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Analyzing the complementarity of web infrastructure and eInnovation for business value generation

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Abstract

Purpose – In recent years, there has been much debate about the value generated by the firms' investments in information technology (IT). Although literature suggests that technology itself will rarely create superiority, web infrastructure can be critical for knowledge sharing and the formation of virtual teams to execute innovation processes which, in turn, may enhance e-innovation and business value. Building on these antecedents, the purpose of this paper is to explore whether and how web infrastructure and e-innovation can create business value by complementing each other.

Design/methodology/approach – Based on the resource-based view (RBV) of the firm this paper develops a conceptual model to assess the effects of web infrastructure and e-innovation on business value as well as the complementarity between these resources. To test the associated hypotheses, a regression model was estimated and tested on a large sample of Spanish firms from different industries.

Findings – The results show that web infrastructure is not positively related to business value, but on the contrary e-innovation has a positive impact on business value. However, support for complementarity between web infrastructure and e-innovation was not found.

Originality/value – The present study tests the RBV logic, arguing that not all IT resources are source of competitive advantage. In the same vein, this study shows that e-innovation, as it requires combination of IT infrastructure with other unique intangible resources, is much more difficult to imitate, leading to competitive advantages.

Keywords Information systems, Resource-based view, Technology management, Business value, E-business, E-innovation

Paper type Research paper

Introduction

Recent studies are starting to analyze the adoption and use of internet technologies within organizations and how these technologies support specific business processes and innovation (e.g. Bordonaba-Juste *et al.*, 2012; Palacios-Marqués *et al.*, 2015a, b; Soto-Acosta *et al.*, 2014). Effective adoption and use of internet technologies have become therefore a major management concern (Colomo-Palacios *et al.*, 2013; Soto-Acosta and Meroño-Cerdan, 2008; Soto-Acosta *et al.*, 2013, 2015). The literature agrees that technology itself will rarely create superiority but, at the same time, suggests that relative advantage can be created and sustained where the technology leverages some other critical resources (Gonzálvez-Gallego *et al.*, 2010; Soto-Acosta *et al.*, 2010a, b; Zhu, 2004). This complementarity of resources is a corner stone of the resource-based view (RBV) of the firm and has been offered as an explanation of how information technology (IT) has largely overcome its paradoxical nature and is contributing to business value (Bhatt and Grover, 2005; Clemons and Row, 1991).

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For that reason, the RBV has been significantly dominant in the management information systems literature for many years and remains an important element in e-business research. Very recent studies have employed this theoretical framework to analyze factors affecting internet technologies adoption and use (e.g. Perrigot and Pénard, 2013; Soto-Acosta *et al.*, 2014, 2015; Wang *et al.*, 2012). Moreover, the complementarity of resources has been found to come mostly from intangibles. For instance, Ravichandran and Lertwongsatien (2005) and Soto-Acosta *et al.* (2010b) found that intangible IT resources such as IT skills and IT training are critical determinants of how IT is deployed in the organization which, in turn, affect business value. More recently, Soto-Acosta *et al.* (2014) found that organizational and intangible IT resources strongly affect web knowledge sharing, while Arvanitis *et al.* (2013) found that firms' "soft ICT capital" is particularly important for their innovation performance.

Innovation can be defined as the search for, the discovery and development of new technologies, new products and/or services, new processes and new organizational structures (Carneiro, 2000). Many researchers (e.g. Hamel, 2002; Kleis *et al.*, 2012; Soto-Acosta *et al.*, 2014) emphasized the role of IT, and especially internet technologies, as enablers of important product and process innovations which have quite positive impacts on business performance. Thus, IT may be source of competitive advantage through innovation. As analyzed in more detail in the following section, web-based tools allow information and knowledge exchange, as well as enable new and more efficient ways of work execution by integrating information, documents and employees. Thus, for instance, intranets can be used to distribute and share individual experience and innovation throughout the organization (Bhatt *et al.*, 2005), and also with other organizations (Kleis *et al.*, 2012). In this sense, research is starting to focus on analyzing how the web is and will change innovation within and between companies (Soto-Acosta *et al.*, 2014).

In this paper, aiming to respond to these important challenges, we develop a conceptual model, grounded in the RBV, for analyzing the relationship between web infrastructure and e-innovation as sources of business value at the level of an individual firm. Then we use this model for an empirical investigation of the above question employing a large sample of companies from different industries for testing our research hypotheses. We expect that the results of this study will be useful for both researchers in the areas of ICT-based (and especially web technologies) innovation and business value, and also for practitioners, such as firms' managers interested in the effective exploitation of these technologies and the maximization of the business value generated by them.

The paper consists of six sections and is structured as follows: The next section describes the background of this study. Then, our research hypotheses are developed. Following that, the methodology used for sample selection, data collection, variables' measurement and data analysis is discussed. Then, results are presented. Finally, the paper ends with a discussion of research findings, limitations and concluding remarks.

Background

The RBV and IT

The RBV suggests that distinctive firm-specific resources for performing one or more of the firm's value-chain functions (not easily imitable by other firms) can lead to significant competitive advantages and positive financial performance differentials (above-normal rates of return – i.e. rents) (Mahoney and Pandian, 1992). The RBV generally tends to define resources broadly, and includes assets, infrastructure, skills, capabilities and so on. In this regard, the theory is based on two underlying

assertions: resource heterogeneity and resource immobility. Resources possessed by competing firms are heterogeneously distributed and may be a source of competitive advantage when they are valuable, rare, difficult to imitate and not substitutable by other resources (Barney, 1991). At the same time, resources are a source of sustained competitive advantage, that is, the resulting positive financial performance differences may be long lasting (resource immobility), if they are protected by barriers to imitation (Mahoney and Pandian, 1992) or isolating mechanisms such as time-compression diseconomies, historical uniqueness, embeddedness and causal ambiguity (Barney, 1991; Peteraf, 1993).

Technology itself will rarely create superiority, as it cannot be rare and difficult to imitate, since it is available to all competitors. However, even though competitors may copy an IT asset, relative advantage can be created and sustained where the technology leverages some other critical resources. Kettinger *et al.* (1994) draw a number of such complementary resources, such as structure, culture, that could make it difficult for competitors to copy the total effect of the technology. However, more recently, studies (e.g. Ravichandran and Lertwongsatien, 2005; Soto-Acosta *et al.*, 2010b, 2014) have found that such complementarity comes almost exclusively from intangible IT and non-IT assets.

Furthermore, the RBV provides a solid foundation within the IT context to differentiate between IT resources and IT capabilities and to study their separate influences on performance (Santhanam and Hartono, 2003). Based on this analysis, Bharadwaj (2000) suggested that if firms can combine IT-related resources in order to create unique IT capabilities, the latter can improve their performance. IS researchers have followed this consideration of unique IT capability, because competition may easily result in the duplication of investment in IT resources, and competitors can purchase the same hardware and software to remove competitive advantage (Santhanam and Hartono, 2003). In this respect, research offers a useful distinction between IT resources and IT capabilities. The former is asset based, while the latter comprises a combination of assets formed around the productive use of IT (Soto-Acosta and Meroño-Cerdan, 2008).

In general, IT resources are not difficult to imitate; physical technology is by itself typically imitable. If one firm can purchase these physical technologies and thereby implement some strategies, then other firms should also be able to purchase these technologies, and thus such tools should not be a source of competitive advantage (Barney, 1991). However, firms may obtain competitive advantages from exploiting their physical technology in a better (and/or different) way than other firms, or combining it with important non-IT resources they possess, even though competing firms do not vary in terms of the physical technology they possess. Therefore IT resources are necessary, but not a sufficient condition, for competitive advantages (Clemons and Row, 1991). IT resources rarely contribute directly to competitive advantage. Instead, they form part of a complex chain of assets than lead to superior and difficult to imitate IT-based capabilities that may lead to better performance. Thus, some researchers have described this in terms of IT capabilities, and argue that IT capabilities can create uniqueness and provide organizations a competitive advantage (Bharadwaj, 2000; Bhatt and Grover, 2005; Mata *et al.*, 1995; Santhanam and Hartono, 2003). Although there is research in e-business (e.g. Soto-Acosta and Meroño-Cerdan, 2006, 2008; Zhu and Kraemer, 2005) that have adopted the IT capabilities notion, this approach has not been extensively used and explored within the literature, and much of the existing literature still relies, to a great extent, on case studies (e.g. McLaren *et al.*, 2004) and conceptual frameworks.

E-innovation

The IT, and especially the web technologies, have a great potential to enable significant innovations in firms' business processes, products and services, leading to considerable business performance improvements. IT differ considerably in this sense from the other "traditional" types of capital that firms use, as they are "general purpose technologies" (Bresnahan and Trajtenberg, 1995), which are characterized by high levels of flexibility and adaptability, and they can be used in numerous different ways by firms and for many different purposes, enabling important innovations in their business processes, products and services. Brynjolfsson and Hitt (2000) argue that IT reduce dramatically communication and information processing costs, and for this reason they can be key enablers and facilitators of new enhanced business processes and work practices, which lead to big productivity increases, initially by reducing costs, and subsequently by enabling firms to improve important intangible aspects of existing products and services, such as convenience, timeliness, quality, etc., and also to introduce new ones. Amit and Zott (2001) developed a model of e-business value creation, which includes four basic value sources: efficiency, novelty, complementarities and customer retention; with the exception of the first, all the other three e-business value sources are associated with innovations it can enable. Zwass (2003) focuses on the web technologies and identifies some categories of innovation opportunities they provide, which are associated with marketplaces, universal supply-chain linkages, networks of relationships, external collaborations, use of forums for setting up private groups spaces and public discussion spaces, interactive media, goods and services delivery, any-time any-place connectivity, interconnection of enterprise IS with the ones of business partners, integration of previous telecommunications networks and computing utility. Wu and Hisa (2004, 2008) conclude that web technologies can facilitate and drive extensive innovations that change both products' core components and business model, which can be categorized into four groups: incremental innovations (small changes in products' core components and business model), modular innovations (considerable changes in products' core components but not in the business model), architectural innovations (considerable changes in the business model but not in products' core components) and radical innovations (considerable changes in both products' core components and business model).

Furthermore, IT can increase the productivity of firms' research and development and innovation creation processes, leading also indirectly to higher innovation performance (Thomke, 2006; Kafouros, 2006; Kleis *et al.*, 2012). In particular, IT can significantly help improving the collection, management and exchange of innovation-related knowledge, and also enable researchers distributed in different research centres of a firm to easily and rapidly share knowledge assets. Also, IT allow a better communication and exchange of knowledge among firm's employees from different functions and disciplines, and this facilitates the combination of scientific and operational knowledge from different domains, which according to the relevant literature (Nerkar and Paruchuri, 2005) is of critical importance for innovation. At the same time electronic networks can support and improve external innovation collaborations (e.g. with universities, research centres, other firms, etc.), through which a firm gains access to specialized knowledge that can be used for designing new products, services and processes.

IT business value

The research of the business value generated by IT has been a quite important issue within the area of management information systems – for reviews see Wan *et al.* (2007) and Kretschmer (2012) – investigating the impact of IT on firm performance. In this

sense, firm performance has been measured through either subjective measures (e.g. Lederer *et al.*, 2001; Zhu and Kraemer, 2005; Soto-Acosta and Meroño-Cerdan, 2008), or financial measures (e.g. Zhu and Kraemer, 2002; Meroño-Cerdan and Soto-Acosta, 2005, 2007). The former has been the dominant approach, using normally senior executives as the key informants on some subjective measures of firm performance. However, many researchers do not attempt to correlate IT investments with firm's overall financial results with, and suggest focusing instead on the performance of the actual processes that IT is supposed to enhance (Mukhopadhyay *et al.*, 1995; Subramaniam and Shaw, 2002; Ray *et al.*, 2004). The main reasons for this are: firms can have superior performance due to some IT investment in some business activities, but not in all the others, so examining the relationship between this IT investment and firm's overall performance can lead to misleading conclusions; and given the fact that IT investments may provide benefits after a certain period, but can increase operating costs in the short term, the locus of impact, that is, the supported business process performance, should be the primary level of analysis (and not overall firm performance). These arguments lead to the conclusion that it would be better to use a process approach in order to explain the generation of IT value from a resource-based perspective, and this is the approach we adopt in the present study. The present research uses the effectiveness of online procurement (or e-procurement) process in order to measure e-business value.

E-procurement, or buying online, can potentially provide significant value to firms (Frohlich and Westbrook, 2002; Panayiotou *et al.*, 2004; Garrido *et al.*, 2008; Chaffey, 2011). These come on one hand from the reduction of procurement and inventory costs, and on the other hand from the facilitation of strategic networks with suppliers that allow effective and efficient supply chain management (SCM). With regard to procurement costs, Kaplan and Sawhney indicated that buying in e-marketplaces considerably reduces transaction costs. With regard to strategic links and SCM, internet technologies can enhance SCM decision making by enabling the collection of real-time information, and then the analysis of this data in order to facilitate collaboration between trading partners in a supply chain. In this sense, Frohlich and Westbrook (2002) showed the importance of linking customers and suppliers together in tightly integrated networks; the collection of real-time information on demand is possible and, more importantly, products and services can be delivered quickly and reliably when and where they are needed.

Development of research hypotheses

This section develops research hypotheses for the present study, drawing on the existing information systems and e-business literature. Three relationships will be explored, between web infrastructure and business value, e-innovation and business value, and also the complementarity of web infrastructure and e-innovation as sources of business value.

Web infrastructure and business value

Firms obtain competitive advantages on the basis of corporate resources that are firm specific, valuable, rare, imperfectly imitable and not strategically substitutable by other resources (Barney, 1991). IT resources are easy to duplicate, and, hence, IT resources *per se* do not provide competitive advantages (Santhanam and Hartono, 2003). Although IT infrastructure is argued to be valuable, it is not a source of competitive

advantage (Bhatt and Grover, 2005). Thus, IT infrastructure will rarely lead to superior performance. Similarly, web infrastructure is not difficult to imitate; in general, internet technology is by itself imitable. If one firm can purchase certain internet technologies and thereby implement some strategies, then other firms should also be able to purchase these technologies, and thus such tools should not be a source of competitive advantage. Furthermore, as the diffusion of the internet continues, the ability of proprietary IT to be a source of competitive advantage continues to be eroded. These arguments suggest that web infrastructure may not have a significant impact on business value. Thus, the following hypothesis is proposed:

H1. There is no relationship between web infrastructure and business value.

E-innovation and business value

Investing in IT is not a sufficient condition for improving firm performance, since IT investments might be misused (Tallon *et al.*, 2000). In this sense, IT assets cannot improve organizational performance if they are not used appropriately. However, when used appropriately IT is expected to create intermediary effects, such as IT being embedded in products and services and streamlined business processes (Ravichandran and Lertwongsatien, 2005). As mentioned in the second section of this paper the IT, and especially the web technologies, being "general purpose technologies" (Bresnahan nd Trajtenberg, 1995), characterized by high levels of flexibility and adaptability, have a great potential to enable significant innovations in firms' business processes, products and services, leading to considerable business performance improvements. IT may facilitate highly beneficial product/service innovation and process innovation, which can be expected to have an influence on business value. IT may be a source of competitive advantage through innovation. These IT-based e-innovations are in general much more difficult to imitate than the mere IT infrastructure, as they require combination of IT infrastructures with some unique firm's resources, such as human and knowledge capital, cooperation networks, processes and routines, culture, etc., so they are much more likely to lead to competitive advantage (Colomo-Palacios *et al.*, 2011, 2014). Thus, since web-based tools allow highly beneficial innovation through information and knowledge exchange, as well as enabling new work practices and processes by integrating information, documents and employees (Meroño-Cerdan *et al.*, 2006, 2008), the following hypothesis is formulated:

H2. There is a positive relationship between e-innovation and business value.

The complementarity of web infrastructure and e-innovation

Although there is research that posits a direct relationship between IT and firm performance (Bharadwaj, 2000; Santhanam and Hartono 2003; Arvanitis and Loukis, 2009), others have questioned the direct-effect argument and emphasized that information technologies are more likely to affect firm performance if they are deployed to create unique complementarities with other firm resources (Clemons and Row, 1991; Powell and Dent-Micallef, 1997; Melville *et al.*, 2004). The RBV highlights the role of complementarity as a source of value creation in e-business, though it is not the only source as suggested by Amit and Zott (2001). As mentioned earlier, web infrastructure is not difficult to imitate and *per se* does not provide competitive advantages. However, having a proper web infrastructure may lead to more and highly beneficial innovations in firm's processes, products and services, leading to more business value. Also, the fact of possessing an adequate web infrastructure can be critical for efficient information and knowledge sharing, as well as for the formation of virtual teams to execute the

innovation process (Adamides and Karacapilidis, 2006; Kessler, 2003), and this can increase innovation activity and the business value of it. The following hypothesis incorporates these expectations:

H3. There is complementarity between web infrastructure and e-innovations with respect to business value generation.

Methodology

Data

Data collection was conducted in two stages: a pilot study and a questionnaire were conducted.

Five firms were randomly selected from a database to pretest the questionnaires. Based on these responses and subsequent interviews with participants in the pilot study, minor modifications were made to the questionnaire for the next phase of data collection. Responses from these five pilot-study firms were not included in the final sample. The field work of the survey was conducted by Ipsos Eco Consulting and was carried out using computer-aided telephone interview (CATI) technology. Telephone interviews were conducted with decision makers of European enterprises. The decision maker targeted by the survey was normally the person responsible for IT within the company, typically the IT manager. Alternatively, particularly in small enterprises without a separate IT unit, the managing director or owner was interviewed.

The population considered in this study was the set of all enterprises which are active at the national territory of Spain, and have their primary business activity in one of ten sectors considered in the above survey (textiles and leather manufacturing, chemicals, electronic machinery, transport equipment, crafts and trade, retail, tourism, business services, telecommunications and computer services, health and social services). The sample drawn was a random sample of companies from the respective sector population with the objective of fulfilling strata with respect to business size. A share of 10 per cent of large companies (250+ employees), 30 per cent of medium-sized enterprises (50-249 employees) and 25 per cent of small enterprises (10-49 employees) was intended. The number of firms totalled 1,010. In total, 91.1 per cent of firms were small- and medium-sized enterprises (less than 250 employees) and each sector considered had finally a share of around 10 per cent of the total sample. With regard to respondents' titles, 54.4 per cent were IS managers, nearly 20 per cent were managing directors and 12.1 per cent were owners.

The data set was examined for potential bias in terms of the respondents' titles. Since respondents included both IT managers and non-IT managers, one could argue that IT managers may overestimate e-business value. To test this possible bias, the sample was divided into two groups, one corresponding to IT managers (respondent was head of IT/DP or other IT senior manager) and a second one non-IT managers (respondent was owner, managing director, strategy development and others). One-way ANOVA was used to compare the means of factor scores between the two groups. No significant differences were found, suggesting that the role of the respondents did not cause any significant bias.

Measurement of variables

Each of our main variables (web infrastructure, e-innovation, business value) was measured as a multi-item construct. Measurement items of these constructs were introduced on the basis of a careful literature review. Confirmatory factor analysis

(CFA) was used to test the constructs. Based on the CFA assessment, the constructs were further refined and then fitted again. Constructs and associated items/indicators, as well as prior research support of them, are listed in the Appendix and discussed below.

Web infrastructure construct. This construct represents the adoption of physical internet technologies. In this sense, respondents were required to assess the presence of four internet tools: website, intranet, extranet and local area network.

E-innovation construct. This construct represents the introduction of product/service and process innovations directly related to or enabled by internet-based technology.

Business value construct. As discussed earlier, the present research uses the effectiveness of e-procurement for measuring business value. That is, business value is assessed through the business impact of purchasing online on procurement costs, relations to suppliers and costs of logistics and inventory.

Since reliable and valid measurement of variables is important, tests of reliability and validity for the three constructs were performed. In order to obtain evidence of construct validity, convergent validity and discriminant validity are assessed according to relevant statistical literature (Straub, 1989; Straub *et al.*, 2004). For the first one, the item-to-total correlation was examined, and compared to its lower limit level of 0.4 proposed by the above statistical literature. The discriminant validity was checked through factor analysis; according to the above statistical literature each item must have a loading in a single factor exceeding 0.5. The results are shown in Table I. They confirm that each construct is unidimensional (convergent validity) and also factorially different with all items employed for operationalizing a particular construct loading on a single factor (discriminant validity). Next we tested the reliability of our constructs, defined as the accuracy or precision of them as measuring instruments. The reliability of each construct was assessed by calculating its Cronbach's α value, and comparing it to the minimum acceptable value of 0.70 proposed by the relevant statistical literature (Straub, 1989; Straub *et al.*, 2004). As we can see in Table I acceptable values were obtained for all constructs. Relatively high values of reliability and validity imply that the instruments used in this study are adequate.

Data analysis

In order to test our research hypotheses we estimated the following regression model:

$$\mathrm{DV} = f(\mathrm{WI},\ \mathrm{EI},\ \mathrm{WI} \times \mathrm{EI},\ \varepsilon) \tag{1}$$

where WI denotes web infrastructure; EI stands for e-innovation; and WI × EI represents the interaction effect between web infrastructure and e-innovation. DV denotes the dependent variable (e-business value). Also, business industry and business size were introduced as control variables in order to capture industrial

Measures	Items	Reliability (Cronbach α)	Convergent validity (correlation of item with total store-item)	Discriminant validity (factor loading on single factors)
Business value	3	0.767	0.841; 0.828; 0.811	0.673; 0.719; 0.521
Web infrastructure	4	0.724	0.669; 0.749; 0.676; 0.707	0.625; 0.747; 0.718; 0.685
E-innovation	2	0.862	0.929; 0.929	0.862; 0.862

Table I. Statistics for reliability and validity tests

and size effects on e-business value. The former identified whether the business was operating at the manufacturing, services or commercial sector and was coded as a dummy variable. The latter was measured as the total number of employees and was coded as a continuous variable.

So finally the regression equation we estimated is:

$$DV = \alpha + \beta_1 WI + \beta_2 EI + \beta_3 WI \times EI + \beta_4 FirmSize + \beta_5 IndustryDummies + \varepsilon \quad (2)$$

where α is the intercept; the βi's are coefficients of the independent variables; and ε is the residual term that captures the net effect of all unspecified factors. We can see that the model includes both main and the interaction effect between web infrastructure and e-innovation. Mathematically, the interaction effect can be expressed by taking the first derivative of Equation (2):

$$\frac{\partial DV}{\partial WI} = \beta_1 + \beta_5 EI \quad (3)$$

The analysis was performed in three steps. In the first step the dependent variable was initially regressed on the control variables (model 1). Then, in the second step web infrastructure and e-innovation were added (model 2). Finally, in the third step the interaction effect was included (model 3). In order to examine the adequacy of using regression analysis, tests were conducted to assess the normality of residuals and the homogeneity of variance of residuals (Hair *et al.*, 1998). No significant violations of these assumptions were observed.

Empirical results

The three estimated models are shown below in Table II. Results in model 1 confirm that the one of the control variables employed (business industry) affects the dependent variable. Model 2 shows that the direct effect of web infrastructure and e-innovation upon business value was significant, as the increment in the squared multiple correlation coefficient (R^2) caused by the inclusion of these two independent variables was statistically significant. We also remark that the effect for e-innovation upon e-business value was positive and statistically significant, while the effect of the web infrastructure was not statistically significant. Finally, model 3 showed no significant interaction between Web infrastructure and e-innovation, while the increment in R^2 was not statistically significant. Thus, support for hypotheses *H1* and *H2* is provided, whereas *H3* is rejected.

	Model 1	Model 2	Model 3
Manufacturing industry	−0.148**	−0.100**	−0.094**
Commercial industry	0.016	0.059	0.064
Number of employees	0.115	0.077	0.075
Web infrastructure (WI)		0.104	0.177
Internet-based innovation (IBI)		0.302**	0.372**
Interaction (WI × IBI)			−0.218
F-value	2.363	4.119**	3.500**
Adjusted R^2	0.019	0.068	0.091
Δ in R^2		0.057**	0.002

Notes: Significance levels: *$0.01 < p \leq 0.05$; **$p \leq 0.01$

Table II.
Web infrastructure, internet-based innovation and business value models

Discussion

This paper developed a conceptual model, grounded in the RBV of firm, which analyzes the complementarity of web infrastructure and e-innovation as sources of business value at the level of an individual firm. Moreover, it is intended to offer results on the business value of the significant investments firms make in internet/www technologies, which are more widely applicable than existing case studies of internet leaders or IT industry companies. In this sense, this study attempts to offer an explanation to why there are cases where firms engage in e-business without deriving any benefits.

The results showed that web infrastructure is not positively related to business value. This finding indicates that, since competitors may easily duplicate investments in IT resources by purchasing the same hardware and software, IT resources *per se* do not provide better performance. This can be explained through the RBV, because IT is not considered a resource that is difficult to imitate; IT is by itself typically imitable. This result supports the findings of previous research (e.g. Bhatt and Grover, 2005) that did not find evidence of a positive link between IT assets and firm performance. Similarly, Powell and Dent-Micallef (1997) showed that IT by itself cannot be a source of competitive advantage. Thus, our results confirm that internet technology by itself will rarely create business value.

Furthermore, results demonstrate that there is a positive relationship between e-innovation and business value. This indicates that exploiting the great potential of the web technologies, outlined in the second section of this paper, to enable significant innovations in firms' business processes, products and services, can lead to the generation of business value. The e-innovation, as it requires combination of IT infrastructure with other unique intangible firm's resources (e.g. human and knowledge capital, cooperation networks, processes and routines, culture, etc.), is much more difficult to imitate than the mere IT infrastructure (Hernández-López *et al.*, 2010), so it can lead to competitive advantages. This finding supports existing empirical research (Bharadwaj, 2000; Santhanam and Hartono, 2003), which found that firms create competitive advantages through intermediary effects, such as IT being embedded in products and services and streamlined business processes, which in turn affect higher levels of firm performance. However, it is worth mention that this paper assesses IT business value from the company's effectiveness on a single electronic process: e-procurement. This is in line with existing investigations which measure IT business value from the company's effectiveness on different e-business processes: e-sales (Soto-Acosta and Meroño-Cerdan, 2009) or e-procurement (Soto-Acosta and Meroño-Cerdan, 2008). However, recent research (e.g. Gonzálvez-Gallego *et al.*, 2015) calls for research using more comprehensive measures of IT business value at the company and the supply chain levels. Thus, in future research, for instance, IT business value could be evaluated through the impact of IT on: the efficiency of internal business processes; the quality of customer service and/or the quality of the relationship between a firm and their customers; and/or the quality of products and services provided by suppliers and/or the quality of the relationship between the firm and their suppliers and other business partners.

Finally, the empirical results did not offer support for the complementarity between web infrastructure and e-innovation. The RBV highlights the role of complementarities between resources as a source of business value. Researchers such as Steinfield *et al.* (1999) suggest that business value can come from synergies between online and offline presence; in this sense, using case studies, they showed the lack of exploitation of these synergies in SMEs. However, this study shows that

the complementarity argument of the RBV as a source of business value is not found for web infrastructure and e-innovation. Therefore, it can be concluded that having a more complete web infrastructure is not critical for achieving higher business value e-innovation.

Conclusions, limitations and future research

In recent years, there has been much debate about the value generated by the big investments firms make in IT, and especially in internet/WWW technologies. Thus, today IS researchers face pressure to answer the question of whether and how these investments create value. This study contributes in this direction, by developing a conceptual model, grounded in the RBV of the firm, and then using it to analyze the relationship between web infrastructure and e-innovation as source of business value at the level of individual firm. The analysis employed a large sample of companies from different industries for testing our research hypotheses.

This research makes the following contributions:

(1) it tests the RBV logic, arguing that not all IT resources are source of competitive advantage;

(2) it demonstrates that web infrastructure is not positively associated with e-business value, while on the contrary e-innovation is positively related to e-business value; and

(3) also it shows that the interaction effect of web infrastructure and e-innovation on e-business value is not significant.

The present study provides important implications for managers. It shows that mere investment in physical internet technology (internet/WWW resources) will rarely create business value by itself, and it is necessary to combine it with other resources, such as existing processes and routines, human and knowledge capital, cooperation networks, culture, etc. Firms' management should be aware that while purchasing the required hardware, software and networking equipment does not present particular difficulties, it is much more difficult to develop the required human resources and knowledge capital, and also the required culture, for the creative exploitation of them, in order to design and implement beneficial e-innovations in firm's processes, products and services, generating through them significant business value. This explains why there are cases where firms make important investments in web technologies without deriving the expected benefits from them.

While this study presents some interesting findings, it has some obvious limitations which can be addressed in future research. First, the sample used was from Spain. It may be possible that the findings could be extrapolated to other countries, since economic and technological development in Spain is similar to other OECD Member countries. However, in future research, a sampling frame that combines firms from different countries could be used in order to provide a more international perspective on the subject. Second, the e-business value measures are subjective in the sense that they were based on Likert-scale responses provided by managers. Thus, it could also be interesting to include objective performance data for measuring e-business value. Third, the key informant method was used for data collection. This method, while having its advantages, also suffers from the limitation that the data reflects the opinions of one person. Future studies could consider research designs that allow data collection from multiple respondents within an organization.

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Further reading

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(The Appendix follows overleaf.)

Appendix

Constructs and indicators	Description	Literature support
Web infrastructure		
WI1	Does your company have a website? (Y/N)	Soto-Acosta and Meroño-Cerdan (2008), Zhu *et al.* (2003), Zhu and Kraemer (2005)
WI2	Does your company use an intranet? (Y/N)	Kowtha and Choon (2001), Soto-Acosta and Meroño-Cerdan (2008), Zhu *et al.* (2003), Zhu and Kraemer (2005)
WI3	Does your company use an extranet? (Y/N)	Kowtha and Choon (2001), Soto-Acosta and Meroño-Cerdan (2008), Zhu *et al.* (2003), Zhu and Kraemer (2005)
WI4	Does your company use a LAN? (Y/N)	Soto-Acosta and Meroño-Cerdan (2008), Zhu and Kraemer (2005)
E-Innovation		
EI1	Have any of your product or service innovations over the past 12 months been directly related to or enabled by internet-based technology? (Y/N)	Adamides and Karacapilidis (2006), Hamel (2002), Kessler (2003)
EI2	Have any of your company process innovations over the past 12 months been directly related to or enabled by internet-based technology? (Y/N)	Adamides and Karacapilidis (2006), Hamel (2002), Kessler (2003)
Business value: e-procurement effectiveness		
IP1	What effect has online procurement on the procurement costs? (1-5)	Soto-Acosta and Meroño-Cerdan (2008), Wu *et al.* (2003), Zhu *et al.* (2003), Zhu and Kraemer (2005)
IP2	What effect has online procurement on your relations to suppliers? (1-5)	Tallon *et al.* (2000), Soto-Acosta and Meroño-Cerdan (2008), Teo and Pian (2003), Wu *et al.* (2003), Zhu *et al.* (2003), Zhu and Kraemer (2005)
IP3	What effect has online procurement on the costs of logistics and inventory? (1-5)	Soto-Acosta and Meroño-Cerdan (2008), Wu *et al.* (2003), Zhu and Kraemer (2005)

Notes: Y/N = dummy dichotomous variable; 1-5 = five-point Likert-type scale

Table AI.
Variables measures

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