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Moderating effect of environmental supply chain collaboration

Evidence from Taiwan

Yenming J. Chen
Department of Logistics Management, National Kaohsiung First University of Science and Technology, Kaohsiung City, Taiwan
Yenchun Jim Wu
Graduate Institute of Global Business and Strategy, National Taiwan Normal University, Taipei City, Taiwan, and
Tienhua Wu
Department of Logistics Management, Air Force Institute of Technology, Kaohsiung, Taiwan

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Abstract

Purpose – The purpose of this paper is to explore how corporate environmental strategies, namely, environmental management strategy (EMS) and green product strategy (GPS), affect the competitiveness of a firm. In addition, this study investigates whether the environmental collaboration in supply chains (ECSC), namely, environmental collaboration with suppliers (ECS), and environmental collaboration with customers (ECC) moderate the environment-performance relationship.

Design/methodology/approach – Survey methodology and regression modeling are adopted to assess the relationship between corporate environmental strategy and competitive performance of a company, including the moderating effects of ECSC.

Findings – Competitiveness is positively affected by EMS and GPS. ECSC moderately affects the links among EMS, GPS, and competitiveness. Regarding the differences between the impacts of ECS and ECC on performance, only ECS acts as a moderator in the enhancement of EMS and GPS. Thus, ECS positively contributes to enhance competitive advantage. In contrast to perceptions, ECC directly improves firm competitiveness.

Research limitations/implications – The findings support the understanding that the moderating role of ECSC may explain the conflicting results in environment-performance linkages. In particular, suppliers and customers could impact EMS and GPS in direct or interactive ways, or both, to enhance the performance of a firm.

Practical implications – Significant performance improvements are influenced not only by the real environmental commitment of companies to internal green management but also by the positive relations of firms with their external cooperative capabilities in environmental relationships with chain partners.

Originality/value – This research is the first to suggest and empirically test the moderating impacts of ECSC on the relationship between corporate environmental strategy and competitiveness.

Keywords Competitiveness, Taiwan, Environmental management strategy, Corporate environmental strategy, Environmental collaboration in supply chains, Green product strategy

Paper type Research paper

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Introduction

As institutional forces increase, effective environment management becomes increasingly important to firms that aim for legitimacy and competitiveness (Bansal and Roth, 2000; Nidumolu *et al.*, 2009). Legal trends, such as the European Union Directives, significantly influence operation systems, product-markets, and business strategies of firms (Linton *et al.*, 2007). Consequently, electrical and electronic equipment (EEE) producers adopt process reengineering and non-toxic materials/substances in the design, production, and end-of-life treatment of products (Boks and Stevels, 2007; Walls, 2006). Globalization and competitive pressures reshape the production chains of companies and broaden the networks of business relationships. Managing supply chain (SC) members toward environmental proactivity is necessary and advantageous for brand-owning firms (Markley and Davis, 2007; Mollenkopf *et al.*, 2010). Companies, such as IBM and HP, adopt cooperative environmental innovations with chain members to deliver consumer safety benefits and eliminate environmental impacts (Huang and Wu, 2010; Seuring and Müller, 2008). Evidence indicates that green practices, especially in the SC, not only reflect environmental responsibility of firms toward society (Seuring and Müller, 2008) but also show the strategic aims of these firms in relation to improving competitiveness (Rao and Holt, 2005), minimizing risk of business interruption (Donnelly *et al.*, 2006; Seuring and Müller, 2008), and sustaining innovation for future markets (Nidumolu *et al.*, 2009).

Taiwan plays a critical role in the global value chains of the electronics industry, as exemplified by services it provides in terms of production platforms and contract manufacturing centers. For instance, Foxconn emerged as the industry's largest player with a revenue of US$ 44,065 million in 2009. With the new platform solution for low-cost mobile devices and competence upgrade, some Taiwan-based original design manufacturers and suppliers spin off their product divisions in end markets, and a few become lead firms in the computer and consumer electronics markets (e.g. Acer, ASUS, and HTC) (Sturgeon and Kawakami, 2010). In 2012, the Bureau of Foreign Trade in Taiwan specified that several Information and Communications Technology product categories, such as notebook personal computers (87.8 percent), liquid crystal display monitors (53.9 percent), and digital cameras (30 percent), demonstrate the highest global market share in terms of production value. Moreover, a large number of broadband communication terminals and broadband access device products provided by Taiwan-based firms hold the highest global market share in terms of production value, including cable customer premises equipment devices (81.0 percent), wireless local area network devices (66.9 percent), and personal navigation devices (64.0 percent). Therefore, the corporate social responsibility of Taiwan's EEE industry toward global environmental protection and sustainability becomes bigger. Export-oriented firms in Taiwan underwent significant changes during the process of internally pursuing environment-friendly practices and external collaboration with buyers to sustain a competitive role and to comply with the regulations in the global SCs. For example, Acer, ASUS, and Foxconn developed new "green standards and sustainability strategies" to meet the requirements of customers and regulators (Huang and Wu, 2010). Companies accumulated abundant experience and, sufficient knowledge in sustainable environmental policies, thereby making cooperation with other chain partners or the government possible. Thus, Taiwan merits further research on exploring effects of corporate effort and SC collaboration on environmental issues.

Firms increasingly become proactive in responding to environmental issues, but their efforts do not always guarantee positive performance (Molina-Azorín *et al.*, 2009).

However, ironically, a study by Wu *et al.* (2014) indicated the environmental issue was emphasized and discussed far more than the economic and social issues in the sustainable transport context by universities in North America and English speaking-Europe.

This condition is possibly induced by the omission of the moderating role of SC consideration in environment-performance relations. Currently, many of the existing studies focus on analyzing the direct effect of SC integration on corporate sustainability rather than on the interactive influence of SC integration on increasing performance. For example, several studies (e.g. Vachon, 2007; Vachon and Klassen, 2006, 2008) suggest that effective SC integration is beneficial in the selection of environmental technology, environmental monitoring and collaboration, and/or operations excellence. Previous research emphasizes effective supplier management as an influencing factor in environmental innovations (Sarkis, 2001), eco design (Johansson, 2002), lean production (Kleindorfer *et al.*, 2005), and green supply (Simpson and Power, 2005). Based on the perspective of green supply chain management (GSCM), Zhu and Sarkis (2004) and Zhu *et al.* (2007) showed that the existence of significant positive, and direct relationships among several GSCM practices (e.g. internal environmental management, external GSCM, and investment recovery) and performance.

Various institutional and technical variables in a chain adds to the complexity and uncertainty of environmental strategy adoption. For instance, managing SC with different regulations across countries is a challenge to environmental management (Mollenkopf *et al.*, 2010). CEOs' interpretations of environmental norms at local and global levels often affect the extent of the implementation of SC responsibility, thereby leading to variations in the practices of suppliers (Bielak *et al.*, 2007). For SC managers, sustainability as a new business model is no longer a pioneering perspective but instead a high-level requirement for the following: changes in operations (e.g. a comprehensive and ethical sourcing strategy) (McCrea, 2010); relationship management (e.g. a trust and transparency collaboration or intensive communications) (Cardon *et al.*, 2011; Mckinsey and Company, 2010); and governance systems that effectively select and manage stakeholders (Mckinsey and Company, 2010). In this context, a successful environmental strategy must be implemented as a practice of wide-ranging organizational change initiatives. In particular, this practice is intertwined within the authority control and cooperative activities of the SC of a firm on environmental issues. Thus, a linkage between environmental strategy and performance is likely constrained to or enhanced by channel members in environmental cooperation. However, very few studies explored whether or not environmental collaboration in SCs enhances corporate environmental strategy; few studies have focussed on whether or not such collaborations consequently offer better opportunities for increased competitiveness. Thus, the present research aims to fill this gap by testing the moderating role of environmental collaboration in SCs.

In this study, environmental collaboration in supply chains (ECSC) is regarded as a collaborative effort between a firm and its chain members to engage in organizational commitment and jointly provide solutions to environmental issues for performance enhancement. Environmental collaboration can be an initiative shared with upstream players, such as suppliers. Environmental collaboration can also be a cooperative relationship with downstream parties, such as customers. The manner by which environmental collaboration with suppliers (ECS) affects performance on the context of sustainability may differ from that of environmental collaboration with customers (ECC). Exploring the interactive impacts of supplier/customer collaboration involves identifying the different means of incorporating green partnerships into specific corporate environmental strategies to attain the desired performance. Hence, further research is required for this topic.

We also investigate the direct link between environmental strategy and competitiveness, and provide evidence that can clarify the research concerns regarding the effects of real environmental commitment of firms on performance. Two different corporate environmental strategies, namely, environmental management strategy (EMS) and green product strategy (GPS), are examined to understand SC interactive effects. EMS helps identify the process through which a firm's commitment to internal operations and management systems affects the firm's performance. GPS helps examine market-oriented environmental efforts for economical and beneficial outcomes. Overall, these two approaches can be linked to product, production, and managerial mechanisms from an environmental perspective (Kleindorfer *et al.*, 2005; Sarkis, 2001), and can represent the introduction of sustainability concerns into corporate environmental strategy (Hart, 2005).

We aim to examine the direct effects of corporate environmental strategy on performance. Our results might help clarify various findings in the environmental management literature regarding the impacts of a firm's real environmental commitment. Additionally, this study seeks to extend the SC theory by examining the moderating role of ECSC, particularly the different insights into supplier or customer influence on firms with a specific strategy toward sustainability. This study contributes to management knowledge by emphasizing the effects of environmental strategy and SC collaboration in a positive manner. It also discusses the implications of green resource allocation to internal management mechanisms and external cooperative capabilities for improved performance.

In the remainder of the paper, a theoretical background is presented and the research hypotheses are developed. Sections describing the methodology, empirical results, and discussion follow. The paper ends with a summary of the research and managerial implications.

Theoretical background and hypotheses

In this section, we provide a theoretical background on environmental strategy, competitiveness, and environmental collaboration in SCs, and we propose a research model in which five constructs (EMS, GPS, competitiveness, ECS, and ECC) are interrelated. The independent variables are EMS and GPS, the dependent variable is competitiveness, and the moderators are ECS and ECC (Figure 1). We define the constructs and develop the relationships between them in the following sub-sections.

Corporate environmental strategy: EMS and GPS

Corporate environmental strategy is the extent to which a company is voluntarily involved in a wide range of organizational and managerial actions to reduce its impact on the environment (Banerjee, 2001). According to Hart (2005), committing to green

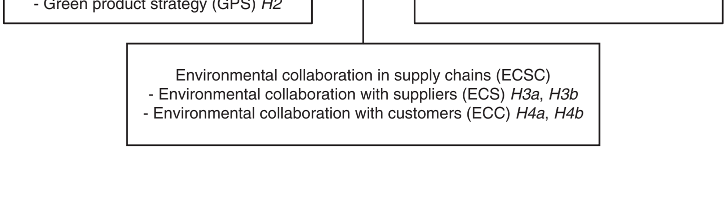

Figure 1.
The conceptual model

efforts and resources in product, process, and management systems can enhance profitability. Lee and Rhee (2007) empirically proved that firms that adopt a proactive approach emphasize the decision areas of environmental management, including products, manufacturing processes, organizations and systems, SC and recovery, and external relationship. According to Nidumolu *et al.* (2009), companies must rethink their business models, products, technologies, and processes to gain competitive advantages through sustainability innovations. In addition, Kumar *et al.* (2012) indicated that companies could address green issues at the source by rethinking everyday business practices in the product and process design phase. In this context, EMS and GPS emerge as corporate environmental strategies in need of further analysis.

In environmental management literature, three common perspectives, namely, the natural-resource-based view, stakeholder management view, and top managers' support view, are used to examine the extent of the involvement of a firm in EMS. The resource-based theory stipulates that competitiveness and sustainability might be rooted in the resources and capabilities of organizations, as well as their relationship to the natural environment (Aragón-Correa *et al.*, 2008; Hart, 2005). The stakeholder theory emphasizes the importance of effectively managing environmental expectations of stakeholders to green practice adoption and how these expectations affect green practices (Kirchoff *et al.*, 2011). Top managers' support view is related to managers' behavior, attitudes, or interpretations of environmental issues (e.g. opportunities or threats), which significantly affect the levels of managers' social responsibility and their strategic choice of corporate environmental strategy (Aragón-Correa *et al.*, 2004; Sharma, 2000). In general, considerable research suggests that firms moving toward a proactive EMS seem to exhibit unique capabilities for strategic opportunities, positively react to improved environmental practices, adopt an "ethical" attitude toward environmental issues, and effectively manage a broad range of stakeholders (Molina-Azorín *et al.*, 2009). Thus, in this study, EMS refers to a firm that commits to high levels of the three above-mentioned organizational aspects related to operations and management systems as a mechanism for attaining the desired environmental and performance benefits.

Given the integrated nature of influencing antecedents, a substantial number of these antecedents must be considered when addressing GPS. Johansson (2002) and Boks (2006) suggest relevant organizational and technical factors, including management, customer/supplier relations, development process, competence, and motivation because these factors can help with successfully integrating the eco-design principle into product development. Pujari *et al.* (2003) emphasize the underlying dimensions (environmental management focus, process, technical, and interface issues) when developing new environmental products. Boks and Stevels (2007) note that adopting the concept of design for the environment must involve a considerably broad focus that includes not only the environment, but also the following issues: multidisciplinarity, life-cycle boundaries, weighing functionalities, and stakeholder interests. In this situation, GPS is viewed as an integrated practice involving multifaceted aspects of organizational, technical, and environmental considerations in new product development, which fulfills sustainable and societal demands during the entire life cycle of a product (Johansson, 2002; Karlsson and Luttropp, 2006).

Competitiveness

In this research, competitiveness is used to measure performance. Competitiveness is perceived as the potential for a corporate environmental strategy to improve long-term profitability (Bansal and Roth, 2000). Extant literature suggests that sustainability transformed the competitive landscape, which has become a major motivational force for companies to go green (Bansal and Roth, 2000; McCrea, 2010; Nidumolu *et al.*, 2009). On one hand, executives may choose to comply with the lowest environmental standards for as long as possible. On the other hand, companies may view these regulatory and stakeholder forces as opportunities rather than threats. Companies increasingly become environment friendly, and they formulate strategic objectives to gain a competitive edge (Beske, 2012; Kleindorfer *et al.*, 2005), improve corporate image (Segarra-Oña *et al.*, 2011; Seuring and Müller, 2008), and save on costs, and obtain differentiation strengths (Christmann, 2000; Segarra-Oña *et al.*, 2011).

Currently, studies have identified the positive effects of green strategies. However, the mixed results of environment-performance links and the influence of corporate real green commitment on performance need to be clarified (Molina-Azorín *et al.*, 2009). Research elucidates that lack of financial and market returns is one of the main obstacles in achieving environmental proactivity at both focal company and SC levels (Bielak *et al.*, 2007; Burnson, 2013; Segarra-Oña *et al.*, 2011). Managers must transform environmental paradigms into profits so that companies will have the incentive to continue developing and implementing green practices (Burnson, 2013; Kumar *et al.*, 2012). Consequently, an enhanced understanding of the competitive effects of environmental strategy could help managers move toward enhanced responsibility for the natural environment, which can lead to increased leverage in economic and environmental goals. Based on the studies of Christmann (2000) and Rao and Holt (2005), this study uses indicators of cost and differentiation advantages to assess competitive performance. Such indicators focus on firms' environment- related cost reductions and firm benefits that are associated with profit margins, markets, and products.

Hypotheses for corporate environmental strategy and competitiveness

Forward-thinking companies tend to proactively adopt environment-friendly policies not only to minimize environmental loads but also to gain competitiveness and to create values. For example, firms may focus on clean production, product stewardship (Hart, 1995), and/or sustainable product development (Karlsson and Luttropp, 2006). The effectiveness of these eco-friendly practices often relies on a significant number of organizational and technical resources and on close interaction and communication with chain partners. By these green efforts, forward-thinking firms that adopt proactive EMS achieve positive performance outcomes.

Academically, studies have proven that the consequences of the relations between environmental proactivity and performance are significant and positive. For instance, Christmann (2000) empirically indicates that innovative pollution prevention technology may result in cost advantages. Rao and Holt (2005) show that greening production is a critical factor in enhancing firm competitiveness and economic performance. According to Banerjee (2001) and Kleindorfer *et al.* (2005), most of the manufacturers that implement advanced environmental activities relating to their operations process may generate cost and differentiation benefits as they reduce environmental impacts. Using the resource-based theory, Aragón-Correa *et al.* (2008) observed that firms adopting proactive environmental practices as dynamic organizational capabilities – with focus on areas of shared vision, strategic proactivity, and stakeholder management – exhibit a significantly positive financial performance. Thus, a proactive mentality regarding the linkage between the increased levels of a firm's environmental commitment and its competitiveness leads directly to our first hypothesis, as follows:

H1. A high EMS level of a firm is positively associated with firm competitiveness.

A strategy such as the development of green/sustainable products allows companies to generate innovation opportunities, which serve as a channel for these firms to become environment friendly and become leaders in the emerging green marketplaces. Previous studies indicate that eco-design principles enable a company to develop an innovative product for the improvement of eco-efficiency (van Hemel and Cramer, 2002), to generate a first-mover advantage over competitors (Kleindorfer *et al.*, 2005; Nidumolu *et al.*, 2009), and to reduce environmental loads and the consumption of resources (Karlsson and Luttropp, 2006). Pujari *et al.* (2003) provide evidence that supports the significantly positive connections among green new product development approaches, key organizational issues, and eco- and/or market-performance. Huang and Wu (2010) observe that green product innovation performance positively affects performance implications in terms of profitability and market shares. Accordingly, this study offers a second hypothesis, as follows:

H2. A high GPS level of a firm is positively associated with firm competitiveness.

ECSC

In addressing the adoption of voluntary green practices, the literature significantly highlights the role of ECSC in enhancing the results of effective environmental management. The first reason emphasizes the potential opportunities for firms to view synthesized competitive strengths when addressing green initiatives in an SC (Beske, 2012; Rao and Holt, 2005). Likewise, a research suggests that a linkage between a close SC relationship and green strategy success is demonstrable and necessary (Cardon *et al.*, 2011; Pujari *et al.*, 2003).

Previous studies view ECSC as an influencing factor in the performance of environmental practices such as eco-design concept (Johansson, 2002), lean production (Simpson and Power, 2005), and proactive environmental strategy (Lee and Rhee, 2007). Several studies use SC as a construct to explore how environment-related SC activities significantly and positively contribute to firms. For instance, researchers have suggested that effective SC cooperation in environmental operations lead to sustainability fulfillment (Sarkis, 2001), economic advantages (Zhu *et al.*, 2007), manufacturing and environmental performance (Vachon and Klassen, 2006, 2008), and accurate investment decisions related to environmental technology (Vachon, 2007). According to Beske (2012), the growth of all partners on environmental issues is a perceivable dynamic capability of a firm that can be used to gain competitive and sustainable benefits. In this sense, opportunities exist for an individual company to become a highly efficient and sustainable corporation through environment-specific SC cooperation.

The literature clearly underlines the positive influence of environmental SC practice. Firm performance and green SC goals may be directly or indirectly affected by ECSC (Handfield *et al.*, 2005; Kumar *et al.*, 2012). As previously mentioned in the Introduction, SC factors such as different environmental requirements, operational changes, and management mechanisms play a critical role in enhancing or constraining the expected performance results of environmental strategies. In several cases, cross-echelon coordination helps focal companies execute their environmental strategies more effectively, thereby enhancing their performance. However, firms could fail to achieve the desired performance outcomes because of inefficiencies and ineffectiveness throughout the chain. Therefore, this research assumes that ECSC exerts an interactive effect on the relationships among EMS, GPS, and firm competitiveness. Consistent with the results of previous studies (e.g. Vachon and Klassen, 2008), the present study groups ECSC into two categories, namely, ECS and ECC.

Hypotheses for corporate environmental strategy, ECS, and competitiveness

Drawing upon the studies of Vachon (2007), and Vachon and Klassen (2008), this study views ECS as the direct involvement of an organization with its suppliers in planning and implementing sustainable environment-friendly practices. ECS covers the following areas: suppliers' environmental management system, product design, process, distribution, and pollution prevention.

Because of the globalization of the production chain, the environmental efforts of a manufacturer must be applied across the chain; this action strengthens the abilities of the manufacturing function to remain green and advantageous (Sarkis, 2001; Simpson *et al.*, 2007). Specific manufacturing practices (e.g. lean-and-green) that, generally rely heavily on integration and value-added investment among suppliers offer sustainability outcomes (Kleindorfer *et al.*, 2005; Mollenkopf *et al.*, 2010; Simpson and Power, 2005). In addition, ECS is positively linked to delivery performance (Vachon and Klassen, 2006, 2008), and greater investment in pollution prevention technologies (Vachon, 2007). In particular, several broad concepts of environmental management systems, such as closed loop SC (Kleindorfer *et al.*, 2005) or sustainable SC management (Carter and Rogers, 2008; Seuring and Müller, 2008), implicitly or explicitly show the desired outcomes through improved supplier assessment and management. Thus, focal firms enforce stringent environmental requirements in their manufacturing facilities and closely cooperate with suppliers worldwide to achieve merits, such as energy efficiency, waste and carbon reductions, environmental innovations, cost-effective and clean production, and/or SC operation optimization (Nidumolu *et al.*, 2009; Simpson *et al.*, 2007). These benefits lead to cost reduction and revenue increase in firms. Thus, this study assumes that ECS helps companies efficiently implement EMS and enhance their competitive performance.

Analyzing and managing ECS is significantly essential to GPS. Reducing design and production complexities by ensuring superior ecological performance of suppliers may contribute to the successful modification of the ecological impact of an existing product and green new product development (Baumann *et al.*, 2002; Pujari *et al.*, 2003). Based on the case of Lucent Technologies, Donnelly *et al.* (2006) have emphasized a rigorous supplier relationship, where the environmental performance of suppliers is effectively managed to ensure that they meet legal and customer requirements while minimizing the risk of business interruption. Regarding the sustainable SC context, Seuring and Müller (2008) suggest SCM strategy for sustainable products, in which the focus on supplier environmental collaborative activities may lead to risk avoidance and performance achievement in the economic, environmental, and social areas. Similarly, Cardon *et al.* (2011) and Nidumolu *et al.* (2009) have indicated that supplier management practices, such as scaling up green materials and the manufacturing process, are highly relevant to the success of GPS in terms of cost reduction and future market domination. This study assumes that ECS helps firms effectively implement GPS and strengthen their competitiveness. Thus, the following hypotheses are proposed:

H3a. ECS moderates the relationship between EMS and the competitiveness of a firm.

H3b. ECS moderates the relationship between GPS and the competitiveness of a firm.

Hypotheses for corporate environmental strategy, ECC, and competitiveness

ECC refers to the direct involvement of a firm with its customers to jointly develop solutions to environmental issues (Vachon, 2007; Vachon and Klassen, 2008).

The above-mentioned definition suggests numerous activities in the areas of environmental goals and management, operations processes, and technologies related to eco design, clean production, green packaging and distribution, take-back program, and recycling (Rao and Holt, 2005; Vachon and Klassen, 2006, 2008).

Research also suggests that similar to the green practices required to achieve greater supplier involvement, ECC is beneficial and necessary when firms promote environmental initiatives. For example, Henriques and Sadorsky (1999) indicate that firms with proactive perspective exhibit a strong awareness of external stakeholders (e.g. customers), and such behavior influences their natural environmental practices. Vachon and Klassen (2006) provide evidence relating the positive effects of green customer partnership to performance in terms of quality, flexibility, and environment. From the SCM standpoint, Zhu *et al.* (2007) identify customer cooperation as a critical factor in implementing GSCM practices toward the improvement of operational results. Empirically, Aragón-Correa *et al.* (2008) state that high degrees of close interactions with stakeholders help integrate external resources and generate innovative solutions to environmental issues. Previous studies generally suggest that customer focus on environmental issues inherently presents strategic opportunities that would be reflected in long-term sustainability, as well as in other performance enhancements, such as high credibility of marketing claims, increased shareholder value and satisfaction, high productivity, and cost reductions (Hart, 2005; Kirchoff *et al.*, 2011; Nidumolu *et al.*, 2009). We assume that ECC helps firms efficiently implement EMS and strengthen their competitiveness implications.

Evidence shows that engaging customers in green relationships results in high levels of GPS, which is used as a response to competitive challenges. According to Johansson (2002) establishing close customer relations helps managers effectively establish product requirements that correspond to customer demands, thereby suggesting successful environmental product development for targeted markets and consumers. Based on the eco-design context, van Hemel and Cramer (2002) and Boks (2006) have presented customization as a key factor in product development, specifically in relation to conflicts with design, production, management, and market requirements. Customization is also a critical variable in stimulating benefits such as cost reduction, image improvement, and/or new markets. Vachon and Klassen (2006, 2008) have found that customers within an environmental collaborative setup positively affect product quality performance, which is associated with conformance to specifications and durability. In this sense, higher degrees of ECC in GPS would strengthen the performance of a company's green product in terms of meeting different customer needs and enhancing the company's competitiveness (Nidumolu *et al.*, 2009). The assumption that ECC helps firms implement GPS more efficiently and achieve increased competitiveness leads to the following hypotheses:

H4a. ECC moderates the relationship between EMS and the competitiveness of a firm.

H4b. ECC moderates the relationship between GPS and the competitiveness of a firm.

Methodology

Data collection and the sample

The analysis unit is at the firm level, and environmental-related collaborative activities are focussed on cooperation with upstream/downstream partners in an SC context.

Therefore, the target respondents are companies in Taiwan, specifically those that belong to the EEE-related industries. Because most industries in Taiwan are export-oriented in nature, these companies are significantly affected by global environmental regulations and market pressures. The surveyed firms would be either suppliers or customers, or both, in a chain. By our request, potential respondents are those that occupy the following positions: vice president or higher, senior managers, R&D managers, or environmental-related department managers and specialists. Using these selection criteria, our key informants are individuals with the most amount of knowledge on every aspect of EMS, GPS, ECSC, and competitive performance of their company. We initially mailed 974 survey questionnaires to companies listed on the database of the Taiwanese stock market. Subsequently, follow-up telephone calls were made to improve the response rate. We received a total of 212 questionnaires, of which seven were invalid. The final total provided a sample size of 205 and a response rate of 21.05 percent. The surveyed firms belong to the chemical (17.1 percent), electrical (23.9 percent), semiconductor (9.8 percent), optoelectronic (13.2 percent), computers and peripheral equipment (19.0 percent), communications and internet (6.8 percent), and other (i.e. automobiles, machines, molds) (10.2 percent) industries. The number of employees of participating firms was classified into the following categories: less than 1,000 (63.4 percent), 1,001-5,000 (22.4 percent), and more than 5,000 (14.1 percent). The geographic dispersion characteristics of the firms included local (30.7 percent), Asian (36.6 percent), and global (32.7 percent).

To test for possible non-response bias, we used the number of employees and geographical dispersion as contextual variables. We compared the answers of early respondents vs late respondents on the assumption that late respondents are more characteristic of non-respondents than early respondents (Armstrong and Overton, 1977). The tests between the early and late waves revealed no significant difference at a 5 percent significance level for the two contextual variables. Thus, non-response bias was not a major concern in this study. We also tested the effect of common-method variance using Harman's one-factor test based on the study of Podsakoff and Organ (1986). No single factor emerged, and no general factor accounted for most of the variance, thereby suggesting that common-method bias does not exist in the data.

Research measurement and scale validation

The survey questionnaire is structured into five sections, namely, EMS, GPS, ECSC, competitiveness, and demographics data. The measurement of all variables and the related literature is summarized in Table I. The four main constructs (i.e. EMS, GPS, ECSC, and competitiveness) are measured using the multiple-item scales, which are drawn from the literature on environmental management, green/environmental new product development, environmental collaboration, and green/sustainable SCM. The constructs are reworded to associate specifically with the context of our study's scope and objectives. A Likert-type scale is formulated for each item in the questionnaire; the scale ranges from 1 (strongly disagree) to 5 (strongly agree). We use firm size (i.e. number of employees) as the control variable because it is generally known as an important variable in distinguishing environmentally proactive firms (e.g. Aragón-Correa *et al.*, 2008).

The first scale validation is used to assess the construct validity of the five measurement scales via confirmation factor analysis through the EQS program. Seven common measures are used to estimate the measurement model fit: χ^2 normalized by degree of freedom, goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI),

Construct	Measurement items	Selected sources	Factor loading	Cronbach's α	Composite reliability	AVE
Environmental management strategy (EMS)	To achieve environmental proactivity, our company: 1. Provides environmental education and training for managers and employees 2. Has written environmental policies and a formal mechanism for management and operations 3. Has specialists that monitor environment-related institutional and regulatory changes worldwide 4. Aims at leadership in terms of environmental protection in the industry and society 5. Sponsors internal and external activities to preserve the natural environment 6. Views environmental issues as opportunities and pursues advanced environmental initiatives	Henriques and Sadorsky (1999), Sharma (2000), and Aragón-Correa *et al.* (2008)	0.700 0.711 0.740 0.800 0.801 0.792	0.891	0.890	0.574
Green product strategy (GPS)	To develop environment-friendly products, our company: 1. Commits managerial, financial, and manufacturing resources and support 2. Integrates eco-design considerations in the production processes, facilities, and strategies 3. Has a system for managing cross-functional teams and activities 4. Has environmental experts, a database, and the competence to support the managerial and technical activities of environment-friendly product development 5. Develops firm-specific eco-design principles, standards, and tools	Johansson (2002), Pujari *et al.* (2003), and Boks (2006)	0.754 0.824 0.877 0.813 0.798	0.906	0.907	0.661
Environmental collaboration with suppliers (ECS)	To enhance competitiveness, our company works collaboratively with suppliers to: 1. Evaluate and build the environmental management system, practices, and policies of suppliers and 2. Be involved in the environmental activities of suppliers in the areas of product design, process, distribution, and pollution prevention	Vachon (2007) and Vachon and Klassen (2008)	0.783 0.865	0.808	0.811	0.683
Environmental collaboration with customers (ECC)	To enhance competitiveness, our company works collaboratively with customers to: 1. Adapt to changing environmental demands derived from markets and regulations 2. Achieve goals in terms of eco-design, clean production, green packaging, take-back programs, and recycling	Rao and Holt (2005) and Vachon and Klassen (2006, 2008)	0.813 0.761	0.765	0.763	0.617
Competitiveness (COMPE)	Corporate environmental strategy enables our company to: 1. Enter specific and new marketplaces 2. Provide differentiating products 3. Achieve higher profit margins 4. Reduce managerial and operational costs related to environmental issues	Christmann (2000) and Rao and Holt (2005)	0.862 0.838 0.735 0.710	0.864	0.868	0.624

Table I.
Reliability and convergent validity test

non-normed fit index (NNFI), comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). Except for GFI and AGFI, all the model-fit indices have exceeded their respective common acceptance levels. GFI and AGFI are close to the recommended cut-off value of 0.9. Thus, the measurement model exhibits a good fit with the gathered data (χ^2/df = 265.564/142 = 1.870, GFI = 0.873, AGFI = 0.830, NNFI = 0.983, CFI = 0.948, RMSEA = 0.065, SRMR = 0.043).

Convergent validity of measurement scales is evaluated with the following criteria: all indicator factor loadings should be significant and should exceed 0.7, construct reliability (CR) should exceed 0.8, and average variance extracted (AVE) should surpass the recommended 0.5. All indicator factor loadings exceed 0.7 and are significant. Cronbach's α values of constructs range from 0.765 to 0.906, CR values of constructs range from 0.763 to 0.907, and AVE values range from 0.574 to 0.683. The CR value of ECC is 0.763, which is also close to the required value of 0.8. Thus, all three conditions for convergent validity are met, as shown in Table I.

Finally, discriminant validity is performed. The square root of AVE for each construct should exceed the correlation between that and any other construct. Table II indicates the square root of the AVE in the diagonal row, which ranges from 0.758 to 0.826 and surpasses the correlation between that and any other construct. The result suggests the acceptance of discriminant validity. The descriptive and correlation details are shown in Table II.

Results

This study performs the hierarchical moderated regression analysis to test the hypotheses, and uses the "centering" method to reduce multicollinearity, which has been employed in a previous study (e.g. Zhu and Sarkis, 2004). The analysis comprises four steps, Tables III and IV depict the results of our hypothesis testing followed by the following four steps. First, the control variable is entered into the regression. Second, the independent variable of EMS or GPS is entered into the regression to examine the direct effects on performance. Third, the two moderators, namely, ECS and ECC, are entered as a block. Fourth, the two interaction terms of moderators are entered as a block. The moderating effects exist either individually as signified by the values of the β's or collectively as signified by the values of the incremental (step) F-statistic. The variance inflation factors of the analysis in this study range from 0.053 to 0.085. These values are lower than 10 and are thus acceptable.

Direct effect relationship results

As shown in Step 2 in Table III, a positive EMS-competitiveness relationship is significant ($\beta = 0.583$, $p \leqslant 0.001$), thereby supporting *H1*. Similarly, the results for Step

Table II. Descriptive statistics and correlations of the constructs

	Mean	SD	EMS	GPS	ECS	ECC	COMPE
EMS	3.824	0.694	*0.758*				
GPS	3.418	0.780	0.665	*0.813*			
ECS	3.731	0.862	0.665	0.714	*0.826*		
ECC	3.846	0.734	0.740	0.576	0.644	*0.785*	
COMPE	3.623	0.704	0.652	0.655	0.555	0.618	*0.789*

Note: The italic numbers in the diagonal row are square roots of AVE

Independent variable entered	Step 1	Step 2	Step 3	Step 4
Firm size	0.153*	−0.014	−0.022	0.014
Environmental management strategy		0.583***	0.382***	0.412***
Collaboration with suppliers			0.145*	0.150*
Collaboration with customers			0.201**	0.182*
EMS × ECS				0.167*
EMS × ECC				−0.123
F for step	4.876*	94.819***	8.077***	3.199*
F for regression	4.876*	50.974***	31.311***	22.400***
Adjusted R^2	0.019	0.329	0.373	0.386

Notes: The main table contains standardized coefficient β's. $*p \leqslant 0.05$; $**p \leqslant 0.01$; $***p \leqslant 0.001$

Table III. Hierarchy moderated regression analysis with EMS

Independent variable entered	Step 1	Step 2	Step 3	Step 4
Firm size	0.153*	0.017	−0.006	−0.016
Green product strategy		0.607***	0.458***	0.485***
Collaboration with suppliers			0.045	0.100
Collaboration with customers			0.257***	0.223***
GPS × ECS				0.224***
GPS × ECC				−0.126
F for step	4.876*	112.576***	9.690***	5.274**
F for regression	4.876*	60.066***	37.462***	27.800***
Adjusted R^2	0.019	0.367	0.417	0.441

Notes: The main table contains standardized coefficient β's. $*p \leqslant 0.05$; $**p \leqslant 0.01$; $***p \leqslant 0.001$

Table IV. Hierarchy moderated regression analysis with GPS

2 in Table IV show that the relationship between GPS and competitiveness (*H2*) is significantly positive ($\beta = 0.607$, $p \leqslant 0.001$), thereby indicating that both are supported and highly significant and that both EMS and GPS directly impact performance.

Moderated relationship results

The relationships between corporate environmental strategies and ECSC and performance show increased complexity. Step 4 in Table III shows that the incremental *F*-statistic ($F = 3.199$, $p \leqslant 0.05$) for the block of interacting items is significant. This result provides evidence that ECSC moderates the link between EMS and competitive strengths. In addition, the moderating influence of ECS exhibits a significant and positive β-value ($\beta = 0.167$, $p \leqslant 0.05$) whereas ECC shows no significant β-value ($\beta = -0.123$, $p \geqslant 0.05$). Thus, *H3a* is supported but *H4a* is not supported. As shown in Step 4 in Table IV, the relationship between the incremental *F*-value for the block of interaction and competitive performance ($F = 5.274$, $p \leqslant 0.01$) is significantly positive, thereby suggesting that ECSC moderates the relationship between GPS and firm competitiveness. The β-value of ECS is significantly positive ($\beta = 0.224$, $p \leqslant 0.001$), but the β-value of ECC is not significant ($\beta = -0.126$, $p \geqslant 0.05$). Thus, *H3b* is supported whereas *H4b* is not supported.

Discussion

Direct effects of corporate environmental strategy on competitiveness

Table III shows the significantly positive relationship between EMS and competitiveness. Once managers embrace environmental challenges while considering competitive enhancements, they can rely on EMS. When firms decide to go beyond legislative compliance, they tend to develop organizational capabilities for continuous improvement and fostering innovations (Hart, 1995), allocate resources to increase consumer stakeholder perceptions of environmental commitment (Kirchoff *et al.*, 2011), view green issues as opportunities to facilitate future success (Nidumolu *et al.*, 2009; Sharma, 2000), and integrate environmental considerations into business strategies (Banerjee, 2001; Lee and Rhee, 2007). The real environmental commitment of a firm to the internal integration of the three organizational areas (i.e. resources investment, stakeholder management, and top management support) leads to positive outcomes. The findings provide evidence on the existence of a direct and positive link between environment and performance.

The results in Table IV, which are consistent with those in previous studies (e.g. Huang and Wu, 2010; Pujari *et al.*, 2003), emphasize the positive link between GPS and firm competitiveness. However, environmental-friendly product development requires synthesizing not only technical-based capabilities, but also cooperative capacities with other departments/organizations (Nidumolu *et al.*, 2009). These uncertainties may influence the interest of top management in GPS because of the major changes and risks in investment allocations and mechanism building. If the benefits gained from eco-products are visible and significant, then GPS issues become inherently inevitable in the decision-making process of the enterprise, and its business model for improved outcomes. Thus, our findings should encourage managers to take advantage of GPS to allow companies to differentiate their business in the marketplace.

Taiwanese companies are export-oriented and are significantly influenced by globalization in terms of increased market, regulation, and competitive pressure. Proactive firms should not focus solely on objectives associated with preventing pollution to avoid losing business opportunities. Rather, these firms should also explore strategic factors of EMS that affect competitiveness (Hart, 2005; Molina-Azorín *et al.*, 2009). If GSP is an effective strategy that drives competitive advantage and the pursuit of corporate social responsibility of a firm, then companies will show their willingness to implement green product practices. In light of the empirical results in the current study, the experience of Taiwan can be used by other manufacturers in the EEE industry, specifically those based in China, India, and other developing countries. Firms that aggressively commit to EMS and GPS and ultimately create difficult-to-imitate innovative capabilities and dominate leading "green" positions for both current and future competitiveness (Hart, 2005; Kirchoff *et al.*, 2011).

Overall, our findings provide evidence to the argument that committing to real green efforts in internal operations, environmental management systems, and external product strategies will lead to positive strategic performance (Molina-Azorín *et al.*, 2009; Segarra-Oña *et al.*, 2011). Given the importance of environmental issues in emerging markets, the results from Taiwanese firms reveal valuable insights that can help practitioners re-examine attitudes toward and interpretations of sustainable development and its links to corporate strategies. Moreover, the discussion on decision making is not focussed on what occurs when firms react to external constraints (e.g. legislation), but rather on what occurs when they focus on environmental proactive responses. Hence, managers should consider the strategies for adoption under increasing institutional and competitive pressures (Hart, 2005).

Moderating effects of ECSC on competitiveness

Step 4 in Tables III and IV shows that ECSC significantly moderates the relationship among EMS, GPS, and competitiveness. Therefore, collaboration degree significantly affects the environmental proactivity performance of firms where competitiveness is strengthened by a close-chain cooperative network. Current findings suggest that SC executives need to re-examine the authority control and interactive activities of their SCs on environmental challenges to predict the best practices for the concurrent implementation of EMS, GPS, and ECSC and enhance performance.

ECS assists firms in implementing EMS and GPS efficiently to indirectly achieve increased competitive benefits (Step 4 in Tables III and IV). Thus, SC cooperative practices, particularly those in close interaction with supplier firms, can enhance the pursuit of environmental excellence goals in several ways, as follows: environmental strategy success (e.g. EMS) may not be exposed to threats and risks from suppliers (Carter and Rogers, 2008; Seuring and Müller, 2008), and utilizing supplier eco-capabilities (e.g. GPS) results in increased competitive strengths and avoids business interruptions (Donnelly *et al.*, 2006). A long-term and trusting relationship in environmental issues is beneficial for enhancing partner development and management; co-evolving with upstream members can be viewed as a dynamic capability for synergistic resource combination and new capability generation in a sustainable SC context (Beske, 2012; Simpson *et al.*, 2007). Thus, ECS should be considered beyond the daily company tactical activities with suppliers; ECS should also be considered at both future and strategic levels.

The β-values of ECC are insignificant (Step 4 in Tables III and IV) contrary to expectations. ECC interaction effects are not related to EMS- or GPS-competitiveness relationships but exert direct effects on EMS and GPS desired performances instead (Step 3 in Tables III and IV). The direct influence of ECC is highlighted and should be considered in business strategy decisions. This would be in line with previous studies that suggest customers affect the effectiveness of solutions to meeting stakeholder societal expectations or concerns for improving corporate image (Henriques and Sadorsky, 1999; Segarra-Oña *et al.*, 2011), environmental innovative abilities of a company required in market introduction, price, and quality for new green product success (Boks, 2006; van Hemel and Cramer, 2002), and success in influencing consumer perception of green marketing claims (Kirchoff *et al.*, 2011). Given that our respondents are both supplier and brand-owning companies, customer demands (e.g. international leading firms and end consumers) are strong and inevitable drivers that directly force firms to continuously pursue advanced environmental activities and meet the specific characteristics of green management, operations, and products.

According to a survey data in Taiwan, understanding the complexity of ECS influence and opportunities for enhanced supplier management assists firms in avoiding undesirable consequences, while achieving competitiveness for itself and its SC. Practitioners should not only be aware of current customer needs, but also move toward satisfying unconsidered demands through environmental innovations. Consequently, firms transform into value-adding and sustainable enterprises in future market conditions (Hart, 2005; Nidumolu *et al.*, 2009). In the context of rapid market changes and increased institutional pressures (e.g. EEE industry), upstream and downstream firms should focus on cross-organizational management mechanisms to collaborate efficiently and flexibly with green innovation partners for improved outcomes.

Conclusions

This study examines the effects of EMS and GPS on firm competitiveness. We investigate whether ECSC moderates the relationships among EMS, GPS, and performance to provide opportunities for increased performance. Basing on sample industries in Taiwan that are affected by EU Directives, high EMS and GPS levels positively influence competitiveness. This study also determines that ECSC moderates the relationships among EMS, GPS, and competitiveness. ECS acts as a moderator in enhancing EMS and GPS and positively contributes to increased competitive advantages. In contrast, ECC exhibits no interactive effects on EMS- or GPS-competitiveness relationships but directly influences corporate environmental strategies related to desired performance.

From a theoretical perspective, our study clarifies the mixed results of green initiative effects on performance by showing how real environmental commitment and effort lead to competitive and sustainable enterprises. GPS-associated results contribute to studies on environmental new product development, which currently offer numerous normative suggestions with minimal practical relevance (Baumann *et al.*, 2002). Moreover, ECS and ECC affect EMS and GPS of firms related to performance enhancement in different and complicated ways. Thus, separating upstream and downstream considerations is essential in setting environmental goals and strategies and establishing joint environmental activities. The moderating role of ECSC enables scholars to further analyze the critical but perplexing relationships among environment, SC, and performance.

From a managerial viewpoint, this study contributes to management studies by providing empirical evidence of positive relationships between environmental proactivity and performance. Moreover, we contribute by suggesting managers to move toward sustainability through EMS or GPS and build new business paradigms. Companies benefit from instant cost reductions of green internal processes and materials and long-term sustainable competitive edges in green marketing and branding, particularly when viewed from the perspective of satisfaction exceeding customer expectations. Moreover, verifying the interactive effects of SC cooperation is critical to practitioners because it benefits both effective management and resource allocations for joint collaborative forms under global tough regulations and uncertainty of SC continuity. Specifically, the ECS effects on environment-performance relationships are different from those of ECC. SC managers should develop different practices and communication plans to offer upstream and downstream partners to collaborate effectively and efficiently in responding to environmental challenges. Overall, managers should not only focus on executing environmental practices, but also on strengthening SC cooperative capabilities to achieve environmental and competitive excellence together with chain members (McCrea, 2010).

Current findings should be interpreted within the study limitations. First, this study focusses on a limited number of practices. Relevant green initiatives (e.g. closed loop SC) should be considered along with corporate social responsibility and innovations to improve the firm performance (Kleindorfer *et al.*, 2005). Second, this study does not consider the difference between short-term and long-term effects. According to Christmann (2000), time lags related to initial investments of sustainable practices and their results influence the relationship between green management and performance; these two limitations constitute future research directions. Further studies (e.g. intervening model or marketing perspective with consumer emphasis) should provide specific direction for firms in explaining the direct relationship among ECC, corporate environmental strategy, and effects on performance. Moreover, adding environmental- or societal-related performance indicators are beneficial in further examine triple-bottom-line impacts of a corporation's sustainability commitment and effort.

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About the authors

Dr Yenming J. Chen is an Associate Professor at Department of Logistics Management, National Kaohsiung First University of Science and Technology, Taiwan. He has received his a PhD in Systems Science and Mathematics in 1998 at the Washington University in St. Louis. His research interests include green supply chain, channel management, regional sustainable development, differential games, and cooperative games. He has published numerous articles on environmental management and strategic analysis.

Yenchun Jim Wu (PhD, University of Michigan) is a Distinguished Professor of Graduate Institute of Global Business and Strategy at the National Taiwan Normal University, Taiwan. His papers have appeared in *Academy of Management Learning and Education*, *Sloan Management Review*, *IEEE Transactions on Engineering Management*, *Information & Management*, *Computers in Human Behavior*, *Computers & Education*, *International Journal of Operations & Production Management*, *Supply Chain Management*, *Management Decision*, *Journal of the American Society for Information Science and Technology*, *International Journal of Physical Distribution & Logistics Management*, *International Journal of Logistics Management*, *European Journal of Operational Research*, *International Journal of Production Economics*, *Transportation Research Part A,D & E*, and *Technological Forecasting and Social Change*. His research interests include supply chain management, technology management, and lean manufacturing, and management education. Professor Yenchun Jim Wu is the corresponding author and can be contacted at: wuyenchun@gmail.com

Tienhua Wu is an Associate Professor of Department of Logistics Management at the Air Force Institute of Technology. Her research interests include green supply chain management, waste management, and risk management. She holds a PhD in Graduate Institute of Management from the National Kaohsiung First University of Science and Technology, Taiwan.