# FROM IT RESOURCES TO PERFORMANCE IN COMPETITIVE AGGRESSIVENESS LANDSCAPES: THE MEDIATING ROLE OF GREEN SUPPLY CHAIN MANAGEMENT CAPABILITY (011-0057)

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**Abstract (011-0057)**

Drawing on a resource-based view, the literatures on operations management (OM) and management information systems (MIS) have recently demonstrated and emphasized that information technology (IT) business value, namely IT impact on organizational performance (OP), is generated indirectly, not directly, by means of other higher-order business capabilities. This study investigates the mediating role of green supply chain management capabilities (e.g., Zhu and Sarkis, 2004) in the relationship between IT resources (technological IT assets and human IT capabilities) and OP. Additionally, building upon contingency theory, we argue that these relationships are moderated by the level of competitive aggressiveness in the landscape (Ferrier, 2001). A proposed research model and hypotheses are tested by using cross-sectional survey data collected from a sample of 203 Spanish firms. This is complemented by the use of objective data to measure OP. The implications of the findings for researchers and practitioners are discussed and further research directions suggested.

**Keywords:** Sustainability, green supply chain management, IT resources, competitive aggressiveness, OM-MIS interface

## 1. Introduction

The literature on Operations Management (OM), Management Information Systems (MIS), and Strategic Management (SM), has recently demonstrated and emphasized that information technology business value (ITBV)—namely, IT's impact on organizational performance (OP)—is generated not directly but indirectly, by means of other higher-order business capabilities. Social and corporate concern for green issues has also increased significantly in recent years. "Environmental issues are becoming increasingly important in organization theory and practice" (Banerjee, 2001: 498). Specifically, academic and corporate interest in

sustainable supply chain management (SCM) has risen considerably. However, we know relatively little about the relationships between the IT artifact, environmentalism in the SCM and competitive aggressiveness landscapes.

Various studies have combined an IT-business complementarity perspective with a resource-based view (RBV) and a dynamic capabilities theory to propose and test core competences (e.g., Ravichandran and Lertwongsatien, 2002), complementary human and business resources (e.g., Teo and Ranganathan, 2003), and dynamic capabilities (e.g. Sher and Lee, 2004) as missing links that mediate the IT-based generation of business value. Specifically, cutting-edge evidence shows that good examples of business variables that mediate the IT artifact-OP link are: (1) SCM capabilities (e.g., Byrd and Davidson, 2003; Wu et al., 2006), (2) digital options and agility capabilities (e.g., Sambamurthy et al., 2003), (3) manufacturing, marketing and supply chain (SC) processes (Bharadwaj et al., 2007), and (4) production information integration with suppliers (Devaraj et al., 2007). Further, building on Environmental Management (EM) and green SCM (GSCM) practices literatures, several authors have found positive and significant relationships of GSCM practices with green performance and/or OP (e.g., Rao, 2002; Zhu and Sarkis, 2004 and 2007; Gonzalez-Benito and Gonzalez-Benito, 2008; Zhu et al., 2008).

However, we know relatively little about the IT-green issues interface. First, the relationship between IT resources and GSCM capabilities is poorly understood. Second, even if research has tested the mediating role of SCM capabilities in ITBV, there has been relatively little study of the mediating role of their sustainability in this issue. Third, the combination of the former set of relationships with the landscape's level of competitive aggressiveness has received insufficient analysis. Finally, according to Melville et al. (2004), the study of ITBV

is almost unknown in firms outside the U.S. These issues are even less familiar in the Spanish entrepreneurial context, there being extremely little research in the main international forums to date. To the best of our knowledge, this is the first study that analyzes the mediating role of GSCMC and the moderating effects of the competitive aggressiveness landscape on the relationship between technological and human IT resources and OP in the Spanish entrepreneurial context. We define GSCM as the firms' ability to implement GSCM practices (e.g., Zhu and Sarkis, 2004; Vachon, 2007) in order to generate business and/or environmental value. We conceptualize competitive aggressiveness landscape as a business sector in which the competitive attacks of firms are high in volume, duration, complexity, and unpredictability (e.g., Ferrier et al., 1999; Ferrier, 2001).

Specifically, the purpose of this study is to analyze the relationships between IT resources [technological IT (TIT) assets and human IT (HIT) capabilities], GSCM capabilities, OP, and competitive aggressiveness landscape in the context of leading Spanish firms. To achieve this, we pose the following research questions: (1) How does GSCM capability help firms to improve their OP?, (2) how should IT resources be configured and oriented to aid in the development of complex and green capabilities such as GSCM capabilities?, (3) do IT resources influence OP by means of GSCM capabilities?, and (4) are the foregoing relationships strengthened by higher levels of competitive aggressiveness in the scenario? The study is consistent with an IT-business complementarity perspective (e.g., Bharadwaj et al., 2007), the indirect view (e.g., Pavlou and El Sawy, 2006), or a contingency approach, suggesting the need to consider other variables that may mediate or moderate payoff from the IT artifact (e.g., Weill, 1992; Ray et al., 2005). Our approach is also consistent with the process approach to the question of ITBV. This suggests that enterprise-level IT impact should be measured with regard to performance of specific business processes (i.e., SC,

organizational agility, information sharing) (e.g., Barua et al., 1995; Ray et al., 2004 and 2005). This research also is consistent with an RBV (e.g., Barney, 1991), dynamic capabilities theory (e.g., Teece et al., 1997), and contingency theory (e.g., Burns and Stalker, 1961). The proposed research model and hypotheses are tested using cross-sectional survey data collected from a sample of 203 Spanish firms, complemented by the use of objective data to measure OP. Overall, our data provide strong support for the hypothesized relationships.

The paper is structured as follows. The next section presents a brief literature review of prior research from the IT-business complementarity perspective. The third section introduces the key latent variables in the study and develops the hypotheses linked to the constructs of TIT assets and HIT capabilities, GSCM capability, OP, and competitive aggressiveness landscape. The research model section includes information on the proposed research model, the operationalization of variables, and data collection. After the data analysis and results, the study discusses the results and conclusions, analyzing the key findings, limitations, suggestions for future research, and contributions to research and practice. Finally, we include three appendices with the instructions, response scales, and purified measurement items for the main constructs of the research.

## 2. The Complementarity of IT Business Value

The attempt to resolve the IT productivity paradox (e.g., Roach, 1991; Brynjolfsson, 1993; Brynjolfsson and Hitt, 1996 and 1998; Lucas and Spliter, 1999; Porter, 2001) has generated much debate and research in recent decades. The empirical evidence to date has yielded truly mixed and contradictory results (Devaraj and Kohli, 2003; Wade and Hulland, 2004; Coltman et al., 2007). The following relationships have been proposed or demonstrated between IT and OP: A direct and positive relationship (e.g., Jelassi and Figon, 1994; Mata et al., 1995;

Brynjolffsson and Hitt, 1996; Bharadwaj, 2000; Santhanam and Hartono, 2003); a direct and negative relationship (e.g., Warner, 1987; Weill, 1992; Brynjolffsson, 1993; Barua et al., 1995); the absence of effects between the two variables (e.g., Venkatraman and Zaheer, 1990); and indirect and positive, or contingent effects (e.g., Clemons and Row, 1991; Powell and Dent-Micallef, 1997; Brynjolffsson et al., 1998; Li and Ye, 1999; Ravichandran and Lertwongsatien, 2002; Devaraj and Kohli, 2003; Sher and Lee, 2004; Wade and Hulland, 2004; Tanriverdi, 2005 and 2006; Pavlou and El Sawy, 2006; Coltman et al., 2007; Devaraj et al., 2007).

Based on our exhaustive analysis of the ITBV literature[1], we can confirm that a growing majority of these studies indicate and/or provide evidence that IT-business complementarities have value for the firm. In other words, it is quite probable that IT resources only enable the firm to generate superior OP in the presence, or with the interaction, of other higher-order business/organizational capabilities. It follows from this evidence that IT impacts on business performance are indirect or contingent. In our opinion, the study by Clemons and Row (1991) advances beyond the study of IT impact on the sustainability of superior OP. Their study proposes conceptually that IT per se does not help in obtaining a sustained competitive advantage (SCA) over competitors, although it could help other business resources to do so. Some years later, Powell and Dent-Micallef (1997) demonstrate empirically the so-called

[1] We followed the three-stage methodology proposed by Webster and Watson (2002) to identify research articles. This methodology has been used previously in the MIS literature (e.g., Melville et al., 2004). First, introducing keywords associated with this research, we searched journal databases (e.g., *Business Source Premier, ISI Web of Knowledge Searcher*) and browsed the titles of articles in leading MIS and Management journals (e.g., *MIS Quarterly, Academy of Management Journal, Organization Science, Strategic Management Journal, Information Systems Research, Management Science, Journal of Operations Management, Information & Management, Journal of Information Technology*) and conference proceedings [e.g., *International Conference on Information Systems (ICIS), Academy of Management Annual Meeting, Annual Production and Operations Management Society (POMS) Conference, European Conference on Information Systems*]. Second, we used citations to identify articles as further sources. Finally, we also identified prior reviews of the literature (e.g., Chan, 2000; Melville et al., 2004; Wade and Hulland, 2004).

strategic necessity hypothesis. This shows that using IT to leverage intangible, complementary human and business resources leads to sustainable performance advantages. Using secondary data, Li and Ye (1999) subsequently show evidence that IT investing has a stronger positive impact on financial performance when changes in the environment are greater, firm strategy more proactive, and links between Chief Executive Officer (CEO) and Chief Information Officer (CIO) closer. Recently, from an IT-business complementarity perspective many missing links have been proposed and/or tested in the literature about MIS, OM, and SM. Thus, the following factors have been proposed and tested as mediating variables in the IT-based generation of business value: Core competences (Ravichandran and Lertwongsatien, 2002), the complementary human and business resources (Teo and Ranganathan, 2003; Wade and Hulland, 2004), and the organizational competences necessary to adopt and use IT successfully (Caldeira and Ward, 2003). Specifically, the most recent evidence shows that good examples of organizational variables that mediate the relationships between the IT artifact and OP are: SCM capabilities (e.g., Byrd and Davidson, 2003), digital options and agility capabilities (e.g., Sambamurthy et al., 2003), dynamic capabilities (e.g., Sher and Lee, 2004), new product development (NPD) dynamic capabilities and NPD functional competences (Pavlou and El Sawy, 2006), manufacturing, marketing and SC processes (Bharadwaj et al., 2007), production information integration with suppliers (Devaraj et al., 2007), and co-specialized relational assets (Saraf et al., 2007). Table 1 includes a selection from our literature review of some of the most representative papers from an IT-business complementarity perspective.

| Table 1: Selected Studies of ITBV from an IT-Business Complementarity Perspective[2] | | | | |
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| **Authors (In Chronological Order)** | **Title** | **Publication** | **Type of Paper** | **Conclusions** |
| Clemons and Row (1991) | "Sustaining IT advantage: The role of structural differences" | *MIS Quarterly* | Conceptual | Proposes the strategic necessity hypothesis. They argue that IT per se does not generate SCA but that it can help other resources to do so |
| Powell and Dent-Micallef (1997) | "Information technology as competitive advantage: The role of human, business, and technology resources" | *Strategic Management Journal* | Empirical (survey) | They provide empirical evidence for the proposal of Clemons and Row (1991), demonstrating that using IT to leverage intangible, complementarity human and business resources leads to SCA in the retail industry |
| Li and Ye (1999) | "Information technology and firm performance: Linking with environmental, strategic and managerial contexts" | *Information & Management* | Empirical (secondary data) | IT spending has a stronger positive impact on financial performance when changes in the environment are greater, firm strategy more proactive, and the links between CEO and CIO closer |
| Ravichandran and Lertwongsatien (2002) | "Impact of information systems resources and capabilities on firm performance: A resource-based perspective" | *ICIS Proceedings* | Empirical (survey) | Information systems (IS) capabilities permit firms to develop core competences that are positively and significantly related to firm performance |
| Byrd and Davidson (2003) | "Examining possible antecedents of IT impact on the supply chain and its effect on firm performance" | *Information & Management* | Empirical (survey) | IT technical skills, IT plan utilization, and top management support of IT increase the impact of IT on SC, which in turn leads to superior firm performance |
| Caldeira and Ward (2003) | "Using resource-based theory to interpret the successful adoption and use of information systems and technology and manufacturing | *European Journal of Information Systems* | Empirical (cases study) | In an industrial context of small and medium enterprises (SMEs), the development of both IT internal skills and top management support of IT helps to develop organizational competences necessary to adopt and use |

[2] The list of studies analyzed by the authors was far greater than that included in Table 1. For reasons of space and brevity, the authors decided to present only a selection. The full list is available upon request.

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|---|---|---|---|---|
| | small and medium-sized enterprises" | | | IT successfully |
| Sambamurthy et al. (2003) | "Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms" | *MIS Quarterly* | Conceptual | IT competence enables firms to develop digital options capability, which in turn enables development of agility capabilities, capabilities that can increase the quality of competitive actions. These relationships are moderated by entrepreneurial alertness. Implementing appropriate competitive actions leads to superior financial performance. They argue an integrated perspective on IT and business |
| Teo and Ranganathan (2003) | "Leveraging IT resources and capabilities at the Housing and Development Board" | *Journal of Strategic Information Systems* | Case study | When IT resources and capabilities are complemented with human and business resources and capabilities, they lead to superior performance |
| Melville et al. (2004) | "Review: Information technology and organizational performance: An integrative model of IT business value" | *MIS Quarterly* | Conceptual (literature review) | In the face of the demands of a competitive environment, IT used properly in conjunction with complementary organizational resources will improve business process performance, which in turn leads to superior organizational performance |
| Sher and Lee (2004) | "Information technology as a facilitator for enhancing dynamic capabilities through knowledge management" | *Information & Management* | Empirical (survey) | This study analyzes how IT resources help the firm to channel knowledge to develop dynamic capabilities |
| Wade and Hulland (2004) | "Review: The resource-based view and Information Systems research: Review, extension, and suggestions for future research" | *MIS Quarterly* | Conceptual (literature review) | They study the reactivity and proactivity of IT capabilities. The paper argues the complementarity between IT and business resources to generate SCA |
| Tanriverdi (2005) | "Information technology relatedness, knowledge | *MIS Quarterly* | Empirical (survey) | The impact of IT relatedness on firm performance is mediated by knowledge management |

| | | | | |
|---|---|---|---|---|
| | management capability, and performance of multibusiness firms" | | | capability. Complementarity between IT and business resources that includes the attributes generally proposed by the RBV will lead to SCA |
| Pavlou and El Sawy (2006) | "From IT leveraging competence to competitive advantage in turbulent environments: The case of new product development" | *Information Systems Research* | Empirical (survey) | IT leveraging competence in NPD indirectly influences competitive advantage (CA) in NPD through NPD dynamic capabilities and NPD functional competences (full mediation). These relationships are moderated by environmental turbulence |
| Bharadwaj et al. (2007) | "The performance effects of complementarities between information systems, marketing, manufacturing, and supply chain processes" | *Information Systems Research* | Empirical (survey and secondary data) | Complementarity between IS capability and manufacturing, marketing, and SC processes has a significant impact on manufacturing performance |
| Devaraj et al. (2007) | "Impact of e-business technologies on operational performance: The role of production information integration in the supply chain" | *Journal of Operations Management* | Empirical (survey) | E-business technologies' impact on operational performance is mediated by integration of production information with the suppliers. E-business capability is not related directly to operational performance |
| Saraf et al. (2007) | "IS application capabilities and relational value in interfirm partnerships" | *Information Systems Research* | Empirical (survey) | IS application capabilities influence business unit performance positively and significantly through co-specialized relational assets |

In summary, a growing body of literature shows what this study conceptualizes as an IT-business complementary perspective: There must be complementarity between IT resources and other higher-order organizational variables in order to obtain an IT-based CA.

## 3. A Conceptual Model of Business Value of IT Resources: The Mediating Role of Green Supply Chain Management Capability in Competitive Aggressiveness Landscapes

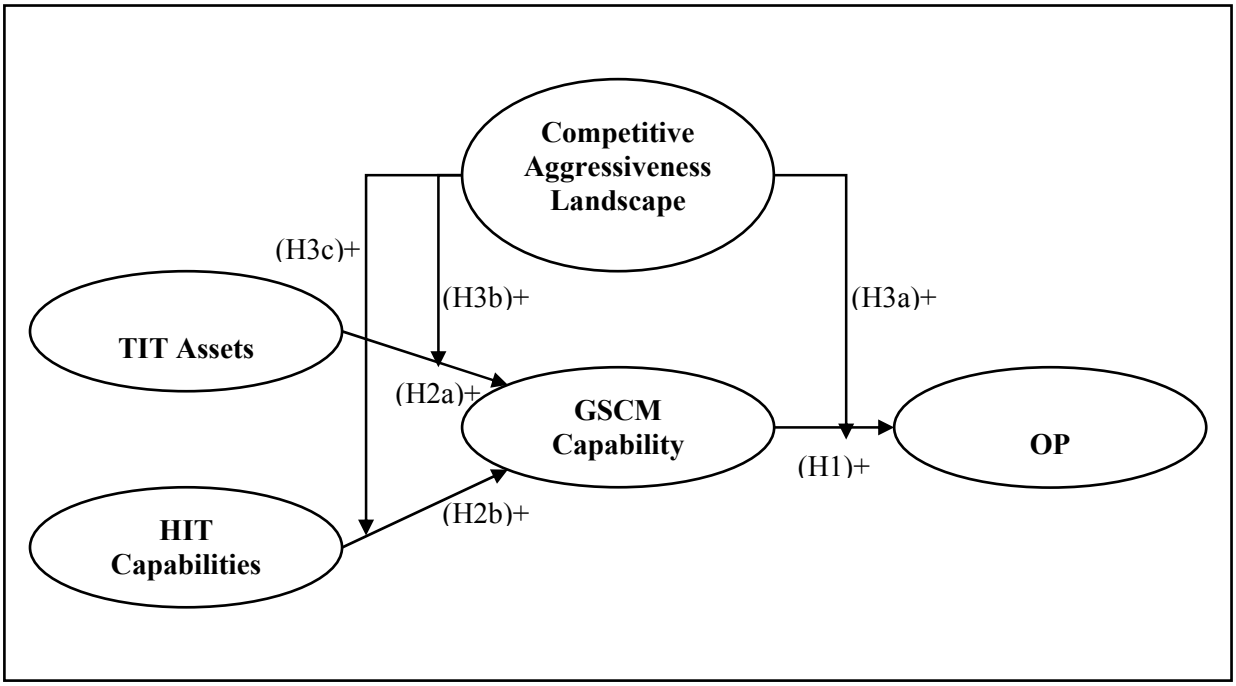
Our proposed conceptual model draws on the growing importance of environmental issues for companies and adopts an IT-business complementarity perspective. Using this framework, the model attempts to indicate the importance of the complementarity between IT resources (TIT assets and HIT capabilities) and GSCM capability to generate superior firm performance in landscapes with a higher level of competitive aggressiveness. Specifically, this paper argues that ability to implement appropriate GSCM practices (when these practices are perceived as useful to generate business and/or environmental value) is a higher-order capability that acts as a mediating variable in the link between IT resources and OP. Further, the proposed model includes the competitive aggressiveness landscapes as a moderating variable. Specifically, we argue that technological and human IT resources per se do not lead to superior OP but require the mediation of GSCM capability. Thus, we propose links between IT resources (TIT assets and HIT capabilities) and GSCM capability and between GSCM capability and OP. This paper argues that the links mentioned above will be reinforced when the firm operates in a landscape with a high level of competitive aggressiveness. We base this argument on the assumption that it is more likely that the firm will seek IT-business complementarity in a situation of competitive aggressiveness. Figure 1 (p. 12) presents our proposed research model.

### 3.1. The Effects of Green Supply Chain Management Capability on Organizational Performance

Social concern and awareness about the need for sustainability of the planet has increased significantly in recent decades. Scientific prognoses alert us to the problem of climate change. Institutions like the European Union and the United Nations are pushing for many kinds of

environmental initiatives. Customers are demanding that firms show responsible environmental corporate behaviour (e.g., in the U.S.). Environmental legislation is increasingly restrictive, and the sanctions for not complying are greater (e.g., in Spain).

**Figure 1: The Proposed Research Model**




As a result, firms are increasingly developing green capabilities in many of their processes and implementing green corporate strategies. This paper specifically studies corporate environmental behaviour by incorporating the construct GSCM capability[3] into its research model. A GSCM capability is defined in this study as a firm's ability to implement GSCM practices to improve products or manufacturing processes, environmental performance, and/or OP. We should take into account both that "the term SC describes the network of suppliers, distributors, and consumers" (Messelbeck and Whaley, 1999: 42) and that sustainability of

[3] A great variety of labels (e.g., inputs, assets, knowledge, capabilities, or competences) have been used to describe the deployment of resources (Ray et al., 2005). We classify resources into assets and capabilities. Some freestanding assets can be evaluated in isolation from others. Capabilities are defined as abilities to integrate and coordinate assets to achieve the final goal desired (e.g., Amit and Schoemaker, 1993; Teece et al., 1997; Aragon-Correa and Sharma, 2003).

SCM is not a concern exclusive to manufacturing firms but is also very useful for service firms. Sustainability must be incorporated into the main functions of the firm, including SC, even in the case of service organizations. Further, consumers are demanding sustainability, and analysts are rewarding it. Thus, among other issues, GSCM capabilities include: (1) The ability of manufacturing and service firms to implement GSCM practices as commitment and support for GSCM from managers, cross-functional for environmental improvements, the implementation of EM systems (EMS) (e.g., ISO 14001 and/or EMAS certification), the cooperation with suppliers and customers for green issues (Zhu and Sarkis, 2004), or decision-making about ways to reduce overall environmental impact of the firm's products and/or services (Vachon, 2007) among others.

Prior literature provides evidence that EM focusing on higher-order capabilities such as GSCM capabilities leads to superior firm performance (Klassen and McLaughlin, 1996; Russo and Fouts, 1997; Judge and Douglas, 1998; Klassen and Whybark, 1999; Alvarez Gil et al., 2001). The literature on SM to date shows that a number of economic benefits emerge when proactive green issues are integrated in corporate strategy (Hart, 1995; Porter and van der Linde, 1995; Shrivastava, 1995; Klassen and McLaughlin, 1996; Russo and Fouts, 1997; Judge and Douglas, 1998; Sharma and Vredenburg, 1998; Klassen and Whybark, 1999; Marcus and Nichols, 1999; Christmann, 2000; Sarkis and Cordeiro, 2001; Aragon-Correa and Sharma, 2003). These benefits include: (1) Cost savings and improvements in firms' efficiency and productivity, (2) product quality improvements (e.g., involving satisfaction of green consumers' demand for green products and services), (3) increases in market share, (4) getting ahead of competitors and legislation, (5) access to new markets, (6) enhanced employee motivation and satisfaction, (7) improvements in public or community relations, (8) improved access to credit, and (9) improvements in corporate reputation or brand image.

Building on the OM literature, several authors find positive and significant empirical relationships between GSCM practices and environmental performance and/or OP (Geffen and Rothenberg, 2000; Rao, 2002; Melnyk et al., 2003; Zhu and Sarkis, 2004 and 2007; Rao and Holt, 2005; Chien and Shih, 2007; Del Brio et al., 2008; Gonzalez-Benito and Gonzalez-Benito, 2008; Zhu et al., 2008). For instance, Zhu and Sarkis (2004) demonstrate empirically that GSCM practices are positively and significantly related to environmental and economic benefits in Chinese firms from different manufacturing industries. The implementation of GSCM practices has been associated with lower materials costs and energy consumption, decrease in fees for waste treatment and waste discharge, and decrease in fines for environmental accidents (Zhu and Sarkis, 2004; Zhu et al., 2008). An empirical study by Chien and Shih (2007) of 151 manufacturers of electrical and electronic firms in Taiwan (all with ISO 14000 EMS certification) also shows that GSCM practices improve environmental performance (reducing waste and emissions as well as increasing green commitment). The same study shows that GSCM practices also improve firms' competitiveness (improving product quality, increasing efficiency, enhancing productivity, reducing costs). This increase in competitiveness in turn causes an increase in financial performance (new marketing opportunities and higher product price, profit margin, market share, and sales volume). More recently, a study by Gonzalez-Benito and Gonzalez-Benito (2008) analyzes a sample of 184 Spanish manufacturers to obtain support for its predictions based on the idea that environmental practices in operations management generate commercial advantages such as developing the ability to access new markets, being more innovative, and obtaining public recognition.

In summary, substantial theoretical and empirical evidence in the corporate environmental strategy and GSCM practices literatures leads us to think that superior GSCM capabilities

could serve as the platform for environmental issues-based CA. We therefore hypothesize the following:

**Hypothesis 1:** Superior GSCM capability positively influences OP in leading Spanish firms.

### 3.2. The Impact of IT Resources on Organizational Performance through Green Supply Chain Management Capability

From an IT RBV, the IT artifact can be defined in terms of IT resources, whose importance is emphasized in the MIS and SM literatures (e.g., Bharadwaj, 2000; Tippins and Sohi, 2003, respectively). IT resources can be classified as TIT assets and HIT capabilities (Ross et al., 1996; Bharadwaj, 2000; Melville et al., 2004)[4]. TIT assets incorporate both IT infrastructure (i.e., shared technology and technology services across the organization) and specific business applications that utilize infrastructure (i.e., purchasing systems, sales analysis tools, e-mail systems, Intranet applications, Internet applications, etc.) (Broadbent and Weill, 1997; Melville et al., 2004; Ray et al., 2005; Coltman et al., 2007). Thus, TIT assets refer to the physical assets associated with IT, including both hardware and software. As for HIT capabilities, we follow definitions by Mata et al. (1995) and Powell and Dent-Micallef (1997), which incorporate both IT managerial skills and IT technical skills. IT managerial skills indicate IT managers' skill in identifying appropriate projects, marshalling adequate resources (Byrd and Davidson, 2003), collaborating with business units and external stakeholders[5], etc. IT technical skills refer to the technical expertise of IT personnel in database design (Ray et al., 2005), business applications software development, and communications services

[4] The most recent research on ITBV (e.g., Butler and Murphy, 2008) also considers it appropriate to study the IT artifact through constructs IT assets and capabilities.

[5] The conjunction of IT-related and business-related knowledge possessed and exchanged among IT managers and business unit or line managers on how to improve process performance and OP has been emphasized in the ITBV literature (e.g., Boynton et al., 1994; van der Heijden, 2001; Ray et al., 2005). IT managers could also play a prominent role in improving environmental performance. This would allow us to include in HIT capabilities the common understanding of IT-business management as able to use IT assets and skills to improve environmental performance.

efficiency (Byrd and Davidson, 2003). Thus, HIT capabilities are the human skills associated with IT, including IT technical personnel's skills and IT executives' abilities.

There is evidence from an IT-business complementarity perspective that IT resources in and of themselves do not lead to an increase in OP. Rather, they require the complementarity, mediation or moderation of other higher-order or complex business capabilities. Drawing on this evidence, we propose the indirect impact of IT resources on OP through the mediating role of GSCM capability. We expect firms that possess and control IT resources will develop capabilities related to GSCM more easily, which will help them to improve their OP. The foregoing is based on the following arguments: First, "in the organizations and the natural environment literatures, researchers recognize the role of a firm's resources in its development of a proactive environmental strategy" (Aragon-Correa and Sharma, 2003: 82). Along these lines, Christmann (2000) analyzes survey data from 88 chemical companies to determine that capabilities for process innovation and implementation are complementary assets. These complementary assets moderate the relationship between best EM practices and cost advantage, a significant factor in determining OP. The conceptual work of Aragon-Correa and Sharma (2003) shows that possession and/or control of organizational resources and capabilities increases firms' ability to implement proactive corporate environmental strategies. For example, they stress that cross-functional capabilities are complex capabilities that will increase the organization's ability to implement proactive environmental strategies. More recently, an empirical study by Gonzalez-Benito and Gonzalez-Benito (2008) finds a positive and significant relationship between higher availability of resources and a firm's ability to implement EM practices (e.g., ISO 14001 certification). Grant (1995) proposes a hierarchy of firm capabilities in which MIS-related functional competencies are viewed as the platform on which other higher-order organizational capabilities are built. Drawing on both

arguments, it is plausible to conclude that one role of IT resources may be to enhance higher-order capabilities like GSCM capabilities, which have a direct link to superior OP.

Second, there is almost no empirical evidence on the relationship between IT resources and GSCM practices. In contrast, MIS and OM researchers have obtained evidence on the interesting role of IT resources in efficient SCM. Byrd and Davidson (2003) demonstrate that IT technical skills, IT plan utilization, and top management support of IT increase the IT impact of the SC, in turn improving OP. Recent research has proposed, and find evidence supporting, the mediating role of SCM capabilities in analysis of the business value of IT (e.g., Rai et al., 2006; Wu et al., 2006; Dehning et al., 2007; Devaraj et al., 2007; Bharadwaj et al., 2007). For example, Bharadwaj et al. (2007) stress the complementarity of IS capabilities-SC processes. Devaraj et al. (2007) find evidence that production information integration with suppliers plays a mediating role between e-business technologies capability and operational performance.

Third, one might think that the relationship between a firm's TIT assets and green issues is one of conflict. The famous Gartner Consulting report claims that these assets were responsible for 2% of the planet's carbon dioxide emissions. However, firms could improve their green behaviour through green TIT assets, namely, green IT infrastructure and green business applications. One might conclude that TIT assets are green when their environmental impact is lower, that is, when they take into account issues like the reduction of dangerous materials, use recyclable materials, and optimize energy efficiency. Thus, to the extent that firms invest in more sustainable TIT assets, they will be reducing their environmental impact and thus improving their green performance. Manufacturers of IT equipment, who are familiar with the business opportunities that arise from investing in sustainable TIT assets,

have made many advances in business lines of green hardware and software available to companies. For example, Fujitsu Siemens' new portfolio of monitors recently presented the Premium Line model for businesses. The main added value of this model is its dramatically lower energy consumption. IBM Spain developed a full range of products to help firms improve environmental performance through green software. Thus, through a series of business applications, firms can reduce their consumption of energy and water (e.g., Green Sima); measure emissions of gases, especially those containing carbon (e.g., greenCert) and contribute to the greenhouse effect, moderate the use of carbon and energy in the entire SC (e.g., Carbon Tradeoff), find solutions for the EM of the life cycle of products (e.g., Environmental Product Lifecycle Management), or use programs that eliminate the preservation of unnecessary attached files (e.g., Lotus Notes and Domino 8.5). In a study of the Canadian and U.S. package printing industry, Vachon (2007) finds that collaboration with suppliers on green issues is positively associated with greater investment in green technologies. Furthermore, the possession of technological assets is associated with the level of implementation of GSCM practices. Klassen and Whybarck (1999) reach the same conclusions in a study of the furniture industry. More recent research stresses the role of virtualization of servers in optimizing resources and reducing the firm's energy consumption (Berrone, 2008).

Fourth, human capabilities, specifically human managerial skills, play a critical role in aligning employee skills, motivations, and abilities with organizational systems, structures, and processes that achieve capabilities at the organizational level (Teece et al., 1997). Researchers in both environmental SM (e.g., Russo and Fouts, 1997; Andersson and Bateman, 2000; Cordano and Frieze, 2000; Sharma, 2000; Aragon-Correa and Sharma, 2003); Human Resources Management (HRM) (e.g., Fernandez et al., 2003; Del Brio et al., 2007)

and OM (e.g., Zhu and Sarkis, 2004; Del Brio et al., 2008) indicate the importance that human resources have in high-performance corporate environmental behaviour. Senior and middle management skills and appropriate leadership are shown to be key factors in implementing advanced environmental approaches (e.g., Russo and Fouts, 1997; Andersson and Bateman, 2000; Cordano and Frieze, 2000; Sharma, 2000; Aragon-Correa and Sharma, 2003; Fernandez et al., 2003; Zhu and Sarkis, 2004; Del Brio et al., 2007; Del Brio et al., 2008). Employee participation in environmental issues and the use of green work teams are also recognized as key variables that increase businesses´ environmental performance (e.g., Madsen and Ulhoi, 2001; Fernandez et al., 2003; Del Brio et al., 2007; Del Brio et al., 2008). Drawing on these arguments, it seems likely that IT managers' skills, as well as IT personnel with their technical skills, can contribute positively and significantly to improving the firm's green performance. Finally, SC virtualization offers great opportunities, as well as new ways of relating to third parties (e.g., suppliers, workers, and consumers). Proper use of more and better communication mechanisms (e.g., Internet, interactive software, corporate Intranet, e-mail, etc.) will be crucial in collaboration with suppliers and consumers on green issues and in developing environmental cross-functional activities. However, it will not be enough to invest in TIT assets. IT managers must participate in these activities, exchanging knowledge with SC managers to improve environmental issues in the firm. In addition, IT workers must participate in green cross-functional teams, using their technical expertise to develop green business software, improve the efficiency of communications services, design products and services that reduce material/energy consumption, create new ways to reduce the firm's overall environmental impact, etc.

The following testable hypotheses are derived from these arguments:

**Hypothesis 2a:** TIT assets positively influence GSCM capability in leading Spanish firms.

**Hypothesis 2b:** HIT capabilities positively influence GSCM capability in leading Spanish firms.

**Hypothesis 2c:** GSCM capability mediates the link between TIT assets and OP in leading Spanish firms (full mediation).

**Hypothesis 2d:** GSCM capability mediates the link between HIT capabilities and OP in leading Spanish firms (full mediation).

### 3.3. The Moderating Role of a Competitive Aggressiveness Landscape

Research emphasizes the importance of studying the intensity of competition in a business sector (e.g., Miller and Friesen, 1978 and 1983). Ferrier et al. (1999) and Ferrier (2001) study competitive aggressiveness empirically using an approach that draws on the conceptual underpinnings of Abbott (1990) and is consistent with the hypercompetition view (D´Aveni, 1994). Competitive aggressiveness occurs when competitive attacks (i.e., the sequence of competitive action events) are high in volume, duration, complexity, and unpredictability. Attack volume indicates the number of competitive action events in each attack by key competitors in a business sector. Attack duration is defined as the time elapsed from the beginning to the end of a sequence of competitive action events. Attack complexity "is defined as the extent to which a sequence of actions is composed of actions of many different types" (Ferrier, 2001: 860). Attack unpredictability "is defined as the extent to which a firm's sequential order of competitive actions is dissimilar from one attack period to the next" (Ferrier, 2001: 861).

According to Ferrier et al. (1999) and Ferrier (2001), a business sector can be associated with as well as characterized by its level of competitive aggressiveness[6]. Our paper defines a competitive aggressiveness landscape as a business environment in which the main firms are able to initiate and sustain an aggressive pattern of competitive actions (e.g., pricing actions, marketing actions, NPD actions, capacity actions, service actions, etc.)[7]. Thus in this paper, a competitive aggressiveness landscape is conceptualized as a landscape in which firms' competitive attacks are high in volume, duration, complexity, and unpredictability.

In general, the contingent theory argument states that superior OP is a result of the proper alignment of endogenous organizational design variables with exogenous context variables (Burn and Stalker, 1961; Lawrence and Lorsch, 1967). Combining contingent theory with resource-based theory, Brush and Artz (1999) coin the term contingent resource-based theory. This theory includes a contingent perspective in assessments of the competitive value of organizational assets and capabilities (Brush and Artz, 1999). These conceptual principles indicate that the potential of assets varies in any particular business environment. The reach of the attributes that RBV establishes for resources to generate an SCA also varies. In fact, scholars have argued that firms facing hypercompetitive environments tend to be more proactive, take greater risks, use more innovative strategies (Paine and Anderson, 1977; Miles and Snow, 1978; Milliken, 1987), use more flexible forms (D´Aveni, 1994; Volberda, 1996), and ultimately deploy and use more sophisticated and complex resources (Black and Boal, 1994) than firms in less turbulent environments. In sum, the competitive scenario influences

[6] "Industry structure is a key driver of the intensity of competition among major players" (Ferrier, 2001: 872).

[7] We recognize that the competitive landscape can be defined in other ways, just as we are aware that there are other environmental characteristics that this study does not take into account. The foregoing allows us to restrict the study's conceptual and empirical limits and control the paper's length. The examples of competitive action events are taken from Young et al. (1996), Ferrier et al. (1999), and Ferrier (2001).

the business value of assets and capabilities (Barney, 2001; Priem and Butler, 2001a and 2001b).

We will now analyze the particular influence of the competitive aggressiveness landscape on relationships between TIT assets, HIT capabilities, and GSCM capabilities. First, Aragon-Correa and Sharma (2003) propose a contingent RBV of proactive corporate environmental strategy. They argue conceptually that the specific characteristics of the business environment (i.e., uncertainty, complexity, and hostility) positively moderate (reinforce) the relationship between proactive corporate environmental strategy and CA. For instance, firms in the electronic industry obtain benefits when forced by competitors to improve their EM (Hui et al., 2003). In the literature on GSCM practices, Zhu and Sarkis (2007) find that the impact of GSCM practices implementation on OP is higher (positive) under competitive external pressure.

Furthermore, the literatures in both MIS (e.g., Li and Ye, 1999; Devaraj and Kohli, 2003; Melville et al., 2004; Pavlou and El Sawy, 2006; Coltman et al., 2007) and Management (e.g., Aragon-Correa and Sharma, 2003) have shown that external environment plays a prominent role in IT resources-based business value. Specifically, Li and Ye (1999) find moderating effects of environmental dynamism on the impact of IT investment on OP. Aragon-Correa and Sharma (2003) also affirm that the relation between organizational resources and proactive corporate environmental strategy is moderated by environmental uncertainty. Melville et al. (2004) develop a conceptual argument that the complementarity between IT-business resources will depend on industry characteristics. According to these authors, the greater the competition in an industry, the greater the extent to which firms gain efficiency via IT. More recently, Pavlou and El Sawy (2006) show in a study based on a survey of 180 NPD

managers that the strategic effect of IT leveraging competence is more pronounced in higher levels of environmental turbulence. Thus, when the environment is competitively aggressive, leading to a greater need for efficient and effective management of knowledge (Grant, 1996), companies are more likely to turn to higher deployment of IT resources (TIT assets and HIT capabilities) to develop dynamic capabilities as GSCM, a key factor in improving OP.

The following testable hypotheses are derived from these arguments:

**Hypothesis 3a:** The positive relationship between GSCM capability and OP will be greater, the greater the level of competitive aggressiveness in the landscape in which the leading Spanish firms operate.

**Hypothesis 3b:** The positive relationship between TIT assets and GSCM capability will be greater, the greater the level of competitive aggressiveness in the landscape in which the leading Spanish firms operate.

**Hypothesis 3c:** The positive relationship between HIT capabilities and GSCM capability will be greater, the greater the level of competitive aggressiveness in the landscape in which the leading Spanish firms operate.

## 4. Research Methodology

### 4.1. Operationalization of Variables

Wherever possible, measurement items were adapted from existing scales. For new measures and for those that required significant changes, standard scale development procedures were used (Churchill, 1979; Pavlou and El Sawy, 2006). First, the domain of each construct was specified. Second, a large pool of items was developed based on the conceptual definition, ensuring that these items tapped the construct's domain. From this pool, items were chosen based on whether they conveyed different yet related shades of meaning. Third, the items

were refined based on pretests of the survey instrument (Churchill, 1979; Pavlou and El Sawy, 2006).

Following Ray et al. (2005) and Coltman et al. (2007), TIT assets were measured through annual IT investment per employee. The key respondent was asked to provide the organization's annual investment in IT. This figure was divided by the number of firm employees, information obtained from the database used for administration of the survey (see more below). There is no problem in using a single-item measure when respondents understand clearly that the question refers to only one characteristic. Such measures are termed concrete singular and can be captured adequately using single-item measures (Rossiter, 2002). HIT capabilities were measured with seven items from validated scales, which in some cases were adapted to the context of this paper's study (Boynton et al., 1994; van der Heijden, 2001; Byrd and Davidson, 2003; Ray et al., 2005). Appendix 1 includes the instructions, response scale, and purified measurement items for IT resources.

We measured GSCM capability using scales developed by Zhu and Sarkis (2004) and Vachon (2007) for implementation of GSCM practices, including internal EM, external GSCM practices, investment recovery, and eco-design. Items 5 and 6 were adapted to the specific nature of the study. The respondents were asked to provide information about the firm's ability to implement some GSCM practices when these practices were perceived as useful in generating business and/or environmental value for the company. Appendix 2 includes the instructions, response scale, and purified measurement items for GSCM capability.

Environmental competitive aggressiveness was measured with four new items based on the conceptual underpinnings of Ferrier et al. (1999) and Ferrier (2001), which focus on the

volume, duration, complexity, and unpredictability of competitive attacks of each firm's key competitors in its business sector. Firm size and quality management (QM) practices implementation were proposed as control variables. First, firm size has traditionally been used as a control variable when OP is used as a dependent variable (e.g., Li and Ye, 1999; Zhang, 2005). Large firms may be in a better position to achieve OP due to their ability to garner efficiencies of scale (Hitt et al., 2002; Zhu and Kraemer, 2002; Rai et al., 2006; Coltman et al., 2007). Further, large firms can develop complex capabilities like GSCM to a greater extent due to the extra resources at their command. This study controlled for firm size by computing the natural logarithm of the total number of a firm's employees (e.g., Zhu and Sarkis, 2004; Tanriverdi, 2005). This information was extracted from the *Actualidad Económica 2007* database (explained below). Second, QM practices implementation has been suggested as an important enabler of financial and marketing performance (e.g., Powell, 1995; Molina et al., 2007), as well as of employee motivation and satisfaction (Llorens-Montes et al., 2003). The implementation of QM practices also can influence the impact of GSCM practices on OP (Zhu and Sarkis, 2004). This variable was measured using two validated scale items developed by Zhu and Sarkis (2004) that focus on the implementation level of programs like ISO 9000 serial certification and Total QM (TQM). Appendix 3 includes detailed information on the scales used for the variables of competitive aggressiveness landscape and QM practices implementation.

We were concerned to include a relative measure of OP that would take into account the results of the main competitors and that would minimize the appearance of possible bias derived from common method bias. In the MIS and OM literatures, it is a very common practice to use relative measures of OP (Rai et al., 2006; Molina et al., 2007). Measuring OP by means of secondary or objective data has also been considered a good practice for

protecting the study results against common method bias. "Although the use of perceptual measures is quite prevalent in the literature, the use of objective measures is generally preferred" (Ahmad and Schroeder, 2003: 37). Thus, this study proposes to measure OP through a rate of sectorial excellence (RSE), which indicates the firms' relative sectorial performance. RSE was calculated for organizations that responded appropriately to the questionnaire, starting from the information in the *Actualidad Económica 2007* database (described below) as follows: RSE = 1 - (Ranking position of firm in the business sector in the database analyzed/ Total number of firms in the business sector in the database analyzed). In all cases, RSE will have a value between 0 and a value very close to 1 (termed the sector's maximum value)[8]. Thus, the closer the RSE is to the maximum value for the sector, the greater the relative sectorial performance obtained by the firm. The proposed RSE takes into account firms' business excellence and position in their industry with respect to their main competitors, following recommendations in the ITBV literature on how to measure competitive performance (e.g., Zahra and George, 2002; Rai et al., 2006). Furthermore, managers (e.g., Armstrong and Collopy, 1996; Song et al., 1999) and some previous research (e.g., Anderson and Zeithaml, 1984) note that market share gain is associated with higher profits.

### 4.2. Survey Development and Administration, Response Rates, and Assessment of Informant Competency

Due to the typical problems of low response rate to questions on aspects of IT and environmental strategies, extra care was taken to maximize the response rate. We followed the procedures and used the sources described above to design a questionnaire. The survey

[8] The sector's maximum value is determined by the following expression: 1 – (1 / Total number of firms in the business sector included in the database analyzed). For instance, if business sector A has 20 firms included in the database, the maximum value of the sector will be 0.95. In contrast, if industry B has a total of 15 firms, the maximum RSE value for the sector obtained by the firm will be 0.93.

instruments were pretested with 15 academic experts from five European and North American universities. We invited these experts to complete the questionnaire and then to revise and comment on its content and appearance. This was done in most cases in meetings of approximately 30 minutes and in exceptional cases by e-mail. Each participant's comments were reviewed and used to update the instrument before each new meeting. We then performed a pilot test of the questionnaire with eight managers, primarily from organizations whose main offices were in the south of Spain. In most cases, this was done through brief meetings of approximately 25 minutes. When meetings were not possible, contact was made by phone or e-mail. The participants were invited to complete the survey and provide comments about the wording of the items, especially whether they were clear and unambiguous. As a result, some of the questionnaire items were then rewritten and some words that were too technical eliminated or replaced. In both stages of this process, we assessed the face and content validity of the operational measures and ensured that informants understood the study's instructions, questions, and response scales in the intended ways.

Although a multiple-respondent approach would provide a stronger basis to demonstrate our hypothesized effects, a key respondent approach (Bagozzi et al., 1991) with a cross-sectional design was chosen to maintain an acceptable response rate. The final version of the questionnaire was sent to senior IT and business or strategy executives[9] in 1046 firms taken from *2007 edition of Actualidad Económica "Las 5000 Mayores Empresas Españolas"*[10]. *Actualidad Económica* is a Spanish business magazine that, like *Fortune*, develops an annual ranking of the most prestigious firms in different activity sectors based on revenue obtained in the past year. Both databases have been used before in the literatures on ITBV (e.g.,

[9] Thus, senior managers were targeted from two overall functional areas reducing the impact of key informant bias (Coltman et al., 2007).
[10] "*The 5000 Largest Spanish Firms*".

Tanriverdi, 2005 and 2006), Management (e.g., Aragon-Correa, 1998) and OM (e.g., Molina et al., 2007). The survey was mailed to a specific individual in each firm, in the following way. First, the questionnaire with a cover letter was mailed to firms. The letter informed the recipients that a Web-based version of the survey was available for their convenience and provided them with an individual password to access the survey. The e-mail letter assured recipients that the responses would be treated confidentially and that the results would only be reported in aggregate. Second, an e-mail reminder was sent to firms that had not responded at 2, 4, 6, 8, 10, 12, 14, 16, and 18 weeks. Finally, at 19 weeks, we again reminded the non-responding firms of the study survey, this time by telephone. This data collection process, inspired by other procedures used previously in the literature (e.g., Dillman, 2000; Tanriverdi, 2005 and 2006; Rai et al., 2006), was performed from December 2007 to April 2008.

The survey was administered in Spanish. Back translation (material translated from English to Spanish and then back into English, versions compared, discrepancies resolved) was used to ensure consistency between Spanish and the original English version of the instrument (Singh, 1995; Mullen, 1995; Bock et al., 2005; Molina et al., 2007). The first translations were prepared by a professional translator with knowledge of the material and a strong record of experience in the translation of scientific documents in this line of research.

43 organizations answered that they were not interested in participating, some due to internal company policy that prevented their participation and others due to the executives' lack of time. A total of 203 valid questionnaires from firms in 25 different sectors[11] were returned, giving an effective response rate of 20.24%. This response rate is in line with similar studies

[11] The sample's distribution by sector is as follows: Wholesale trade (19.21%), construction (17.24%), graphic arts and communications (7.88%), chemical industries (7.39%), retail trade (5.91%) and others (42.37%).

of executives (e.g., Byrd and Turner, 2001: 20.7%; Byrd and Davidson, 2003: 22.5%; Coltman et al., 2007: 18%; Saraf et al., 2007: 23%; Vachon, 2007: 23%). Further, the rate can be considered reasonable satisfactory if we take into account the difficulty of accessing companies with excellence performance. Possible bias due to non-respondent firms has been analyzed. An independent t-test did not show any statistically significant difference between early and late respondents (Armstrong and Overton, 1977) in terms of firm size, revenues, ranking position in the *Actualidad Económica 2007* database, or RSE[12]. We can be confident the responding firms represent the survey population and that there is no bias in the responding firms.

Using IT and senior business executives as key respondents for each organization is a procedure widely adopted in the Management literature. In our survey, a high percentage of informants were at the level of CEO, CIO, or higher (e.g., Vice President, Chief Financial Officer, Director of Information Systems, Director of Operations, Environmental Director, Director of Corporate Communications). Average organizational tenure of the informants was 13.3 years. Following Kumar et al. (1993), Tanriverdi (2005), and Wu et al. (2006), to determine the key respondent's evaluation of his or her expertise on the topic under investigation, the questionnaire included a final item that read, "Overall, the degree to which I am qualified to respond this survey is... (1 = Very low, 4 = Intermediate, 7 = Very high). This enabled us to determine the informant's opinion about the degree of fit between his or her skills and the questions posed. An average value of 5.39 (s.d. = 1.04) was obtained for this item. Collectively, these measures indicate that the informants were highly competent to answer the questions in the study.

[12] Details of these analyses are omitted to conserve space. A full report is available from the authors.

## 5. Data Analysis and Results

In the study tested in this paper, IT resources (TIT assets and HIT capabilities) are linked to OP through a higher-order capability, namely the GSCM capability. We also propose that these relationships are moderated by the competitive aggressiveness of the landscape in which the firms operate. Data analysis was conducted with partial least squares (PLS), a structural equation modeling (SEM) technique that uses a component-based approach to estimation. The analysis was performed using the software SmartPLS 2.0.M3 (Ringle et al., 2005). The literatures on both MIS (e.g., Ravichandran and Rai, 2000; Liang et al., 2007; Saraf et al., 2007; Im and Rai, 2008), OM (e.g., Haffer and Kristensen, 2008), and Management (e.g., Milbert et al., 2000; Sarkar et al., 2001; Schulze et al., 2008) recognize PLS as a SEM technique that is appropriate in a research context like that of this study. Because of the study's predictive and exploratory nature and the existence of moderating effects, PLS is more appropriate than other SEM techniques such as LISREL and EQS (e.g., Barclay et al., 1995; Chin, 1998a).

According to Jarvis et al. (2003), the decision to model a construct as formative or reflective should be based on four major criteria: (1) Direction of causality from construct to indicators, (2) interchangeability of indicators, (3) covariation among indicators, and (4) nomological net of construct indicators. Constructs should be modeled as reflective if the following decision rules hold: (1) The direction of causality is from constructs to indicators, (2) the indicators need to be interchangeable, (3) covariation between indicators is necessary, and (4) the nomological net of indicators may not differ. For the three first-order constructs in our research model, these decision rules suggest that the above-mentioned constructs should be

modeled as reflective[13]. Further, Zhu et al. (2008) find that GSCM practices experience interrelationships among themselves and expect these to be correlatable. The results obtained by Ferrier (2001) show some correlation between competitive attack characteristics, where for example attack volume and attack complexity co-vary in the same direction. Finally, PLS is a technique appropriate for testing hypotheses when the research model includes reflective latent variables (e.g., Saraf et al., 2007).

### 5.1. Model of Measurement

To validate our measurement model, three types of validity were assessed: Content validity, convergent validity, and discriminant validity. Content validity was established by ensuring consistency between the measurement items and the extant literature. This was done through meetings with 15 academic domain experts to pretest the survey, and the pilot test with eight practicing managers, as explained above in this paper. According to the recommendations of Hair et al. (1998), we assessed convergent validity by examining Cronbach's alpha (Cronbach, 1971), Fornell and Larcker´s measure of composite reliability (Fornell and Larcker, 1981), and average variance extracted (AVE). In Nunally´s (1978) guidelines for Cronbach's alphas and composite reliabilities, a score of 0.70 or above is an acceptable value of internal consistency and convergent validity for exploratory research. Our Cronbach's alpha values range from 0.86 to 0.91, and all or our composite reliabilities are higher than 0.82, providing strong evidence of measure reliability. The generally recommended threshold is 0.8 for basic research. Appendices 1-3 report the cross loadings and composite measure reliability used for capturing IT resources, GSCM capability, and QM practices implementation. For the AVE by a measure, a score of 0.5 is acceptable (Fornell and Larcker,

[13] We used the PLS product indicator approach for measuring interaction (Chin et al., 1996 and 2003) to test the moderating effects of competitive aggressiveness landscape (see more below). A reflective first-order model is also proposed because this procedure requires that the latent variables are reflective.

1981). Table 2 shows that, according to our measures, the AVE ranges from 0.54 to 0.75, above the acceptable value. Finally, the factor loadings from constructs to indicators are greater than 0.5 (ranging from 0.63 to 0.90), indicating that the individual reliability of the items is acceptable. All measures are significant on their path loadings at the level of 0.001. Thus, the constructs meet tests of convergent validity in our empirical context.

| Table 2: Measurement of Construct | | | | |
|---|---|---|---|---|
| **Latent Construct** | **Type** | **Number of Items** | **Cronbach´s Alpha** | **AVE** |
| HIT Capabilities | Reflective | 7 | 0.86 | 0.54 |
| GSCM Capability | Reflective | 7 | 0.91 | 0.66 |
| Competitive Aggressiveness Landscape | Reflective | 4 | 0.89 | 0.75 |
| QM Practices Implementation | Reflective | 2 | NA[14] | 0.69 |

We verified the discriminant validity of our instrument by comparing the square root of the AVE and its correlations with other latent constructs as recommended by Fornell and Larcker (1981). The result in Table 3 confirms discriminant validity: The square root of AVE for each construct is greater than the levels of correlations involving the construct. The results of the inter-construct correlations also show that each construct shares larger variance with its own measures than with other measures (Fornell and Larcker, 1981) and that each construct is different from the others (Barclay et al., 1995). These findings provide strong support for the study's content validity, convergent validity, and discriminant validity of the operational measures and response scales.

Finally, the correlation matrix (Table 3) did not indicate any exceptionally correlated variables (highest correlation among principal constructs is r = 0.46); evidence of common method bias usually results in very high correlations (r > 0.90) (Bagozzi et al., 1991; Pavlou and El Sawy, 2006). Furthermore, "it should be noted that by using the PLS algorithm under a

[14] Cronbach´s alpha is not reported for QM practices implementation, a 2-item construct.

reflective mode for all constructs, we eliminate any concerns of colinearity within blocks of variables used to represent underlying constructs" (Chin et al., 1996: 40).

| Table 3: Correlations between Constructs | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **CAL** | **FS** | **GSCMC** | **HITC** | **OP** | **QMPI** | **TITA** |
| **CAL** | **0.87*** | | | | | | |
| **FS** | 0.07 | **1** | | | | | |
| **GSCMC** | 0.46 | 0.19 | **0.81** | | | | |
| **HITC** | 0.30 | 0.12 | 0.34 | **0.74** | | | |
| **OP** | 0.23 | 0.61 | 0.43 | 0.31 | **1** | | |
| **QMPI** | 0.28 | 0.26 | 0.37 | 0.16 | 0.36 | **0.83** | |
| **TITA** | 0.21 | -0.25 | 0.27 | 0.45 | -0.01 | 0.10 | **1** |

Note: CAL: Competitive aggressiveness landscape; FS: Firm size; GSCMC: Green supply chain management capability; HITC: Human IT capabilities; OP: Organizational performance; QMPI: Quality management practices implementation; TITA: Technological IT assets.
*The shaded numbers in the diagonal row are square roots of the AVE.

### 5.2. Structural Model

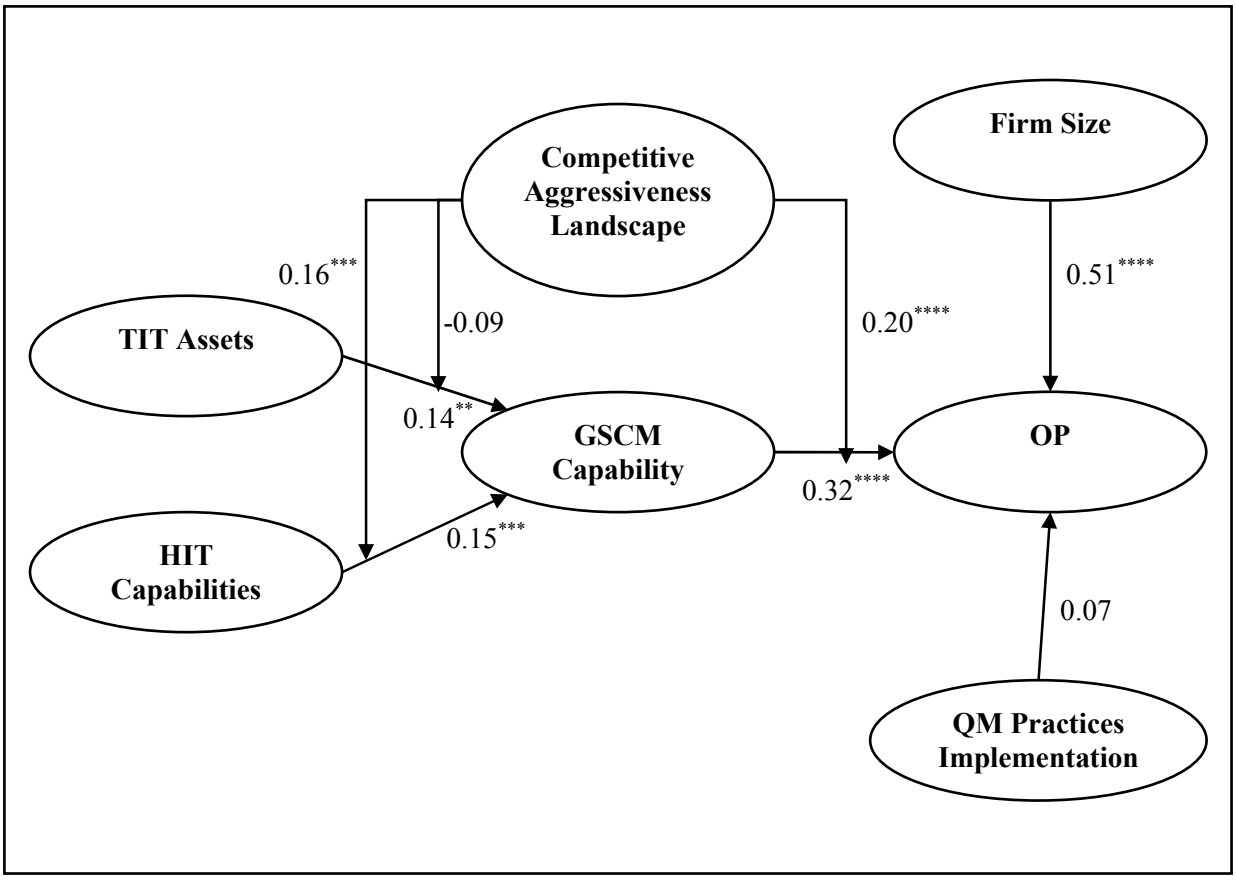
#### 5.2.1. Testing the Proposed Research Model

The proposed research model was tested with SmartPLS 2.0.M3. The PLS path coefficients are shown in Figure 2, and the significance levels were assessed with 500 bootstrap runs. The moderating effects of competitive aggressiveness landscape were tested as part of the overall structural model with interaction terms formed by cross-multiplying all standardized items of each construct, following the PLS product indicator approach for measuring interaction proposed by Chin et al. (1996 and 2003).

GSCM capability has a significant direct impact on OP (beta = 0.32, $p < 0.001$), supporting H1. Moreover, TIT assets have a significant impact on GSCM capability (beta = 0.14, $p < 0.05$), supporting H2a. HIT capabilities also lead significantly to the development of GSCM capability (beta = 0.16, $p < 0.01$), supporting H2b. The direct impact of TIT assets on OP is negative and not significant (beta = -0.05) when GSCM capability is included in the model. This supports the mediating role of GSCM capabilities and thus H2c. Contrary to the

connection hypothesized, the direct link between HIT capabilities and OP is positive and significant, even when GSCM capability is included in the model (beta = 0.14, $p < 0.01$). This result does not support H2d (see also next sub-section). Even if a significant portion of the literature on ITBV has argued the need for complementarity between HIT capabilities and other business capabilities to generate business value, HIT capabilities seem to be an important predictor of OP for leading Spanish firms in the context of this study.

**Figure 2: The PLS Path Coefficients of the Proposed Research Model**




Notes: Variance explained in bold.
** Significant at $p < 0.05$.
*** Significant at $p < 0.01$.
**** Significant at $p < 0.001$.

The impact of GSCM capabilities on OP is positively moderated by the level of competitive aggressiveness of the landscape (beta = 0.20, $p < 0.001$), supporting H3a. Surprisingly, the relationship between the interaction of TIT assets-competitive aggressiveness landscape and the GSCM capabilities turns out to be in the opposite direction of that hypothesized (beta = -0.09, not significant). This result does not support H3b. It indicates that the link between TIT assets and GSCM capabilities is not reinforced when firms challenge aggressively in their business sector. On the other hand, environmental competitive aggressiveness positively moderates the relationship between the HIT-GSCM capabilities interface (beta = 0.16, $p < 0.01$), thereby supporting H3c. We conducted tests for the moderated relationships by following Carte and Russell's (2003) recommendations, assuring that the variance explained by the moderated effects is significant beyond the main effects. More specifically, $f^2$ tests comparing the $R^2$ values between the main and interaction effects were performed (Chin et al., 1996 and 2003)[15]. This procedure has been used previously in the ITBV literature (e.g., Pavlou and El Sawy, 2006). With regard to the control variables, firm size is positive and significant (beta = 0.51, $p < 0.001$), thus validating its importance as indicated in the prior literature but not the importance of QM practices implementation (beta = 0.07, not significant).

"PLS has as its objective the explanation of variance in a regression sense, and thus $R^2$ and the significance of relationships among constructs are measures more indicative of how well a model is performing" (Barclay et al., 1995: 288). $R^2$ is 0.29 and 0.53 for the latent variables

[15] $f^2 = R^2$ (interaction model) - $R^2$ (main effects model) / [(1 – $R^2$ (main effects model)]. Interaction effect sizes are small if 0.02, medium if 0.15, and large if 0.35 (Cohen, 1988). Thus, the interaction effect between GSCM capability and competitive aggressiveness landscape (H3a) is $f^2 = 0.08$, denoting a small-to-medium effect. For the interaction effect between TIT assets and environmental competitive aggressiveness (H3b) (excluding the interaction between HIT capabilities and competitive aggressiveness landscape), $f^2 = 0.16$, which denotes a medium effect (but in the opposite direction of that hypothesized). For the effect between HIT capabilities and competitive aggressiveness landscape (H3c) (excluding the interaction between TIT assets and competitive aggressiveness landscape), $f^2 = 0.18$, which also denotes a medium effect.

GSCM capability and OP respectively. All relationships among the constructs are significant except two, indicating predictive power for the proposed research model. The $Q^2$ index or Stone-Geisser test (Stone, 1974; Geisser, 1975) has been proposed as a good index for evaluating the predictive capacity of models estimated using PLS path analysis. The Stone-Geisser test ($Q^2$) measures the goodness of fit with which the values observed are reconstructed by the model and its parameters (Chin, 1998b). It is generally accepted that a model has predictive relevance when the cross-validated redundancy ($Q^2$) > 0 for its dependent variables (e.g., Pinto et al., 2006). Using the Blindfolding procedure, we estimated $Q^2$ for GSCM capability ($Q^2 = 0.16$) and OP ($Q^2 = 0.38$). The findings show that our model has high predictive power.

### 5.2.2. Further Examining the Mediating Role of GSCM Capabilities

In this study, GSCM capability (the ability of firms to implement GSCM practices adequately) was formally hypothesized to be a key mediator in the relationship between TIT assets and OP (H2c), and between HIT capabilities and OP (H2d). To provide further support for Hypotheses 2c and 2d, we used the test of superiority of the mediating role proposed by Pavlou and El Sawy (2006). Specifically, four models were tested (excluding competitive aggressiveness landscape). Model A.1 (direct model 1) includes a direct relationship between TIT assets and OP (beta = 0.12, $p < 0.05$, $R^2 = 0.43$). Model B.1 (mediated model 1) includes the GSCM capability construct mediating between TIT assets and OP (beta = 0.04, not significant, $R^2 = 0.49$). Thus, when GSCM capability is included as mediator in Model A.1, the beta coefficient between TIT assets and OP ceases to be significant. Further, Model B.1 explains higher variance in OP than Model A.1. According to Baron and Kenny (1986), full mediation occurs when the predictor variable (i.e., TIT assets) no longer affects the dependent variable (i.e., OP) after controlling for the process variable (i.e., GSCM capability), making

the path between the predictor and dependent variables zero. From a predictive perspective, it is thus necessary to include GSCM capabilities to predict OP more accurately. In addition, GSCM capabilities fully mediate the business value of TIT assets (as hypothesized in H2c).

In contrast, Model A.2 (direct model 2, with a HIT capabilities-OP direct link) and Model B.2 (mediated model 2, including GSCM capabilities as a mediator in Model A.2) were estimated to test the mediating role of GSCM capabilities in the HIT capabilities-OP link. The comparison between Model A.2 (beta = 0.24, $p < 0.001$, $R^2 = 0.48$) and Model B.2 (beta = 0.17, $p < 0.001$, $R^2 = 0.52$) suggests that GSCM capabilities do not fully mediate the relationship between HIT capabilities and OP. Nevertheless, since the path between HIT capabilities and OP is smaller in absolute size but is still different from zero when we control for GSCM capability (Baron and Kenny, 1986), we can assume that GSCM capabilities partially mediate the impact of HIT capabilities on OP. Thus there is only partial support for H2d. Table 4 summarizes the hypothesis testing results.

## 6. Discussion and Conclusions

### 6.1. Key Findings

This study has four key findings. The first is the conceptualization and operationalization of the construct of competitive aggressiveness landscape built on studies by Ferrier et al. (1999) and Ferrier (2001). Drawing on the GSCM practices, RBV, and dynamic capabilities theory literatures, this study also conceptualizes and operationalizes the construct of GSCM capability, a complex and dynamic capability that undoubtedly merits special attention from scholars as a future line of research. This paper also proposes the RSE, a ratio that measures the relative sectorial performance obtained for each firm. The RSE can easily be constructed from well-known databases and used to measure OP relatively and objectively. Second, the

study shows that GSCM capabilities lead to superior OP and that IT resources help to develop green capabilities in the SC in Spanish firms. Third, mediating tests of GSCM capabilities in IT resources business value show an important twofold empirical result: (a) This core capability fully mediates the impact of TIT assets on OP, and (b) GSCM capabilities only partially mediate the HIT capabilities-OP link. Fourth, this study demonstrates that competitive aggressiveness of the landscape reinforces the positive impact of GSCM capability on OP. In addition, the impact of HIT capabilities on GSCM capability is higher when the scenario has a higher level of competitive aggressiveness.

**Table 4: Results of Hypothesis Testing**

| Hypothesis | Results |
|---|---|
| H1: Superior GSCM capability positively influences OP in leading Spanish firms | Supported |
| H2a: TIT assets positively influence GSCM capability in leading Spanish firms | Supported |
| H2b: HIT capabilities positively influence GSCM capability in leading Spanish firms | Supported |
| H2c: GSCM capability mediates the link between TIT assets and OP in leading Spanish firms (full mediation) | Supported |
| H2d: GSCM capability mediates the link between HIT capabilities and OP in leading Spanish firms (full mediation) | Partially supported (partial mediation) |
| H3a: The positive relationship between GSCM capability and OP will be greater, the greater the level of competitive aggressiveness in the landscape in which the leading Spanish firms operate | Supported |
| H3b: The positive relationship between TIT assets and GSCM capability will be greater, the greater the level of competitive aggressiveness in the landscape in which the leading Spanish firms operate | Not supported |
| H3c: The positive relationship between HIT capabilities and GSCM capability will be greater, the greater the level of competitive aggressiveness in the landscape in which the leading Spanish firms operate | Supported |

### 6.2. Limitations and Suggestions for Future Research

This study has both strengths and limitations, and its results must be interpreted within its limitations. First, because using multiple respondents has a high cost in terms of financial resources and response rate, we opted for a single informant. However, we tried to minimize the extent of potential common method bias by capturing and validating the dependent variable with objective archival data. Correlation analysis also confirms empirically that the results do not suffer from common method bias. The fact that the key respondent was targeted from two overall functional areas must also contribute to this effort. Further, the study is cross-sectional in nature, and its results are only generalisable to 25 business sectors of Spanish firms. However, cross-sectional studies are justified in exploratory studies that seek to identify theoretical perspectives (e.g., Coltman et al., 2007). Since Spanish firms could have different characteristics than firms in other countries, future research could extend these results in the entrepreneurial context of other countries in addition to testing the proposed research model with two key respondents.

Second, this study explores GSCM capability and competitive aggressiveness landscape using a single measure (one-dimensional construct). Possible extensions of this paper could test the proposed relationships using a multidimensional construct to measure them. Third, since the methodology used is cross-sectional and static and the study predictive and exploratory in nature, it is only possible to show association, not causality. The data show that variance in OP is associated with the complementarity between IT resources and GSCM capabilities. The data also demonstrate that this complementarity is especially important when the landscape has a high level of competitive aggressiveness. From an IT-business complementarity perspective, this result suggests that this IT-GSCM complementarity is rare and valuable. Future studies might examine the relationships proposed here in greater detail and over time

to provide support for a causal perspective. However, "while a longitudinal analysis would be a desired approach, solid cross-sectional models must first be established before future research can examine their viability over time" (Pavlou and El Sawy, 2006: 220). Fourth, this study focuses on large Spanish firms included in the *Actualidad Económica 2007* database. Future research can extend this study to SMEs.

Finally, because we propose competitive aggressiveness landscape to be associated with competitive environment, this study does not take into account the moderating effects of the environment's general characteristics (e.g., IT infrastructure of country, research and development investment, IT culture, etc.). Future research could fruitfully explore how these characteristics moderate the proposed relationships, either reinforcing or attenuating them. Scholars interested in these topics face a promising future in studying the IT-natural environment interface and determining what other resources mediate the IT-OP link. Notwithstanding its limitations, this study makes several important contributions to both theory and practice related to the literatures on ITBV and GSCM practices.

### 6.3. Contributions to Research

This study has four main contributions: (1) The conceptualization and operationalization of the constructs of competitive aggressiveness landscape and GSCM capabilities and the proposal of a new objective and relative measure of OP, namely, estimating a RSE, (2) the importance of investing in IT resources for developing green capabilities as GSCM, and the business value generated from them, (3) determination of the indirect impact of IT resources on OP through GSCM capabilities (full mediation for TIT assets and partial mediation for HIT capabilities), and (4) identification of the moderating role of competitive aggressiveness landscape. These contributions are discussed briefly below.

The concept of competitive aggressiveness in the firm's internal environment proposed by Ferrier et al. (1999) and Ferrier (2001) is used to measure the external level of competitive aggressiveness generated by firms in a business sector. This study thus extends the contributions of Ferrier et al. (1999) and Ferrier (2001) to the specific environment. As the level of competitive aggressiveness in business sectors is growing, it is likely that this extension will be useful for continuing this line of research. This paper extends the concept of GSCM practices (e.g., Zhu and Sarkis; 2004, Vachon, 2007; Zhu et al., 2008) to the technical language of two paradigms in vogue in the Management literature: RBV and dynamic capabilities theory. Our research also proposes the RSE, a relative and objective measurement of OP that can be estimated from any well-known database.

In addition, this paper breaks new ground in analysis of the IT-environmentalism interface. To the best of our knowledge, this is the first study that analyzes the mediating role of GSCM capabilities and the moderating effects of competitive aggressiveness landscape in the relationship between IT resources (TIT assets and HIT capabilities) and OP in the Spanish entrepreneurial context. Specifically, we find support for H1 (superior GSCM capability positively influences OP in leading Spanish firms). This result provides new evidence for a new higher-order green capability (i.e., GSCM capability) that leads to superior performance of firms, extending and reinforcing prior findings in the EM literature (e.g., Klassen and McLaughlin, 1996; Judge and Douglas, 1998; Alvarez Gil et al., 2001; Aragon-Correa and Sharma, 2003). The foregoing extends previous results in the OM literature concerning the business value of implementing GSCM practices (e.g., Geffen and Rothenberg, 2000; Zhu and Sarkis, 2004 and 2007; Chien and Shih, 2007; Del Brio et al., 2008; Gonzalez-Benito and Gonzalez-Benito, 2008).

Our empirical results also show a positive and significant association between IT resources and GSCM capabilities (H2a and H2b). We can conclude that the IT-natural environment interface does exist and that it is possible to deploy and configure TIT assets and HIT capabilities taking into account the natural scenario. In general, this result provides empirical evidence for the conceptual work of Aragon-Correa and Sharma (2003). They argue that organizational assets and capabilities increase firms' ability to implement proactive corporate environmental strategies. In particular, the findings derived from H2b extend prior evidence on the critical role human skills play in developing green organizational capabilities. Such evidence appears in the disciplines of Environmental SM (e.g., Russo and Fouts, 1997; Sharma, 2000), HRM (e.g., Fernandez et al., 2003) and OM (e.g., Del Brio et al., 2008). The foregoing extends the results obtained by Vachon (2007), as well as conventional wisdom in the MIS literature about the potential of IT capabilities to develop other key business capabilities (e.g., Ravichandran and Lertwongsatien, 2002; Sher and Lee, 2004).

Our data analysis shows that TIT assets indirectly impact on OP through GSCM capabilities (H2c). However, these complex capabilities only partially mediate HIT capabilities in the generation of business value. The repercussions are twofold: The findings (1) indicate a new missing link between the relationship IT assets investment-OP, and (2) incorporate sustainability into the mediating effect of SCM capabilities in ITBV. It is true that prior literature on ITBV has found several kinds of the IT capability artifact to be mediated by different kinds of higher-order business capabilities [namely, knowledge management capability (Tanriverdi, 2005), strategic flexibility (Zhang, 2005), NPD capabilities (Pavlou and El Sawy, 2006), SCM capabilities (Wu et al., 2006)]. However, data analysis show evidence that GSCM capabilities only partially mediate the HIT capabilities-OP interface, thus also indicating that HIT capabilities directly lead to OP. This conclusion is consistent

with what is probably a minority current in the MIS literature arguing that HIT capabilities may also have direct effects on OP in certain circumstances (Mata et al., 1995; Nelson and Cooprider, 1996; Dehning and Stratopoulos, 2003; Overby et al., 2006). To open the black box of the IT-business complementarity perspective, further research should clarify whether the necessary complementarity differs depending on the type of IT resource or the way the IT artifact is defined.

We also find support for Hypotheses 3a and 3c. When the landscape's level of competitive aggressiveness is higher, the positive relationships between both GSCM capabilities and OP (H3a) and between HIT capabilities and GSCM capability (H3c) are reinforced. These results also provide empirical support for the model developed by Aragon-Correa and Sharma (2003). This model proposes an RBV of proactive corporate environmental strategy in which they specify conceptually that environmental uncertainty and hostility moderate (reinforce) the relationships between proactive corporate environmental strategy and competitive advantage. The support for Hypotheses 3a and 3c also extends the conclusions obtained by Melville et al. (2004), Pavlou and El Sawy (2006), and Zhu and Sarkis (2007). H3b [the relationship between TIT assets and GSCM capability is moderated (reinforced) by the competitive aggressiveness landscape] is not supported by the data. Two explanations occur to us: (1) It is likely that the general environment characteristics (e.g., the country's IT infrastructure, research and development investment, IT culture) participate in moderating the effects of this relationship, and (2) it is plausible that IT executives value the development of HIT capabilities more than investment in TIT assets when their business sector is embroiled in competitive aggressiveness. Further research should resolve this debate.

### 6.4. Contributions to Practice

The findings of the present study have important implications for several distinct trends observed in today's business world. In a general sense, to obtain superior performance, managers should deploy IT resources (IT assets and HIT capabilities) in their firms to develop green capabilities such as GSCM (the ability to implement GSCM practices appropriately). This is especially important when a business sector's level of competition is extreme. This result indicates that the IT resources-environmentalism interaction does occur in the SC and that this complementarity is likely to be profitable. Specifically, CEOs and CIOs should perceive sustainability in the SC as an opportunity rather than a threat, an opportunity whose business value will be higher when there is competitive aggressiveness in their business industries. In this task, executives could deploy TIT assets such as Internet, interactive software, corporate Intranet, and e-mail. Executives could also deploy HIT capabilities such as sharing specific knowledge between IT and environmental managers to reduce the overall environmental impact of the firm, using IT expertise to develop green business software and to design products and services for reduced consumption of material/energy. In developing green capabilities in the SC and other key business capabilities through investment in IT, human capital skills will be more successful when there is a higher level of competitive aggressiveness in the business landscape. This is also likely to lead directly to OP. In contrast, it is likely that TIT assets help to develop GSCM capabilities directly but only lead to superior performance indirectly though these green capabilities.

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## Appendix: The Survey

| **Appendix 1: IT Resources: Instructions, Response Scale, and Purified Measurement Items** | | | | |
|---|---|---|---|---|
| **Instructions and Response Scale** | | | | |
| **Measurement Item** | | **Composite Reliability** | **Factor Loadings** | **Key References** |
| **TIT Assets:** Please indicate approximately your firm's annual expenditure dedicated to IT assets (IT infrastructure or hardware, and specific business applications or software) | | | | Ray et al. (2005); Coltman et al. (2007) |
| **HIT Capabilities:** Please indicate, on a scale of 1 to 7, the degree to which you agree or disagree with the following statements as they apply to your organization. 1 = Strongly disagree, 7 = Strongly agree | | 0.89 | | |
| HITC1 | Managers in the IT unit understand the business practices (e.g., environmental issues, agility etc.) implemented in the organization | | 0.66 | Boynton et al. (1994); Ray et al. (2005) (adapted) |
| HITC2 | There is a common understanding between managers in the IT and business units regarding how to use IT to improve business processes performance in the firm | | 0.63 | Boynton et al. (1994); Ray et al. (2005) (adapted) |
| HITC3 | There is a common understanding between managers in the IT and business units regarding how to use IT to improve OP | | 0.81 | Boynton et al. (1994); van der Heijden (2001); Ray et al. (2005) |
| HITC4 | IT managers restructure work processes to leverage IT opportunities in your firm | | 0.82 | Byrd and Davidson (2003) |
| HITC5 | IT unit skills in database design | | 0.77 | Ray et al. (2005) |

| | | | | |
|---|---|---|---|---|
| | are excellent | | | |
| HITC6 | IT unit skills in software development for business applications are excellent | | 0.71 | Byrd and Davidson (2003) |
| HITC7 | IT unit skills in communications services efficiency are excellent | | 0.70 | Byrd and Davidson (2003) |

| **Appendix 2: GSCM Capability: Instructions, Response Scale, and Purified Measurement Items** | | | | |
|---|---|---|---|---|
| **Instructions and Response Scale** | | | | |
| **Measurement Item** | | **Composite Reliability** | **Factor Loadings** | **Key References** |
| **GSCM Capability:** How would you evaluate your firm's ability to implement the following GSCM practices when they are perceived to be useful in order to generate business and/or environmental value? 1 = Poor, 4 = Good, 7 = Excellent | | 0.93 | | |
| GSCMC1 | Commitment and support for GSCM from managers | | 0.84 | Zhu and Sarkis (2004) |
| GSCMC2 | Cross-functional cooperation for environmental improvements | | 0.84 | Zhu and Sarkis (2004) |
| GSCMC3 | Design of products (or services) for reduced consumption of material/energy | | 0.79 | Zhu and Sarkis (2004) |
| GSCMC4 | EMSs exist | | 0.84 | Zhu and Sarkis (2004) |
| GSCMC5 | Collaboration with suppliers on environmental issues | | 0.83 | Zhu and Sarkis (2004) (adapted) |
| GSCMC6 | Cooperation with customers on environmental issues | | 0.77 | Zhu and Sarkis (2004) (adapted) |
| GSCMC7 | Making decisions about ways to reduce overall environmental impact of our products or services | | 0.78 | Vachon (2007) |

| **Appendix 3: Competitive Aggressiveness Landscape and Control Variables: Instructions, Response Scale, and Purified Measurement Items** | | | | |
|---|---|---|---|---|
| **Instructions and Response Scale** | | | | |
| **Measurement Item** | | **Composite Reliability** | **Factor Loadings** | **Key References** |
| **Competitive Aggressiveness Landscape:** Please indicate, on a scale of 1 to 7, the degree to which you agree or disagree with the following statements as they apply to your business sector in the last 5 years. 1 = Strongly disagree, 7 = Strongly agree | | 0.92 | | |
| CAL1 | Key competitors typically carried out competitive attacks with a high number of competitive action events (e.g., pricing actions, | | 0.88 | Ferrier et al. (1999), Ferrier (2001) (adapted) |

| | | | | |
|---|---|---|---|---|
| | marketing actions, NPD actions, capacity actions, service actions) | | | |
| CAL2 | Key competitors typically carried out competitive attacks of long duration | | 0.84 | Ferrier et al. (1999), Ferrier (2001) (adapted) |
| CAL3 | Key competitors typically carried out competitive attacks with a broad range of types of competitive actions (complex repertoire of competitive actions) | | 0.88 | Ferrier et al. (1999), Ferrier (2001) (adapted) |
| CAL4 | Key competitors typically carried out unpredictable sequences of competitive moves | | 0.87 | Ferrier et al. (1999), Ferrier (2001) (adapted) |
| **QM Practices Implementation:** How would you evaluate your firm's implementation—or where relevant, degree of implementation—of the following QM practices? 1 = Not considering it, 2 = Planning to consider it, 3 = Considering it currently, 4 = Implementation will begin in the short term, 5 = Initiating implementation currently, 6 = Intermediate implementation phase, 7 = Implementing successfully | | 0.82 | | |
| QMPI1 | ISO 9000 serial certification | | 0.76 | Zhu and Sarkis (2004) |
| QMPI2 | TQM type programs | | 0.90 | Zhu and Sarkis (2004) |

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