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Determinants of information technology competitive value. Evidence from a western European industry

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Abstract

Information technology (IT) management is currently one of the most exciting issues in business administration. Business managers and researchers have made a big effort trying to find the reasons that explain the relationship between IT and organizational structure, evolution, or performance. This study focuses on the relationship between IT implementation and competitive advantage, analyzing the circumstances under which IT influences the competitive advantage of pharmaceutical distribution companies in Spain. The results show that intangible factors of an internal nature explain the effect of the technology, but also there are other factors relating to the organization and to the specific business environment that strongly affect the competitive impact of IT.

Keywords: Information technology (IT); Competitive advantage; Productivity paradox; Pharmaceutical distribution; Resources; Capabilities; Competitive rivalry

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1. Introduction

From the beginning of the computing era (Kaufman, 1966) various studies have been made that predicted several positive effects ensuing from the implementation of information technology (IT) (Cash & Konsynski, 1986; McFarlan, 1984; McLean & Soden, 1977; Parsons, 1983; Porter & Millar, 1985). From the strategic point of view IT could affect each one of the competitive strategies of Porter (1980), whether it be cost leadership, differentiation or specialization in a market niche, or efficiency in the activities involved in the value chain (Rayport & Sviokla, 1995). During the 1980s and 1990s, many cases have been published, as well as articles in the professional press, which predicted a net increase in business results of companies that invested more in IT (Buday, 1986).

However, the problem of the conversion of IT into lasting competitive advantage is a long way from being resolved (Byrd & Turner, 2001, p. 41). During the little more than 10 years of this research line (Amit & Zott, 2001; Bharadwaj, 2000; Brynjolfsson, Hitt, & Yang, 2002; Powell & Dent-Micallef, 1997; Solow, 1987), contradictory results have been found (C. S. Lee, 2001; Lichtenberg, 1995). These range from the pessimistic early positions (Solow, 1987; Strassmann, 1990) to other more optimistic positions in recent times (Brynjolfsson & Hitt, 1996; Brynjolfsson et al., 2002; Hitt & Brynjolfsson, 1996). Skeptical positions have generally focused on the so-called productivity paradox (Brynjolfsson, 1993), which describes the phenomenon seen in the 1970s and 1980s whereby those companies that invested more in IT suffered a relative setback in the work factor productivity indexes.

According to the most recent findings, a large part of the positive effect of IT on business results seems to reside in the fact that the technology encouraged organizational changes (Orlikowski & Iacono, 2000), such as restructuring into interdisciplinary workgroups, an increase in decision-making autonomy, and a support for worker training (Brynjolfsson & Hitt, 2000). Additionally, some human and management factors have been identified, which provide a complementary effect alongside the technology (Bharadwaj, 2000; Powell & Dent-Micallef, 1997). This perception is in accordance with the so-called strategic necessity hypothesis (Clemons & Kimbrough, 1986; Clemons & Row, 1991, 1992), by which IT is a necessary but not sufficient factor in improving competitive position.

Nevertheless the relation between IT and competitive advantage continues to be intensely argued over (McCune, 1998; Strassmann, 1998, 1999). A large number of earlier studies were based on the evolution of the stock market results of companies that used IT heavily, so that they could have been affected by market fluctuations. These companies saw a strong increase in their worth in the previous decade (P. M. Lee, 2001, p. 795), but suffered a sudden and sharp change of tendency at the end of it.

From the methodological perspective there are additionally other controversial aspects. Firstly, in those studies we have analyzed, the authors have generally focused on the economic data of large companies appearing in the stock market—public corporations—using aggregated economic data, which may underestimate those aspects that affect the IT-business results binomial, which can only be discovered by focusing on the organization using direct sources of information (C. S. Lee, 2001).

Secondly, the mechanisms by which a greater investment in IT influences the competitive position of organizations have not been well defined, nor what role other factors might play, whether internal or industrial, for example, the characteristics of the technology that is implemented (Andersen & Segars, 2001, p. 87) or the effect that variables from the specific business environment might play, such as the intensity of competitive rivalry (Ramaswamy, 2001).

Thirdly, the literature has traditionally used measures of business results based on secondary sources—profitability, productivity, and market value—which ignore some dimensions of competitive position, such as the perception of the organization that the client has or variations in market share. Fourthly, we still need to extend the investigations to different economic environments and organization types from those characterized by U.S. firms (Powell & Dent-Micallef, 1997, p. 397). Lastly, it is necessary to test the validity of the various existing approaches in business administration that might explain the relationship between technology and competitive position in companies (Bharadwaj, 2000).

2. Background and hypothesis

Various theoretical approaches in the field of business administration have tried to explain the link among IT, value creation, and obtaining and maintaining competitive advantage. Among these we might mention industrial organization (Porter, 1980), the transaction cost economics (Williamson, 1975), the resource-based view (RBV) of the firm (Wernerfelt, 1984) and the interorganizational networks approach (Freeman, 1979).

According to the industrial organization, IT affects the products and services offered in the marketplace, the structure of the industry, competitive forces and production economies (Parsons, 1983), improving the efficiency of the activities of the value chain (Porter & Millar, 1985). From the strategic perspective, IT may promote advantages in cost leadership, differentiation, or focusing (Cash & Konsynski, 1986).

According to work on the transaction cost economics, IT could reduce the cost of coordination between activities and the risks inherent to the transaction (Clemons & Row, 1991), enabling in this way the creation of value for the client (Bakos, 1991), which constitutes a base from which to improve the competitive position of the company (Dyer, 1997). However, the transaction cost economics only looks at those transactions that take place between hierarchies and the market (Amit & Zott, 2001, p. 499), ignoring other relationships, such as those that appear in networks formed by various organizations. The interorganizational networks approach (Freeman, 1979) itself tries to study this question by identifying the formulas by which the network can create advantages for participants, advantages in terms of speed of access to information, markets, and technology. In this way, economies of scale or scope can be generated that benefit the organizations that form the network (Gulati, Nohria, & Zaheer, 2000).

The RBV (Barney, 1991, 1995; Penrose, 1959; Peteraf, 1993; Wernerfelt, 1984) has suggested new ideas helping to explain, at least partially, the function of IT as a strategic tool in the company. Regarding this approach, business elements susceptible of becoming strategic resources, such as IT, might be valuable (Barney, 1995, 1996; Prahalad & Hamel, 1990), rare (Grant, 1996), and difficult to imitate or to substitute for (Wilcox-King & Zeithaml, 2001; Dierickx & Cool, 1989). Barney (1996) added a fourth condition that consists in the element being complementary to other elements or resources of the organization. This results in complementary or synergy effects that would explain improvements in competitive position that are more than proportionate when the resources operate jointly, compared to when they operate separately.

Applying the assumptions made by RBV, IT, considered in isolation, may constitute a value-generating resource (Byrd & Turner, 2001); in its most advanced form it may be rare, but it can hardly be called difficult to imitate (Barney, 1996; Kettinger, Grover, Guha, & Segars, 1994). Moreover, due to the rapid distribution of technological innovations nowadays (Freeman & Soete, 1996), IT would be closer to the concept of commodity than to the notion of differentiating element. Nevertheless, when IT acts in conjunction with other human or management elements it can generate a positive synergy effect that rival organizations find much more difficult to imitate or substitute for (Keen, 1993).

However, what are the factors that produce a positive combinatorial effect alongside information technology? Various authors have tried to answer this question: Neo (1988) identified 10 such factors, among which are the existence of fluid communication between management and technical staff, harmony between a firm's strategic planning and IT, and previous experience in technological development. Kettinger et al. (1994) identified as key elements the upper management's commitment to IT implementation and the existence of a strong learning effect related to technological development.

Mata, Fuerst, and Barney (1995) pointed out the ability of executives to conceive, develop, and exploit applications based on IT. Ross, Beath, and Goodhue (1996) stressed three areas that promoted technological efficacy: the first related to the human dimension, the second with the design of the technological platform, and the third with the relations between the organization's management and technical teams. Powell and Dent-Micallef (1997) put forward as key elements the absence of conflict, organizational flexibility, a fluid internal communication, and certain management techniques. In a similar vein, although using a different methodology, is the work of Brynjolfsson et al. (2002).

In short, it is possible to divide resources complementary to IT into two large groups (Powell & Dent-Micallef, 1997). In one group would be those elements related to the human factor inside the organization. Among these are the existence of an open and receptive climate in the organization, the fluidity of communication between management and technical staff, and the leadership among upper management of the implementation of new technologies. In the second group would be those resources related to the techniques of business administration, such as the use of interdepartmental workgroups, a dedication to training in the new technologies, as well as the joint planning of business and technology.

Additionally, and with reference to the work of Ross et al. (1996), we have noted a third component related to the way the technology is organized inside the company. This body of resources is related to the existence of an unmistakable design of the technological infrastructure, which allows the distribution of information between the different departments and functional areas, and to the existence of standard procedures for the manipulation and management of data (Davenport, 1999).

Based on the theories exposed above, we propose to test several hypotheses that relate to each one of the objectives of this study. Firstly, we aim to determine the real effect of IT on the competitive position of companies. According to the hypothesis of strategic necessity (Clemons & Kimbrough, 1986; Clemons & Row, 1991), the productivity paradox (Solow, 1987), and the RBV (Powell & Dent-Micallef, 1997), having technological tools is not sufficient on its own to gain and maintain competitive advantage, a claim that is contained in the following hypothesis:

Hypothesis H1: The level of implementation of IT, considered separately, is not associated with the presence of sustainable advantages that influence the competitive position achieved by an organization.

Observing a company in terms of its resources, intangible human and management elements complementary to IT could comply with the conditions of inimitability and being scarcely obtainable by rival firms (Barney, 1986; Prahalad & Bettis, 1986). There are many precedents related to RBV that link the existence of certain intangibles with an improvement in competitive position (Godfrey & Hill, 1995; Hall, 1993) and company performance (Hitt, Bierman, Shimizu, & Kochhar, 2001). Among them are some cultural or anthropological components, such as the organizational climate (Hansen & Wernerfelt, 1989), employees being culturally heterogeneous (Richard, 2000), the professional specialization of staff (Henderson & Cockburn, 1994), or the existence of staff that combine technical with management ability (Brush & Artz, 1999).

Additionally, several management practices with a positive effect on a company's competitive position have been found. As an example, we might mention the commitment of management to their employees (Lee & Miller, 1999), the encouragement of company knowledge (Decarolis & Leeds, 1999; Miller & Shamsie, 1996), management coordination (Majumdar, 1998), a commitment to the environment (Russo & Fouts, 1997), organizational training (Mahoney, 1995), or the strategic orientation towards R&D (Yeoh & Roth, 1999). Taking into account these factors, we will attempt to prove with the following hypothesis if the human, management and technology adaptation resources mentioned above, considered separately, have a positive effect on the competitive position of organizations.

Hypothesis H2: Human, management, and technology adaptation resources complementary to IT, considered separately, are associated with the existence of sustainable advantages that influence the competitive position achieved by organizations.

Thirdly, following the work that has dealt with the effect of the function of IT in the organization (Bharadwaj, 2000; Brynjolfsson et al., 2002; Powell & Dent-Micallef, 1997), the combined influence of elements complementary to IT, of human and management factors, alongside the implementation of IT, does lead to an improvement in competitive position. As the following hypothesis claims:

Hypothesis H3: Human, management, and technology adaptation resources, in combination with IT, are associated with the presence of sustainable advantages that influence the competitive position achieved by organizations.

According to earlier suppositions, the differences between the competitive positions of companies and the effect of IT on results may therefore result from the existence of differences in the internal availability of resources, whether technological, human, or management, and from the complementarities between these factors. However, some authors have suggested different structural or industrial factors that may affect competitive position and that need to be studied (Hansen & Wernerfelt, 1989). Once their effects on competitive position measures have been controlled, differences between organizations can be put down to variations in intangible internal resources and capabilities (Powell, 1996; Rouse & Daellenbach, 1999). The hypothesis follows:

Hypothesis H4: There are certain factors apart from the internal existence of strategic resources and IT that are associated with the presence of sustainable advantages and that influence the competitive position achieved by organizations.

3. Industrial framework and variables

We have chosen to study the industry comprising pharmaceutical distribution companies. The reasons for our choice lie in the advanced state of technological development in these types of organizations, in which it is possible to identify a large number of computing, robotic, and telecommunications technologies. This sector was additionally one of the pioneers in introducing computing into companies, computerizing and roboticizing their internal processes for the first time at the beginning of the 1970s (Malo, 1994, p. 83). Furthermore, although IT is an important support tool in this industry, it does not comprise the fundamental business of the company, such as would be the case in the electronics or telecommunications sectors, so that we can eliminate the interactive effects on the technologies studied that other technologies, processes, and products might have (Powell & Dent-Micallef, 1997, p. 384).

The pharmaceutical distribution sector in Spain consists of 77 organizations (Martínez, 1996, p. 129) that, in 1998, had a combined turnover of more than 6000 million ($5700 million) (Farmaindustria, 1999, p. 61). The principal function of these organizations consists of the management of the complex flows of information that is needed for the acquisition, classification, storage, and distribution of more than 20,000 references of highly specialized products.

The geographical area under study comprises 10 provinces in the south and center of Spain (the Andalusia region, plus Murcia and Ciudad Real). Sixteen companies in the sector are active in this area, among which, in 2000, are four of the five largest companies in the country (Fomento de la Producción, 2000). These companies served a population of 8,834,000 inhabitants, which represents 22% of the total Spanish population. The final consumption of pharmaceutical products in this region in 1998 added up to 1384 million ($1315 million)—a sum that represents 22.4% of the total national consumption, according to the Spanish Ministry of Health. No important differences have been found in the characteristics of the sector in Spain and in the geographical area under study: average size, proportion of companies that are cooperative firms, number of inhabitants per warehouse, and applicable legal framework (Martínez, 1996).

The size of the population—16 companies—added to the fact of not incurring sample errors, guarantees that studies involving intangible elements related to human behavior can be fulfilled. As Rouse and Daellenbach (1999, p. 489) state, studies of competitive advantage using the RBV require a new approach. In this case, the use of large-sample, cross-sectional analyses is unlikely to be able to disentangle the variety of effects associated with time, industry, environment, strategy, and the resource capability of interest. We have tried to take into account this new approach by choosing an industry in which we could implement an in-depth and multisource research methodology, avoiding, at the same time, the statistical errors emerging when a sample (and not the whole population) is being analyzed. As a result, we were not able to extend the research to the whole country, although finally the geographical area comprises a wide region whose size is similar to that of other studies carried out using comparable methodology (e.g., Wilcox-King & Zeithaml, 2001).

We shall use, additionally, primary and secondary sources of information to measure the variables that make up the empirical schema. The varied nature of the factors involved in the study—competitive advantage, intangible resources, technological resources, industrial and structural factors—forces us to look at different sources. We shall first analyze those factors that influence the competitive position of companies.

3.1. Competitive position variables

According to the framework that treats a company based on its resources, the competitive position that each organization achieves is equated with its economic performance. In this way, there is a competitive advantage when a company generates better economic results over a sustained period (Mehra, 1996; Miller & Shamsie, 1996; Sharma & Vredenburg, 1998). The formula measuring the economic results in organizational analysis in general and following the RBV in particular (Carpenter, Sanders and Gregersen, 2001; Lee & Miller, 1999) has traditionally consisted of economic profitability indexes. However, we believe that indexes based on profitability lose a large part of their efficacy in our study, due principally to the important role that cooperativization has acquired in this industry. Cooperative firms control more than 70% of the market in the Spanish pharmaceutical distribution industry. Organizations with this form of legal status tend to engage in anticipated distribution of profits such that measures based on profitability can be distorted (García-Gutiérrez Fernández, 1994).

After analyzing the literature (Majumdar, 1998; Miller & Shamsie, 1996), we propose a mixed system for measuring the competitive position, incorporating data from primary sources (based on client perception) as well as secondary (based on market share variation). The competitive position index will be determined by adding the mean interannual variation of market share over the period 1994–1998 and a subjective index formed from client perceptions of service excellence. Using both indexes together allows us to get a more complete view of the nature of competitive advantage, avoiding at the same time the inconsistencies that arise when each index is used alone. In this way, we are taking into account the principle of triangulation in the collection of information (Denzin, 1978; Jick, 1979).

The mean interannual variation of market share has been obtained from the business information directory Fomento de la Producción (2000), as well as from other sectorial databases (Infotel, 2000). The global sales of pharmaceutical products in the various Spanish regions come from the Databank of the General Subdirectorate for Health Care and Pharmaceutical Provision of the Spanish Ministry of Health.

The opinions that clients gave on the quality of service were obtained by sending a questionnaire to 1060 pharmaceutical clients. In the questionnaire, the client was asked to evaluate each distribution company on a scale of 1 to 10, according to the quality of global service. At the same time, we gathered additional information about which factors companies excelled in. Considering the relevance of the territorial distribution of the companies, we used a survey design according to probabilistic sampling, stratified in function of geographical location, with a nonproportional affixation, and implemented by sending by post, combined with personally administered questionnaires by an interviewer. The fieldwork was carried out in June, July, and September, 2000. We received 623 valid evaluations from a total of 231 clients, which represent a proportion of response of 21.86%. This figure is comparable to those obtained by previous studies in the field of business analysis. Hall (1992) obtained a figure of 8.22% in a mailing to 847 executives. Powell (1992) achieved an index of 21%, whereas Powell and Dent-Micallef (1997), Gómez-Mejía (1992), and Zahra and Covin (1993) achieved higher figures (26%, 28%, and 28%, respectively). In the field of IT, Martins and Kambil (1999) achieved a response of 24% for their study.

3.2. Human and managerial variables

The internal intangible variables require a more complex operationalization, in the sense that they can only be identified and measured via studies that are centered on the organization as the immediate element of analysis (Rouse & Daellenbach, 1999). Therefore, and after contacting a manager in each company by telephone, we elaborated an information-gathering procedure using interviews in the head offices of the companies that, in 1999, were active in pharmaceutical distribution in the 10 provinces under analysis. Interviewees from the companies were from three levels: top managers, IT managers, and employees in operations. After analyzing the literature and the preliminary study in which managers from three companies participated, we designed a different questionnaire for each level with a maximum of 45 items with 5-point Likert-type scales and semantic differential scales. The technology managers and operations employees answered 33 and 10 questions, respectively. In the questionnaire, some of the questions had the aim of identifying the level at which intangible resources complementary to technology would appear, as well as the intensity at which each company used IT. The questionnaire initially consisted of open question interviews designed to be an introduction for the subsequent phase and to obtain qualitative information.

Information was gathered from December 1999 to October 2000, with a total of 36 interviews in the 16 organizations of the population; the interviewees comprised 16 upper management, 14 IT managers, and 6 operations personnel. We remained in each organization during at least one workday. The average response from the three groups at each question gave us an evaluation of the resources that each company possessed. Measures were taken to avoid systematic error and error unrelated to the sample, and we eliminated sampling error by addressing the whole population. Specifically, two tools of fundamental control have been introduced: (1) using several informers in each company, which has already been mentioned and (2) using reliability and validity measuring instruments with which the different questions measure the concepts being analyzed.

As a measure of internal reliability (Sekaran, 2000), we calculated the average level of correlation between the responses of the same question by different interviewees, obtaining a finding of .36. Furthermore, the standard deviation between the responses of upper managers and the other two levels was $\pm$.62 points. These results are lower than those of studies using similar methodology; for example, Powell and Dent-Micallef (1997, p. 389) and Lee and Miller (1999, p. 585) gained average correlations of .54 and .61. However, we consider the relation to be acceptable, considering that the above figures correspond to very large analysis populations whose extreme elements tend to be softened. We then proceeded to calculate the alpha indexes (Cronbach, 1951) to analyze the integrity of the multidimensional scales we used in the questionnaire. Although this index has no minimum, some authors suggest .35 as the limit for ensuring an acceptable coherence for each dimension (Powell & Dent-Micallef, 1997; Van de Ven and Ferry, 1979). In other cases, the figure .70 is mentioned (Hair, Anderson, Tatham, & Black, 1999). In our study, we obtained an average value of .80, whereby expectations regarding the reliability of the scales were amply fulfilled. We have also undertaken some tests of predictive validity and of content, reflected in the high levels of negative correlation between opposite variables, such as those that link organizational conflict with internal communication ($r = -.73$), confidence ($r = -.66$), and cognitive capabilities of technical personnel ($r = -.54$). We have additionally tried to ensure content validity in the scales by reviewing the relevant literature beforehand.

As a whole, and based on the theoretical review described earlier, we have analyzed 18 intangible resources with a positive complementary effect alongside IT (see Appendix A). With the intention of synthesizing the combined effect that human, management, and technological adaptation intangibles may have on the competitive position of the company, we have brought the different intangibles together into three final variables. Thus, the human factor complementary to IT value was obtained by calculating the arithmetic mean of the following values: (1) open and frank internal communication, (2) organizational consensus, (3) cognitive and creative capacity of the technical personnel, and (4) level of acceptance of change on behalf of the members of the organization. The value of the management factor complementary to IT was obtained by calculating the arithmetic mean of the following values: (1) use of interdepartmental teams in the resolution of key problems, (2) organizational flexibility and low level of bureaucratization, and (3) managerial support for the implementation and development of new technologies. Thirdly, the value of the technological adaptation factor was calculated from the mean of the variables that measure IT performance in each organization regarding to rivals (see Appendix A).

3.3. Technological variables

We have identified a total of 17 computing, robotic, and telecommunications tools (Madnick, 1991) that are used in the pharmaceutical distribution sector. The presence of these types of technology was evaluated by including the items with Likert-type scales 0 to 5 in the questionnaire given to members of the organizations forming part of the study, during the interview described earlier. In this case, the value 0 indicated that the organization was not interested in the implementation of the technology, whereas 1 meant that the organization was interested in developing it, but had not yet begun to do so. The average statistics describing the population are shown in Table 1.

To facilitate the next analysis, we have built two indexes summarizing the level of IT in an organization. The first, which we will call General Technological Index, refers to the global level of technology use of the company, and consists of the average value of the 17 technological items. The second indicator, the Specific Technological Index, is more selective, in the sense that it only includes the most advanced technologies, and therefore the least widespread. These technologies are (1) systems of internal communication or endogenous networks, (2) robotic and warehouse-management technologies, and (3) Internet/Intranet technologies.

Table 1
Information technology in pharmaceutical distribution industry. Level of use

Technology	Mean implementation level (S.D.)[a]
1. One-way communications via modem between the pharmacies and the information systems of the firm	4.68 (0.57)
2. Two-way communications via modem between the pharmacies and the information systems of the firm	4.22 (1.26)
3. Electronic transactions with buying centers via EDI	2.81 (1.74)
4. Electronic transactions with buying centers via the Internet	1.56 (1.71)
5. Electronic transactions with pharmaceutical suppliers via EDI	2.20 (1.66)
6. Electronic transactions with pharmaceutical suppliers via the Internet	1.50 (1.37)
7. Local network that interconnects the computers and the buildings of the firm	4.51 (.75)
8. Use of e-mail and file transfer	3.65 (1.65)
9. Bar code systems for classifying the items at the supply plant	3.05 (1.75)
10. Weight-control systems for rejecting incorrect consignments	.83 (1.35)
11. Robotic supplying and sorting systems	2.92 (1.96)
12. Loading and transport systems managed via radio frequencies	1.27 (1.45)
13. Specific management software for the pharmacy	3.14 (1.63)
14. URL-based website	2.93 (2.13)
15. Intranet with firewall accessible to clients and to other members of the organization	2.37 (2.02)
16. Technical and professional support via the website	2.05 (1.79)
17. e-Commerce website to sell nonmedical products to final clients	.39 (0.83)

[a] A value of 0 means that the firm is not interested in developing the technology; a value of 1 means that the implementation has not begun yet; and 5 indicates that the company has implemented the technology at the maximum level.

Table 2
Descriptive statistics and Spearman's correlations[a]

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12
1. Competitive position index	.00	1.91												
2. Mean interannual variation in market share	94.36	10.46	.50											
3. Clients valuation	6.99	1.17	.86	.15										
4. Human factor complementary to IT	3.78	.46	.65	.15	.63									
5. Managerial factor complementary to IT	3.72	.46	.59	.33	.72	.75								
6. Technological adaptation factor	3.13	.78	.28	.07	.38	.70	.71							
7. General technological index	2.46	.90	.40	.42	.46	.51	.76	.47						
8. Specific technological index	2.46	1.13	.39	.40	.50	.50	.80	.53	.94					
9. Size	3.92	.65	.58	.40	.61	.52	.73	.43	.84	.88				
10. Competitive intensity index	3.57	.74	− .77	− .35	− .77	− .69	− .64	− .34	− .44	− .43	− .47			
11. Cooperative character[b]	1.37	.50	− .61	− .16	− .84	− .58	− .84	− .53	− .78	− .84	− .81	.61		
12. Strategic orientation towards territorial expansion	2.56	1.50	− .01	.41	− 16	− .19	.02	− .01	.38	.34	.28	.29	− .08	
13. Territorial differences in pharmaceutical consumption	.84	.00	− .32	− .10	− .31	.01	− .00	.13	.07	.15	.13	.31	.14	.21

[a] It is not useful to calculate the level of confidence because the data come from the whole population (there is no sample error).
[b] Correlation results for the cooperative variable must be treated with caution due to its dichotomous character.

3.4. Other industrial and organizational variables

We have used some variables related to the structure of the industry and from the organizations themselves, with the intention of testing their effect on the competitive position of the companies. These variables are (1) the size of the organization, (2) the cooperative character of the company, (3) the strategic orientation towards territorial expansion, (4) the competitive intensity that each organization faces, and (5) territorial differences in pharmaceutical consumption.

The size has been considered a moderating variable in numerous studies related to RBV (Pettus, 2001) and organizational analysis (Hansen & Wernerfelt, 1989; Ramaswamy, 2001; Sepherd, 1972, etc.) and was calculated as the logarithm of the mean sales of the company in the period 1994–1998. Owing to the importance of the cooperative subgroup, we have used a dichotomous variable that is identified with the legal form of the company, 1 corresponding to a cooperative society and 2 a noncooperative firm. There are various precedents that explain the way in which the ownership structure of companies affects their results (e.g., Côté, 1991; Li & Simerly, 1998), which given our earlier analysis of the sector could be especially significant in the pharmaceutical distribution industry.

Considering the earlier analysis of the structure and characteristics of the industry, we have calculated the following variables: strategic orientation towards territorial expansion, differences in competitive intensity, and territorial differences in pharmaceutical consumption. All derive from the strong local element of the competition that is found in the pharmaceutical distribution industry in Spain (Malo, 1994). The ‘‘strategic orientation towards territorial expansion’’ variable was calculated based on the assessments of the company management by Likert-type 5-point scales. The territorial difference in pharmaceutical consumption was defined as the quotient of the mean growth in pharmaceutical consumption in the province or provinces where the company was active in the period 1994–1998, and the mean growth of pharmaceutical consumption in Spain in the same period. These data were provided by the General Subdirectorate for Health Care and Pharmaceutical Provision of the Ministry of Health. Finally, the differences in competitive intensity were calculated from the number of companies with which, on average, each company competes. These figures were obtained from the information given by the pharmaceutical clients in the survey process described earlier. In our case it was not possible to use another type of measure for the competitive intensity index because, like the Herfindhal Index (Hannah & Kay, 1977), they all measure the global rivalry in the sector and not the differences between companies. Table 2 depicts the descriptive values of the variables and their respective levels of association measured by Spearman's ρ coefficient.

4. Analysis and results

To test Hypotheses H1, H2, and H4 we shall use the bivariate and partial correlation analysis. It is possible to use other statistical techniques that at first sight might seem valid to test the hypotheses, in particular multiple lineal regression analysis in particular. However, its application in the present work was discounted because the variables did not meet certain previous conditions. To be precise, the normality requirement is not complied with (maximum values test Kolmogorov–Smirnov: $Z = 0.04$, $P = .99$). We must also stress that in the population there is a clear heteroscedastic effect in the analyses with the variables competitive intensity and variation of market share (Goldfeld–Quandt tests, $f = 5.58$ for the competitive position index and $f = 7.01$ for mean interannual variation in market share), so that we have eliminated the population element with extreme values in the analyses in which these variables occur.

After analyzing Table 2, the industrial or organizational variables with a stronger association are, in this order, the index of competitive intensity, cooperative character, and size factor. Taking into account the strong link between the variables size and cooperative character ($\rho = -.812$), we have chosen to include as moderating variables in the analysis of partial correlation only the size and the index of competitive intensity. The results of this analysis are shown in Table 3, and show that both variables explain a large part of the differences in competitive position. These two factors therefore prove the claim made in Hypothesis H4.

In Table 3, indexes of partial correlation are also shown, these being moderated by the previous variables, which are used to check Hypotheses H1 and H2. According to these results, there are no significant links between general level of IT and competitive position. What is more, this relation is weakly negative, even if the components of the index of competitive position—interannual variation of market share and client evaluation—are taken individually. We therefore accept the claim made in Hypothesis H1. Once the effects of the size and competitive intensity variables are looked at, we do not see any significant links between

Table 3
Partial correlations,[a] moderating variables: size and competitive intensity

Variable	1	2	3	4	5	6	7	8	9	10
1. Competitive position index	–									
2. Mean interannual variation in market share	.31									
3. Client valuation	.73	– .41								
4. Human factor complementary to IT	.15	– .29	.35							
5. Managerial factor complementary to IT	.07	– .28	.25	.76						
6. Technological adaptation factor	– .00	– .36	.25	.82	.77					
7. General technological index	– .14	– .04	– .12	.27	.59	.46				
8. Specific technological index	– .29	– .23	– .12	.28	.70	.53	.88			
9. Cooperative character	– .22	.52	– .58	– .35	– .65	– .50	– .49	– .63		
10. Strategic orientation towards territorial expansion	– .04	.22	– .18	– .25	– .20	– .16	.37	.07	.18	
11. Territorial differences in pharmaceutical consumption	– .20	.09	– .22	– 20	.11	.12	– .08	– .06	.23	.04

[a] It is not useful to calculate the level of confidence because the data come from the whole population (there is no sample error).

competitive advantage of companies and human, management, and technological adaptation resources. Only a modest but significant association can be seen between the human factor complementary to IT and client evaluation, which might be a sign that the client in fact perceives the existence of an adequate human resource inside the company, even though paradoxically this is not translated into a substantial increase in market share. In short, we can consider that Hypothesis H2 is disproved. On the other hand, the notable association relations between the cooperative character and the levels of technology and human and managerial resources are worthy of note, whereby cooperative companies achieve superior results.

Finally, Hypothesis H3 asserts that IT, if it is used in conjunction with certain intangible resources, results in a better competitive position in companies that have both types of factors. Taking into account that combinatorial effects between variables cannot be explained by correlation calculations, we have designed a different method of testing the hypothesis, which we shall discuss now.

The few studies that until now have analyzed the complementary effect between intangibles and IT have used various analytical tools to test the hypothesis of resource complementarity. The most recent precedent (Powell & Dent-Micallef, 1997, p. 392) groups the organizations into those with intensive use of IT and those with nonintensive use of IT, and then calculates correlation indexes for intangible resources–results for each respective group. Subsequently, Bharadwaj (2000, p. 174) compared business results in a sample of companies with intensive use of IT with another chosen at random as control.

In our case, we believe that other analytical techniques are more appropriate. These have explicative power that is sufficiently strong in a population in which, as has been demonstrated, various moderating variables have an important role. Additionally, the size of the population is relatively reduced, so that it is even more unavoidable to resort to tools that allow work on all or most of the elements under analysis simultaneously. Among the techniques that are applicable in testing Hypothesis H3 we have chosen data envelopment analysis (DEA), described for the first time by Charnes, Cooper, and Rhodes (1978), and developed in later work (Banker, Charnes, & Cooper, 1984; Charnes, Cooper, Golany, Seiford, & Stutz, 1985). This is a nonparametric analysis, which requires the identification of the inputs and outputs through which the relative efficiency of the companies in the use of these inputs or factors is measured. This technique has been used in the field of the empirical validation of RBV (Majumdar, 1998) and in other fields of strategic management and organizational analysis in general (Pina Martínez & Torres Pradas, 1992). The technique additionally has a high level of reliability when it is not possible to ensure the required conditions in the parametric tests, such as variable normality, variance equality, or exclusive presence of interval or ratio scales.

The DEA is implemented by lineal programs, one for each company, with an objective function to maximize as many variables as inputs and outputs that are considered and as many restrictions as the number of companies plus one. The result obtained is an objective value of the function for each one of the organizations, which determines the relative efficiency index with which each company manages the factors and inputs to obtain the results or outputs. The efficiency index will range from 0 to 1, with 1 indicating maximum efficiency and 0 minimum efficiency in the management of resources.

Applying the DEA analysis to the problem of the validation of Hypothesis H3 we have the following aims: (1) to identify those companies that achieve a higher index of efficiency in the management of IT; (2) to check the principal variables that might affect the relation between IT and competitive position; and (3) to compare, finally, the efficiency results obtained from the DEA with the quality of the human and management intangibles in the company.

In short, we shall accept that Hypothesis H3 is proved if we find a sufficient relation between a company's efficiency in the management of IT and the quality of the human and management intangible, simultaneously checking the variables that may affect the relation. For this, we have identified as inputs of the DEA model the General Technological Index and the company size. The model has as outputs the two measures of competitive position: client valuation and mean interannual variation in market share for the period 1994–1998.

The above approach ensures that the efficiency indicator finally obtained will be a reliable reflection of good practice in the management of the technological resource and of the company size. The differences between the companies in their efficiency indexes will be due, therefore, to the skill with which some have managed to combine their technological resources with other resources. Every time that company size is included in the model, and consequently its controlled effects, the differences in efficiency must be down to factors related to human or management resources, or to adaptation of technological infrastructure, which are contributory to the technological element.

However, we should point out that there may be other variables that may exogenously affect the model, especially the competitive intensity that each organization faces, and the cooperative character of the companies. To check the effect of the cooperative character, we have applied the DEA analysis only to cooperative societies. The reason for this restriction lies in the fact that this is a homogeneous group of entities that also happens to be numerous in the population, because it comprises 10 of the 16 companies, which is 62.5% of the total. The competitive intensity can also have a certain influence on the results, so it will be taken into account at the moment of discussing and making definite conclusions. An outline of the deductive process applied in testing the Hypothesis H4 is shown in Fig. 1.

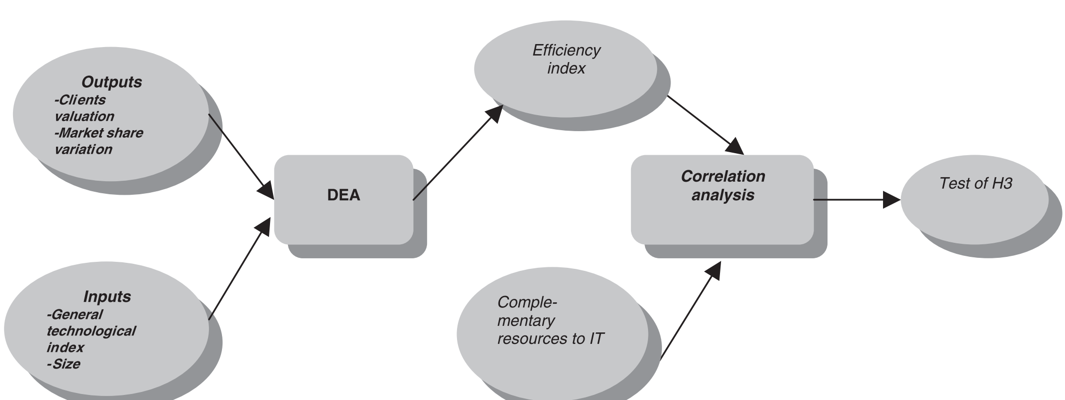

Fig. 1. Test of Hypothesis H3.

Table 4
Inputs, outputs, and DEA results

Company	Inputs		Outputs		Relative efficiency index
	General technological index	Size	Client valuation	Interannual variation in market share	
Company 1	4.71	3.63	8.03	1.66	1.00
Company 2	4.29	3.12	7.02	− 3.48	.75
Company 3	4.01	2.34	8.03	− 6.90	.92
Company 4	3.94	1.85	8.50	− 4.13	1.00
Company 5	4.00	3.56	6.75	− 1.21	.83
Company 6	3.83	2.59	7.04	− 5.10	.85
Company 7	5.16	3.49	7.01	− 2.53	.64
Company 8	3.90	2.71	8.07	− 1.81	1.00
Company 9	4.82	3.78	7.51	1.77	1.00
Company 10	4.18	2.81	8.11	− 3.71	.90

The results of the DEA model for the cooperative societies that make up the population appear in Table 4. These results express the level of efficiency with which the organizational units manage their IT resources and their company sizes. In four cases, the companies analyzed achieve a maximum efficiency index, while the other cases show some level of inefficiency.

In Table 5 are shown the levels of association for the variable pairs that relate the relative efficiency index with human resources, management complementary to IT, as well as technological adaptation. The results indicate that there is a moderate relation between the efficiency index obtained via DEA and human, management, and technological adaptation resources complementary to IT. The Spearman correlation coefficients are positive but relatively weak in the three cases, especially for the last resource. However, for the case of human and managerial variables extreme values can clearly affect the global results, implying therefore that a heteroscedastic situation exists (Goldfeld–Quandt, tests $f > 2$ for the human factor complementary to IT and management factor complementary to IT).

If we remove the extreme element from the above calculations we obtain the association indexes that are shown in Table 6. Looking at the new results, there is a strong level of

Table 5
Efficiency in the management of IT and quality of human, managerial and technological adaptation resources[a] ($N = 10$)

Variable	1	2	3
1. Relative efficiency index	–		
2. Human factor complementary to IT	.41		
3. Managerial factor complementary to IT	.37	.69	
4. Technological adaptation factor	− .03	.50	.72

[a] It is not useful to calculate the level of confidence because the data come from the whole population (there is no sample error).

Table 6
Management efficiency of IT and quality of the human, managerial and technological adaptation resources[a] ($N=9$)

Variable	1	2	3
1. Relative efficiency index	–		
2. Human factor complementary to IT	.844 (.489)		
3. Managerial factor complementary to IT	.752 (.736)	.586	
4. Technological adaptation factor	.246 (.175)	.311	.620

[a] In brackets are shown the partial correlation indexes with competitive intensity as moderating variable. It is not useful to calculate the level of confidence because the data come from the whole population (there is no sample error).

association between the relative efficiency index of the technological resources and company size on the one hand, and the intangible resources of the human factor and management complementary to IT, on the other. This situation does not change substantially if we calculate the partial correlation indexes for the above pairs of variables moderated by the index of competitive intensity—coefficients in parentheses—with which the affirmation made in Hypothesis H3 is proved. A reservation of this must be the weak relation between the technological adaptation factor and the relative efficiency index obtained via DEA.

5. Discussion and conclusions

The results of this work are significant for various reasons. Firstly, we have developed an innovative method of measuring the real impact that IT has on competitive advantage in a European industry. Secondly, we have completed a new procedure of empirical test of the RBV, whose results support some components of the theoretical framework and revise others. Thirdly, we have identified two company factors, unconnected with internal resources or capabilities, as explicative elements of the competitive advantage that firms achieve. These factors are the competitive intensity that each firm faces and the ownership structure of the company.

With regard to the first question, it is possible to conclude that IT appears, in principle, to be associated with better competitive results; however, this relation is strongly moderated by the effect of the size of the company and by the difference in competitive intensity that the firms face. On the other hand, testing Hypothesis H3 has brought to light that once all the variables that may intervene in the relation are checked, the combination of IT and complementary human or management factors are indeed associated with companies that finally obtain more competitive success.

The first results do not sufficiently support the abundant academic and professional literature that presumes there is a net positive effect of IT on company performance (Cash & Konsynski, 1986; Parsons, 1983; Porter & Millar, 1985). Nor do they completely back up the most recent work (Hitt & Brynjolfsson, 1996), where IT is able to improve business results alone. There is therefore some agreement between our results and those of followers of the strictest version of what is known as the productivity paradox (Solow, 1987), and with some ideas in the somewhat techno-skeptical work of Strassmann (1990). Indeed, just as Davenport

(1999) claimed, it is not enough to throw computers at a problem to solve it, nor to improve the economic or production situation: It is necessary to have and to potentiate the framework formed by human and company elements that will enable and develop the potential beneficial effect of technology (Mirvis, Sales, & Hackett, 1991).

Our results coincide, in general, with the assumptions from the hypothesis of strategic necessity, which claims that IT is a necessary but not sufficient condition to achieve privileged competitive positions (Clemons & Row, 1991). In order for that to be achieved, IT must be accompanied by management, economic, and human resources, which is the core of our argument.

From the point of view of RBV, IT, considered separately, is a valuable resource, and in its most advanced form it may be rare, but it can hardly be defined as difficult to imitate (Barney, 1991). In fact, in the pharmaceutical distribution industry we have been able to verify that the robotic technologies used in the warehouse were implemented in practically all the companies by the same supplier, and even by the same technicians. This technology would therefore be closer to the concept of commodity than to that of the differentiating element. If, as in fact is the case, IT appears to be related to other complementary resources (Ross et al., 1996), its positive effects could be potentiated such that it does become an element that generates competitive advantage (Bharadwaj, 2000; Powell & Dent-Micallef, 1997). This result bears a relation with the last condition that Barney (1996) introduced, mentioned before that by Amit and Schoemaker (1993), in the model of obtaining and maintaining competitive advantage, which claims that some resources, in this case IT, must act in conjunction with other resources or capabilities to generate sustainable advantage (Barney, 1996, p. 160).

The method of empirical evaluation that we have described additionally ensures that the combination of resources is associated with net gains in competitive position in companies, leaving aside other industrial and company factors (Porter, 1980; Rajagopalan & Prescott, 1990), so we have used a one-industry design in the empirical analysis (Rouse & Daellenbach, 1999). We have also taken into account the explicative capacity of the size factor (Hansen & Wernerfelt, 1989; Powell, 1996), of territorial differences in market growth, and of the strategic orientation of the company (Hitt et al., 2001; Lee & Miller, 1999). In short, our results show that companies with an optimal level of technology, combined with adequate human and management resources, are able to achieve better competitive results.

The second achievement of the study lies in the procedure of empirical validation of RBV in the European industrial environment. Hypothesis H3 validates the concept of value, complementarity, inimitability, and scarcity that forms the main argument of RBV (Peteraf, 1993). However, an analysis of Hypothesis H2 does not appear to support, in principle, the results of various empirical studies that have shown a positive relation between certain intangible resources and obtaining and maintaining competitive advantage (Decarolis & Leeds, 1999; Miller & Shamsie, 1996). This result does not prevent these conclusions being explained also by using the arguments from RBV: The resources involved in Hypothesis H3 were chosen because of their possible complementary effect with IT, and not because it was presumed that there was a direct relation between them and value creation in the firm. In this case, we would be faced with noncompliance with the first condition of the VRIO model (Barney, 1996), and that the resource therefore does not ensure the creation of value in the firm when it acts in isolation. By way of example, open and fluid intracompany communication or a low level of bureaucratization do not produce an immediate effect on competitive position.

The third substantial finding of the present work lies in the identification of two factors of an intraindustrial nature that intervene in the relation between IT, intangible resources, and competitive advantage. These are the intensity of the competitive rivalry that each company faces and the ownership structure of the company, whether cooperative or noncooperative. The intensity of competition in an industry has been analyzed by industrial organization (Porter, 1980), finding that an increase in competitive intensity in the long term leads to a reduction in the number of companies in competition, while the ones that remain are forced to improve their commercialization capacity, to adopt changes in technology and in processes, and to pay more attention to controlling production costs (Ramaswamy, 2001, p. 991).

Nevertheless, in this study we have demonstrated that the differences in competitive rivalry not only affect the sector globally, but also the companies individually. That is, those companies that face less competition are in a privileged competitive position, if we consider the client perception and the growth in market share. An intensification in competition may make internal processes more dynamic and encourage companies to increase their level of technology (Megginson, Nash, & Van Randenborgh, 1994), but it also increases client choice, and therefore decreases the company's capacity to gain income, especially if that company is one of the weaker ones (Smith & Grimm, 1987). In this way, for a company that has to compete with many rivals in its traditional market, savings in costs and an increase in the quality of service derived from the implementation of IT can only be transformed into net gains in competitive position with great difficulty. This effect is even clearer if we take into account that the increase in competition in the area where each company is active is caused by the entry into the market of large companies following an aggressive strategy of growth via territorial expansion (Malo, 1994). This effect completes RBV, such that the effect of an internal resource is moderated by the conditions that affect the company from its immediate environment. Although the idea has a certain similarity with industrial competitive analysis (Porter, 1980), it is novel because it focuses on the company and not on the industry.

However, it is worth mentioning that technological and competitive results are superior in cooperative companies. As various earlier studies have shown (Côté, 1991), the cooperative societies of the industry have had access to valuable resources that may give them an advantage with respect to companies of other legal statuses. The greater involvement of the member-client, governmental protection, and the strong cooperative feeling of the pharmaceutical profession in Latin countries may have benefited the cooperative firms to the detriment of the other companies, such that the former achieved a greater company size and a higher level of technology in less time (Martínez, 1996), creating anticipation advantages (Dierickx & Cool, 1989) and path-dependent advantages (Arthur, 1989).

The study has some limitations, which we shall now enumerate. First, the results refer to the pharmaceutical distribution industry from one region in Spain, so that the results may not be similar in other industries or other countries. Further research in other regions or countries in western Europe is needed to generalize the conclusions we have obtained. Second, the analyses we have undertaken are based fundamentally on correlation analysis. Thus, it is only possible to certify that there are association relations between variables, and not to claim causality. However, we have taken precautions with a view to eliminating the effect of those variables that might interfere in the links we have found, purging apparent or spurious associations. Third, we have used as a statistical tool the DEA model, which has proved better able to explain findings of the work, but at the same time has imposed certain restrictions, such as a decrease in the number of organizations forming part of the study. Fourth, during the empirical analyses some variables have been used that are not appropriate to be treated with parametric statistical procedures. We have avoided therefore the use of these types of techniques, which has certainly restricted the possibilities of analysis of information and of obtaining subsequent inferences.

Appendix A

Complementary resources to IT
1. Written and oral communication are very open in our firm.[a]
2. Our personnel communicate widely and not just with their own departments.[a]
3. Management and technological staff frequently consult with management about technological or managerial decisions.[a]
4. The IT personnel are able to negotiate, train, and give technological support appropriately.[a]
5. There is a lot of conflict in our firm (reversed).[a]
6. We have a lot of conflict between our home office and our territorial warehouses (reversed).[a]
7. Our technological personnel are very creative.[a]
8. Our IT personnel are committed to continuous learning.[a]
9. Our people are open and trusting with one another.[a]
10. Our people adapt quickly to changes.[a]
11. Our people have enthusiastically accepted the use of innovative IT.[a]
12. New IT projects are clearly supported by top management.[b]
13. Our firm has little bureaucratization.[b]
14. Upper management have championed IT within the company.[b]
15. We frequently use cross-departmental teams to solve key problems.[b]
16. IT training is a high priority in our company.[b]
17. Our IT developing and implementing costs are better than our competitors'.[c]
18. The reliability of our IT systems, the dead times, and the IT management costs are better than our competitors'.[c]

[a] Human resources complementary to IT (integrated in the human factor complementary to IT).

[b] Managerial resources complementary to IT (integrated in the managerial factor complementary to IT).

[c] Resources that are integrated in the technological adaptation factor complementary to IT.

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