



Information technology investment and operational performance in purchasing

The mediating role of supply chain management practices and strategic integration of purchasing

Information
technology
investment

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Abstract

Purpose – The objective of this paper is to study the relationship between information technology (IT) investments and performance in the purchasing function. A study is made not only of whether this relationship exists, but also of the mediating role played by both purchasing practices and the strategic integration of purchasing.

Design/methodology/approach – Statistical analyses of the data provided by 141 purchasing managers of medium and large Spanish companies in three industrial sectors.

Findings – The analyses support the idea that IT investments exert a positive effect on purchasing operational performance. Nonetheless, the results show that this effect arises because IT allows companies to implement certain purchasing practices and, partially, because it facilitates greater strategic integration of the purchasing function.

Originality/value – The results not only reveal the positive effect of IT at the functional level, but they also help us to understand how this effect is produced.

Keywords Purchasing, Technology led strategy, Supply, Purchasing power

Paper type Research paper

1. Introduction

The impact that information technology (IT) has on industrial and business performance has aroused great interest in the last few years. This interest emerged from the earliest empirical studies carried out in the 1980s, which, contrary to what was expected, did not find a positive relationship between the substantial IT investments that were being made in many industries and their productivity rates (Solow, 1987). This controversy is known as the Solow productivity paradox (Triplett, 1999). More recent literature has attributed these initial results to the unavailability of appropriate databases and the simplicity of the models studied and has shown positive effects on productivity that lead us to think that this paradox has disappeared

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(Brynjolfsson and Hitt, 1996, 1998; Dedrick *et al.*, 2003). Nonetheless, this literature has also shown that empirical findings noticeably vary when other performance measures are considered (Hitt and Brynjolfsson, 1996; Dehning and Richardson, 2002), when different indicators of IT are taken into account (Mahmood and Mann, 1993; Sircar *et al.*, 2000), or when different companies or industries are compared. This diversity of results makes it necessary not only to determine whether direct and universal effects exist but also to identify the contingencies and circumstances that explain the achievement of benefits through IT investments (Dehning and Richardson, 2002). What matters is not only the existence of a positive effect, but also how and through which mechanisms this effect takes place (Brynjolfsson and Hitt, 1998).

Furthermore, most of the papers that have studied the relationship between IT investments and performance have been carried out at the country, industry or business level (Dedrick *et al.*, 2003). Few have approached more basic levels such as the functional one. Although some ITs are implemented at the business level, many investments have a functional character or produce very different effects within the different business functions. Knowing the way in which each of these functions benefits from IT investments thus helps us to know how the company must internally use IT to obtain a competitive advantage. In this sense, some papers have already approached this question from the perspective of production and operations (Grover and Malhotra, 1999; McAfee, 2002; Khouja and Kumar, 2002; Gupta and Kohli, 2006), marketing and sales (Martell, 1988; Noh and Fitzsimmons, 1999; Bush *et al.*, 2005) or purchasing, logistics and supply management (Greis and Kasarda, 1997; Narasimhan and Kim, 2001; Sriram and Stump, 2004; Sanders and Premus, 2005; Wu *et al.*, 2006). From these contributions, it can be deduced that the achievement of benefits through IT investments is not trivial at the functional level either; therefore it is important to explore and identify the variables that intervene in this process. As in those papers that adopt a more global view, it is not only important to determine whether IT investments produce a positive effect, but also to investigate how this effect happens.

This paper attempts to contribute along these lines by studying the relationship between IT investments and performance within the purchasing function. Specifically, the objective of this paper is to analyze the extent to which two elements – the set of implemented purchasing and supply practices and the degree of strategic integration of purchasing – mediate this relationship. The interest and contribution of this paper stem not only from the above-mentioned need to know the mechanisms through which IT investments can generate benefits at the functional level, but also from other aspects. First, in the last few years purchasing has evolved from being considered a merely administrative function to playing a very relevant strategic role in many organizations (Reck and Long, 1988; Gadde and Hakansson, 1994; Spekman *et al.*, 1992; Carter and Narasimhan, 1996). The inclination of many companies to focus on their core competences has led to greater dependence on suppliers and has increased the potential of the purchasing function as a source of competitive advantage. It is now more than ever important to know the instruments and practices that may help this function to reach its objectives and improve its performance. The adoption of IT is one of these instruments that must be studied.

Second, although some authors have already tackled the mediating role of purchasing practices in the relationship between IT investments and performance (Sriram and Stump, 2004; Sanders and Premus, 2005), they have exclusively focused on

those practices that establish a cooperative relational structure with the suppliers. This paper extends this approach by also considering other practices such as supplier evaluation and assessment, supplier involvement, and logistics integration.

Third, strategic integration of purchasing – also understood as the extent to which the company recognizes the strategic relevance of the purchasing function – has been identified as an important antecedent of the implementation of more advanced purchasing and supply management practices (Carr and Pearson, 1999; Narasimhan and Das, 2001; Chen *et al.*, 2004). Although Chen and Paulraj (2004a, b) suggest that strategic integration of purchasing is a significant element in the relationship between IT investments, purchasing and supply practices, and performance, evidence to this respect does not exist.

Finally, this paper adopts a functional perspective and focuses on IT investments and operational performance in the context of the purchasing function. This performance is measured according to the achievements made within each of the four basic competitive priorities proposed by Hayes and Wheelwright (1984) for the production function: cost, quality, dependability and flexibility. These competitive priorities have also been proven to represent competitive dimensions in the purchasing function (Krause *et al.*, 2001).

The paper is structured in four more sections. In Section 2, the literature is reviewed and some research hypotheses are argued. The methodology used to test them is explained in Section 3 and the results are presented and discussed in Section 4. The paper ends in Section 5 with a summary of the main implications and limitations of the paper.

2. IT investment and performance: literature review and research hypotheses

The identification and measurement of the effect of IT investments on business productivity and financial or commercial performance have been important research objectives in the last two decades. They have given rise to a number of works that have adopted either a theoretical perspective based on mathematical models (Barua *et al.*, 1991; Thatcher and Pingry, 2004) or an empirical perspective (Brynjolfsson and Hitt, 1996; Bharadwaj *et al.*, 1999). The challenge has mainly consisted of developing more and more sophisticated approaches, models and measurement instruments in order to more precisely and objectively elucidate the consequences of a greater adoption of IT. While in the 1980s the empirical studies concluded that IT does not have an effect on business productivity and profitability, giving rise to the so-called “productivity paradox” in recent years a series of papers have shown, with different nuances, that these conclusions were somewhat precipitated (Harris and Katz, 1991; Dos Santos *et al.*, 1993; Mahmood and Mann, 1993; Brynjolfsson and Hitt, 1996; Hitt and Brynjolfsson, 1996; Rai *et al.*, 1997; Bharadwaj *et al.*, 1999; Bharadwaj, 2000; Sircar *et al.*, 2000; Lee and Bose, 2002; Byrd *et al.*, 2006; Lin and Tseng, 2006). Although debate is still open as to the most appropriate approach and methodology to tackle this question (Mahmood and Mann, 2000), these more recent papers suggest that IT investments generate different benefits in companies (Dedrick *et al.*, 2003). Nonetheless, this literature also reveals that not all IT investments have positive effects on all types of performance, that such effects might be contingent on many other circumstances, and that there are important differences among companies.

As far as the explanations that justify a positive effect of IT on organizations are concerned, the literature review carried out by Dewett and Jones (2001) reveal that there are five arguments typically used IT:

- (1) links and enables employees both within and between functions and divisions;
- (2) encodes, communicates and stores information, thus contributing to the capture, preservation, protection and expansion of organizational knowledge;
- (3) increases boundary spanning since it facilitates quicker analyses of the external environment and more effective resolution of projects;
- (4) promotes efficiency, for example, by facilitating and making communications and information storage and retrieval less expensive; and
- (5) promotes innovation since a more effective management of information and knowledge fosters the generation of new ideas.

Nonetheless, Dewett and Jones (2001) argue that all these advantages are the consequence of two meta-benefits attributed to IT: information efficiencies (cost and time savings) and information synergies (integration of and cooperation between people, units and groups that participate in organizational processes).

All these arguments suggest that the most immediate consequences of IT investments within an organization are of an operational nature. That is to say, thanks to these information efficiencies and synergies, the organization can reduce costs, improve product and service quality, enhance dependability, or increase flexibility. For example, the detection of the causes of certain quality problems depends to a great extent on the capacity of the company to collect and process historical data on business processes. In this sense, Barua *et al.* (1995) conclude that many of the significant impacts of IT investments take place in intermediate organizational levels, thus being registered by variables that measure the company's operational performance. This idea is also present in the paper by McAfee (2002) and is consistent with the results of Mukhopadhyay *et al.* (1997) and Sanchez-Rodriguez *et al.* (2006), who show a positive effect of IT usage on quality. All this suggests that IT investments have a much more evident and unequivocal positive effect on operational performance measures than on other more overall measures of business performance such as profitability or market share (Ray *et al.*, 2004).

In the specific context of the purchasing function, as pointed out by Sriram *et al.* (1997), most of the empirical studies have focused on analyzing the beneficial effects of a specific tool: electronic data interchange – EDI – (Kekre and Mukhopadhyay, 1992; Mukhopadhyay *et al.*, 1995; Crum *et al.*, 1998; Droge and Germain, 2000; Hsieh and Lin, 2004; Ngai and Gunasekaran, 2004; Craighead *et al.*, 2006). Rantala and Hilmola (2005) also provide case study evidence about the advantages of automated purchase order processing. Realizing that EDI is only one of various investment opportunities, Sriram and Stump (2004) adopt a more integrative view and provide empirical evidence that those companies with the highest IT investments in the purchasing function also tend to be the companies that rank the best in some indicators of purchasing operational performance. In this specific context, information efficiencies can lead to reductions in costs, ordering times, and conflict resolution times. Information synergies facilitate the

interaction with suppliers and other organizational functions directly involved in the production process (e.g. production, design or engineering).

All these arguments lead us to propose the following hypothesis:

H1. IT investment in the purchasing function is positively related to the operational performance of purchasing.

2.1 *The mediating role of purchasing practices*

Although the most recent empirical studies lead us to think that IT investments are generating benefits for companies, there are important differences in the conclusions reached so far. This suggests that the effect of IT on business performance and productivity might not be direct and universal. Rather, it might depend on the capability of the company to carry out a series of routines and internal changes through the use of this technology. Brynjolfsson and Hitt (1998) point out in that respect that the most recent literature has evolved from studying whether or not benefits associated with IT investments exist to studying how these benefits can be obtained. Venkatraman (1994) feels that the key to success does not lie in acquiring IT, but in how this technology is internally used. The literature review carried out by Dedrick *et al.* (2003) concludes that certain management practices have a major impact on returns to IT investments, and a review by Dehning and Richardson (2002) reveals that most of the literature maintains that the relationship between IT investments and performance is mediated by the way in which business processes are conducted within the company. Rai *et al.* (1997) also point out the existence of contingent factors and Kearns and Lederer (2003) study the mediating role played by the alignment between business and IT strategies.

In the specific context of purchasing, Sriram and Stump (2004) show that the effect of IT investment on some indicators of purchasing performance is channeled through the establishment of a cooperative relationship with suppliers. Sanders and Premus (2005) also provide empirical evidence of the mediating role played by internal and external collaboration, although from the broader perspective of supply chain management. These papers offer initial evidence that a large part of the potential of IT in the purchasing function is based on the use of these technologies to implement certain management practices. Indeed, studies by Stump and Sriram (1997) and Ellram and Zsidisin (2002) show that the implementation of IT is associated with the implementation of some purchasing practices.

This paper proposes that the effect of IT investments on purchasing performance depends, at least partially, on the capacity of the purchasing function to use these technologies to implement and develop advanced purchasing and supply practices. As advanced practices we understand those practices that are considered to be at the forefront in supply management by the most recent literature: collaborative relationships with suppliers (Ellram, 1991; Dyer and Singh, 1998), supplier evaluation and development (Humphreys *et al.*, 2004), supplier involvement in product design and development (Chung and Kim, 2003; Petersen *et al.*, 2005), and logistics or tactic integration of suppliers (Frohlich and Westbrook, 2001; Stank *et al.*, 2002). All of them have been considered, to a greater or lesser extent, as part of the supply chain management – SCM – approach (Harland, 1996; Tan *et al.*, 1999; Shin *et al.*, 2000; Mentzer *et al.*, 2001; Ho *et al.*, 2002; Cigolini *et al.*, 2004) and also constitutive elements of JIT purchasing or lean

supply (Womack *et al.*, 1990; Waters-Fuller, 1995; González-Benito *et al.*, 2000; Lamming, 1993). These practices are considered to be useful instruments for improving purchasing performance and also business performance.

IT helps to implement these advanced practices in a more efficient and effective manner. For example, supplier evaluation requires the creation and maintenance of registers and customer-supplier interfaces (Humphreys *et al.*, 2005); the joint design and development of new products require additional processing and storage of information and knowledge and tools for teamwork (Huang *et al.*, 2005); logistics integration entails agile data interchange with suppliers and other functions and appropriate software (Helo and Szekely, 2005); trust and collaborative relationships are often built on fluent communications and greater sharing of information. It is thus reasonable to think that the effect of IT investment on performance within the purchasing function depends on how successfully the company implements these advanced purchasing practices. The following hypothesis is then proposed.

- H2.* The relationship between IT investment and operational performance in the purchasing function is mediated by the implementation of advanced purchasing practices.

2.2 The mediating role of the strategic integration of purchasing

Not all companies recognize the strategic relevance of the purchasing function in the same way. The extent to which they do is measured in the literature through constructs such as strategic purchasing (Carr and Smeltzer, 1997; Carr and Pearson, 1999, 2002; Carr *et al.*, 2000; Chen *et al.*, 2004; Chen and Paulraj, 2004a, b) or purchasing integration (Narasimhan and Das, 2001). This integration is revealed through concrete actions and realities such as the direct participation of purchasing managers in the business strategic planning process, the formalization of a strategic plan in the purchasing function to support business strategy, a good knowledge of strategic objectives by purchasing professionals, training of purchasing professionals oriented to requirements derived from business strategy, or measurement of purchasing performance in terms of its contribution to business strategic objectives.

The implementation of the above-mentioned advanced purchasing practices requires significant effort and support within the organization. Thus, several researchers have concluded that strategic integration of purchasing is an important antecedent of this implementation because it indicates the extent to which the company recognizes the strategic role played by this function and is willing to provide the necessary resources for its development (Carr and Pearson, 1999; Carr and Smeltzer, 1999; Narasimhan and Das, 2001; Chen *et al.*, 2004). On the other hand, the information efficiencies and synergies that IT provides (Dewett and Jones, 2001) can promote the strategic integration of the purchasing function since they facilitate vertical communications within the organization and contribute to a correct understanding and deployment of business strategy. Thus, these observations suggest that at least a part of the effect of IT investment on the implementation of advanced purchasing practices could be due to the greater strategic integration of purchasing fostered by this investment. This idea, which is present in the theoretical framework of Chen and Paulraj (2004a, b), is incorporated in the following hypothesis.

H3. The relationship between IT investment and the implementation of advanced purchasing practices is mediated by the degree of strategic integration of purchasing.

Figure 1 shows a graphical representation of the three hypotheses. Basically, it has been argued that both strategic integration of purchasing and advanced purchasing practices intervene in the relationship between IT investments and performance in the purchasing function. They must therefore be taken into account in order to understand this relationship. It must be kept in mind that *H1* actually suggests a positive relationship between IT investment and purchasing performance. Although this hypothesis has been represented with a direct arrow from IT investment to purchasing performance in Figure 1, this relationship could also be indirect through any of the other variables.

It is worth noting at this point that we have chosen IT investment as the independent variable because the focus of this paper is on the benefits and consequences of IT and because most of the previous research on this topic considers IT investment as the exogenous variable (Stump and Sriram, 1997; Sriram and Stump, 2004; Chen and Paulraj, 2004a, b). Nonetheless, causal relationships might also take place in the opposite direction. For example, a greater strategic integration of the purchasing function might denote a greater influence of this function in top management and, therefore, a greater chance of obtaining organizational resources. IT investments in purchasing might then also be thought of as a consequence of a high degree of strategic integration of the purchasing function. These alternative views must be taken into account, but, in essence, they also recognize the relevance of IT investment for the development and success of the purchasing function.

3. Methodology

3.1 Data

The data used to test the hypotheses was collected with a postal questionnaire addressed to the purchasing managers of Spanish companies with 100 or more employees in three industrial sectors: industrial and commercial machinery (SIC 35), electronic and other

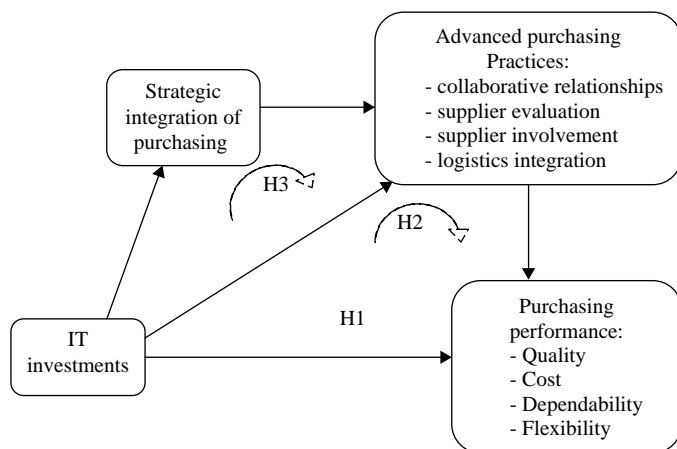


Figure 1.
Research hypotheses
(initial model)

electrical equipment (SIC 36) and transportation equipment (SIC 37). An initial list of 505 companies meeting these conditions was drawn from the 2004 Dun & Bradstreet database of the 50,000 largest Spanish companies. As a consequence, of the contacts made during the data collection process, this list was purged by eliminating:

- companies that had recently disappeared or been acquired;
- companies that, in spite of being classified in these sectors, were only devoted to distribution and installation but not to manufacturing;
- companies that did not have purchasing responsibilities because decisions were made in a parent company; and
- companies whose manufacturing manager has assumed purchasing responsibilities so that purchasing is not explicitly recognized in the organizational structure.

The target population was finally composed of a total of 417 companies: 134 machinery manufacturers, 140 electronic equipment manufacturers and 143 transportation equipment manufacturers.

The questionnaire was based on an extensive review of the literature and was critically revised by academic colleagues. It was also initially administered to three companies in each sector in order to identify and correct ambiguous or difficult to understand sentences. The questionnaire, along with a presentation letter and a pre-paid envelope for return, was then administered to the whole population. The following procedure was followed for each company. A phone call was previously made in order to identify the purchasing manager, to (personally or through another person) ask for his/her collaboration in the research and to announce the imminent arrival of the questionnaire. About three weeks later, if the company had not returned the questionnaire, a second phone call was made and the questionnaire was sent again, this time by electronic mail. These contacts and electronic submissions were repeated up to two more times for the companies that did not provide a response, waiting a minimum of two weeks between contacts. This process, carried out from September to December, 2005, yielded a total of 181 responses. However, 40 managers declared not to have enough information about purchasing performance relative to competitors. Thus, this paper was based on the information provided by 141 companies (33.81 percent); 54, 47 and 40 from each sector, respectively.

3.2 Measurements

3.2.1 IT investment in the purchasing function. Purchasing managers were asked to rate the extent to which the company had made investments in those aspects listed in Table I on a seven point Likert scale (from 1 – not at all – to 7 – to a great extent-). Sriram *et al.* (1997) classify purchasing IT into three categories: base systems and support, purchasing specific applications and vendor communications interface. The first item in Table I refers to the first category, the following three items to the second category and the last item to the third one. Thus, the measurement instrument captures the most common IT investments in the purchasing function. The average score given to all these items was then used as a measure of the intensity of IT investments in the purchasing function. Principal components analysis was applied to verify the validity and one-dimensionality of the construct. All the items strongly load on the only factor

with eigenvalue higher than 1, which is able to explain 63.96 percent of the variance (Table I). A Cronbach's α of 0.85 denotes acceptable reliability.

3.2.2 Strategic integration of purchasing. Respondents were asked to value the extent to which each of the statements in Table II corresponds to the reality of their companies on a seven point Likert scale (from 1 – not at all – to 7 – completely-). The average of all the scores was used to measure strategic integration of purchasing. The items were taken from previous scales used in the literature (Carr and Pearson, 1999, 2002; Narasimhan and Das, 2001; Chen and Paulraj, 2004a, b). The high item loadings in the only factor with eigenvalue higher than 1 constitute a proof of the validity and one-dimensionality of the construct and the Cronbach's α of 0.85 indicates adequate reliability (Table II).

3.2.3 Advanced purchasing practices. Purchasing managers were asked to rate the extent to which each of the statements in Table III corresponds to the reality of their companies on a seven point Likert scale (from 1 – not at all – to 7 – completely-). The first five items refer to the establishment of a relational structure based on trust in and cooperation with suppliers. The next three refer to the existence of supplier evaluation and assessment systems. The following four items are related to the implication and involvement of suppliers in the design, development and improvement of products. The last six items refer to the level of logistics integration, which is understood as the degree

	Mean (SD)	Factor 1
Renewal of hardware used in the purchasing department	5.14 (1.52)	0.787
Acquisition of software used for purchasing activities (e.g. order emission and monitoring)	5.36 (1.59)	0.764
Training purchasing personnel in the use of new information technologies	4.86 (1.58)	0.897
Hiring of personnel qualified in the use of information technologies to support purchasing activities	4.10 (1.76)	0.826
Establishment of electronic communications (computer to computer) with suppliers	3.99 (2.06)	0.712
Explained variance: 63.964 percent; Cronbach's α : 0.856		

Table I.
Measurement of information technology investments in the purchasing function: exploratory factor analysis

	Mean (SD)	Factor 1
The purchasing department participates directly in the business strategic planning process	5.04 (1.77)	0.796
Purchasing professionals have a good knowledge of the business strategic objectives	5.32 (1.41)	0.810
The performance of the purchasing department is measured in terms of its contribution to the business strategic objectives	5.25 (1.55)	0.779
Training of purchasing professionals is oriented to meet the needs derived from business strategic plans	4.67 (1.54)	0.764
The purchasing department has a formally written long-term plan to develop and support business strategy	3.99 (1.87)	0.682
Purchasing plans are continuously revised to adapt them to changes in business strategic planning	4.76 (1.59)	0.795
Explained variance: 59.599 percent; Cronbach's α : 0.859		

Table II.
Measurement of strategic integration of purchasing: exploratory factor analysis

Table III.
Measurement of
advanced purchasing
practices: exploratory
and confirmatory factor
analyses

	Confirmatory factor analysis				
	F1	F2	F3	F4	
	Exploratory factor analysis				
We rely on a reduced number of suppliers (maximum 2 or 3 per product)	0.053	0.714	-0.080	0.178	0.58
We establish long-term and stable relationships with our key suppliers	-0.089	0.839	0.092	0.038	0.80
We are working on strengthening the relationships with our key suppliers	-0.032	0.864	0.134	-0.007	0.87
We share relevant information with our key suppliers (e.g. production plants, financial reports, research findings)	0.158	0.733	0.312	-0.026	0.71
Our negotiation of prices is based on cost analyses	0.261	0.634	0.130	0.236	0.57
We monitor the fulfillment of specifications by our suppliers and register their errors	0.169	0.109	0.057	0.805	0.74
We require quality certifications from our suppliers (e.g. ISO9001)	0.030	0.046	0.146	0.756	0.54
We continuously and systematically assess the capabilities of our suppliers (there are formal processes for that)	0.280	0.154	0.106	0.765	0.84
Our key suppliers collaborate with us in product design and development	0.071	0.079	0.847	0.048	0.77
Our key suppliers collaborate with us to solve problems within our production processes	0.184	0.134	0.833	-0.031	0.81
Our decisions about launching new products are made taking into account the opinions of our key suppliers	0.089	0.158	0.797	0.179	0.76
We have established systems to collect the ideas and proposals of our key suppliers on the improvement of our products	0.285	0.084	0.695	0.250	0.71
Our key suppliers make daily deliveries of their products	0.798	0.0850	0.108	-0.065	0.73

(continued)

	Confirmatory factor analysis			
	F1	F2	F3	F4
	Exploratory factor analysis			
Orders are electronically transferred to the factories of our key suppliers	0.721	0.018	0.031	0.032
Our logistics activities are integrated with those of our suppliers (e.g. standardized containers, compatible equipment)	0.849	0.000	0.195	0.097
Our key suppliers have adapted their delivery arrangements to our requirements (e.g. packaging, shipment size, frequency)	0.771	0.093	0.097	0.231
We are coordinated with different suppliers to optimize the usage of vehicle capacity (shipment consolidation)	0.696	0.051	0.129	0.148
We have access to information on the stocks and available resources of our key suppliers	0.683	0.039	0.135	0.247
<i>F1</i> : Collaborative relationships				
<i>F2</i> : Supplier evaluation				
<i>F3</i> : Supplier involvement				
<i>F4</i> : Integrated logistics				
	Varimax rotation			
explained variance:	$\chi^2/df = 10.710$; GFI = 0.853;			
65.15 percent	AGFI = 0.805; TLI = 0.899;			
Cronbach's α	CFI = 0.915			
		0.736	0.836	0.850
Correlations	F1	F2	F3	F4
	0.27**	0.30**	0.36**	0.35**
	0.32**	0.36**	0.36**	0.35**
	0.20*	0.36**	0.36**	0.35**

Notes: * $p < 0.05$; ** $p < 0.01$; + $p < 0.10$

Table III.

of synchronization and mutual adaptation as regards the physical flow of products. All the items were first subjected to an exploratory factor analysis with varimax rotation (Table III). This analysis revealed that each group of items represents a different dimension. Consequently, the averages of scores for each group of items were then, respectively, used as measures of the extent to which the company makes use of collaborative relationships, supplier evaluation, supplier involvement and logistics integration. A confirmatory factor analysis was also carried out to provide additional evidence of the validity and one-dimensionality of the constructs (Table III). Each of the four constructs presents a Cronbach's α over 0.7, which shows acceptable reliability. Nonetheless, although the four practices represent independent dimensions according to the analyses, they show a high and statistically significant rate of correlation (Table III). This indicates that they are compatible and tend to appear together in many companies.

3.2.4 Purchasing operational performance. Each of the four basic competitive priorities established by Hayes and Wheelwright (1984) – quality, cost, dependability and flexibility – can be adapted to the context of purchasing (Krause *et al.*, 2001). These basic priorities were articulated into 18 objectives that are more concrete and easier to assess (Table IV). Respondents were asked to rate purchasing performance as compared to competitors for each of these objectives over a five-point Likert scale (1 – lower-, 3 – equal-, 5 – higher-), because of the non-existence of public databases dealing with this subject, the reluctance of companies to provide numerical information, and the difficulty that there is in obtaining comparable information from different companies, a common and accepted procedure for measuring performance in competitive priorities is the use of perceived measures relative to competitors (Youndt *et al.*, 1996; Narasimhan and Das, 2001). All the items were subjected to exploratory factor analysis (Table IV), which grouped the items related to each competitive priority into a different factor except for the priority of cost. In this case, the three items that refer to the productivity of human and technical resources in the purchasing department load on a factor and the two items related to the achievement of better prices and inventory reductions load on a different one. Two competitive dimensions relative to cost were then distinguished and, given the nature of the items, respectively, labeled as purchasing efficiency and logistics efficiency. The averages of item scores for each factor were taken as measurements of purchasing performance, thus distinguishing five performance dimensions. A confirmatory factor analysis was then applied as an additional test for the validity and one-dimensionality of the constructs and the Cronbach's α was computed for each factor to verify reliability (Table IV). Only the construct of logistics efficiency presents a limited value, but it is acceptable for newly developed scales (Nunnally, 1978). The different dimensions of purchasing performance present high correlations, thereby showing compatibility.

3.3 Analysis

H1 was tested with multiple regression analysis by considering the dimensions of purchasing operational performance as dependent variables and IT investment as independent variable. To isolate the relationship under study, three control variables were considered:

- (1) company size, measured by hundreds of employees;
- (2) the relevance of purchasing in organizational design, measured with a binary variable that distinguishes those companies whose purchasing function

	Confirmatory factor analysis				
	F1	F2	F3	F4	F5
	Exploratory factor analysis				
Quality					
Features and functionality of purchased products	0.767	0.168	0.180	0.113	0.004
Durability of purchased products	0.837	0.096	0.189	0.138	0.055
Reliability of purchased products	0.879	0.090	0.138	0.137	0.084
Fit between purchasing specifications and purchasing products (high finish, uniformity ...)	0.758	0.314	0.057	0.227	0.111
Efficacy of suppliers in attending to our complaints	0.680	-0.048	0.311	0.216	0.201
Cost					
Labor productivity in the purchasing department	0.189	0.174	0.285	0.773	0.080
Productivity of purchasing resources	0.181	0.067	0.260	0.830	0.084
High utilization of purchasing resources	0.243	0.159	0.008	0.808	0.028
Low cost of purchases (purchasing price, transportation ...)	0.223	0.279	0.084	0.198	0.752
Low inventory levels	0.045	0.135	0.268	-0.027	0.837
Dependability					
Quick order dispatch times in our company	0.174	0.112	0.680	0.282	0.405
Quick delivery time by suppliers	0.157	0.790	0.128	0.174	0.298
Fulfillment of agreed schedules by suppliers		0.840	0.284	-0.006	0.157
Fulfillment of agreed delivery terms by suppliers (quantity, quality, format ...)	0.096	0.827	0.296	0.108	0.109
Supplier flexibility to adapt capacity to the needs of our company	0.249	0.437	0.661	0.111	0.101
Wide range of product versions, options and features offered by suppliers	0.283	0.250	0.751	0.167	0.198
Flexibility					
					0.80
					0.83
					(continued)

Table IV.
Measurements of
purchasing operational
performance

Table IV.

	Exploratory factor analysis					Confirmatory factor analysis				
		F1	F2	F3	F4	F1	F2	F3	F4	F5
Supplier capability to introduce (customized) changes in products	0.300	0.320	0.740	0.217	0.096					0.89
Supplier rate of introduction of new products (updated and leading products)	0.132	0.226	0.778	0.231	0.188					0.78
<i>F1</i> : Quality										
<i>F2</i> : Cost (purchasing efficiency)										
<i>F3</i> : Cost (logistics efficiency)										
<i>F4</i> : Dependability										
<i>F5</i> : Flexibility										
Varimax rotation explained variance 75.88						$\chi^2/\text{df} = 1.810$; GFI = 0.859; AGFI = 0.807; TLI = 0.921; CFI = 0.936				
Cronbach's α						0.893	0.835	0.656	0.890	0.891
Correlations						F1	F2	F3	F4	F5
						0.48**	0.28**	0.43**	0.46**	0.50**
						0.34**	0.43**	0.46**	0.48**	0.66**
						0.41**	0.50**	0.48**	0.66**	
						0.54**	0.50**	0.48**	0.66**	

Notes: * $p < 0.05$; ** $p < 0.01$; + $p < 0.10$

occupies the same or a higher level than the manufacturing function in the organizational chart; and

- (3) industrial sector, which required the introduction of two binary variables distinguishing the electronic and electrical equipment industry and the transport equipment industry, respectively.

These were incorporated to control the potential effects of scale economies, different organizational structures, and the unique competitive circumstances that each industry faces.

The procedure described by Judd and Kenny (1981) and Baron and Kenny (1986) was used to test the mediational relationships proposed in *H2* and *H3*. This procedure requires the estimation of three regression models and the fulfillment of three respective conditions:

- (1) The dependent variable must be regressed on the independent variable, which must present a significant and positive coefficient.
- (2) The mediator must be regressed on the independent variable, which must also present a positive and significant coefficient.
- (3) The dependent variable must be regressed on both the independent variable and on the mediator, the mediator must show a positive and significant effect, and the effect of the independent variable must be weaker and less significant than in the regression of condition 1.

If the effect of the independent variable is not significant in the third regression model, all the effect of this variable channeled through the mediator and the mediation is said to be perfect or complete. Otherwise, the mediation is said to be partial and only part of the effect of the independent variable takes place through the mediator. All the regression models were estimated considering the three control variables mentioned above.

The results obtained for *H2* and *H3* allowed us to revise the model shown in Figure 1. This revised model was then estimated through structural equation modeling by computing second-order factors with the advanced purchasing practices and performance dimensions identified as relevant in the previous analyses. This additional analysis must be simply understood as a proof of robustness for the results found with the previous analyses.

4. Results and discussion

Regression models 1 and 2 in Table V can be used to test *H1*. For each dimension of purchasing performance as dependent variable, the control variables were first considered as independent variables and the measure of IT investment in the purchasing function was incorporated afterwards in a second model. In the case of four of the five dependent variables, the predictive power of model 2 significantly increases with respect to model 1, thus revealing that IT investment is associated with better operational performance in the purchasing function. However, this relationship does not show up in the case of logistics efficiency, thus indicating that IT neither helps the firm to obtain better prices nor is it used to reduce inventory levels. A possible interpretation of these results is that companies use IT to improve competitive

Table V.
Regression of purchasing
operational performance
on IT investment and
advanced purchasing
practices

	Quality			Cost (purchasing efficiency)			Purchasing operational performance			Dependability			Flexibility		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Intercept	3.826**	3.333**	2.405**	3.621**	3.035**	2.434**	3.514**	3.383**	2.349**	3.647**	3.141**	2.388**	3.375**	2.850**	2.130**
Company size	0.020 ⁺	0.015	0.012	0.001	-0.005	-0.008	0.018 ⁺	0.017	0.013	0.006	0.001	-0.008	0.007	0.002	-0.007
Purchasing operational relevance in															
organizational															
design	-0.111	-0.139	-0.153	-0.233*	-0.286**	-0.259*	0.119	0.111	0.119	0.116	0.087	0.067	0.035	0.005	-0.022
Electric and electronic															
industry	0.013	-0.012	-0.051	-0.020	-0.050	-0.077	-0.085	-0.091	-0.138	-0.345**	-0.371**	-0.392**	-0.184	-0.211 ⁺	-0.229*
Transport equipment															
industry	-0.120	-0.126	-0.135	0.143	0.135	0.156	-0.026	-0.027	-0.006	-0.198	-0.205	-0.167	-0.131	-0.137	-0.114
IT investment	-	0.113**	0.068	-	0.134**	0.110*	-	0.030	-0.009	-	0.116**	0.052	-	0.120**	0.056
Collaborative relationships	-	-	0.156**	-	-	0.084	-	-	0.178**	-	-	0.033	-	-	0.041
Supplier evaluation	-	-	0.021	-	-	0.037	-	-	0.023	-	-	0.101*	-	-	0.082 ⁺
Supplier involvement	-	-	0.013	-	-	-0.034	-	-	-0.034	-	-	-0.017	-	-	0.007
Logistics integration	-	-	0.039	-	-	0.049	-	-	0.068	-	-	0.107**	-	-	0.091*
R ²	0.043	0.101	0.193	0.045	0.128	0.170	0.034	0.039	0.168	0.059	0.116	0.224	0.020	0.089	0.187
F	1.511	3.031*	3.482**	1.608	3.956**	2.974**	1.205	1.090	2.936**	2.120 ⁺	3.532**	4.208**	0.709	2.631*	3.347**

Notes: * $p < 0.05$; ** $p < 0.01$; + $p < 0.10$

attributes such as dependability or flexibility while maintaining habitual negotiation systems and stock levels. In any case, the results lead us to accept *H1* since the analyses give evidence of a positive relationship between IT investment and several dimensions of operational performance in the purchasing function.

These results lead us to think that, although the literature has found it complicated to demonstrate the relationship between IT investment and business performance at the company or industrial levels, this relationship is much more visible at the functional level. These empirical results are therefore consistent with those studies that have found positive impacts of IT investment at intermediate and basic organizational levels, this impact being registered in variables that fundamentally reflect the operational performance of the company (Barua *et al.*, 1995; Mukhopadhyay *et al.*, 1997). They are also consistent with the paper by Sriram and Stump (2004) in the context of the purchasing function.

The acceptance of *H1* indicates that there is a positive relationship between IT investment and purchasing performance. The testing of *H2* and *H3* will provide information about the nature of this relationship. According to the procedure proposed by Judd and Kenny (1981) and Baron and Kenny (1986) commented upon above, three conditions must be fulfilled to accept *H2*.

- (1) Purchasing operational performance must be regressed on IT investment, which must present a significant and positive coefficient.
- (2) The implementation of advanced purchasing practices must be regressed on IT investment, which must also present a significant and positive coefficient.
- (3) Purchasing operational performance must be regressed on both IT investment and the implementation of advanced purchasing practices, the latter must show a positive and significant effect, and the effect of IT investment must be weaker and less significant than in the regression of condition 1.

The acceptance of *H1* implies the fulfillment of the first condition. Models 1 and 2 in Table V show a significant and positive effect of IT investment on four of the five dimensions of purchasing performance. Thus, *H2* is possible only for these four dimensions. Models 1 and 2 in Table VI show that the second condition is met. For each advanced purchasing practice as dependent variable, the control variables were first introduced as independent variables in model 1 and the measurement of IT investment was subsequently incorporated in model 2. Model 2 has a predictive power significantly higher than model 1. That is to say, the coefficient of IT investment is significant (at a minimum confidence level of 90 percent) and positive in model 2 and the second condition necessary to accept *H2* is therefore met. The third condition requires that the explanatory power of IT investment registered in model 2 of Table V should decrease when the advanced purchasing practices are incorporated as independent variables. This exercise is shown in model 3 of Table V. In three cases (quality, dependability and flexibility) the coefficient of IT investment shrinks and is no longer significant, thus indicating that mediation is complete. In the case of purchasing efficiency, the coefficient decreases less sharply and is still significant at the confidence level of 95 percent. This indicates that mediation is partial for this dimension of performance. Given the high collinearity between the different purchasing practices considered in the analysis, trying to distinguish which of them have a significant effect on performance and act as mediators can lead to erroneous

Table VI.

Regression of advanced purchasing practices on IT investment and strategic integration of purchasing

	Collaborative relationships			Advanced purchasing practices			Logistics integration				
	Model 1	Model 2	Model 3	Supplier evaluation Model 1	Supplier involvement Model 2	Model 3	Model 1	Model 2	Model 3		
Intercept	5.325**	4.777**	4.208**	5.182**	3.950**	3.122**	3.303**	1.435**	3.619**	2.058**	0.843
Company size	0.004	-0.001	-0.007	0.046*	0.034+	0.026	0.050*	0.033	0.078**	0.064*	0.052*
Purchasing relevance in organizational design	0.012	-0.020	-0.142	0.188	0.117	-0.062	0.657**	0.549*	0.256	0.166	-0.095
Electric and electronic industry	0.279	0.250	0.293	0.257	0.193	0.255	0.019	-0.077	-0.002	-0.079	0.012
Transport equipment industry	0.133	0.126	0.079	0.211	0.196	0.128	0.409	0.385	-0.498	-0.517+	-0.617*
IT investment	-	0.126+	0.081	-	0.282**	0.217**	-	0.428**	-	0.358**	0.262**
Strategic integration of purchasing	-	-	0.181*	-	-	0.263**	-	-	-	-	0.386**
R ²	0.015	0.041	0.082	0.052	0.151**	0.215	0.096	0.241**	0.084	0.179	0.261
F	0.501	1.158	1.996+	1.878	4.801	6.105**	3.610**	8.594**	3.131*	5.895**	7.899**

Notes: * $p < 0.05$; ** $p < 0.01$; + $p < 0.10$

interpretations. All the practices must be interpreted as a whole. In any case, the results indicate that the third condition is met and support *H2* for four of the five dimensions of purchasing operational performance. In general, they indicate that advanced purchasing practices act as complete mediators. That is, all the effect of IT investment on purchasing performance is channeled through its effect on the implementation of advanced purchasing practices.

These results help us to learn how the effect of IT on operational performance takes place within the purchasing function, and they are consistent with the abundant literature that holds that this effect is mediated by certain management practices and by the way in which business processes are carried out (Dehning and Richardson, 2002; Dedrick *et al.*, 2003). The results are also consistent with the paper by Sriram and Stump (2004), which shows the mediating role played by the establishment of collaborative relationships with suppliers, and with the studies by Stump and Sriram (1997) and Ellram and Zsidisin (2002), which show a relationship between the acquisition of IT and certain purchasing management practices. This research, however, shows that a broader set of purchasing practices intervene in the relationship between IT investment and operational performance in the purchasing function.

Testing *H3* – which proposes the mediating role played by the strategic integration of purchasing in the relationship between IT investment and the implementation of advanced purchasing practices – also requires the fulfillment of the three conditions established by Judd and Kenny (1981) and Baron and Kenny (1986):

- (1) The implementation of advanced purchasing practices must be regressed on IT investment, which must present a significant and positive coefficient.
- (2) The measure of strategic integration of purchasing must be regressed on IT investment, which must also present a significant and positive coefficient.
- (3) The implementation of advanced purchasing practices must be regressed on both IT investment and the strategic integration of purchasing, the latter must show a positive and significant effect, and the effect of IT investment must be weaker and less significant than in the regression of condition 1.

The first condition is equal to the second condition needed to accept *H2* and, according to models 1 and 2 of Table VI, it is met. Table VII provides information to assess the fulfillment of the second condition. It shows the results of a regression that includes

	Strategic integration of purchasing	
	Model 1	Model 2
Intercept	4.230 *	3.147 *
Company size	0.041 **	0.031
Purchasing relevance in organizational design	0.739 *	0.677 *
Electric and electronic industry	-0.181	-0.237
Transport equipment industry	0.273	0.259
IT investment	-	0.248 *
R^2	0.131	0.197
F	5.115 **	6.641 *

Notes: * $p < 0.01$; ** $p < 0.10$

Table VII.
Regression of strategic
integration of purchasing
on IT investment

strategic integration of purchasing as dependent variable and the control variables and IT investment as independent variables. Also in this case two models have been distinguished, the first one exclusively including the control variables and the second one incorporating the measure of IT investment. The coefficient of IT investment is positive and significant in model 2, thus indicating that the second condition is met. Furthermore, according to what is reasonable to expect, the analyses show a strong relationship between the relevance of the purchasing function in the organizational hierarchy and the degree of strategic integration of this function, thereby providing additional signs of the validity of the data. The third condition requires that, for each advanced purchasing practice, the predictive power of IT investment registered in model 2 of Table VI decreases when strategic integration of purchasing is incorporated as independent variable. Model 3 in Table VI shows the results of this analysis for each advanced purchasing practice and reveals that the coefficient of IT investment decreases for all the dependent variables, but only in the case of collaborative relationships is it no longer significant. Thus, the results suggest that the strategic integration of purchasing mediates the relationship between IT investment and advanced purchasing practices in all cases, and they also indicate that generally the mediation is partial. *H3* is therefore accepted. That is, only a part of the effect of IT investment on the implementation of advanced purchasing practices is channeled through its effect on the strategic integration of purchasing.

These results suggest that part of the influence of IT investments on the adoption of advanced purchasing practices is due to the fact that IT facilitates the strategic integration of purchasing. This greater recognition of the purchasing function within the organization allows it to obtain extra resources to develop more sophisticated practices. Although previous empirical research along these lines does not exist, the results are consistent with the theoretical arguments developed in the few papers that have related IT to the strategic integration of purchasing (Chen and Paulraj, 2004a, b).

Although data analyses support *H2* and *H3*, in the first case mediation seems to be complete and in the second one it tends to be partial. Thus, in the first case, the data indicates that, although there is an effect of IT investment on purchasing performance, this effect does not appear to be direct but it takes place through the implementation of advanced purchasing practices. In the second case, the analyses reveal that there is both a direct effect and an indirect effect through an increase of the strategic integration of purchasing. These results led us to propose a revised version of the initial model (Figure 1), which is shown in Figure 2. As suggested in *H1*, there is a relationship between IT investment and purchasing performance, but it is channeled through the other two variables considered in the analysis. In order to ensure the robustness of the results reached with the regression analyses, this revised model was estimated with a structural equation modeling analysis (Figure 3). To keep parsimony, the estimated model includes the second order latent constructs that underlie, respectively, the implementation of advanced purchasing practices and the different dimensions of purchasing operational performance identified as relevant in the previous analyses. The χ^2 test as well as the absolute and incremental goodness-of-fit indexes indicate a good model fit (Figure 3). The coefficients of the different relationships are significant at the confidence level of 99 percent. This analysis therefore confirms that both the degree of strategic integration of purchasing and the implementation of advanced purchasing practices are necessary and must be taken

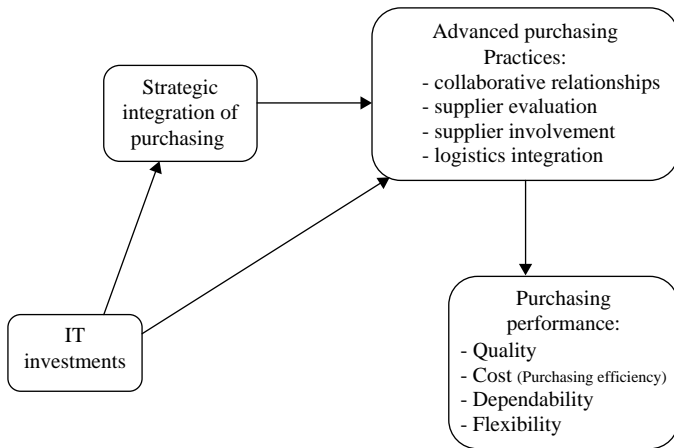


Figure 2. Revised model

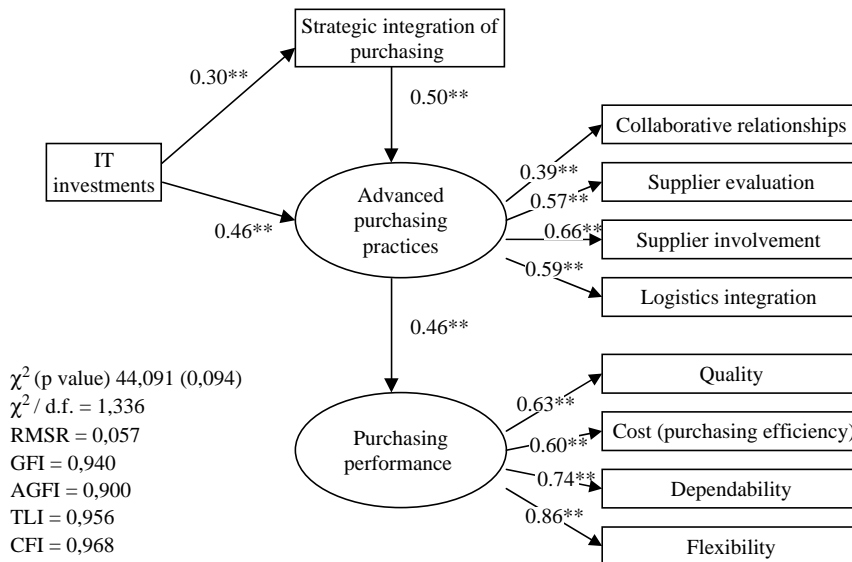


Figure 3. Estimation of the revised model with structural equation modeling

into account to understand the relationship between IT investment and operational performance in the purchasing function.

5. Conclusions

The objective of this paper was to analyze the relationship between IT investment and operational performance in the purchasing function. Not only have we theoretically argued and empirically shown that this relationship exists, but we have also identified the mediating role played by two variables: the implementation of advanced purchasing practices and the degree of strategic integration of the purchasing function. The results have theoretical as well as practical implications.

From a theoretical point of view, this research has provided evidence that supports the existence of a positive effect of IT investments on several dimensions of purchasing operational performance. Nonetheless, the results suggest that this effect is produced as long as this IT is used to better implement a series of advanced purchasing practices and, partially, as long as IT facilitates greater strategic integration of the purchasing function. The fact that IT investment is related to the degree of strategic integration of purchasing, the selection of purchasing practices, and the achieved performance reveals that the influence of IT in the purchasing function takes place in very different ways and at different levels. IT therefore constitutes a determinant factor that should be taken into account in diverse areas of the purchasing and supply management literature.

In terms of Dewett and Jones (2001), it can be concluded that the information efficiencies and synergies derived from the adoption of IT are used to increase the strategic integration of purchasing and, mainly, to implement and develop certain advanced purchasing practices such as collaboration with suppliers, supplier evaluation, supplier involvement in product design and development, and logistics integration. The implementation of these practices is what actually allows the company to improve several dimensions of operational performance without damaging others. These advanced practices are especially relevant to turn IT investment into improvements in quality, dependability and flexibility. Therefore, the combination of both elements, IT and advanced practices, are essential in order to induce the purchasing function to effectively support a differentiation strategy without reducing efficiency.

From a practical point of view, top management should take into account that the integration of IT in the purchasing function contributes to the development of more sophisticated practices and helps to achieve better operational performance. Furthermore, IT can also help to integrate the purchasing function into the strategic planning process so that its actions are better aligned with business objectives and with the objectives of other functions. IT investments can therefore be understood as an antecedent or a necessary means to developing a more proactive purchasing function capable of playing a more relevant role in the organization. It appears to be an especially necessary measure for those companies that are experiencing a growing dependence on suppliers. These investments must not only consist of the acquisition of equipment and applications (hardware and software), but also of the development of human and managerial capabilities that facilitate an appropriate use of this equipment and applications.

As noted earlier, other interpretations of causality are also possible. On the one hand, the strategic integration of the purchasing function could be viewed as an antecedent of IT investment because it denotes a greater chance of obtaining organizational resources for this function. In this sense it might be thought that part of the effect of the strategic integration of purchasing on the implementation of advanced purchasing practices is due to the capacity of purchasing to accomplish IT investments. On the other hand, some authors have viewed IT investment as a consequence of the implementation of advanced purchasing practices (Ellram and Zsidisin, 2002). This is based on the idea that these practices require IT to be either fully implemented or fully efficient. However, in the first case, IT should be viewed as a necessary antecedent of advanced purchasing practices (rather than a consequence) and, in the second case, as a moderator of the relationship between these practices and purchasing performance (rather than as a mediator of this relationship). This second

alternative has not been tested in this paper, but it is not necessarily incompatible with the proposed effects. In any case, although alternative interpretations are possible, the essence of the model continues to be the same: IT investment is key for the development and success of the purchasing function.

The limitations of this paper suggest directions for future research. First, longitudinal analysis and case studies could help to identify the most appropriate causal interpretation of the results. Testing moderating effects would also shed light on the problem. Second, this paper has exclusively focused on the operational performance of a single function. It would be interesting to replicate the analyses in other functions and to analyze under which circumstances of inter-functional alignment better performance at the functional level is more likely to lead to better performance at the business level. Third, this research relies on the perceptions of purchasing managers. Although there are multiple barriers to obtaining objective data at the functional level, any effort along these lines would contribute to improving the validity of the results. Finally, this paper has considered very general facets of IT investment. More disaggregated information on the specific character of these investments (e.g. types of hardware, software or training activities) would lead to more precise conclusions and to more detailed advice for managers.

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