

The Effect of Corporate Environmental Commitment on Green Product Innovation

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Abstract--This study utilizes structural equation modeling (SEM) to explore the positive effects of corporate environmental commitment on green relationship learning and green human capital which are positively associated with green product innovation in the Taiwanese manufacturing industry. This study selects the external factor, green relationship learning, and the internal factor, green human capital, as two mediators, and discusses their mediation effects on the positive relationship between corporate environmental commitment and green product innovation. The results show that corporate environmental commitment is a driver of green relationship learning and green human capital. This study shows that corporate environmental commitment can positively affect green product innovation performance via the two mediators: green relationship learning and green human capital on the relationship.

I. INTRODUCTION

Many companies argue corporate environmental management is unnecessary, and even misunderstand that it is harmful to corporate performance. Companies pioneer in environmental management or green innovation can possess the first mover advantage which allows them to gain competitive advantages [9, 17, 34]. Companies should change their strategies so that they can comply with the trend of environmentalism. Companies with high level of environmental commitment are prone to undertake green management [11]. Corporate environmental commitment of companies can stimulate proactive environmental actions that can facilitate and integrate the operations among different departments to solve their environmental problems [34, 40]. While companies recognize environmental improvement as an economic and competitive opportunity, they would take the proactive attitude toward environment issues. Previous studies suggested that the maximization of the wealth of equity holders is the only one mission for managers [21]. However, some researchers argued that companies should take more responsibility that beyond the mission of maximizing their profits [43, 6].

Resource-based view (RBV) argues that a firm's sustainable competitive advantage is obtained by unique resources which are valuable, rare, inimitable, and non-substitutable [4]. Corporate environmental commitment can be regarded as proactive environmental actions that can facilitate and integrate the operations among different departments to solve their environmental problems [34, 40, 25]. The fundamental principle of RBV is that the basis for competitive advantage of a firm lies primarily in the application of the bundle of valuable resources at the firm's disposal [49]. Because the external factor - green relationship learning - and the internal factor - green human capital - are

valuable, rare, inimitable, and non-substitutable capabilities and resources with respect to green management, this study selects them as mediators and explores their mediation effects on the relationship between corporate environmental commitment and green product innovation performance. This study defines green relationship learning as the interaction learning activities between companies and their partners, such as customers, suppliers, and network members to exchange and to share the environmental information, knowledge, and technologies. Under the environmental trend, green relationship learning facilitates Taiwanese manufactures to build up their capabilities which meet the environmental regulation by integrating information from one another. Manufactures can exchange knowledge with their suppliers, which enable them to learn from each other and have better environmental performance [46, 9]. There are strong ties between companies and their suppliers, customers and other stakeholders. While the manufacturing companies in Taiwan face an emergent crisis, they build up their collaborative relationships and organize their resources in response to the uncertainty [15, 33]. The networking between companies can help them to integrate and exchange information with each other. In the Chinese context, relationship is internal resources and it is important for business trust in social networking [18]. Relationship means the connection and networking between one and the others, such as the connections between companies and their suppliers, clients, and customers, etc. Companies should learn from their relevant partners to improve the quality, and reliability.

Besides external factor - green relationship learning, companies need to have internal factor - green human capital - to enhance their green product innovation performance. Green human capital is the summation of employees' knowledge, skills, capabilities, experience, attitude, wisdom, creativity, and commitment, etc. about environmental management and environmental concern [9]. It is important for companies to develop green innovation in compliance with environmental pressures. Companies should hire skilled employees and develop their competences about environmental management to achieve public environmental expectation and meet the strict environmental standard [19, 45]. Managers and employees with high level of environmental concerns may help their companies to discover the opportunities of green innovation [37].

There is a conflict between environmental protection activities and corporate performance traditionally [17]. Green product innovation provides win-win solution for this conflict [34]. When the negative effects of global warming are more significant, companies are more willing to put much emphasis on the improvement of environmental issues in

order to comply with the environmental trend. The prevalence of environmental concerns generates great business opportunities for companies, so they should enhance the qualities of their products to meet environmental regulations and obtain competitive advantages. To attain the goal of sustainable development, green product innovation can raise resource productivity efficiently and decrease pollution effectively. Green product innovation has become one of the most important strategic tools in manufacturing industries under the environmental era.

There is no prior study exploring the positive effects of corporate environmental commitment on green relationship learning and green human capital which further positively affect green product innovation from the perspective of environmental management. This study summarizes the literature on the issues of green management, organizational commitment, relationship learning, human capital, and product innovation into a new managerial framework. There are three aims in this study. First, this study verifies that corporate environmental commitment is a positive driver of green relationship learning and green human capital. There is no study exploring this issue. This study highlights the importance of environmental commitment. Second, this study verifies green relationship learning and green human capital are positively associated with green product innovation. Third, this study addresses green relationship learning and green human capital play the mediation role between corporate environmental commitment and green product innovation. The structure of this study is as follows. In section 2, this study reviews the literature and proposes four hypotheses in this section. In section 3, this study describes the methodology, the sample and data collection, and the measurements of constructs. In section 4, this study shows the descriptive statistics, reliability of the measurement, correlations among constructs, and the empirical results. In the end, this study mentions the conclusions and implications in section 5.

II. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

A. The positive effect of corporate environmental commitment on green relationship learning

Environmental commitment is defined as the efforts and involvements of a company in the environmental management and protection [25]. Environmental commitment is motivated by a strong sense of being green [30]. When a company has a stronger sense of environmental commitment, it would invest more resources in environmental management [25, 31]. A company's environmental management system develops clear environmental goals and communicates them throughout the company. Hence, environmental commitment in a company can facilitate the company to attain environmental goals [41].

Green relationship learning is defined as companies' learning activities in environmental management field by

facilitating information exchange, developing common learning arenas, and updating their behavior accordingly from their suppliers, customers, partners, and stakeholders, etc [2, 9, 27, 38, 44]. Relationship means "guanxi" in Chinese. Through green relationship learning, companies cultivate a collaborative culture about green issues, formulate specific objectives for learning activities for environmental management, and develop relational trust about environmental protection with their partners [8, 38, 28]. Companies with high level of environmental commitment would not only view their key suppliers, customers, and stakeholders as important partners, but also invest resources to maintain and to enhance their relationships actively [25, 39]. Once companies have environmental concept, they can learn from their partners to know where the weakness is and how to overcome the defects with respect to green environmental management. Corporate environmental commitment can prompt companies to seek opportunities to engage in green relationship learning with their partners. Under the growing green trend, relationship learning enables companies to obtain crucial information and knowledge from their networking partners [28, 38]. Therefore, this study asserts that corporation environmental commitment has a positive effect on the green relationship learning and implies the following hypothesis:

Hypothesis 1 (H₁): Corporate environmental commitment is positively related to green relationship learning.

B. The positive effect of corporate environmental commitment on green human capital

Companies can take positive action on developing corporate environmental commitment to comply with external environmental pressures [10, 47]. Companies should not shrink their duties under the environmentalism era, because the environmental pressure could turn into a force that drives them to develop human capital about environmental management. To meet the strict environmental standard, companies should hire high potential employees and develop their competences about environmental protection to achieve public environmental expectation [19, 45]. As the global environmentalism has dramatically risen for the past decades, companies should invest many resources and efforts in enhancing their green capability achieve the goal of sustainable development. Previous study asserted that companies' social policies can attract high potential talents [45]. High level of corporate environmental commitment can improve corporate green image which can attract skilled employees who are interested in environmental management. In addition, companies with high level of environmental commitment are more prone to recruit and to develop excellent talents in the field of environmental management. Hence, corporate environmental commitment is beneficial to increasing green human capital, and this study implies the following hypothesis:

Hypothesis 2 (H₂): Corporate environmental commitment is positively related to green human capital.

C. The positive effect of green relationship learning on green product innovation

In order to response environmental uncertainty, companies could build their collaborative relationships and organizes their resources [15, 33]. Under the prevalent environmental trend, companies are motivated to engage in building the relationship with their partners to reduce the environmental uncertainty [28, 38]. Sharing knowledge, insights and know-how about its business context with partners can help companies develop knowledge-learning from external partners, and update their R&D capabilities in the field of environmental management [36]. Relationship learning depends on both parties' willingness to cooperate in joint learning activities which promote the effectiveness and the efficiency of the relationship [26, 38]. For manufacturers, possessing more knowledge and information about their customers helps companies better understand market needs. Besides, knowledge sharing with key partners helps companies improve products with other partners [5, 46, 48,].

As the pace of environmentalism accelerates, green innovation is getting important to companies. Green innovation can enhance the performance of environmental management to satisfy the requirements of environmental protection. A company devotes to developing green innovation can not only meet the environmental regulations but also build up the barriers to the other competitors [4, 11, 30]. Green innovation performance divides into green product innovation and green process innovation. This study focuses on green product innovation which includes the product that are involved in energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management [11]. Green innovation can improve product value, and thus offset the costs of improving environmental impact. Ultimately, green product innovation can further make companies more competitive [34]. Companies require the motivation and ability to produce creative and innovative ideas to develop new products [7]. To develop green product innovations, companies can learn from their partners, customers and suppliers through green relationship learning. Green relationship learning enables companies to obtain crucial information and knowledge from their networking members for developing innovation [28, 38, 35]. Customers can express their discontent by boycotting a company's product and force the company to employ a more environmental way. Suppliers can also exert their influence by sharing their information and knowledge with their clients in the field of environmental management [25]. Previous research asserts that there is a positive association between relationship learning and innovation performance [3, 12, 22]. Hence, this study implies the following hypothesis:

Hypothesis 3 (H₃): Green relationship learning is positively related to green product innovation.

D. The positive effect of green human capital on green product innovation

Previous studies argued that human capital has a positive effect on innovation performance [14, 42]. Although environmental management gradually draws more attention recently, no research explores whether green human capital has a positive association with green product innovations performance. The development of human capital can help companies facilitate the distinctive competencies and innovation opportunities [23, 50]. Employees and managers can modify the attitude, capacities, and behaviors to achieve the organizational goal [13]. Green human capital can build up a managerial climate that tolerates the risk, failure, and uncertainty of green innovation [32]. To facilitate green product innovation, companies must create a clear vision, commitment, objective and strategy driven from their top managers. Companies face much uncertainty and variability in the innovation process. Hence, companies need flexible, risk taking employees to tolerate uncertainty and to face ambiguity [29]. Employees and managers play an important role to generate new ideas in innovation. If firms need to develop new products, they must develop their human capital to generate creative ideas and to exert new opportunities [37]. Top managers provide a shared organizational belief to develop green product innovations, because it can not only influence the behaviors and expectations of employees, but also motivate them to develop innovation [7]. Previous study asserted that there is a positive relationship between human capital and innovation [7, 11, 14,]. The summation of employees' knowledge, skills, capabilities, experience, attitude, wisdom, creativity, and commitment, etc. about environmental management and environmental concern can help companies increase their green product innovation, so this study implied the following hypothesis:

Hypothesis 4 (H₄): Green human capital is positively related to green innovation performance.

This study proposes four hypotheses and demonstrates the research framework in Fig. 1. The first purpose of this study is to verify that corporate environmental commitment is a positive driver of green relationship learning and green human capital in the Taiwanese manufacturing industry. The second purpose of this study is to address green relationship learning and green human capital play the mediation role on the positive relationship between corporate environmental commitment and green product innovation. This study selects the external factor, green relationship learning, and the internal factor, green human capital, as two mediators, and discusses their mediation effects on the positive relationship between corporate environmental commitment and green product innovation in the Taiwanese manufacturing industry. Hence, the determinant of the research framework is corporate environmental commitment and the consequent is green product innovation, while green relationship learning and green human capital are the mediators in this research framework.

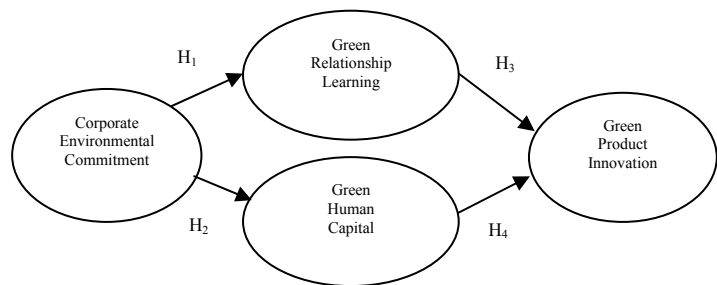


Fig. 1 Research framework

II. METHODOLOGY AND MEASUREMENT

A. Data Collection and the Sample

The research object of this study is the Taiwanese manufacturing industry. The unit of analysis in this study is business level. This study uses the questionnaire survey to verify the hypotheses and research framework. This study selects the samples randomly from “2009 Business Directory of Taiwan.” The respondents of the questionnaires are CEOs or managers of manufacturing, purchasing, R&D, marketing, human resources management, or environmental protection departments. To heighten the valid survey response rate, the research assistants explain the objectives of this study and the questionnaire content, and confirm the names and job titles of the respondents before mailing the questionnaires to the companies. The respondents are asked to return the completed questionnaires within two weeks after mailing the questionnaires. Moreover, to avoid common method variance (CMV), different respondents answer the different constructs in the questionnaire. This study sent 400 questionnaires to the respondents. There are 111 valid questionnaires, and the effective response rate is 27.75%.

B. Definitions and Measurements of Variables

The questionnaire comprises four parts. The first part of the questionnaire consists of the descriptive data of companies (including the number of employees, year founded, and industrial sector, etc.); the second part is the measurement of corporate environmental commitment; the third part is the measurement of green relationship learning; the fourth part is the measurement of green human capital, and the fifth part is the measurement of green product innovation. The measurement of the questionnaire items is by use of “five-point Likert scale from 1 to 5” rating from strongly disagreement to strongly agreement. The measurements of the constructs are in the following.

Corporate environmental commitment: The measurement of environmental commitment includes six items: (1) the company has an environmental vision or mission; (2) the company has a concrete plan of environmental management; (3) the company has communicated its environmental plan to employees; (4) the company has communicated its environmental plan to its stakeholders; (5) the company has an environment, health, and safety unit or committee; (6) the

company’s budget planning includes the concerns of environmental investment or procurement [25].

Green relationship learning. The measurement of green relationship learning includes three items: (1) the company exchanges information related to environmental management of products with its relevant partners; (2) the company can learn from its relevant partners to adjust its common understanding of environmental trends in technologies related to its business; (3) the company establish joint teams to analyze and to discuss environmental issues with its relevant partners [9, 28, 38].

Green human capital. The measurement of green human capital includes five items: (1) the productivity and contribution of the employees about 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 green products and services developed by the employees of the company are better than those of its major competitors; (4) the cooperative degree of team work about environmental protection in the company is more than that of its major competitors; (5) the managers can fully support their employees to achieve the goals of environmental protection [9, 16].

Green product innovation. The measurement of green product innovation performance includes three items: (1) the company chooses the materials of the product that consume the least amount of energy and resources for conducting the product development or design; (2) the company uses the fewest amount of materials to comprise the product for conducting the product development or design; (3) the company would regularly evaluate whether its products are easy to recycle, reuse, and decompose for conducting the product development or design [11].

IV. EMPIRICAL RESULTS

This study uses Structural Equation Modeling (SEM) to verify the research framework and hypotheses. SEM is a statistical technique for testing and estimating causal relationships in a more powerful way. In addition, SEM includes two levels of analysis - the measurement model and the structure model. The measurement model verifies how hypothetical constructs are measured in terms of the observed variables and the structural model examines the relationships among the constructs [1].

A. The Results of the Measurement Model

This study demonstrates the means and standard deviations of the constructs and the correlations among them in Table 1. There are positive correlations among the constructs: corporate environmental commitment, green relationship learning, green human capital, and green product innovation. This study shows the result of factor analysis in Table 2. Every construct in this study can be classified into only one factor in Table 2. This study applies confirmatory

factor analysis (CFA) to verify the validity and reliability in the measurement model. The results of the CFA indicate that the measurement model exhibits the acceptable levels of the model fit ($\chi^2=113.6$, d.f.=98, $\chi^2/d.f.=1.159$, GFI=0.903, NFI=0.926, CFI=0.989, RMSEA= 0.038).

There are several measures to confirm the reliability and validity of the measurement. One measure of reliability is to examine the loadings of each of the constructs' individual items. With respect to the quality of the measurement model, the loadings (λ) of items of the constructs listed in Table 3 are all significant. Table 3 lists the Cronbach's α coefficients for the measure of reliability. In general, the minimum requirement of the Cronbach's α coefficient is 0.7 [24]. Because the Cronbach's α coefficients of the four constructs are more than 0.7, the measurement of this study is acceptable in reliability. In addition, it is also important to verify whether the validity of the measurement is acceptable. There are three ways to verify the validity of the measurement. First, the study refers to previous studies to design questionnaire items. Prior to mailing to the respondents, eight experts and scholars modified the questionnaire in the first pretest. Subsequently, the authors distributed the questionnaires to ten CEOs, managers of manufacturing, purchasing, R&D, marketing, human resources management, or environmental protection departments in different companies. They filled in the questionnaires to identify ambiguities in terms, meanings, and issues in the second pretest. The questionnaire of this study has high level of content validity. Second, this study applies Fornell and Larcker's measure of average variance extracted (AVE) to access the discriminative validity of the measurement [20]. The AVE measures the amount of variance captured by a construct through its items relative to the amount of variance due to the measurement error. To satisfy the requirement of the discriminative validity, the square root of a construct's AVE must be greater than the correlations between the construct and other constructs in the model. For example, the square roots of the AVEs for the two constructs,

corporate environmental commitment and green relationship learning, are 0.822 and 0.831 in Table 3 which are more than the correlation, 0.526, between them in Table 1. This demonstrates there is adequate discriminative validity between corporate environmental commitment and green relationship learning. The square roots of all constructs' AVEs in Table 3 of this study are all more than the correlations among all constructs in Table 1. Therefore, the discriminative validity of the measurement in this study is acceptable. Third, the AVEs of the four constructs are more than 0.5 in Table 3. It means that the convergent validity of the four constructs is acceptable. In sum, there are adequate reliability and validity in the measurement of this study according to the above analysis.

The Results of the Structural Model

This study verifies the hypotheses in the structural model. The results of the structural model are presented in Table 4 and Fig. 2. The measures of overall fit indicate the fit of the structural model is acceptable ($\chi^2=113.6$, d.f.=98, $\chi^2/d.f.=1.159$, GFI=0.902, NFI=0.925, CFI= 0.988, RMSEA= 0.040). Adding more paths in this research framework would not significantly improve the fit. The residuals of the covariance are also small and centered near 0. All of the four paths are positive and significant in Table 4. The results of the full model are shown in Fig. 2. According to the results in Table 4 and Fig. 2, all of the four hypotheses are supported. Therefore, this study verifies that corporate environmental commitment is a positive driver of green relationship learning and green human capital in the Taiwanese manufacturing industry. In addition, this study finds out green relationship learning and green human capital play a mediation role in the positive relationship between corporate environmental commitment and green product innovation. It means that corporate environmental commitment can indirectly affect green innovation performance via the two mediators: green relationship learning and green human capital.

TABLE 1. MEANS, STANDARD DEVIATIONS, AND CORRELATIONS OF THE CONSTRUCTS

Constructs	Mean	Standard Deviation	1	2	3
1. Corporate Environmental Commitment	3.571	0.924			
2. Green Relationship Learning	3.279	1.067	0.526**		
3. Green Human Capital	3.472	0.657	0.608**	0.443**	
4. Green Product Innovation	3.904	0.644	0.487**	0.367**	0.450**

Note: ** p<0.01.

TABLE 2. FACTOR ANALYSIS OF THIS STUDY

Constructs	Number of Items	Number of factors	Accumulation percentage of explained variance
Corporate Environmental Commitment	6	1	72.459%
Green Relationship Learning	3	1	80.022%
Green Human Capital	5	1	74.980%
Green Product Innovation	3	1	72.125%

TABLE 3. THE ITEMS' LOADINGS (λ) AND THE CONSTRUCTS' CRONBACH'S α • COEFFICIENTS AND AVEs

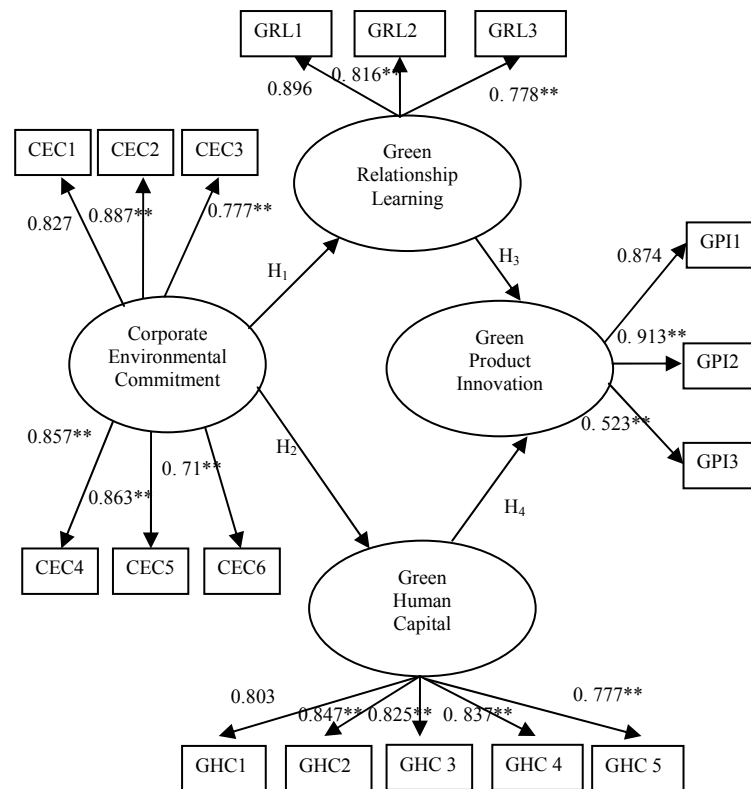
Constructs	Items	λ	Cronbach's α	AVE	The square root of AVE
Corporate Environmental Commitment	CEC1	0.827	0.923	0.676	0.822
	CEC2	0.887**			
	CEC3	0.777**			
	CEC4	0.857**			
	CEC5	0.863**			
	CEC6	0.71**			
Green Relationship Learning	GRL1	0.896	0.875	0.691	0.831
	GRL2	0.816**			
	GRL3	0.778**			
Green Human Capital	GHC1	0.803	0.915	0.669	0.818
	GHC2	0.847**			
	GHC3	0.825**			
	GHC4	0.837**			
	GHC5	0.777**			
Green Product Innovation	GPI1	0.874	0.793	0.624	0.790
	GPI2	0.913**			
	GPI3	0.523**			

Note: ** p<0.01.

TABLE 4. THE RESULTS OF THE STRUCTURAL MODEL

Hypothesis	Proposed effect	Path coefficient	Results
H ₁	+	0.657**	H ₁ is supported
H ₂	+	0.667**	H ₂ is supported
H ₃	+	0.293†	H ₃ is supported
H ₄	+	0.321*	H ₄ is supported

Note: †p<0.1, * p<0.05, ** p<0.01.



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

Fig. 2. The results of the full model

V. CONCLUSION AND IMPLICATIONS

This study applies structural equation modeling (SEM) to discuss the positive effects of corporate environmental commitment on green relationship learning and green human capital which further have a positive effect on green product innovation. The results demonstrate that H_1 , H_2 , H_3 , H_4 are supported in this study. This research indicates that the investments in corporate environmental commitment can enhance green relationship learning and green human capital. Besides, this study finds out that the more investments in the green relationship learning and green human capital, the better is green product innovation. Therefore, in the era of environmentalism, corporate environmental commitment is an important determinant for green relationship learning and green human capital which are mediators in the relationship between corporate environmental commitment and green product innovation.

There are several interesting implications in this study. First, this study verifies that corporate environmental commitment is the driver of green relationship learning and green human capital. If companies would like to develop their green relationship learning and green human capital, they should raise their corporate environmental commitment. Second, this study verifies that green relationship learning and green human capital are positively associated with green product innovation. If a company would like to enhance its green product innovation, it may hire skilled employees who are knowledgeable about environmental management and improve the interaction learning activities with their partners, such as customers, suppliers, and network members. Third, empirical results show that green relationship learning and green human capital mediate the positive relationship between corporate environmental commitment and green product innovation. From the RBV perspective, the two mediators, green relationship learning and green human capital, are important triggers which can stimulate the positive relationship between corporate environmental commitment and green product innovation. It also means that corporate environmental commitment can indirectly influence green product innovation via the two mediators, green relationship learning and green human capital. Fourth, there are few studies exploring the issue of relationship learning in Chinese social-cultural settings, such as Taiwan. This study proposes a novel construct, green relationship learning, to discuss its mediation effect in the research framework. The networking is extremely important in Chinese culture, because networking within Chinese social-cultural settings are strong and long-term. Green relationship learning provides a platform for companies to share knowledge and information and foster green product innovation. Fifth, green product innovation is a differentiation strategy which enables Taiwanese entrepreneurs to create new businesses in Taiwanese manufacturing industry. Green product innovation is able to seize opportunities or to lead in the market. If companies are willing to undertake green product innovation,

they can obtain the advantage of differentiation and even change the existing competitive rules to become one of successful companies [34]. Furthermore, the design of green products can increase their differentiation advantages [11, 40].

This research suggests three directions for future studies. First, this study focuses on the manufacturing industry in Taiwan, so further studies can focus on other industries or countries and compare with this study. Second, this study verifies hypotheses by use of questionnaire survey, only providing cross-sectional data, so that this study can not observe the dynamic change of corporate environmental commitment, green relationship learning, green human capital, and green product innovation in the different stages of the manufacturing industry in Taiwan. Future studies can use longitudinal data to discuss the differences of corporate environmental commitment, green relationship learning, green human capital, and green product innovation performance in the different stages of the manufacturing industry in Taiwan. Third, this study explores the relationships among corporate environmental commitment, green relationship learning, green human capital, and green product innovation. Further studies can add other important constructs into the research framework and compare with this study. Finally, this study hopes the research results are beneficial to practitioners, researchers, and policy makers, and contribute to future studies as reference.

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