation on the same is extremely complex, depending on the case, which is why some authors have stated that the distinction is meaningless in this sector (Gallouj & Weinstein, 1997; Evangelista, 2000). In this sense, we must bear in mind that, traditionally, product innovation is strongly related to the execution of R&D activities. However, in services the innovation is much more related to "alteration, redesign, and continuous development of existing own products or processes or adopted technologies. This feature tends to make the innovations in services incremental in nature" (Asikainen, 2015). Consequently, in service companies R&D activities are not as important as in manufacturing firms, to the extent that in service companies these kinds of activities do not necessarily constitute the most important input of the innovation processes (Miles, 2005; Rubalcaba, Gallego, & Hertog, 2010). In fact, manufacturing companies tend to cooperate with R&D organizations while service companies prefer to do so with consulting firms (Tether & Tajar, 2008). Therefore, in service firms the line that separates product and process innovation is difficult to define (Hertog, 2000).

So, according to the previous arguments, our objective is to analyse the relations between technological innovation, organizational innovation and marketing innovation in the services sector, since the simultaneous adoption of different types of innovation not only favours the appearance of synergies, but also increases the likelihood that the innovation process will be successful (Leiponen & Helfat, 2010). For this, we use the

complementarity approach as empirical methodology (Topkis 1978; Milgrom & Roberts 1990). Within this approach, two research methods are used to evaluate the existence of complementarity (Ennen & Richter, 2010): the systems approach and the interaction approach. In general, when it comes to analysing the complementarity between more than two variables, the systems approach is the most used by researchers (Ennen & Richter, 2010), since this approach allows to overcome some of the drawbacks of the interaction approach (Ballot et al., 2015), and it also provides more information, although its execution presents greater technical complexity (Guisado-González, González-Blanco, Coca-Pérez, & Guisado-Tato, 2017). Therefore, in this paper we use the systems approach.

Following the complementarity approach, the relationship between variables is tested pairwise. For example, when we analyse the relationship between technological innovation and organizational innovation the number of nontrivial inequality constraints implied by the definition of supermodularity is two (Mohnen & Roller, 2005): the first nontrivial constraint inequality is tested among firms without marketing innovation; the second, among firms that perform marketing innovation. If the two inequalities give complementary results, it is said that there is complementarity. If only one of the inequalities is complementary, it is said that there is conditional complementarity.

Mothe, Nguyen-Thi, and Nguyen-Van (2015) point out that product innovation and process innovation are subject to different organizational management tools. Therefore, the relationship between technological innovation and organizational innovation will be determined by the weight of product innovation and the process innovation in the technological innovation variable. In this sense, we have already commented that in the services sector it is difficult to differentiate both types of innovation, but given its incremental nature (Asikainen, 2015), technological innovation in the services sector is closer to process innovation than to product innovation, since services are basically processes (Weitlaner & Kohlbacher, 2015). The main objective of process innovation is cost reduction (Hervas-Oliver, Sempere-Ripoll, Rojas Alvarado, & Estelles-Miguel, 2017a).

On the other hand, the literature recognizes that organizational innovation plays an important role in the innovation process (e.g., Yang & Hsiao, 2009). In relation to organizational innovation, we consider the three types of organizational innovation practices (OECD & Eurostat, 2005): new organizational method (e.g. knowledge management), new workplace organization (e.g. lean and just-in-time production) and new external relations (e.g. alliances, outsourcing and subcontracting). The new workplace organization is an innovation practice with a strong weight in the services sector of the Spanish economy (Meroño-Cerdán & López Nicolás, 2017), and its

implementation pursues the goal of cost reduction (Meroño-Cerdán & López Nicolás, 2017).

Therefore, in the services sector, technological innovation and organizational innovation pursue the same objective of cost reduction. Consequently, the simultaneous adoption of both types of innovation can generate positive or negative synergies, depending on whether they both reinforce or cancel out each other. For example, in the Spanish manufacturing sector, Hervas-Oliver, Sempere-Ripoll and Boronat-Moll (2014) found that the production process performance increases when companies adopt organizational and technological innovation simultaneously, and that the adoption of the innovation process has a positive and significant influence on the performance of organizational innovation (Hervas-Oliver & Sempre-Ripoll, 2015). Both studies are indicators of a possible complementarity between technological innovation and organizational innovation. However, in the set of Spanish service companies we intuit that the relationship between both types of innovation is substitutive, taking into account the following circumstances:

a) The Spanish services sector is mainly made up of small companies (INE, 2001) with scarce financial resources to undertake investments in innovation. This circumstance probably forces a large number of companies to select one of the two innovation alternatives indicated. Consequently, the simultaneous adoption of technological and organizational innovations is not possible in many cases, especially if the high costs involved in the implementation of new organizational methods are taken into account (Shin, 2004).

b) Also, during the period covered by our analysis (2008-2012), the crisis in Spain has been particularly intense (Canto-Cuevas, Palacín-Sánchez, & Pietro, 2016). Therefore, in a scenario of diminishing resources, it seems logical to assume Spanish companies have dedicated their scarce resources to the development of only one of the two innovation alternatives indicated. In short, the resources of the firms dedicated to technological innovation and organizational innovation are limited and, therefore, can only be invested in one of these innovations, that is, technological innovation and organizational innovation may lead to trade-offs in terms of resources. In addition, in small companies the management staff are scarce, so they tend to focus on the implementation of one type of innovation. In this sense, the literature points out that the simultaneous adoption of different types of innovation requires the availability of additional resources, including management (OCasio, 1997; Hervas-Oliver, Sempere-Ripoll, Boronat-Moll, & Rojas-Alvarado, 2017b).

Likewise, it must be borne in mind that the probable substitutive relationship between technological innovation and organizational innovation of Spanish service companies does not constitute a unique position. For example, Ballot et al. (2015) found that in France and the UK the relationship between process innovation and organizational innovation is substitutive, as long as companies also carry out product innovation. Likewise, Le Bas, Mothe and Nguyen-Thi (2015) found that external relations and knowledge management – two of the three dimensions of organizational innovation – exhibit a negative influence on process innovation. Moreover, Hall, Lotti and Mairesse (2013) did not find any evidence of complementarity between technological innovation and organizational innovation when they analysed this issue in Italy.

Consequently, according to the literature review conducted and the situation and structure of Spanish service companies, we propose the following hypothesis:

Hypothesis 1: The relationship between technological innovation and organizational innovation is substitutive.

The technological innovation process is subject to high uncertainty and, consequently, exhibits a very high rate of technical failure (Schilling, 2008). But the failure rate of commercialization of new products is even greater (Gourville, 2006). The marketing capabilities of companies can help reduce both rates of failure: on the one hand, marketing can provide those responsible for innovation with information about the products that customers demand or about their needs that are not properly met – this helps to reduce the rate of technical failure; on the other hand, marketing aims to convince customers to buy the new products that the company offers, which helps to reduce the failure rate of commercialization of new products. Marketing can also guide the need to implement process innovations aimed at reducing costs, so that the company can redefine a more competitive pricing policy (Germain, 1996).

Likewise, technological innovation can create new technologies that influence how companies update their product offerings and achieve better recognition of their customers' needs (Moorman & Slotegraaf, 1999). These arguments suggest that technological innovation and marketing innovation reinforce each other, that is, that both types of innovation are complementary. Consequently, we propose the following hypothesis:

Hypothesis 2: The relationship between technological innovation and marketing innovation is complementary.

The relationship between organizational innovation and marketing innovation has been poorly studied. Walker (2004) emphasizes that different types of innovation influence each other and they should be implemented in conjunction. We only know one study that uses the complementarity approach to analyse the relationship between these two types of innovation. This study does not find that there is a relationship between both types of innovation. However, other studies provide evidence on the potential complementarity between organizational innovation and marketing innovation. Thus, Ettlie and Reza (1992) pointed out that the ways of organizing things makes it easier for companies to better satisfy their customers. Walker (2008) announced that marketing and organizational innovations are inter-related, and Rehman (2017) suggested that market-related networks and organizational innovation are complementary. Therefore, we propose the following hypothesis:

Hypothesis 3: The relationship between organizational innovation and marketing innovation is complementary.

Data, Methodology and Variables

Data

We use Technological Innovation Panel (PITEC) data for Spanish services firms for 2008-2012. PITEC is based on the database Community Innovation Survey (CIS). After removing the observations with missing values and those that had some sort of impact on the variables of interest, we obtained 8935 observations for the whole data database. Our panel data are strongly balanced.

Methodology

The theory of supermodular games, based on the mathematical model developed by Topkis (1978), allows to formalize precisely the necessary conditions to understand the relationship of complementarity/substitutability between two variables. Milgrom and Roberts (1990) have been the first to implement the complementarity approach in the field of management.

Formally, a pair of innovation activities is complementary if the sum of the benefits to do just one or the other is no greater than the benefit of doing both together (Ennen & Richter, 2010).

To implement the approach of complementarity proposed by Milgrom and Roberts (1990), it is necessary to define an objective function. Suposse that Xi and Xj are two types of innovation, and Z is a vector of exogenous variables in the function F (Xi, Xj, Z). Consider that Xi and Xj are dichotomous variables that take the value 1 when they are adopted and the value 0 when they are not. The complementarity approach regresses an objective on exclusive combinations of innovation activities and the vector of exogenous variables:

$$F(X_i, X_j, Z) = \beta_{00}(1- X_i)(1- X_j)+\beta_{10}X_i(1- X_j)+\beta_{01}(1- X_i)X_j+\beta_{11}X_iX_j+\beta_zZ+ e$$

β_{11} measures partial cross return of choosing X_i and X_j jointly; β_{10} measures the return of only choosing X_i; β_{01} measures the return of only choosing X_j; β_{00} measures the return derived from not choosing either of the two activities.

So we can say that the objective function $F(X_i, X_j, Z)$ is supermodular, and X_i and X_j are complementary if:

$$\beta_{11}+ \beta_{00} - \beta_{10} - \beta_{01}> 0$$

Obviously, it is said that the objective function $F (X_i, X_j, Z)$ is submodular, and X_i and X_j are substitutives if:

$$\beta_{11}+ \beta_{00} - \beta_{10} - \beta_{01}< 0$$

In the complementarity approach two different methods are used to test the hypotheses. On the one hand, Mohnen and Röller (2005) uses as null hypothesis H0: $R\beta > r$ vs H1: $R\beta \leq r$, while Belderbos, Carree, and Lokshin (2006) uses H0: $R\beta = r$ vs H1: $R\beta \geq r$. Ballot et al. (2015) call the first test, unconditional complementarity, and the second, conditional complementarity. However, since the unconditional test often offers abundant inconclusive results, Ballot et al. (2015) propose to use the conditional complementarity test, since this is usually more conclusive, mainly when analyzing more than two variables. Consequently, we focus on conditional tests.

The number of inequalities necessary to contrast depends on the number of variables whose complementarity we want to check. According to Topkis (1978) and Mohnen and Röller (2005), when there are k variables, the number of nontrivial inequalities that must be contrasted will be $2^{k-2}\sum_{i=1}^{k-1} i$. In this study, as there are three variables, the number of restrictions to contrast will be 6, i.e., two restrictions for each hypothesis. For example, if we contrast the complementarity between technological

innovation and organizational innovation, we should test the following two nontrivial inequalities:

$\beta_{110} + \beta_{000} - \beta_{100} - \beta_{010} > 0$ (between companies not engaged in marketing innovation)

$\beta_{111} + \beta_{001} - \beta_{101} - \beta_{011} > 0$ (between companies engaged in marketing innovation)

In this study, we used a random effects model. The econometric technique we use to estimate the coefficients is the maximum-likelihood, since this technique allows obtaining the coefficients of the eight exclusive innovation profiles (strictly necessary to test the existence of complementarity). This is possible, since the output of the regression provides a constant that can be suppressed to prevent the perfect multicollinearity originated by the presence on the model of all the dummies that represent the eight unique profiles. Furthermore, this econometric technique has the added advantage to provide estimates of all coefficients, even in the case of regressors that do not vary over time.

Description of Variables

To perform the test of complementarity proposed by Milgrom and Roberts (1990), it is necessary to define the function of business performance. In this sense, in the field of innovation, the variable most frequently used to measure performance is the labor productivity (e.g. Roper et al., 2008). It is a measure of broad spectrum, which includes influences from many different innovation sources that generate productivity.

Regarding the independent variables, due to the peculiarities of innovation in the service sector, where it is difficult to distinguish between product and process innovation, we have chosen to introduce technological innovation variables that mix both. By contrast, the non-technological innovations, i.e., organizational and marketing innovation, are incorporated separately. In turn, all possible combinations between these three variables (technological innovation, organizational innovation and marketing innovation) shape eight exclusive variables, whose regression coefficients are needed to test the relations of complementarity/substitutability.

In addition, we have also introduced a number of control variables, according to their potential influence on the productivity of the company. In this sense, relying on the evidence shown by the economic literature, we have incorporated variables whose influence on innovation performance and thus on productivity in the company are presumed positive: size, export intensity, cooperation, business group, training, measures

of legal protection for innovations, knowledge sources (internal, external with industrial origin and external with scientific origin) and R&D intensity. We also include four obstacles to innovation whose influence on productivity is presumed negative: cost, knowledge, financial obstacles and market obstacles (Cassiman & Vegeulers, 2006; Mohnen & Röller, 2005).

Finally, as the importance of innovation differs between different activities, it is necessary to control these possible asymmetries; therefore, we include dummy variables of the national classification of economic activities in the service sector.

Table 1 shows the precise definition of all variables and their basic descriptive statistics.

Table 1. Definition of variables and descriptive statistics

Name of variable	Variable construction	Mean (Stand. deviation)
Labour productivity	Logarithm of sales per employee ratio.	4.978 (0.488)
Technological innovation	If the company performs at least one of the following innovations: product innovation and process innovation (0,1).	0.881 (0.323)
Organizational innovation	If the company introduces or modifies at least one of the following practices or methods: work organization, sharing of responsibilities and external relations (0,1).	0.595 (0.491)
Marketing innovation	If the company introduces or modifies at least one of the following practices or methods: product design, product promotion, sales channels and prices (0,1).	0.377 (0.485)
R&D intensity	Relationship between internal and external R&D expenditure and total sales of the company.	1.015 (48.612)
Legal protection	Sum of the results of the following methods of protection of innovation (where 1 means it is used and 0 that it is not): Patents, Design registration, Trademarks, Copyright. Rescaled between 0 and 1.	0.109 (0.191)
Internal sources	The importance of information of the company or group of companies to the innovation process (valued between 0 and 3, depending on their importance). Rescaled between 0 and 1.	0.815 (0.294)
External industrial sources	Sum of the results of the following sources of information that affect the innovation process (valued between 0 and 3, depending on their importance): Suppliers, Customers, Competitors, Fairs and exhibitions, Magazines and professional associations. Rescaled between 0 and 1.	0.454 (0.245)

External scientific sources	Sum of the results of the following sources of information that affect the innovation process (valued between 0 and 3, depending on their importance): Commercial laboratories, Universities, Public research centre, Technology centres. Rescaled between 0 and 1.	0.332 (0.289)
Cost barriers	It is a measure of the importance of R&D costs as obstacles of the innovative process (valued between 0, not relevant costs, and 3, very relevant). Rescaled between 0 and 1.	0.633 (0.334)
Financial barriers	Sum of the results of the following obstacles to the innovation process (valued between 0 and 3, depending on their importance): Lack of funds in the company or group and lack of external funding. Rescaled between 0 and 1.	0.657 (0.318)
Knowledge barriers	Sum of the results of the following barriers to the innovation process (valued between 0 and 3, depending on their importance): Lack of technological information, Lack of market information, Difficulty of finding partners to cooperate. Rescaled between 0 and 1.	0.409 (0.230)
Market barriers	Sum of the results of the following barriers to the innovation process (valued between 0 and 3, depending on their importance): Market dominated by established companies, Uncertain demand for innovative goods or services. Rescaled between 0 and 1.	0.523 (0.299)
Group	The company belongs to a group (0,1).	0.414 (0.493)
Training	The company incurs training expenses (0,1).	0.222 (0.416)
Cooperation	The company cooperates with other companies or institutions (0,1).	0.474 (0.499)
Export intensity	Percentage of exports in total sales.	0.122 (0.259)
Size	Logarithm of the number of employees.	1.772 (0.830)
Sectors	Dummies for: transport, hospitality, telecommunications, consulting, other information services, financial activities, real estate activities, R&D services, other activities, auxiliary services, education, health activities, artistic activities, other services.	

Results and Discussion

The company practices regarding the use of eight different unique combinations of types of innovation are reflected in Table 2. This table shows relevant information, since it reveals that the combination of the three types of innovation is the preferred choice for

companies in all years of the study period (2008-2012). In turn, the development of technological innovation exclusively is the second most used, except in 2008, so the principles of integrative approach (or synthetic) are reinforced. In this sense, the technological trajectory shows not being linked to manufacturing, which is a clear indication that non-technological innovation (organizational and marketing innovation) does not have to be predominant in the service sector. Finally, it is noteworthy that the combination of technological and organizational innovation also enjoys wide prestige among companies in the tertiary sector.

Table 2. Frequency of the eight exclusive combinations of innovation

	2008	**2009**	**2010**	**2011**	**2012**
(0, 0, 0)	5,9%	5,0%	4,0%	9,1%	11,8%
(1, 1, 1)	30,9%	31,2%	31,5%	30,6%	27,8%
(1, 0, 0)	25,6%	28,0%	30,4%	27,1%	25,8%
(0, 1, 0)	2,4%	2,1%	2,4%	3,2%	4,0%
(0, 0, 1)	0,4%	0,4%	0,2%	0,4%	1,1%
(1, 1, 0)	29,0%	27,1%	25,3%	23,1%	20,3%
(1, 0, 1)	5,1%	5,1%	5,3%	5,2%	6,4%
(0, 1, 1)	0,7%	1,0%	1,0%	1,4%	3,0%

On the other hand, by the method of maximum likelihood, we estimate the coefficients of random effects model (Table 3). Our goal is to perform complementary tests in order to obtain information on relations of complementarity/substitutability of the three innovations analyzed. Thus, we are only interested in the coefficients of the eight unique combinations of the three types of innovation, as these factors are essential to perform for complementary tests. However, as the estimation of the model's coefficients is not a goal but a means, we do not comment on its statistical significance. However, as an exception, the fact that the R&D intensity is significant and has a negative sign draws attention powerfully. This result highlights the particular nature of the service sector and is consistent with the existence of an innovative process less dependent on formal R&D investment (Camacho & Rodriguez, 2008; Ettlie & Rosenthal, 2011). Obviously, less

dependence stems from the important presence of marketing and organizational innovations in the service sector, being less relevant in the manufacturing sector. In fact, concepts such as open innovation, where users assume a leading role in the innovation process (Hippel, 2005), have emerged in the service sector.

Table 3. Regression of labor productivity

	Coef.	S.E.
R&D Intensity	- 0.001***	0.000
Legal protection	0.007	0.016
Internal sources	0.001	0.009
External industrial sources	0.013	0.015
External scientific sources	-0.003	0.014
Cost barriers	0.007	0.010
Financial barriers	-0.059***	0.012
Knowledge barriers	0.014	0.015
Market barriers	-0.015	0.012
Group	0.079***	0.010
Training	0.004	0.006
Cooperation	0.011	0.006
Export intensity	0.011	0.012
Size	-0.074***	0.009
(0, 0, 0)	5.598***	0.031
(1, 1, 1)	5.621***	0.031
(1, 0, 0)	5.621***	0.031
(0, 1, 0)	5.643***	0.034
(0, 0, 1)	5.609***	0.043
(1, 1, 0)	5.622***	0.031
(1, 0, 1)	5.635***	0.032
(0, 1, 1)	5.587***	0.036
Year 2009	-.031***	0.006

Year 2010	-.033***	0.006
Year 2011	-.024***	0.006
Year 2012	-.036***	0.006
Dummy variables service sector	Included	
Model	p-value= 0.0000	

Statistical significance of the coefficients: 1% ***, 5%** and 10% *
Total sample size is 8935
Dependent variable is "Labour productivity"
Examples: (0,0,0)= (No technological innovation, No organizational innovation, No marketing innovation
(1,1,1)= (Yes technological innovation, Yes organizational innovation, Yes marketing innovation)

Meanwhile, Table 4 contains the results of the complementarity tests performed. In this sense, the complementarity approach proposes the creation of two tests for each pair of variables analyzed. The first test is checked if the relationship between the variables is significant. If it is not, it is understood that there is no relationship between the variables, which is consistent with the distinctive view. Conversely, if the relationship between the two variables is significant, then a second test must be executed in order to ensure that this relationship is complementary or substitutive. If the relationship shows up complementary, that would fit with the proposal that raises integrative vision and would be a support for the premise that the innovative phenomenon must be understood in terms of interdependence between the various parts that comprise it. Conversely, if the relationship shows up substitutive, the postulates of the distinctive vision would be countersigned.

In relation to the hypotheses, the results partially confirm hypothesis 1. In this sense, we have found that there is a substitutive relationship between technological innovation and organizational innovation, conditioned by the absence of marketing innovation. If companies simultaneously perform marketing innovation, then there is no relationship.

The literature on the relationship between technological innovation and non-technological innovation, in its various forms, is not very abundant. However, in spite of the scarcity of studies, it is possible to find arguments that support the substitutive relationship that we have found in our study. For example, Ballot et al. (2015) and Polder et al. (2010) have found that product and organizational innovations are substitutive, and Brouillette (2014) and Guisado-González, Wright and Guisado-Tato (2017) have also found that process and organizational innovations are substitutive. Likewise, Le Bas et al.

(2015) noted that external relations have a negative influence on process innovation, and Cozzarin (2015) has found that in labour-intensive structures, as in the service sector, none of the managerial practices has significant influence on process innovation.

Table 4. Complementarity tests

		Chi2	P-value
Technological-Organizational	Marketing innovation = 0 T1: $\beta_{110}+\beta_{000}-\beta_{010}-\beta_{100}=0$ T2: $\beta_{110}+\beta_{000}-\beta_{010}-\beta_{100}\leq 0$ Complementarity/Substitutability/No relation	6.42 - **Substitutability**	0.0113 0.9943
	Marketing innovation= 1 T1: $\beta_{111}+\beta_{001}-\beta_{011}-\beta_{101}=0$ T2: $\beta_{111}+\beta_{001}-\beta_{011}-\beta_{101}\leq 0$ Complementarity/Substitutability/No relation	0.05 **No relation**	0.8239
Technological-Marketing	Organizational innovation= 0 T1: $\beta_{101}+\beta_{000}-\beta_{100}-\beta_{001}=0$ T2: $\beta_{101}+\beta_{000}-\beta_{100}-\beta_{001}\leq 0$ Complementarity/Substitutability/No relation	0.01 **No relation**	0.9358
	Organizational innovation = 1 T1: $\beta_{111}+\beta_{010}-\beta_{110}-\beta_{011}=0$ T2: $\beta_{111}+\beta_{010}-\beta_{110}-\beta_{011}\leq 0$ Complementarity/Substitutability/No relation	5.35 **Complementarity**	0.0208 0.0103

Organizational-Marketing	Technological innovation= 0 T1: $\beta_{011}+\beta_{000}-\beta_{010}-\beta_{001}=0$ T2: $\beta_{011}+\beta_{000}-\beta_{010}-\beta_{001}\leq 0$ Complementarity/Substitutability/No relation	3.05 **Substitutability**	0.0808 0.9595
	Technological innovation = 1 T1: $\beta_{111}+\beta_{100}-\beta_{110}-\beta_{101}=0$ T2: $\beta_{111}+\beta_{100}-\beta_{110}-\beta_{101}\leq 0$ Complementarity/Substitutability/No relation	1.40 **No relation**	0.2363

Likewise, the results also partially confirm hypothesis 2, since we have found that there is a complementary relationship between technological innovation and marketing innovation, conditioned by the simultaneous realization of organizational innovation. However, among the companies that do not implement organizational innovation, we have not found any relationship between technological innovation and marketing innovation.

In this regard, Mohnen and Hall (2013) state that it is expected that product and marketing innovations are complementary. In addition, indications of complementarity between technological innovation and marketing innovation have been previously confirmed by other studies. For example, Schmidt and Rammer (2007) and Schubert (2010) found a significant effect of marketing innovation on sales and cost reductions for those firms which also introduced product and process innovation. Likewise, other studies have pointed to the complementary interaction between marketing innovation and technological innovation (e.g., Song, Droge, Hanvanich, & Calantone, 2005; King, Slotegraaf, & Kesner, 2008).

Finally, we must emphasize that our hypothesis 3 predicts that the relationship between marketing innovation and organizational innovation is complementary. However, the results indicate that this relationship is partially substitutive. In this regard, it should be noted that there are studies that indicate that there is a complementary relationship in mature companies, but the same relations are substitutive in young companies, since young firms are more resource-constrained than mature firms (e.g., Bhargava, Chatterjeeb, Grimpec, & Sofkad, 2011). This same criterion can be applied between large companies and small businesses. Therefore, given that the Spanish services sector is mostly made up of small companies, the substitution relationship we have found is understandable. In this

sense, the studies by Brouillette (2014) and Egbetokun et al. (2016) have not found any relationship between these two types of innovation either.

According to the results of Table 4, it is found that there is one complementary relationship, two substitutive and three interactions that show no significant relationship. Accordingly, in the context of Spain services industry, the postulates of the distinctive view find majoritarian endorsement. In contrast, the assumptions of the integrative view only find endorsement in the "technological innovation - marketing innovation" relationship, if companies implement organizational innovations simultaneously. That is, it is found that there is a complementary relationship between technological innovation and marketing innovation, conditioned by the simultaneous realization of organizational innovation.

But beyond the aseptic endorsement of the positions of the distinctive view and integrative view, the complementarity tests show us a radiograph of the possibilities arising from the combination of the three innovations analyzed in terms of additional increment/decrement of productivity.

Thus, it is found that the simultaneous implementation of the three innovations never have detrimental effects on business productivity, since there have not been detected additional increases or decreases in productivity in two of the pairs of the tested relations, while in the other pair there is complementarity. Therefore, the simultaneous implementation of the three types of innovation analyzed seems advisable, since in the worst case it will not have adverse effects on business productivity. In this sense, the simultaneous implementation of different types of innovation, recommended by the integrative view, seems like a wise policy. Therefore, it seems that the possession and combination of higher levels of resources and capabilities (technological innovation, organizational innovation and marketing innovation) are one of the key factors leading to achieve complementary effects on productivity (Ballot et al., 2015).

However, in three of the relationships in which two types of innovation are present, two is substitutive; in the other case, the simultaneous implementation does not impact detrimentally on productivity. Consequently, the simultaneous implementation of two different types of innovation constitutes an unwise practice, with the exception of the joint implementation of technological innovation and marketing innovation.

Conclusions

In the field of economic literature, there is a debate about whether technological innovation (product and process innovation) and non-technological innovations (organizational and innovation in marketing) have or do not have the same background. As a result of this debate, two opposing views have emerged: the distinctive view argues

that the determinants of both technologies are different; on the contrary, the integrative view considers that the two types of technologies share their determinants.

Indeed, one of the main objectives of this study was to compare which of the two views is prevalent in the context of the Spanish economy service sector. To do this, we have used the approach called complementarity. But the application of the complementarity approach not only allows us to compare the prevalence of the two opposing views but, also and above all, allows us to get a complete picture of relations between both types of innovation and the benefits or losses that these relations have on business productivity. This is another of the goals we pursue in this study.

In general, the literature on the search for complementarities between technological innovations and non-technological innovation is scarce, but it is even more scarce in the service sector. Another of our goals is making contributions in this regard, given the huge importance of this sector, both socially and economically.

With regard to the results, we tested the existence of one complementary relationship, two of substitutability and three of independence. Therefore, in general, we can say that neither of the two visions has been fully accredited, although the distinctive vision is more prevalent within the Spanish service sector.

Moreover, through the test of complementarity we have found that the simultaneous implementation of the three innovations (technological, organizational and marketing innovations) never have detrimental effects on business productivity, since additional increases or decreases in productivity have not been detected in two of the pairs of the tested relations, while in the other pair there is complementarity. Therefore, the simultaneous implementation of the three types of innovation analysed seems advisable, since in the worst case it will not have adverse effects on business productivity. In this sense, the simultaneous implementation of different types of innovation, recommended by the integrative view, seems like a wise policy.

Likewise, we have also detected that the simultaneous implementation of only two different types of innovation constitutes an unwise practice, with the exception of the joint implementation of technological innovation and marketing innovation.

These findings can provide an important guide to business decision makers and policy makers. Managers can achieve additional levels of efficiency, if they implement technological, organizational and marketing innovations jointly. Moreover, this knowledge gives policy makers an important guide for improving the design of their policies to promote innovation in the service sector, especially when the coexistence of technological, organizational and marketing innovations is more common in services than in manufacturing (Cainelli et al., 2006). In this sense, this study reveals that the design of a

policy to promote innovation that deals separately with technological and non-technological innovations does not seem appropriate (Rubalcaba et al., 2010). In the services sector, policies for public support for innovation must take into account that technological and non-technological innovations must be considered together, since a policy that is too focused on technological innovations may hinder or prevent the participation of service companies in public policies to promote innovation (Meroño-Cerdán & López-Nicolas, 2017).

We recognize that our paper is not without its limitations, some of which are opportunities for new studies. Using CIS survey data limits the variables that can be analysed. In this sense, it must be borne in mind that many questions from the CIS surveys are designed more for manufacturing companies than for services, mainly in terms of innovation inputs and outputs, barriers to innovation and measures of innovation. For example, as far as legal protection measures are concerned, the CIS does not take into account that the process of innovation in services is less formalized than in manufacturing, so in this situation the protection of intellectual property is more difficult (Asikainen, 2015). Therefore, on the basis of ad hoc surveys it would be desirable for future research to ask questions that take into account the singularities of the service sector. Likewise, it would be interesting for future research to carry out similar studies in countries with different production structures (less labour-intensive), in order to check if the productive structure of the countries influences the relationship between different types of innovation.

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