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Article

Effects of Green Innovation on Environmental and Corporate Performance: A Stakeholder Perspective

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Abstract: "Going green" has become an important environmental issue in contemporary business practice worldwide. This study examined the influence of a number of factors on green innovation and the consequences in terms of performance. The stakeholder theory was adopted to observe the effects of each stakeholder on the green innovation practices of companies and to determine how green innovation practices influence environmental and business performance. A research model with eight hypotheses was proposed to determine the associations between the variables of interest. An empirical survey was conducted of 202 Taiwanese service and manufacturing companies. The survey found that pressure from competitors and the government, along with employee conduct, all had significant and positive effects on green innovation practices. Additionally, a moderating effect of innovation orientation existed only in the relationship between green product innovation practices and employee conduct. This study not only provides a systematic way to analyze the effects of green innovation practices but also suggests the best means for companies to adopt green innovation practices.

Keywords: green innovation; stakeholder theory; performance

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1. Introduction

The excessive use of natural resources occasioned by rapid economic growth has damaged the environment and raised many environmental concerns [1,2]. To conserve energy and reduce carbon emissions, many countries have established environmental regulations; examples include restrictions on chlorofluorocarbons, the sustainable development announcements of the Johannesburg world summit, and restrictions on the use of certain hazardous substances (e.g., electrical and electronic equipment requirements, the European Union's Restriction of Hazardous Substances Directive). These regulations have not only increased awareness of environmental management [3,4]; they have also resulted in changes in management practices and competition among companies [5]. To conform to the new environmental regulations, companies have had to adopt environmentally friendly practices. They have also had to improve their environmental images and branding [6,7] in the hope of sustaining and improving their performance and competitive advantage [4,8].

"Going green" has been one of the important ways that companies have dealt with environmental issues. Methods of acquiring green capabilities and conducting green practices have drawn increased attention and prompted discussion for the last two decades [9,10]. To facilitate the adoption of green innovations, companies must consider the important drivers and antecedents in their businesses [11]. These include the concerns of customers [12], the preferences of business owners [13], the capabilities of suppliers [14], government regulations [1,15], and the technological, organizational, and environmental determinants of green practices [16]. Although previous studies have provided some evidence of the influence of various factors on green practices, to date, few systematic and complete analyses of the antecedents and drivers of green innovation have been performed. Therefore, it is important to acquire a holistic view of the effects of each stakeholder in a company on establishing green innovation capabilities and practices. Company managers are interested in knowing what the key drivers are in establishing green innovation practices. Are customer requests or government regulations the main drivers of green innovations? How should companies address the concerns of various stakeholders? Moreover, much past research has focused on the manufacturing industry (e.g., [17,18]) or on a single industry sector (e.g., [16,19]). It would be advantageous to provide a general model to examine issues related to green innovation for both the manufacturing and the service industries. Thus, in the present study, we adopted the stakeholder theory [20] to frame our approach to the research. The stakeholder theory has been used to obtain a complete view of a given company to investigate the impacts of each stakeholder on green innovation practices. Adopting Freeman's perspective for the stakeholders, this study classified the various stakeholders as internal (customers, suppliers, and employees) or external (competitors and the government). To respond to pressure from and the conduct of stakeholders, companies must consider an overall strategy that takes into account the supplies and demands of multiple stakeholder groups [21].

As illustrated in Figure 1, this study sought to establish a conceptual model regarding the relationships among stakeholders, green innovation, and performance. The remainder of this paper is organized as follows. First, the theoretical background that motivates this research is provided. The relevant literature related to the proposed model is presented, along with the corresponding hypotheses. Second, the research methodology is provided, followed by demonstration and discussion of the results of the analyses. The final section draws conclusions about the contributions, implications, and limitations of the current study and addresses areas of future research.

Figure 1. Conceptual framework.

2. Literature Review

2.1. Stakeholder Theory

The term *stakeholders* was coined by the Stanford Research Institute in 1963 and was defined as "those groups without whose support the organization would cease to exist" [22]. In 1984, Freeman was the first to bring the stakeholder concept into a strategic discipline, which not only distinguished stakeholders from the shareholders in corporations but also showed the impacts of various stakeholders on companies' decision-making processes [23,24]. Based in four key academic areas—strategic planning, systems theory, corporate social responsibility, and organizational theory—the stakeholder theory has a different view of a company and therefore provides a different explanation of an organization's structure and daily operations [25]. The domain of the theory, based on four essential premises [26], indicates first that companies have relationships with several stakeholder groups, all of which affect or are affected by the companies' decisions [20,27,28]. Second, these relationships are established in the processes and outcomes for the company and its stakeholders. Third, stakeholders' interests have intrinsic value, and each stakeholder's interests cannot be allowed to overshadow the interests of other stakeholders [23,28,29]. Fourth, decision making of the company is the focal point [23].

The stakeholder theory has been adopted for several environmental studies such that stakeholders have been instrumental in influencing both corporate ecological responsiveness (e.g., [30]) and environmental strategies (e.g., [31,32]). However, the results have been mixed, and the influence of stakeholders on environmental management has been inconsistent. For example, whereas Kassinis and Vafeas [33] found that the corporate board of a large company is the core decision-making unit in forming corporate environmental policies, in a smaller family business, the owners make decisions about adopting green innovations [13]. In addition, in German manufacturing firms, stakeholders were found to influence companies' choices regarding environmental response patterns [34], and they were positively associated with patented environmental innovations [35]; in contrast, the relationship between environmental strategies and stakeholder management was more limited in Belgian companies [32].

2.2. Green Innovation

Studies of green innovation can usually be categorized into two types. The first type defines green innovation as a company's capabilities (e.g., [6,18,36]), while the second treats green innovation as a company's environmental practices (e.g., [1,14,17,37,38]). When considered as a company's practices, green innovation is defined as the hardware or software innovation related to green products or processes [39] and suggests that green innovation consists of technical improvements or new administrative practices that improve the environmental performance and the competitive advantage of an organization (e.g., [13,40]). Other scholars suggest that green innovation consists of new or modified processes, practices, systems, and products that benefit the environment and contribute to environmental sustainability (e.g., [41,42]).

The current study defines green innovation as the new or modified products and processes, including technology, managerial, and organizational innovations, which help sustain the surrounding environment. Moreover, because of increasing customer concerns regarding protection of the environment, environmental management has become a key part of strategic planning in many organizations [14]. Environmental regulations may lead to a "win-win situation" [5]—that is, they may both reduce pollution and increase profits—suggesting that green innovation should be treated differently than other innovative tactics because it produces not only a spillover effect for research and development efforts but also positive external effects, *i.e.*, improvements in the environment [15].

3. Green Innovation Model

In this study, a green innovation model was developed that includes six primary constructs: external stakeholders, internal stakeholders, green innovation practices, environmental performance, firm performance, and orientation toward innovation. We intended to identify the green innovation practices and examine the effects of stakeholders on the adoption of green innovation practices and the consequences on the environment and the performance of companies. Figure 2 illustrates the hypotheses proposed in this study.

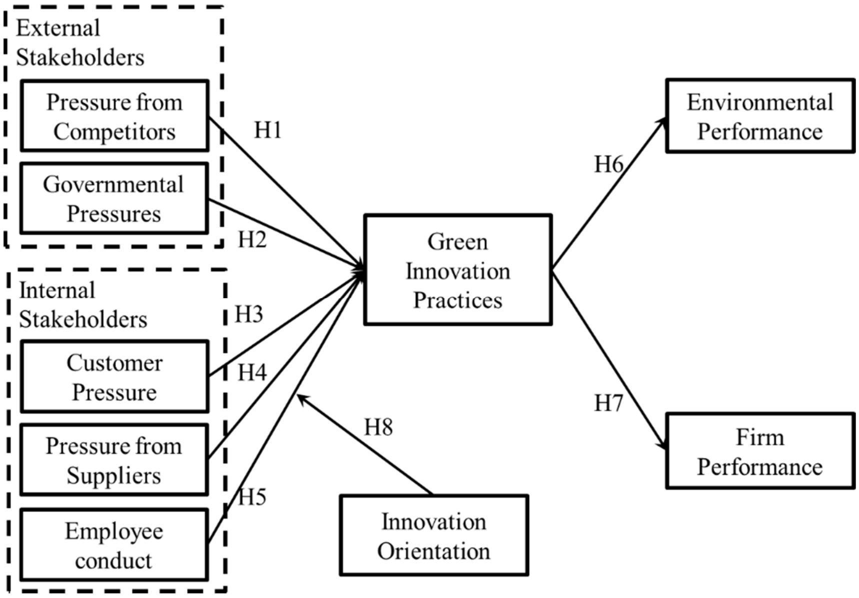

Figure 2. Theoretical framework—green innovation model. Note: H1 indicates Hypothesis 1, H2 indicates Hypothesis 2, and so on.

3.1. External and Internal Stakeholders

We followed Freeman's stakeholder framework [20] and identified competitors and governments as external stakeholders and customers, suppliers, and employees as the internal stakeholders.

Additionally, we viewed each stakeholder as a factor exerting pressure on the companies and driving the companies toward better environmental practices.

3.1.1. Pressure from Competitors

Companies usually react and respond to the actions of their competitors. When competitors adopt new environmental practices, companies in the same industry will feel pressured to reevaluate their current status regarding environmental responsibility and to decide whether to increase and/or improve the implementation of environmental practices [43,44]. In general, companies need to be aware of their competitors' offerings and industry norms to ensure that their innovation capabilities are similar to those of the rest of the industry. For example, companies must be aware of new energy-saving techniques and new equipment that is available on the market. They need to know what their competitors have done to reduce energy costs while renovating their manufacturing plants or power supplies in efforts to outperform their competitors. Therefore, to sustain competitive advantages, companies may imitate the environmental activities of competitors—especially the leaders—in their industries [13,45]. Thus, hypothesis 1 is suggested:

Hypothesis 1: Pressure from competitors has a positive impact on green innovation practices.

3.1.2. Governmental Pressures

A number of studies have investigated the relationships between governmental regulations and environmental practices and have suggested that governmental pressure is one of the most significant external stakeholders (e.g., [20,46,47]). Regulatory changes and enforcement of these changes by the government affect companies' actions regarding environmental management [13,44] and sustaining their business. Additionally, to compete globally, companies need to follow both global and local regulations to protect the environment. The rigor of the regulations and firms' perceptions of the stringency of the regulations will determine the extent to which companies actually implement environmental protection practices [1,42]. Moreover, the degree to which the government supports/enforces the regulations has a significant impact on companies' environmental policies [48,49], making this an important task to investigate. Therefore, we propose hypothesis 2:

Hypothesis 2: Governmental pressures have a positive impact on green innovation practices.

3.1.3. Customer Pressure

Several studies have discussed the impact of customer pressure on companies' decisions regarding environmental practices [3,50,51]. Customer expectations have become one of the most important factors influencing companies' environmental practices [44,52,53]. More and more customers now have strong concerns about the environment and prefer to purchase environmentally friendly products [54–56]. Customers may refuse to buy products that damage the environment, which encourages companies to create green products [1,49,57]. Furthermore, customer experience with the company's product or interacting with the company's services affects word of mouth and the company's branding and image. Thus, hypothesis 3 is proposed:

Hypothesis 3: Customer pressure has a positive impact on green innovation practices.

3.1.4. Pressure from Suppliers

Suppliers affect the cost, lead time, development risks, and market availability of manufacturers [58]. Pujari [59] pointed out that a firm's green innovation is largely determined by "upstream" environmental impacts, meaning that suppliers' materials and components could influence the quality, design, and competitiveness of a company's products. Sometimes, suppliers may refuse to supply products to firms that they believe damage the environment [13,58]. Geffen and Rothenberg [60] noted that, through unique partnerships with suppliers, companies can improve their environmental performance, indicating that supplier involvement plays an important role in the firm's innovation. Therefore, hypothesis 4 is proposed:

Hypothesis 4: Pressure from suppliers has a positive impact on green innovation practices.

3.1.5. Employee Conduct

Top managers recognize the importance of environmental protection and their company's responsibility to influence strategic planning with regard to environment management. Strong recognition of and attention to environmental factors by management should yield better innovation and performance [13]. Additionally, a company's future direction with regard to environmental practices depends heavily on whether the management team encourages employees to actively participate in environmental management initiatives and on management's own commitment to green practices [1,61]. Similar situations exist among employees. In an organization, employees are often the initiators of environmental practices [50,62]. Companies will have difficulty in accomplishing environmental goals if employees do not support their policies [63]. Thus, companies need to provide employees with training on environmental issues, to involve appropriate employees, and to enhance their commitment to environmentally friendly practices [64]. The cited studies suggest that pressure from both management and employees could encourage organizations to adopt green practices. Thus, we propose hypothesis 5:

Hypothesis 5: Employee conduct has a positive impact on green innovation practices.

3.2. Performance

Two types of performances will be discussed in this study: *environmental performance* and *firm performance*. Environmental performance can be defined as the environmental impact of a company's activities on the natural surroundings [4,65]. Firm performance incorporates several factors, including financial performance, business unit performance, and organizational performance [66,67].

3.2.1. Environmental Performance

Environmental performance comprises the inclusion of recyclable materials in products, reduced pollution emissions and waste at the source, improvements in energy efficiency, reduction of environmentally hazardous substances, and more [48,68]. With respect to long-term environmental impacts, a company's regulatory measures, including pollution prevention as well as resource and waste reduction, are more productive than end-of-pipeline solutions [69,70]. Past studies suggested that improvements in the manufacturing process and productivity will increase opportunities to improve environmental performance [71]. Therefore, we propose hypothesis 6:

Hypothesis 6: Green innovation practices have a positive impact on environmental performance.

3.2.2. Firm Performance

A firm's performance can be measured both financially and non-financially [72]. With respect to financial performance, companies can cover their environmental costs by increasing resource productivity through green innovation [5,73]. In addition, companies can develop new markets and increase their market share through implementing environmental practices [39,74]. As a long-term operational objective, improved non-financial performance may be manifested by increased customer loyalty, new customers, and an enhanced image and reputation of a firm [67,73,75]. Chen [6,18] proposed that companies who are pioneers in green innovation will gain the "first-mover advantage," *i.e.*, higher product prices, an improved corporate image, new market opportunities, and competitive advantages. Thus, hypothesis 7 is proposed:

Hypothesis 7: Green innovation practices have a positive impact on firm performance.

We tested the moderating effects of innovation orientation only on the relationship between employee conduct and green innovation practices because innovation orientation is correlated with business strategy settings and organizational culture, both of which are related mainly to the company's employees.

3.3. Innovation Orientation

Innovation orientation is a type of strategic orientation that affects organizational innovation practices and serves as a guiding principle for strategy making and implementation to enhance a company's innovativeness [76,77]. It describes an organization's openness to new ideas, technologies, skills, resources, and administrative systems [78] and a knowledge system that incorporates a learning philosophy, strategic direction, and trans-functional acclimation within an organization to promote innovation [79]. Innovation orientation is a key driver in overcoming hurdles and enhancing a firm's ability to successfully implement new systems, products, and processes [80]. Companies with a more innovative atmosphere and leadership will encourage and motivate employees to undertake innovative conduct. Hence, we propose that an innovation orientation can improve the relationship between employee conduct and green innovation practices, as illustrated in hypothesis 8:

Hypothesis 8: Innovation orientation positively moderates employee conduct on green innovation practices.

4. Research Methodology

4.1. Instrument Design

A questionnaire survey approach was developed to investigate the proposed model. Based on a review of the literature, we designed a structured questionnaire with six primary constructs: external stakeholders (competitors and government); internal stakeholders (customers, suppliers, and employees); green innovation; environmental performance; firm performance; and innovation orientation. To ensure that the questionnaire would more precisely extract the data sought for the current study, several in-depth pilot interviews with managers and executives were conducted. To gain adequate insight into their experiences, opinions, aspirations, and attitudes toward perceived stakeholders' views and green innovations within the organization, interviews were scheduled for up to 2 h. Interviewees were then asked to review and complete the questionnaire (*i.e.*, as a pretest) to identify ambiguities and suggest improvements to the questionnaire. An examination of the feedback led to further refinement and, eventually, the final version. All of the variables were measured on multiple-item five-point Likert-type scales (1 = strongly disagree, 5 = strongly agree). Two other steps were taken to ensure the accuracy and appropriateness of the items. First, to confirm the accuracy of the translation, the items, which had been translated into Chinese, were translated back into English and compared to the original English-language version. Adjustments were made to correct any discrepancies. Also, all items were examined for their relevance to actual conditions in Taiwan. Data collection was conducted during spring 2012.

4.2. Operationalization of Constructs

All of the constructs were measured with multiple-item scales. In all, fifty-four question items, excluding items that asked about company demographics, were used and covered all variables discussed in the model.

4.2.1. Pressure from Competitors (COM)

Competitor pressure was measured with four items that were drawn and modified from Christmann [43]. These items measured the extent of competitors' actions regarding environmental issues, including setting environmental standards for operations and implementing environmentally friendly strategies.

4.2.2. Governmental Pressure (GOV)

Governmental pressure was measured with four items drawn from two previous studies [1,49]. These items measured the stringency of government regulations and the degree to which future regulation and its effects on business could be predicted.

4.2.3. Customer Pressure (CUS)

Customer pressure was measured by adapting four items from previous studies [13,48,81]. The items inquired about customers' environmental concerns, the importance of environmental issues to customers, customer preferences for environmentally friendly products, and customers' concerns about energy savings.

4.2.4. Pressure from Suppliers (SU)

Based on Huang *et al.* [13], pressure from suppliers was measured with four items. The items sought to determine whether suppliers could offer materials and components that were environmentally friendly.

4.2.5. Employee Conduct (EM)

Five questions regarding employee conduct inquired about environmental awareness among employees and the commitment of management to the environment, based on two previous studies [48,82]. *Management commitment* refers to a company's support for environmental protections and the acceptance of these ideas within the firm's culture. In addition, environmental awareness among employees was measured by employees' environmental education and training.

4.2.6. Green Innovation Practices (GI)

Green innovation practices were measured with twelve items. We employed and modified items from previous studies [14,39,82]. Rather than treating GI as a single construct, we treated GI practices as a second-order construct, including green *product* innovation practices and green *process* innovation practices. In this model, green product innovation practices (five items, GIa) were measured by the extent that new products reduced pollution and energy consumption, whereas green *process* innovation practices (seven items, GIb) were measured by the degree that new processes reduced pollution and energy consumption.

4.2.7. Environmental Performance (EP)

Environmental performance was measured by six items adopted from previous studies [14,68,83]. These items measured reductions in hazardous waste and emissions, scrape rate, and increases in regulation knowledge.

4.2.8. Firm Performance (FP)

Firm performance inquired about financial and non-financial performance of the company, and eight items were drawn from Chen *et al.* [67], Blazevic and Lievens [75], and Avlonitis *et al.* [84]. Financial performance was measured by market share, sales, and profitability. Non-financial performance was measured by a company's reputation and competitive advantage.

4.2.9. Innovation Orientation (IO)

Innovation orientation was used as a moderating construct. This construct included seven items employed and modified from Siguaw *et al.* [79], Zhou *et al.* [78], and Hurley and Hult [85]. These items measured the learning philosophy, strategic direction, and transfunctional acclimation of an organization.

4.2.10. Control Variables

Two control variables—firm size and firm age—were included in the proposed model. Larger firms may have greater capacity and resources to adopt innovations [13,86]; therefore, we assessed firm size as the number of employees for individual firms. Huang *et al.* [13] stated that, as an organization grows older, it may not want to change and hence, adoption of innovations may be impeded by organizational inertia [87]. Accordingly, we measured firm age by the number of years that the establishment had been in existence.

4.3. Sampling

This study sought to analyze green innovation practices in both manufacturing and service firms in Taiwan. Possible firms were gathered from "the 2011 largest corporations in Taiwan—Top 5000" published by the China Credit Information Service. The total sample size was 830 companies; this included 472 companies in the service industry and 358 companies in manufacturing. Our targeted samples included hotels, contractors, and logistics firms in the service industry and manufacturers of automobiles, computer peripherals, and photo electricity equipment in the manufacturing industry. The service industry companies included 118 hotels, 145 logistics companies, and 209 contractors, while the manufacturing companies consisted of 91 computer peripherals companies, 181 photoelectricity companies, and 86 automobile manufacturing companies. These sectors were chosen because they are among the best developed and most "green-conscious" industries in Taiwan.

4.4. Data Collection

The focal point of this study is green innovation practices, the factors that influence it, and the performance of firms that adopt green practices. We sent out most questionnaires to operations or marketing managers for companies in the service industry and operations or research/development managers for companies in the manufacturing industry because these functional managers tend to be the most familiar with the green innovation practices of their companies. They received an envelope that contained a cover letter, a four-page questionnaire, and a self-addressed, stamped return envelope. To encourage responses, we stated that we would donate NT$100 for each completed questionnaire to The Garden of Hope Foundation (http://www.goh.org.tw/english/). Additionally, we promised to provide all responders with the survey results and report our gratitude for their participation.

Initially, we received 127 responses. To increase the respondent rate, we followed up through telephone calls, e-mails, and an online questionnaire. We contacted managers who had not yet returned the questionnaire. After 2 months of follow-up, the valid sample in this study increased to 202, for a response rate of 24.34%.

Non-response bias was tested among the early and late respondents using an independent *t*-test to test the measured variables [88]. In this study, we classified a first mailing response as an early response (n = 127), and the follow-up contacts were considered late responses (n = 75). There was no significance between the early group and the follow-up group with respect to years established (p = 0.508), firm capital (p = 0.897), number of employees (p = 0.990), tenure within their firm (p = 0.812), and job position (p = 0.079). The results of the independent *t*-test are shown in Table 1.

Table 1. Results of independent *t*-test of demographics of the surveyed companies.

Construct	Mean		*T*-test for the equality of means		
	Early response (n = 127)	**Late response (n = 75)**	**Mean difference**	***t*-value**	***p*-value (2-tailed)**
YE	4.850	4.720	0.130	0.663	0.508
FC	3.803	3.787	0.016	0.130	0.897
NE	3.158	3.160	−0.003	−0.013	0.990
TW	3.677	3.627	0.050	0.238	0.812

YE = years established in Taiwan; FC = firm capital; NE = number of employees; TW = tenure with the firm.

To detect common method bias, Harman's single-factor test is one of the most popular methods [89]. This test shows whether all variables load to only one factor. To conduct this test, an Exploratory Factor Analysis (EFA) is processed with extraction factor fixed to one single factor, instead of 5 factors in our original analysis. The five extracted factors accounted for 74.3% of the variance. A single factor did not emerge and the first factor accounted for 44.0% of the variance, indicating that no common method bias exists. A second method, a marker variable test, is used to double check the common method bias. Suggested by Lindell and Whitney [90], this method investigates the correlations between the marker and other variables. We chose the tenure of the informant as the marker because Tenure does not have any theoretical relationships with other variables. The average correlation with the marker is 0.07 and the average *p*-value of the correlation is 0.43. Both suggest no common method bias in our data.

We obtained 112 questionnaires from service industry firms and 90 questionnaires from manufacturing companies. We conducted an independent *t*-test to determine whether the service and manufacturing industries were significantly different in their responses. Table 2 shows the results of this analysis and indicates that there were no significant differences between the service and manufacturing industries. The p values for competitors (p = 0.366), governments (p = 0.416), customers (p = 0.065), suppliers (p = 0.125), employees (p = 0.195), green product innovation (p = 0.673), green process innovation (p = 0.624), innovation orientation (p = 0.308), environmental performance (p = 0.652), and firm performance (p = 0.443) were all above 0.05 (*i.e.*, not significantly different). Based on this result, we combined the data from the two industries in further analyses of the proposed model, as illustrated in Figure 2.

Table 2. Results of independent *t*-test in two industries.

Construct	Mean		*T*-test for the equality of means		
	SI (n = 112)	MI (n = 90)	Mean difference	*t*-value	*p*-value (2-tailed)
COM	3.833	3.917	−0.084	−0.906	0.366
CUS	3.938	4.106	−0.168	−1.856	0.065
SU	3.813	3.978	−0.165	−1.540	0.125
GOV	3.864	3.778	0.086	0.815	0.416
EM	3.721	3.842	−0.121	−1.303	0.195
GIa	4.009	3.975	0.034	0.423	0.673
GIb	3.929	3.885	0.043	0.492	0.624
IO	3.973	4.065	−0.092	−1.022	0.308
EP	3.987	3.950	0.037	0.452	0.652
FP	3.757	3.689	0.068	0.769	0.443

SI = service industry; MI = manufacturing industry; COM = pressure from competitors; CUS = customer pressure; SU = pressure from suppliers; GOV = governmental pressures; EM = employee conduct; GIa = green product innovation practices; GIb = green process innovation practices; IO = innovation orientation; EP = environmental performance; FP = firm performance.

5. Data Analysis and Results

We combined data from both industries and conducted data analysis in two stages. The first stage included both exploratory factor analysis and confirmatory factor analysis. The second stage tested the hypotheses of the proposed model. In this study, we mainly used the Statistical Package for the Social Sciences (SPSS 18.0) and partial least square analysis (PLS) (Smart PLS 2.0) to test and analyze our hypotheses. PLS is part of structural equation modeling, which is appropriate for studies that employ an approach based on formative constructs components [91,92]. Because our study had a relatively small sample size (n = 202), we adopted PLS as the tool to analyze the path coefficients. In addition, PLS can be used to evaluate both the reliability and validity of the theoretical constructs, as well as examine the latent variables as the extracted linear combinations of the observed measures [93].

5.1. Sample Demographics

The demographics of the surveyed firms are shown in Table 3. The unit of analysis was the firm level. A majority of the firms had been established in Taiwan for more than 20 years (46.5%). The vast majority had capital between US$3.3 million and US$170 million (74.3%). About half of the firms had 101 to 500 employees (53%). A majority of respondents were the manager or assistant manager of their firms (58.4%). The most common tenure of respondents (31.2%) with their current employer was between 5 and 10 years. For survey respondents in the service industry, 17.3% were hotels, 18.3% were in logistics, and 16.3% were contractors; of the manufacturers that responded, 15.4% were photoelectric firms, 14.9% manufactured computer peripherals, and 10.9% were involved in automobile manufacturing.

Table 3. Demographics of the sample firms.

Variable	Category	N	Rate (%)
Years of firm established in Taiwan	3 years and fewer	5	2.5
	Over 3 years to 5 years	5	2.5
	Over 5 years to 10 years	28	13.8
	Over 10 years to 15 years	43	21.3
	Over 15 years to 20 years	27	13.4
	Over 20 years	94	46.5
Firm capital (1 US dolla ≈ 30 NT dollars)	Less than USD 0.33 million	5	2.5
	USD 0.33 million to 1.6 million	17	8.4
	USD 1.6 million to 3.3 million	14	6.8
	USD 3.3 million to 170 million	150	74.3
	USD 170 million to 330 million	10	5.0
	Over USD 330 million	6	3.0
Number of employees (people)	50 and fewer	25	12.4
	51 to 100	19	9.4
	101 to 500	107	53.0
	501 to 1000	20	9.9
	1001 to 2000	12	5.9
	Over 2000	19	9.4
Industry	Hotel	35	17.3
	Logistics	37	18.3
	Contractors	33	16.3
	Photoelectric	31	15.4
	Computer Peripherals	30	14.9
	Automobile Manufacturing	22	10.9
	Others	14	6.9
Tenures of informants	3 years and fewer	14	6.9
	Over 3 years to 5 years	26	12.9
	Over 5 years to 10 years	63	31.2
	Over 10 years to 15 years	45	22.3
	Over 15 years to 20 years	20	9.9
	Over 20 years	34	16.8

Note: "N" represents the total frequency of the all respondents "Rate" in % means the frequency divided by the total valid response number

5.2. The Measurement Model

Before evaluating the measurement model, we conducted an exploratory factor analysis for the constructs of the five selected stakeholders: pressures from competitors, governmental pressures, customer pressures, pressures from suppliers, and employee conduct. The maximum likelihood method was used to extract the initial factors, and the Varimax rotated method was taken into the consideration of correlations among factors [94]. The results of loading and cross loading are shown in Table 4. The factor loadings were all above 0.5, and all items therefore loaded on their own constructs.

Table 4. Results of exploratory factor analysis (EFA).

Item	Factor				
	1	2	3	4	5
EM1	0.690	0.256	0.180	0.248	0.172
EM2	0.847	0.092	0.058	0.144	0.209
EM3	0.745	0.120	0.156	0.195	0.248
EM4	0.515	0.257	0.116	0.256	−0.059
EM5	0.694	0.130	0.124	0.297	0.121
GOV1	−0.018	0.807	0.159	0.291	0.156
GOV2	0.167	0.880	0.175	0.103	0.109
GOV3	0.322	0.832	0.185	0.050	0.230
GOV4	0.279	0.767	0.043	−0.036	0.226
CUS1	−0.023	0.196	0.807	0.258	0.145
CUS2	0.187	0.170	0.831	0.185	0.194
CUS3	0.164	0.075	0.790	0.157	0.309
CUS4	0.279	0.126	0.763	0.121	0.260
COM1	0.388	0.072	0.245	0.733	0.142
COM2	0.335	0.085	0.100	0.736	0.160
COM3	0.183	0.138	0.201	0.797	0.226
COM4	0.241	0.104	0.245	0.752	0.240
SU1	0.045	0.239	0.277	0.245	0.698
SU2	0.154	0.258	0.292	0.245	0.769
SU3	0.192	0.169	0.290	0.257	0.777
SU4	0.286	0.133	0.153	0.078	0.757

SI = service industry; MI = manufacturing industry; COM = pressure from competitors; CUS = customer pressure; SU = pressure from suppliers; GOV = governmental pressures; EM = employee conduct; GIa = green product innovation practices; GIb = green process innovation practices; IO = innovation orientation; EP = environmental performance; FP = firm performance.

Secondly, we used confirmatory factor analysis to test the multi-indicator constructs. The adequacy of the measurement model was examined by reliability and validity. Reliability analyses included Cronbach's alpha (α) and composite reliability. The values for Cronbach's alpha in this study were all above the threshold of 0.7 (range, 0.845 to 0.945), indicating high internal consistency of the measurements [95]. Moreover, the values for composite reliability all exceeded 0.7 in this study [96] (range, 0.889 to 0.954), indicating that the measures were reliable. The properties of the measurement model are summarized in Table 5.

Table 5. Results of confirmatory factor analysis (CFA).

Construct	Construct identifier	Items	Factor loading	Cronbach's alpha	Composite reliability
Pressures from competitors	COM	COM1	0.838	0.888	0.922
		COM2	0.777		
		COM3	0.820		
		COM4	0.828		

Table 5. *Cont.*

Construct	Construct identifier	Items	Factor loading	Cronbach's alpha	Composite reliability
Customer pressure	CUS	CUS1	0.793	0.898	0.930
		CUS2	0.885		
		CUS3	0.838		
		CUS4	0.804		
Pressure from suppliers	SU	SU1	0.752	0.887	0.922
		SU2	0.906		
		SU3	0.907		
		SU4	0.701		
Governmental pressures	GOV	GOV1	0.721	0.904	0.933
		GOV2	0.884		
		GOV3	0.967		
		GOV4	0.774		
Employee conduct	EM	EM1	0.789	0.845	0.890
		EM2	0.814		
		EM3	0.765		
		EM4	0.542		
		EM5	0.727		
Green product innovation practices	GIa	GI1	0.757	0.845	0.889
		GI2	0.720		
		GI3	0.705		
		GI4	0.683		
		GI5	0.742		
Green process innovation practices	GIb	GI6	0.673	0.891	0.914
		GI7	0.702		
		GI8	0.784		
		GI9	0.750		
		GI10	0.696		
		GI11	0.729		
		GI12	0.784		
Innovation orientation	IO	IO1	0.775	0.924	0.939
		IO2	0.851		
		IO3	0.899		
		IO4	0.669		
		IO5	0.839		
		IO6	0.827		
		IO7	0.727		
Environmental performance	EP	EP1	0.776	0.892	0.918
		EP2	0.828		
		EP3	0.812		
		EP4	0.795		
		EP5	0.721		

Table 5. *Cont.*

Construct	Construct identifier	Items	Factor loading	Cronbach's alpha	Composite reliability
Firm performance	FP	FP1	0.776	0.945	0.954
		FP2	0.856		
		FP3	0.876		
		FP4	0.867		
		FP5	0.888		
		FP6	0.746		
		FP7	0.781		
		FP8	0.815		

Furthermore, we evaluated the convergent validity by calculating average variance extracted (AVE). Table 6 shows the mean, standard deviation, AVE, and correlation coefficient of each variable. The AVE values in this study all exceeded the threshold of 0.5 (range, 0.603 to 0.747), showing that each measure construct had high convergent validity. In addition, we examined discriminant validity via a correlation matrix. The values for the square root of AVE were all higher than the correlations among the measures of diagonal, illustrating acceptable discriminant validity [94]. Thus, the measurements could be considered both reliable and valid.

5.3. The Structural Model

In this study, we employed PLS analysis to examine the proposed research model. The results of PLS estimation for the direct effects are shown in Figure 3, which includes the path coefficients, statistical significance, and the explained variance (R^2). A bootstrapping method was used to determine the significance of the structure paths. The path coefficient for this study is shown in standardized form. The R^2 values for endogenous constructs are treated as the predictive power of the research model. The R^2 value of green innovation practices is 0.48, meaning that the stakeholders accounted for 48% of the variance in green innovation practices. Similarly, green innovation practices explained 59% of the variance in environmental performance and 32% of the variance in firm performance.

Two control variables were used in this study: firm size, represented by the number of employees of the firm, and firm age, represented by the number of years since the firm was established. Statistical analyses showed that firm age had no significant effect on either environmental performance ($\beta = -0.03$; $p > 0.1$) or firm performance ($\beta = -0.01$; $p > 0.1$). Firm size had no significant effects on firm performance ($\beta = 0.04$; $p > 0.1$); however, it did have significant and positive effects on environmental performance ($\beta = 0.1$; $p < 0.05$), indicating that larger firms tended to have better environmental performance.

Table 6. Mean, correlation, and average variance extracted (AVE).

		Mean	SD	AVE	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
COM	**(a)**	3.870	0.655	0.747	0.864									
CUS	**(b)**	4.002	0.638	0.766	0.527 **	0.875								
SU	**(c)**	3.765	0.684	0.747	0.549 **	0.608 **	0.864							
GOV	**(d)**	3.825	0.726	0.645	0.364 **	0.409 **	0.500 **	0.803						
EM	**(e)**	3.775	0.634	0.619	0.629 **	0.439 **	0.502 **	0.479 **	0.787					
GIa	**(f)**	4.034	0.519	0.617	0.550 **	0.457 **	0.492 **	0.451 **	0.550 **	0.785				
GIb	**(g)**	3.946	0.550	0.603	0.503 **	0.362 **	0.346 **	0.395 **	0.572 **	0.674 **	0.777			
IO	**(h)**	4.014	0.635	0.689	0.539 **	0.401 **	0.393 **	0.395 **	0.583 **	0.540 **	0.413 **	0.830		
EP	**(i)**	3.970	0.556	0.651	0.677 **	0.456 **	0.453 **	0.411 **	0.682 **	0.684 **	0.697 **	0.515 **	0.807	
FP	**(j)**	3.726	0.623	0.722	0.666 **	0.505 **	0.529 **	0.426 **	0.574 **	0.525 **	0.497 **	0.546 **	0.637 **	0.850

Note: 1. Sample size (n) = 202 2. ** $p < 0.01$ 3. Values in shaded diagonal are the square root of the AVE 4. COM = pressure from competitors, GOV = governmental pressures, CUS = customer pressure, SU = pressure from suppliers, EM = employee conduct, GIa = green product innovation practices, GIb = green process innovation practices, EP = environmental performance, FP = firm performance.

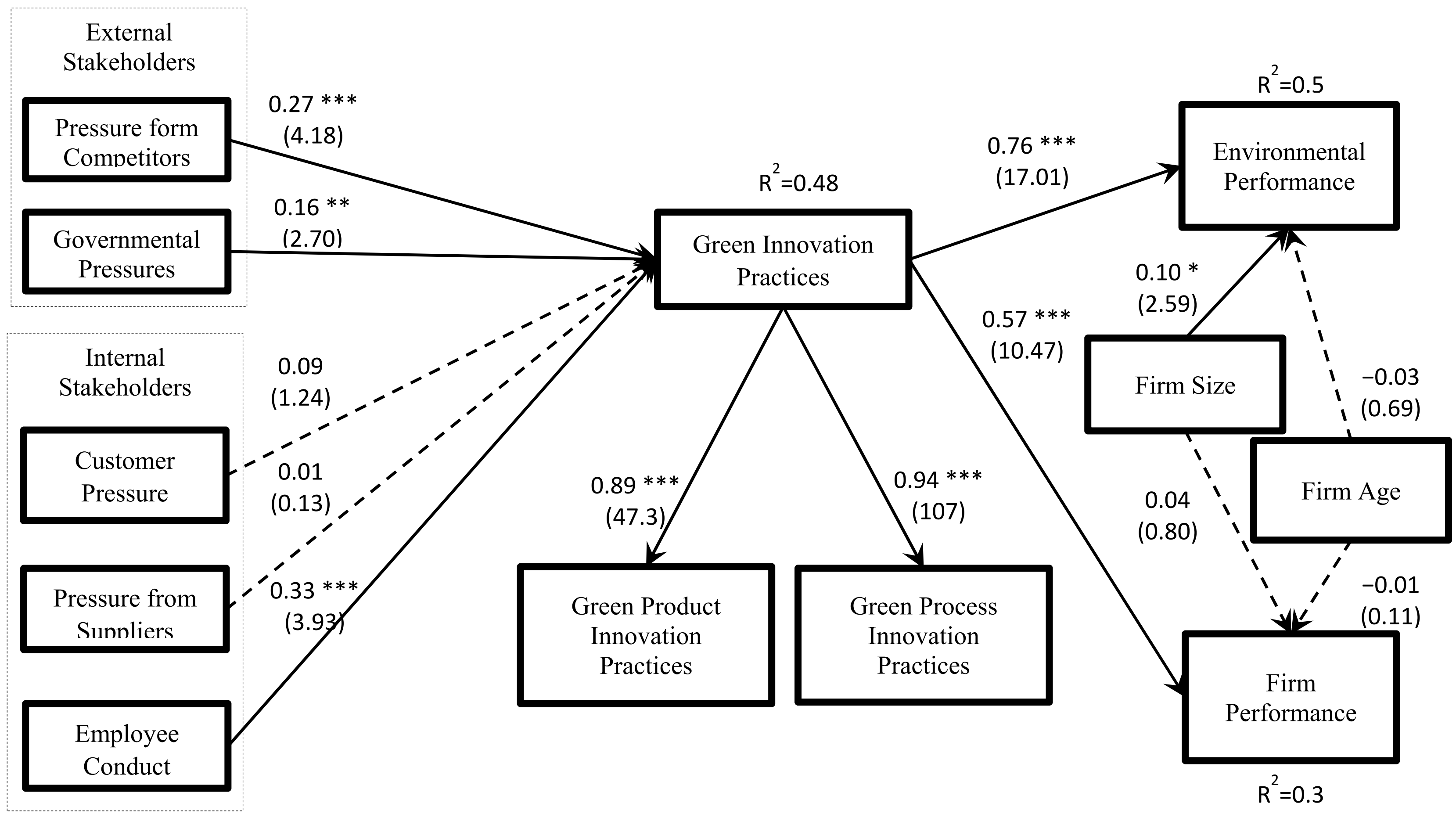

Figure 3. Partial least square analysis (PLS) results of the direct effects. Note: 1. * indicates $p < 0.05$, ** indicates $p < 0.01$, *** indicates $p < 0.001$ 2. t-value in the parentheses.

Results for the Direct and Moderating Effects

Table 7 shows the standardized path coefficients of the structural model. As shown in Figure 3 and Table 7, we found that pressure from competitors (β = 0.27; $p < 0.001$), governmental pressure (β = 0.16; $p < 0.01$), and employee conduct (β = 0.33; $p < 0.001$) all had significant and positive impacts on green innovation. Thus, hypotheses 1, 2, and 5 were supported. In addition, green innovation practices had significant and positive effects on both environmental (β = 0.76; $p < 0.001$) and firm performance (β = 0.57; $p < 0.001$); therefore, hypotheses 6 and 7 were supported. In contrast, customer pressure (β = 0.09; $p > 0.05$) and pressure from suppliers (β = 0.01; $p > 0.05$) did not have significant impacts on green innovation practices. Thus, hypotheses 3 and 4 were not supported.

Table 7. Standardized path coefficients.

Path/hypothesis				**Path coefficient**	***t*-value**	**Results**
Hypothesized relationships						
Pressure from Competitors	→	Green innovation practices	H1	0.27 ***	4.18	Supported
Governmental pressures	→	Green innovation practices	H2	0.16 **	2.70	Supported
Customer pressure	→	Green innovation practices	H3	0.09	1.24	Not Supported
Pressure from Suppliers	→	Green innovation practices	H4	0.01	0.13	Not Supported
Employee conduct	→	Green innovation practices	H5	0.33 ***	3.93	Supported
Green innovation practices	→	Environmental performance	H6	0.76 ***	17.01	Supported
Green innovation practices	→	Firm performance	H7	0.57 ***	10.47	Supported
Firm size	→	Environmental Performance		0.10*	2.59	
Firm size	→	Firm performance		0.04	0.80	
Firm age	→	Environmental performance		−0.03	0.69	
Firm age	→	Firm performance		−0.01	0.11	

Note: * indicates $p < 0.05$, ** indicates $p < 0.01$, *** indicates $p < 0.001$.

We tested the moderating effect, as illustrated in Figure 4. The results indicate that there was no moderating effect of innovation orientation on the relationship between employee conduct and green innovation practices (β = 0.09; $p > 0.05$). The details of the coefficients are listed in Table 8.

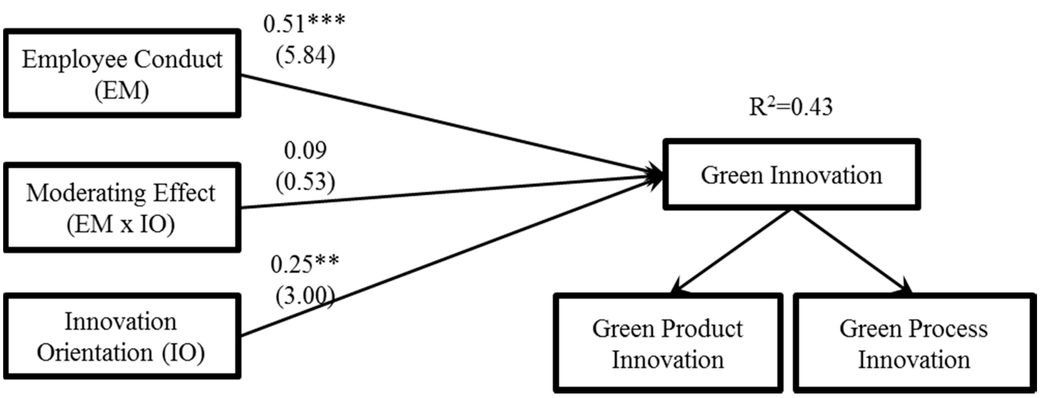

Figure 4. Moderating effects of innovation orientation.

Table 8. PLS results for moderation effects (second order green innovation practices).

Variable(s) entered	Dependent variable: second order green innovation practices			
	Hypothesis	Main effects	Interaction	Result
Innovation orientation		0.244 **	0.247 **	
Employee conduct		0.474 ***	0.508 ***	
Innovation orientation × Employee conduct	H8		0.085	Not supported
R^2	0.42	0.43		

Note: * indicates $p < 0.05$, ** indicates $p < 0.01$, ***indicates $p < 0.001$.

6. Discussion

The current study addresses a central question in the green innovation field from the perspective of the stakeholders. The goals of this study were to determine the effects of pressure from stakeholders and/or the conduct of stakeholders on green innovation practices, to determine the conditions under which the degree of each stakeholder's pressure/conduct would have the greatest effect on green innovation practices, and to determine the consequences on environmental and firm performance. Data were collected from a sample of Taiwanese service and manufacturing firms, listed among the country's 5000 largest businesses, to validate the proposed model that suggests that good environmental and firm performance are dependent on a business's success in green innovation practices. The findings suggest that (1) greater pressure from competitors and the government and better employee conduct contribute significantly to increasing the effectiveness of green innovation practices; and (2) green innovation practices have a strong positive impact on environmental and firm performance. The findings exemplify the theory that companies are compelled to innovate green practices to survive in highly competitive markets. Just as continuous advances in technology are forever creating new opportunities for its application, changes in consumer concerns, behavior, or tastes, along with stricter government regulations, create new opportunities for green practices. However, bringing together knowledge and capabilities will impact a green innovation's timely and successful offering. Pressure from stakeholders has been shown to be essential to green innovation and its implementation, such as offering green products (e.g., recycled paper, energy-saving lighting) or services (e.g., electronic ticketing, quick response code, radio frequency identification applications) that sustain and enhance the business's environmental and overall economic performance.

6.1. Stakeholders and Green Innovation Practices

The results lend strong empirical support for the idea that pressure from competitors, government, and employee conduct encourages green innovation practices [44]. The positive relationship between pressure from competitors and green innovation indicates that companies must place greater emphasis on green products/services, at least matching competitors' capabilities, to achieve greater and more effective green innovation outcomes. Companies also must carefully follow existing regulations and be aware of new trends and possible changes in governmental regulations. In contrast to pressure from competitors and the government, employee conduct defines the internal rules in achieving green management. Employee conduct showed the most significant and positive effect ($\beta = 0.33$) on green innovation practices. Companies need to make environmental management an important issue and educate and train employees to be more environmentally alert and to help in implementing environmentally friendly practices.

Contrary to our expectation, the PLS analysis revealed that pressure from customers and suppliers on green innovation practices did not significantly influence environmental practices. There are two possible explanations for this. First, although customer pressure showed the highest mean value (4.002) of all the surveyed factors, the impact of customer pressure on green innovation practices was, nevertheless, not significant. This indicates that customer pressure is not the top concern of managers with regard to driving green innovation. Customer concerns can be met simply by fulfilling governmental regulations, responding to competitor pressures, and encouraging environmentally friendly employee conduct. Similarly, the impact of supplier pressures on green innovation practices was not significant; this may indicate that companies are not very concerned about finding qualified suppliers to implement green innovation practices. Second, the correlation matrix (see Table 6) showed strong relationships between customer pressure and green innovation practices (product: $r = 0.457$, $p < 0.01$; process: $r = 0.362$, $p < 0.01$) and between supplier pressures and green innovation practices (product: $r = 0.492$, $p < 0.01$; process: $r = 0.346$, $p < 0.01$). Thus, we suspect that the effects of employee conduct, competitor pressure, and governmental pressures on green innovation practices may weaken the effect of pressure from customers and suppliers on green innovation practices.

6.2. Green Innovation Practices and Performance

The results of this study show that green innovation practices have positive and significant effects on environmental performance, indicating that a firm that engages in green innovation will indeed observe better environmental performance. Through implementing green innovation practices, firms can fulfill governmental and industry requirements, decrease waste and pollution, protect the environment, and simultaneously increase their competiveness. The results also indicate that green innovation has positive effects on firm performance, both financial and non-financial. Through these practices, firms cannot only generate better financial performance (e.g., increase their market share, increase sales revenues); they can also improve their corporate image to attract additional customers. On the other hand, our results suggest that "going green" is not merely a way for companies to reactively meet government regulations; companies can also use green innovation to proactively define new rules of the game in enhancing and sustaining their capabilities and performance. Enhancing a company's green innovation capacity can provide a new strategic weapon for managers.

6.3. The Moderating Effect of Innovation Orientation

Our PLS results indicated that there is no moderating effect of a company's innovation orientation on employee conduct regarding green innovation practices. Nevertheless, we further examined the potential moderating effects of green innovation practices by separating it into two first-order constructs—green product innovation practices and green process innovation practices—as distinguished in the confirmatory factor analysis. The results are shown in Tables 9 and 10. Table 9 indicates that innovation orientation has significant and positive moderating effects on employee conduct regarding green product innovation ($\beta = 0.34$; $p < 0.05$), while Table 10 shows that innovation orientation has no significant impact on employee conduct with regard to green process innovation practices (β = 0.04; $p > 0.05$).

Table 9. PLS results for moderation effects (green product innovation practices).

Variable(s) Entered	Dependent variable: green product innovation practices			
	Hypothesis	**Main effects**	**Interaction**	**Result**
Innovation orientation		0.341 ***	0.371 ***	
Employee conduct		0.366 ***	0.412 ***	
Innovation orientation × Employee conduct	H8a		0.343 *	Supported
R^2	0.40	0.50		

Note: * indicates $p < 0.05$, ** indicates $p < 0.01$, *** indicates $p < 0.001$.

Table 10. PLS Results for moderation effects (green process innovation practices).

Variable(s) entered	Dependent variable: green process innovation practices			
	Hypothesis	**Main effects**	**Interaction**	**Result**
Innovation orientation		0.143	0.145	
Employee conduct		0.498 ***	0.513 ***	
Innovation orientation × Employee conduct	H8b		0.041	Not Supported
R^2	0.35	0.35		

Note: * indicates $p < 0.05$, ** indicates $p < 0.01$, *** indicates $p < 0.001$.

We also tested the moderating effects of innovation orientation via a formula [91] to compare the R^2 values between main effects and interaction effects [97]. The effect size was calculated to determine whether the interaction had a small (0.02), moderate (0.15), or large influence (0.35) on service innovation [76,97]. The effect size is calculated as follows:

$$\text{Effect size } f^2 = [R^2 \text{ (interaction model)} - R^2 \text{ (main effects model)}]/[1 - R^2 \text{ (main effect model)}]$$

We calculated the f^2 value as 0.17, suggesting that innovation orientation has a moderate positive effect on the relationship between employee conduct and green product innovation practices.

Thus, we conclude that, with a higher degree of innovation orientation, employee conduct can be influenced with regard to green product innovation practices but not with regard to green process innovation practices. A higher degree of innovation orientation shows that companies are actively pursuing innovation and encouraging employees to take innovative actions. Companies that pay greater attention to innovation could help employees to develop new ideas and improve employees' engagement in adopting/designing new green products. However, the moderating effects of innovation orientation on the impacts of employee conduct on green process innovation practices are not significant. This means that the impact of employee conduct on green process innovation is insignificant, regardless of the company's culture and strategy settings surrounding innovation. For instance, in a highly motivated innovative atmosphere, companies can more easily adopt new materials or packaging of their products; however, implementing new green processes may require more significant reengineering. Our results showed that a highly motivated innovative atmosphere helps little with establishing green processes. This interesting issue may require further investigation.

6.4. Comparison of Manufacturing and Service Industries

One purpose of this study was to compare green innovation practices in the manufacturing and service industries to determine whether any differences exist. We used the PLS-SEM approach to analyze the data obtained from the manufacturing and service industries separately and found the results for both industries were similar but revealed few interesting observations. First, while Pressure from Competitors has significant impacts on both industries, the results indicated that manufacturing industry has a stronger effect on Green Innovation comparing to service industry (*t*-Stat 3.24 *vs.* 1.68). This difference may suggest manufacturing companies need to improve their green practices more often as their competitors may have more accesses to advanced green innovation practices. Second, manufacturing and service industries both showed no significant moderating effects of innovation orientation on the relationship between employee conduct and green innovation practices. However, when separates Green Innovation practices into Green Product Innovation and Green Process Innovation, Innovation Orientation did have a moderating effect on the relationship between Employee Conduct and Green Product Innovation for manufacturing companies, but it is not for the service companies. That is, for manufacturing companies, the effects of employee conduct on green product innovation will be strengthened with a higher degree of innovative orientation.

6.5. Control Variables

In this study, we adopted two control variables: firm size and firm age. Of the two, firm size showed significant and positive impacts on environmental performance. This indicates that larger firms may achieve better environmental performance. This is consistent with previous literature showing that larger firms have more resources to help them adopt innovations and act on environmental policies [13,86].

7. Conclusions

"Going green" has been an emerging issue worldwide driving companies to continuously enhance their green capabilities and implement innovative green practices to protect the environment and improve business performance. This study provides several research contributions and managerial implications.

First, based on stakeholder theory, this study is among the first to provide a holistic view examining the effects of each of the stakeholders on green innovation practices. When the five main stakeholders (external stakeholders: competitors, government; internal stakeholders: customers, suppliers, and employees) are all considered, employee conduct and pressure from competitors and the government were associated with positive and significant effects on green innovation practices. In particular, employee conduct showed the strongest influence. Companies must adopt environmental management issues when setting company strategies, modifying company structures, providing training courses, offering rules to follow, and so on. It is very important for companies to provide clear guidelines and proper monitoring mechanisms for employees to follow. Additionally, continuous research regarding competitors' green practices and updated government requirements is also important, regardless of whether a company is positioning itself as a leader or a follower in green capabilities. Top managers must decide when and how much their companies must invest in going green.

Second, this study showed that green innovation practices affect not only environmental performance but also firm performance. Green innovation should be seen not only as reactive fulfillment of government requests but as a proactive practice to gain a competitive advantage and improve business performance [73]. This empirical evidence suggests that when companies strongly emphasize green practices they can improve both financial and non-financial performance. Top managers can play a key role in conveying the importance of green innovation to all stakeholders.

Third, both manufacturing and service companies were examined in our model. The data collected from both industries showed no significant differences, except for a slight difference in pressure from customers. Customer pressure within the manufacturing industry was stronger ($p < 0.1$) than in the service industry. Going green is an important issue for both industries. Green innovation practices need to be continuously adopted in product or process innovation, or both, regardless of industry.

Finally, this study indicated that there is a moderate positive effect of innovation orientation on employee conduct with regard to green product innovation but not green process innovation. Nevertheless, we suggest that managers emphasize innovation and creativity in their organization's culture. The effort to increase the ingredients of innovation is the key to survival and maintenance of a company. Companies need to view green practices innovatively and provide more innovative green products and processes.

8. Limitations and Further Research

Although this study provides valuable insights, it has limitations, which should serve to stimulate further research. First, the study relied on a sample of managers in Taiwan-based service and manufacturing firms. A manager's perceptions of green innovation practices and outcomes are grounded in industry-specific assumptions. Because they are very knowledgeable in their practices and have exhibited proficiency in the profession, they are appropriate for this study's purpose. However, to afford greater generalizability of our findings, we invite researchers to replicate our study but in different contexts and regions. Second, the self-report measures for all constructs were obtained from individual managers, which may increase the potential for common method bias. Future research studies that rely on top or middle managers as sources may help clarify whether the results reported herein are informant-sensitive. However, the significant moderation effect found in this study does not permit causality to be inferred from the results [98]. Third, given the wide range of potential antecedents to green innovation practices and the limited theoretical and empirical research that has been conducted to date on the factors that lead to green innovation practices, future research studies might consider broadening their investigation to include other potential factors.

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Author Contributions

Hua-Hung (Robin) Wen did most of the work to design and conduct the research, analyze the data, and write the paper. Ja-Shen Chen and Pei-Ching Chen also involved in some parts of the work together. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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