出國報告（出國類別：其他－出國參加國際研討會）

參加 2012 年商學與資訊國際研討會發表學術論文

服務機關：國立臺北大學企管系
姓名職稱：陳宥杉教授
派赴國家：日本
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摘要

此行目的是發表有關環保承諾對綠色智慧資本影響之研究成果，並開拓國際視野，增進國際交流與國際合作的機會，而且希望獲得國際級學者專業評論，以進行論文後續修改。此行的過程為，本人於 2012 年 7 月 2 日抵達日本北海道參加研討會，然後全程參與 2012 年 7 月 3 日至 7 月 5 日 2012 商業與資訊國際研討會，並於 2012 年 7 月 3 日發表論文，然後於 100 年 7 月 6 日與 7 月 7 日轉赴北海道大學，與相關學者進行學術交流，並於 2012 年 7 月 8 日搭機離開日本北海道。此行的成果為，分別獲得數位國際學者的專業評論，目前已依照修改建議進行研討會論文修改，然後轉投知名國際知名期刊，此外亦結識數位國際學者，提升國際視野，增進國際交流與國際合作的機會。

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本文

目的

此行目的是發表有關環保承諾對三類綠色智慧資本（綠色人力資本、綠色結構資本與綠色關係資本）影響之研究成果，並開拓國際視野，增進國際交流與國際合作的機會，而且希望國際級學者提出寶貴的專業評論，以獲得論文後續修改建議。商學與資訊國際研討會是管理領域最重要的年度學術研討會之一，每年有許多國際級管理大師參加商學與資訊國際研討會，而且商學與資訊國際研討會主辦單位也邀請許多全球資深管理學者評審論文，並當場給予論文報告人許多寶貴建議。雖然投稿商學與資訊國際研討會的接受率極低，但是只要被商學與資訊國際研討會接受的論文，能依照論文評論者的建議加以修改的話，轉投國際知名學術期刊的接受率將會大幅提高。因此，商學與資訊國際研討會是全球管理學者最期盼的年度學術研討會。參加本次研討會可以提升本人研究能力，增加國際視野，並提高國際期刊發表能力。本人目前已依照修改建議進行研討會論文修正，然後轉投國際知名學術期刊。此外，本人亦結識卡拉克博士、林黃奕博士、周鎮祺博士、劉方洲博士、伊巴塔愛羅斯博士、林淑萍博士、陳尤周博士，開拓國際視野，並增進國際交流與國際合作的機會。

過程

Business and Information International Conference 是企業管理社群舉辦之國際知名研討會，而該社群的會員不僅來自學術領域，更包含遍佈世界各地的實務界菁英、顧問等。該社群首次於日本北海道舉辦國際研討會，目的是為了能夠邀集來自學術界、產業界、顧問、政府機構，以及相關創新領域的專家及學者等，共同就「管理新趨勢」的主題發表論文、經驗分享，甚至建立研究網路。因此，大會的主題環繞在「策略管理(strategic management）」、「無國界的創新（borderless innovation）」、「生產管理(production management）」、「協同研發的創新（collaborative R&D for innovation）」、「概念發想與創造力（idea generation and creativity）」、「資訊管理(information management）」、「創新政策（innovation policy）」、「人力資源管理(human resource management）」、「創新的衡量與管理（measuring and managing innovation）」、「創新的方法與工具（methods and tools for innovation）」、「行銷管理(marketing management）」、「創新的網路與群聚（networks and clusters of innovation）」，以及「開放式創新（open innovation）」。本研討會總共接受 645 篇文章，分 79 場次發表。

本人非常榮幸出席知名國際研討會 Business and Information 2012 International Conference (BAI2012 國際研討會)，此行的過程為，本人於 2012 年 7 月 2 日抵達日本北海道參加研討會，2012 年 7 月 3 日註冊後，立即參加 Business And Information International Conference 的 Strategy、Technology and Innovation Management 二個場次論文發表會，本人於 Technology and Innovation Management 場次發表論文（地點：Renaissance Sapporo Hotel, Sapporo, Japan, 場次：B7），此外，本人於 2012 年 7 月 4 日參加 Organization Behavior and Human Resource Management、Marketing、Information Decision Analysis、Strategy 四個場次論文發表會，並於 2012 年 7 月 5 日參加 Accounting and Finance、Operation Management and Industrial Engineering、Technology and Innovation Management、Marketing 四個場次論文發表會。本人全程參與 2012 年 7 月 3 日至 7 月 5 日 2012 Business And Information International Conference，並於 2012 年 7 月 3 日發表論

文（地點：Renaissance Sapporo Hotel, Sapporo, Japan, 場次：B7），然後於 100 年 7 月 6 日與 7 月 7 日轉赴北海道大學，與相關學者進行學術交流，並由學校服務中心派員介紹北海道大學，並說明日本北海道地區產業發展現況，並相關學者討論本次研討會論文後續修改建議。本人並於 2012 年 7 月 8 日搭機離開日本北海道。

本次發表論文場次共有七位發表人，除了本人之外，其他六位發表人分別為：Hung-Yi Lin、Chang-Chien Chou、Feng-Chuan Liu、Kathryn C. Ibata-Arens、Shu-Ping Lin、Ada Hui-Chuan Chen，該場次的主持人是 Sadık Rıdvan Karluk。本人的論文係探討環保承諾對三類綠色智慧資本（綠色人力資本、綠色結構資本與綠色關係資本）之影響。研究結果發現環保承諾會對三類綠色智慧資本（綠色人力資本、綠色結構資本與綠色關係資本）產生正向影響。Hung-Yi Lin 所報告的文章則是以數量方法探討多層次分類問題；Chang-Chien Chou 所報告的文章則是發展一個整合性的商業競爭架構；Feng-Chuan Liu 所報告的文章則是探討團對創造力的發展過程；Kathryn C. Ibata-Arens 所報告的文章則是探討創業群聚、策略網絡與知識中心如何提升亞洲成長率與競爭力；Shu-Ping Lin 所報告的文章則是醫療照顧雲端系統的設計架構；Ada Hui-Chuan Chen 所報告的文章則是資訊加值運輸系統對旅行業之影響。參與會議的學者對於本人發表之研究也提出批評，數人建議研究樣本除了臺灣製造業之外，後續研究可挑選其他國家的公司進行分析，並進行跨國比較。此外，本研討會的主持人 Dr. Sadık Rıdvan Karluk 教授也對本論文提出許多寶貴建議，尤其對於文章的管理意涵的不足之處提出具體批評，而且建議後續應再補強專家訪談，以支持本文之論點。參與本次研討會獲得許多寶貴的建議，尤其本研討會的主持人 Dr. Sadık Rıdvan Karluk 教授非常欣賞本文章，並建議該文章可以參考多位學者的評論與建議而加以修改與補強之後，可以進一步投稿國外知名 SSCI 期刊。此外，本人亦與 Dr. Sadık Rıdvan Karluk、Hung-Yi Lin、Chang-Chien Chou、Feng-Chuan Liu、Kathryn C. Ibata-Arens、Shu-Ping Lin、Ada Hui-Chuan Chen 保持聯繫，希望持續提升國際視野，並增進國際交流與國際合作的機會。另外，在參與研討會過程中，本人亦與 Dr. Sadık Rıdvan Karluk 及 Kathryn C. Ibata-Arens 討論數量方法與投稿經驗，期盼提升日後投稿能力。本人亦與這些國外學者保持聯絡，以便日後拓展國際合作機會。

心得及建議事項

參與本次國際研討會除了提高個人的國際視野之外，並能與世界各國管理領域的學者交換研究心得，獲得許多寶貴的研究經驗。此外，透過本次國際研討會也認識了不少國際知名的研究學者，回國後希望能繼續向這幾位國際知名研究學者請益，並期盼日後能有跨國共同研究的機會。參與本次國際研討會並發表文章實在是收獲非常多，而且非常感謝國立臺北大學的補助。尤其，在參與研討會過程，本人亦與 Dr. Sadık Rıdvan Karluk 及 Kathryn C. Ibata-Arens 討論數量方法與投稿經驗，以提升日後投稿能力。本人亦與這些國外學者保持聯絡，以便日後拓展國際合作機會。本人希望明年再次爭取國立臺北大學補助出席國際研討會，以持續開拓國際視野，增進國際交流與國際合作的機會。此外，舉辦國際研討會是一件龐大且複雜的專案工作，主辦單位能成功舉辦這次國際研討會，確實相當不容易，其溝通聯絡與組織分工等專業知識值得國內大專院校借鏡。本人也將建議國立臺北大學舉辦國際研討會，以提昇臺灣的國際學術知名度與能見度。

雖然本人過去曾參與多次國際專業研討會，然而此次的大會安排相較於其他國際研討會更為精緻，各場次主持人強調發表人與觀眾以及其他發表人之間的互動。本場次主持人 Dr. Sadık Rıdvan Karluk 教授非常認真，在會議舉辦之前，就與該場次的發表人聯絡，取得最新的全文，並約定在會場中可能碰面的時間，並要求發表者提前抵達會場。本場次主持人 Dr. Sadık Rıdvan Karluk 教授的專業與認真的態度值得學習，日後本人擔任國際研討會主持人時，將以本場次主持人 Dr. Sadık Rıdvan Karluk 教授為借鏡。

另外，相較於其他國際會議，Business And Information 2012 International Conference 的確是一個相當國際化的研討會，總計有 40 多個來自全球不同國家、對管理相關領域學有專精的學者專家共同參與，我們可以看到不同國家在管理相關領域上所面臨的問題、抱持的觀點與研究的重點，有著極大的差異，但也就是因為這樣的差異，透過這個國際學術會議，大家彼此分享、交流，促進瞭解也開展了更寬闊的視野。此外，在會議中亦結識許多於相同領域深耕之專家學者，透過交流活動分享領域新知，將成為未來國際合作研究之基礎。

（附錄）出席研討會照片

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（附錄）論文全文檔

THE INFLUENCE OF ENVIRONMENTAL COMMITMENTS ON GREEN INTELLECTUAL CAPITAL

ABSTRACT

This study develops an original framework of green intellectual capital to explore the influence of environmental commitments on three types of green intellectual capital - green human capital, green structural capital, and green relational capital. The empirical results of this study demonstrate that environmental commitments have a positive effect on three types of green intellectual capital. If companies would like to enhance their three types of green intellectual capital, they need to increase their environmental commitments.

Keywords: Environmental Commitments, Green Intellectual Capital, Green Human Capital, Green Structural Capital, Green Relational Capital

INTRODUCTION

The notion of intellectual capital is used to evaluate intangible assets of companies (Stewart, 1994). Although the concept of intellectual capital has widely explored for the last decade, the concept of green intellectual capital is recently proposed by Chen (2008) due to the popular environmental trend nowadays. However, there is no research discussing the relationship between environmental commitments and three types of green intellectual capital. Therefore, this study intends to fill this gap and explores the influence of environmental

commitments on three types of green intellectual capital - green human capital, green structural capital, and green relational capital.

It is difficult for governments to meet all of the society's expectations and needs, though they are traditionally responsible for nationwide social welfare (Clarkson, 1995; Waddock et al., 2002). Corporate social responsibility (CSR) can raise social welfare since it can fill the lack of the resources and capabilities of governments. Many outstanding companies consider CSR as an important strategy that can raise their corporate images to obtain more support from stakeholders. Companies often undertake socially responsible activities to meet environmental regulations that lead to a win-win situation to obtain more green intellectual capital. Excellent companies can utilize green management to enhance their corporate reputation nowadays. Hence, companies should take the concepts of green management into their strategic considerations.

Environmental commitments play an important role nowadays due to the rise of international environmental regulations, such as Montreal Convention, Kyoto Protocol, Restriction of the Use of Certain Hazardous Substances in EEE (RoHS), and Waste Electronics and Electrical Equipment (WEEE), etc. It is crucial for companies to adopt a proactive and preventive manner to deal with the impact of the environmental trend. Under the prevalence of the international environmental regulations and the consumer environmentalism, the rules and patterns of industrial competition are different in the

environmentalism era nowadays (Russo & Fouts, 1997; Dwyer, 2009). There are two major environmental forces influencing companies' environmental activities which are consumer environmentalism and environmental regulations (Rugman & Verbeke, 1998). Thus, companies have no choice but to undertake environmental management to comply with the two environmental forces (Berry & Rondinelli, 1998). The relevant issues about environmental management, such as green accounting, green marketing, green production, and green innovation, etc., are more popular in the field of management. Porter & van der Linde (1995) assert that pollution results from inefficient uses of resources. Therefore, firms can increase their productivity via environmental management, though some of them believe environmental protection is an unnecessary investment, or even obstructs their profitability and growth.

It is indispensable for companies to adopt a proactive strategy to deal with the advent of the environmental era (Haden et al., 2009). Firms should not shirk their responsibilities, since the increase of environmental commitments could drive them to enhance green intellectual capital. Because the global environmentalism has dramatically increased for the past decade, the main purpose of this research is to explore the influence of environmental commitments on three types of green intellectual capital: green human capital, green structural capital, and green relational capital. This study is conducted in the manufacturing industry in Taiwan. Besides, the antecedent of the research framework is environmental commitments and the

consequents are three types of green intellectual capital.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Environmental management

Prior research argues the social objective of companies is to maximize their shareholders' wealth and thinks that CSR is not their social objective (Friedman, 1970). However, resource-based view posits that environmental social responsibility can become a key resource or capability that can lead to a competitive advantage (Hart, 1995). Hence, companies should invest more resources and efforts in the increase of their green intellectual capital to achieve the goal of sustainable development. Although Friedman (1970) thinks that maximizing shareholders' wealth is companies' main goal, firms may decide to undertake green management owing to external environmental pressures. Institutional theory concerns about the impacts of external institutions on the adoption of environmental management (Hoffman, 1997). Firms' social objective is not always profit maximization, and they must meet external pressures for legitimacy. Firms have a good reason to carry out environmental management to obtain the trust of external institutions. The popularity of consumer environmentalism and the rise of environmental regulations would bring significant impacts to firms in the world (Chen et al., 2006). Environmental management would force companies to change their strategies and business models (Nidumolu et al., 2009). Firms should change

their managerial mindsets in harmony with the environmental trends.

Previous research argues that why firms should respond to environmental protection (Friedman, 1970; Clarkson, 1995; McGee, 1998). More environmental regulations are implemented by governments nowadays, and they significantly influence the operations of companies (Rugman & Verbeke, 1998; Westlund, 2001). Thus, no matter firms are willing to comply with environmental regulations, they are enforced to adopt environmental management in environmental era (Peattie, 1992; Hart, 1997; Rugman & Verbeke, 1998; Westlund, 2001). Firms adopting proactive environmental strategies could reach the environmental goals and solve the environmental problems (Greeno & Robinson, 1992). Porter & van der Linde (1995) think that firms investing more resources in environmental management can not only avoid the trouble of environmental punishments, but also increase their corporate reputation, develop green markets, and raise their competitive advantages. Besides, firms can use the concept of green marketing into the design and package of their products to undertake their differentiation strategies (Peattie, 1992; Shrivastava, 1994; Shrivastava, 1995; Porter & van der Linde, 1995; Hart, 1995; Aallan et al., 2000; Chen et al., 2006). Therefore, there is a need to incorporate the concept of environmental management into corporate strategies in practice (Rugman & Verbeke, 1998).

Green intellectual capital

Intellectual capital is the stock of collective knowledge, information, technologies, intellectual property right, experience, organization learning and competence, team communication systems, customer relations, and brands that create value for firms (Stewart, 1997). Due to the popular environmental trend, environmental management has become one of the important managerial agendas for firms. Resource-based view argues that key resources and capabilities can lead to competitive advantages of firms (Barney, 1991), and posits that environmental social responsibility can become a key capability that can result in a sustainable competitive advantage (Hart, 1995; Orsato, 2006). Hence, environmental management can be considered as a unique capability (Hart, 1995). Green intellectual capital is the total stock of all kinds of intangible assets, knowledge, capabilities, and relationships, etc. about environmental protection or green innovation of both the individual and organization levels within a company (Chen, 2008). There are three types of green intellectual capital that are green human capital, green structural capital, and green relational capital (Chen, 2008).

Human capital is the summation of knowledge, skills, innovation, and capabilities of employees to reach goals (Dzinkowski, 2000). Human capital is embedded in employees, rather than in organizations (Miller & Wurzburg, 1995). Green human capital is defined as the summation of employees' knowledge, skills, capabilities, experience, attitude, wisdom,

creativities, and commitments, etc. about environmental protection or green innovation (Chen, 2008). Unlike human capital, structural capital is embedded in organizations. Structural capital is the stocks of patents, trademarks, hardware, software, databases, organizational culture, and organizational capabilities within an organization (Edvinsson & Malone, 1997). Chen (2008) defines green structural capital as the stock of organizational capabilities, organizational commitments, knowledge management systems, managerial philosophies, organizational culture, company images, patents, copy rights, and trademarks, etc. about environmental protection or green innovation within a company. Relationship capital is the summation of the relationships between the focal firm and its key stakeholders such as customers, suppliers, and partners (Johnson, 1999; Chen et al., 2006). Companies have to obtain support from external institutions and key stakeholders in order to survive in the environmental era. Under this context, Chen (2008) defines green relational capital as the stocks of a company's interactive relationships with customers, suppliers, network members, and partners about corporate environmental management and green innovation.

The positive effect of environmental commitments on green human capital

Lynes & Dredge (2006) indicate that there are three factors driving environmental commitments of firms which are eco-efficiencies motive, organizational culture, and leadership of managers. McAllister & Studlar (1999) argue that the environmentalism is

emerging recently due to the rise of a new middle class. Henriques & Sadorsky (1999) divide firms into four environmental profiles: reactive, defensive, accommodative, and proactive, and demonstrate that firms with more proactive profiles are different from less environmentally committed ones in the stakeholders' perceptions. Keogh & Polonsky (1998) assert that environmental commitments act as an effective basis of entrepreneurial behavior. Besides, environmental commitments of companies can enhance corporate images (Grunert-Beckmann & Gronhoj, 1997; Ottman, 1998). Gardberg & Fombrun (2006) indicate that environmental investments are one kind of strategic activities which can increase competitiveness. Thus, this study asserts that environmental commitments of companies have a positive effect on their green intellectual capital. Firms which have better environmental performance may raise their overall images and attract high potential employees' attention. Environmental commitments are helpful for employees' identity (Lindorff & Peck, 2009). The rise of environmentalism drives firms to develop their employees' competence to manufacture products that comply with strict environmental regulations (Ferrell et al., 1997). Companies with relatively high level of environmental commitments can attract high potential employees and enhance employees' competence about environmental management to meet public expectation and achieve social mission (Turban & Greening, 1997; Ferrell et al., 1997). Consequently, environmental commitments are useful for the increase of green human capital. Thus, this study asserts that environmental commitments are positively

associated with green human capital and implies the following hypothesis.

Hypothesis 1 (H_1): Environmental commitments of a company are positively associated with its green human capital.

The positive effect of environmental commitments on green structural capital

Firms that undertake proactive environmental strategies could integrate the environmental objectives among different units to solve environmental problems (Greeno & Robinson, 1992). Additionally, firms can reduce the environmental pollution by redesigning their operation processes and by enhancing their green productivity (Porter & van der Linde, 1995). Environmental commitments can raise companies' innovative capability about green technologies and business models (Greeno & Robinson, 1992; Schlegelmilch et al., 1996). Wood (1991) argues that environmental commitments of firms can not only help them develop environmental strategies, but also enhance their green innovations. Furthermore, Borger and Kruglianskas (2006) think environmental commitments are positively associated with environmental innovation and environmental performance of firms. Firms with relatively higher level of environmental commitments can develop higher environmental capability. Thus, this study asserts that environmental commitments of firms are positively associated with their green structural capital and implies the following hypothesis.

Hypothesis 2 (H_2): Environmental commitments of a company are positively associated with its green structural capital.

The positive effect of environmental commitments on green relational capital

Firms with high level of environmental commitments would extend their environmental concerns to their stakeholders such as environmental groups, customers, employees, suppliers, partners, and local communities. Schlegelmilch et al. (1996) point out that the environmentalism of customers may influence their purchase decisions, and indicate that firms should increase their environmental commitments such that they can enhance the relationships with their customers. Several famous companies with high level of environmental commitments, such as Sony and Dell, implement environmental strategies that increase the environmental linkages with their network members, suppliers, channels, and partners. Besides, CSR is positively associated with the customer's relationship (Sen & Bhattacharya, 2001). Companies with relatively high level of environmental commitments can design product in compliance with the environmental needs of their customers and have collaborative relationships with their partners or upstream suppliers. Therefore, this study posits that environmental commitments are positively associated with green relational capital of companies and implies the following hypothesis:

Hypothesis 3 (H_3): Environmental commitments of a company are positively associated with its green relational capital.

This study explores the influence of environmental commitments on three types of green intellectual capital - green human capital, green structural capital, and green relational capital. The research framework is shown in Figure 1.

Insert Figure 1 about here

METHODOLOGY AND MEASUREMENT

Data collection and the sample

This study uses questionnaire survey method to verify the hypotheses and focuses on the manufacturing industry in Taiwan. Besides, the sample is randomly selected from the 'Business Directory of Taiwan'. Respondents are top managers, CEOs, or managers of manufacturing, R&D, marketing, human resource management, or environmental protection departments. The research assistants explain the objectives of this study and the questionnaire content, and confirm the job titles of the respondents before mailing the questionnaires to the selected companies. The respondents are asked to return the completed questionnaires within

two weeks after mailing the questionnaires. The study refers to previous research to design questionnaire items. Prior to mailing to the respondents, eight experts and scholars are asked to modify the questionnaire in the first pretest. Subsequently, the questionnaires are randomly mailed to ten top managers, CEOs, or managers of manufacturing, R&D, marketing, human resource management, or environmental protection departments in different companies who are asked to fill in the questionnaire and identify ambiguities in terms, meanings, and issues in the second pretest. In addition, different respondents answer the different constructs in the questionnaire. The respondents of "environmental commitments" are top managers, CEOs or managers of environmental protection departments in Taiwanese manufacturing companies; those of "green human capital" are managers of human resource management departments; those of "green structural capital" are top managers, CEOs or managers of human resource management, manufacturing, or R&D departments; and those of "green relational capital" are top managers, CEOs or managers of marketing or manufacturing departments. This study sends 460 questionnaires to the respondents. There are 142 valid and 8 invalid questionnaires, and the effective response rate is 30.9%.

Measurement

The measurement of the questionnaire items in this study is by means of "five-point Likert scale from 1 to 5," rating from strongly disagreement to strongly agreement, respectively. The

measurements of the constructs in this study are described as follows:

- ***Environmental commitments***: This study refers to Henriques & Sadorsky (1999) to measure environmental commitments. The measurement of environmental commitments includes six items: (1) the company has an environmental plan; (2) the company has an environmental vision or mission; (3) the company has communicated its environmental plan, vision, or mission to its employees; (4) the company has communicated its plan, vision, or mission to its shareholders and stakeholders; (5) the company has an environment, health, and safety unit, or an environmental management board or committee; (6) the company's budget planning includes the concerns of environmental investment or procurement (Henriques & Sadorsky, 1999).
- ***Green human capital.*** This study refers to Chen (2008) to measure green human capital. The measurement of green human capital includes five items: (1) the productivity and contribution of employees concerning environmental protection in the company is better than those of its major competitors; (2) the employees' competence of environmental protection in the company is better than that of its major competitors; (3) the products and services of environmental protection provided by the employees of the company are better than those of its major competitors; (4) the cooperative degree of team work pertaining to environmental protection in the company is more than that of its major competitors; (5) managers in the company can fully support their employees to achieve

the goals of environmental protection (Chen, 2008).

- ***Green structural capital.*** This study refers to Chen (2008) to measure green structural capital. The measurement of green structural capital includes six items: (1) the management system of environmental protection in the company is better than that of its major competitors; (2) the company's profit earned from environmental protection activities is more than that of its major competitors; (3) the company's ratio of environmental protection investments in R&D to its sales is more than that of its major competitors; (4) innovations about environmental protection in the company are more than those of its major competitors; (5) investments in environmental protection facilities in the company are more than those of its major competitors; (6) the environmental knowledge management system in the company is favorable for the accumulation and sharing of environmental management knowledge (Chen, 2008).
- ***Green relational capital.*** This study refers to Chen (2008) to measure green relational capital. The measurement of green relational capital includes three items: (1) the company designs its products or services in compliance with the environmental desires of its customers; (2) the company's cooperative relationships about environmental protection with its upstream suppliers and downstream clients are stable; (3) the company has stable and cooperative relationships about environmental protection with its strategic partners (Chen, 2008).

EMPIRICAL RESULTS

The antecedent of in this study is environmental commitments, and the consequents are green human capital, green structural capital, and green relational capital. The descriptive statistics are shown in Table 1. There are positive correlations among environmental commitments, green human capital, green structural capital, and green relational capital. The Cronbach's α coefficients of the constructs are shown in Table 2. Generally, the minimum requirement of Cronbach's α coefficient is 0.7 (Hair et al., 1998). It can be observed that the Cronbach's α coefficient of "environmental commitments" is 0.867; that of "green human capital" is 0.904; that of "green structural capital" is 0.895; and that of "green relational capital" is 0.901. The Cronbach's α coefficients of all four constructs are more than 0.7. Therefore, the measurement of this study is acceptable in reliability. The factor analysis of the four constructs is shown in Table 3. Every construct in this study can be classified into one factor. This study refers to the prior research to design questionnaire items. Before mailing to the respondents, this study employs two pretests for the questionnaire revisions. Therefore, the measurement of this study is acceptable in content validity.

Insert Table 1, Table 2, and Table 3 about here

Table 4 shows the empirical results in this study. This study finds out that environmental commitments are positively related to three types of green intellectual capital - green human capital, green structural capital, and green relational capital. All of the hypotheses, H_1, H_2 and H_3, are supported in this study. High level of environmental commitments can not only meet strict international environmental regulations, but also benefit three types of green intellectual capital. This study indicates environmental commitments are positively associated with three types of green intellectual capital. Hence, it is imperative for Taiwanese manufacturing companies to develop their environmental commitments to enhance their three types of green intellectual capital. Besides, this study finds out that the proxy variable of firm size, log assets, is positively related to three types of green intellectual capital in Table 4. There is the advantage of firm size with respect to green intellectual capital in the Taiwan's manufacturing industry.

Insert Table 4 about here

CONCLUSIONS AND IMPLICATIONS

Owing to the environmental disasters resulting from global climate change, the society has

paid more attention to environmental protection (Chen et al., 2006). More firms are eager to be more responsible and less harmful to the environment due to environmental pressures from the society (Chen et al., 2006). Environmental issues have rapidly emerged as a mainstream issue for consumers and many firms are keen to seize the green opportunities to obtain competitive advantages. This study develops an original framework of green intellectual capital to explore the positive effect of environmental commitments on three types of green intellectual capital. The empirical results of this study show that environmental commitments have a positive effect on three types of green intellectual capital. All of the hypotheses, H_1, H_2 and H_3, are supported in this study. Hence, this study indicates that environmental commitments can positively affect three types of green intellectual capital. Besides, this study finds out that there is the advantage of firm size with respect to green intellectual capital in the Taiwanese manufacturing industry.

This study indicates that environmental commitments positively affect green human capital, green structural capital, and green relational capital. The positive relationship between environmental commitments and green intellectual capital is relevant for the literature on green management in the following: First, this study shows that environmental commitments are a driver of green intellectual capital. The rise of environmental commitments within a company is useful for the increase of green intellectual capital. Second, this study shows that environmental commitments would positively influence three types of

green intellectual capital. In addition, Chen (2008) indicates that green intellectual capital would positively affect competitive advantages. Thus, environmental commitments are beneficial for corporate competitive advantages based on the study of Chen (2008). Third, prior research doesn't explore the relationship between environmental commitments and green intellectual capital. This study fills this research gap and verifies that there is a positive relationship between environmental commitments and green intellectual capital.

This study is conducted in the context of a developing country, Taiwan. The results in the context of a developing country can contribute to the environmental management literature in the following. Many practitioners assert that economic development, rather than environmental protection, is the first priority for firms in the context of a developing country (Chen, 2008). However, this study indicates that environmental commitments are useful for the increase of three types of green intellectual capital in the context of a developing country. Besides, Chen (2008) points out that green intellectual capital would positively affect corporate competitive advantages. Therefore, this study shows out that environmental commitments are important in the context of a developing country and the increase of environmental commitments is imperative for firms to increase their competitive advantages in developing countries.

This study proposes four future research opportunities. First, this research is conducted in the context of a developing country, Taiwan. Thus, future research can focus on other

developing countries or developed countries and compare with this study. Second, this paper is undertaken in the manufacturing industry, so future research can focus on other industries such as the service industry and compare with this study. Third, this study verifies the hypotheses by means of questionnaire survey which only includes cross-sectional data, so it is difficult to observe the dynamic changes of environmental commitments and three types of green intellectual capital in the different stages of the manufacturing industry in Taiwan. Future research can collect longitudinal data to explore the differences of environmental commitments and three types of green intellectual capital in the different stages. Fourth, future research can explore other determinants which can influence three types of green intellectual capital and compare with this study. Finally, we hope the results of this study are helpful to practitioners, scholars, and policy makers, and can contribute to the literature on environmental management.

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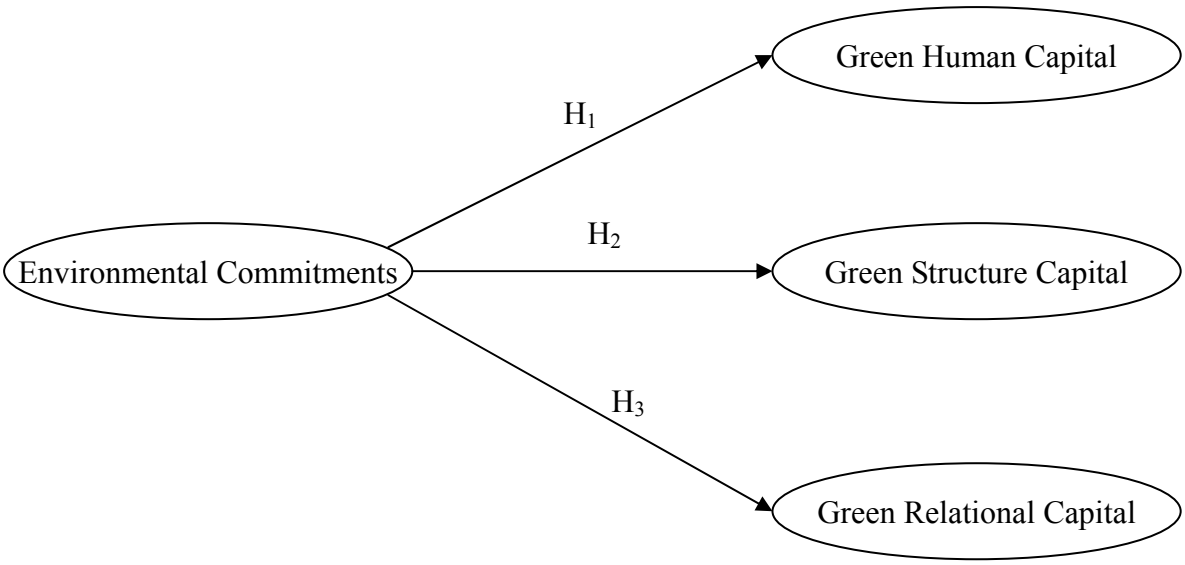

Figure 1 Research framework

Table 1 The descriptive statistics of this study

Constructs	Mean	Standard Deviation	A	B	C
A. Environmental Commitments	3.245	0.974			
B. Green Human Capital	3.237	0.861	0.428**		
C. Green Structural Capital	3.342	0.865	0.416**	0.403*	
D. Green Relational Capital	3.378	0.884	0.437**	0.412*	0.408*

Note: * $p<0.05$, ** $p<0.01$.

Table 2 The Cronbach's α coefficients of the constructs

Constructs	Number of Items	Cronbach's α	Remark
A. Environmental Commitments	6	0.867	acceptable
B. Green Human Capital	5	0.904	acceptable
C. Green Structural Capital	6	0.895	acceptable
D. Green Relational Capital	3	0.901	acceptable

Table 3 Factor analysis of this study

Constructs	Number of Items	Number of factors	Accumulation percentage of explained variance
A. Environmental Commitments	6	1	82.11%
B. Green Human Capital	5	1	81.43%
C. Green Structural Capital	6	1	80.21%
D. Green Relational Capital	3	1	81.07%

Table 4 Empirical results of regression analysis

Dependent Variable:	Green Human Capital	Green Structural Capital	Green Relational capital
Control Variable			
Log Assets	0.204*	0.215*	0.209*
	(2.045)	(2.134)	(2.157)
Independent Variable			
Environmental Commitments	0.265**	0.237*	0.278**
	(3.042)	(2.341)	(3.019)
Adjusted R^2	0.431	0.422	0.443
N	142	142	142

Note: The number in the bracket is t value. * $p<0.05$, ** $p<0.01$.