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Article

Enhancing Green Absorptive Capacity, Green Dynamic Capacities and Green Service Innovation to Improve Firm Performance: An Analysis of Structural Equation Modeling (SEM)

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Abstract: This study discusses the influences of green absorptive capacity, green dynamic capacities, and green service innovation on firm performance. In order to fill the research gap, this study proposes the concept of green service innovation. The results are as follows: First, this study finds that green absorptive capacity has positive effects on green dynamic capacities, green service innovation, and firm performance. Second, this study points out that green dynamic capacities have positive effects on green service innovation and firm performance. Third, this study observes that green dynamic capacities and green service innovation intercede the positive connection between green absorptive capacity and firm performance.

Keywords: green absorptive capacity; green dynamic capacities' green service innovation; firm performance

1. Introduction

The world's response to climate change began at the Rio Earth Summit in 1992, where the "Rio Convention" set out a framework for action aimed at reducing greenhouse gases (GHGs) to avoid a disastrous catastrophe based on the UN Framework on Climate Change (UNFCCC). The major mission of the annual Conference of Parties (COP) is to review the Convention's implementation. Conference of the Parties (COP21) in Paris in December 2015 aim to attain a legally international agreement on climate, with the goal of keeping global warming below 2 °C. Therefore, there are numerous opportunities for companies to sell green products or services under the environmental context [1]. Green or environmentally-responsible products and services are increasingly important for retailers, and their market size continues to rapidly grow [2]. Owing to the advent of new environmentalism, green economy is quickly developed by the prevalence of environmentally friendly products and services. Tully and Winer [2] indicate that more than half of consumers are inclined to pay higher price for green products. Laroche *et al.* [3] assert that most of consumers in developed countries refuse to purchase the products manufactured by companies that do not follow environmental regulations. Consequently, consumers tend to buy green products in the environmental era [4,5].

Countries in the world are committing to create a new international climate agreement recently, so firms must collect timely green knowledge and information that are critical for their business operations [6]. Since environmental responsibility has recently become a hot issue, consumers are increasingly willing to purchase environmentally friendly products, and to pay a premium for these products [7]. Production involves the transformation of inputs into outputs that the market requires. Companies can raise the green functional level of their products by adding environmental value in their products such that their customers are willing to higher premium for their products [8]. If firms can link their products or services to environmental benefits, they can increase their customers' perceived value. Pujari, Wright and Peattie [9] point out that higher environmental functionality of products can enhance their market performance. Developing responsible green products or services thus can be good for companies. Akenji and Bengtsson [10] argue that sustainable consumption and production are important sustainability issues for society.

However, not all companies can solve environmental problems. Firms must build learning mechanism to develop green knowledge and solve environmental problems. Firms can combine existing and newly acquired environmental knowledge to develop green products or services that will be successfully promoted in the market. Energy efficiency is important to modern society. Additionally, stricter environmental regulations and more popular environmentalism force companies to undertake green management [11]. Thus, it is imperative for firms to follow environmental regulations, develop green products, reduce materials, and recycle wastes. Companies can use their carbon footprint to monitor and evaluate the carbon emissions of their products/services and their supply chain management. People advocate environmental protection, and they believe that their purchases can influence companies' decisions and actions. Thus, they think that they can support the activities of environmental protection by means of green consumption. Firms thus must use differentiation strategies to improve their performance in terms of green products.

An energy service company or energy savings company (ESCO) offers a wide range of energy solutions including innovation, designs, invention, and implementation of energy conservation

initiatives, outsourcing of energy infrastructure, retrofitting, power generation, energy conservation, and energy supply. ESCOs are more prevalent in the developed countries, such as Germany, the US, the UK, *etc.* This study introduces a new concept, "green service innovation", which includes elements of green invention, environmental service portfolio, environmental service delivery or environmental service design that involve exclusive innovations. ESCOs develop a variety of green service innovation to satisfy their customers, green needs. For instance, ESCOs apply "green performance contracting" to achieve environmental objectives in new building design and construction as well as in existing buildings. Green performance contracting provides comprehensive energy and resource improvement solutions to a broad range of buildings, sites and institutes, and it allows owners to pay for environmental improvements. Therefore, the development of green service innovation is more crucial for our society, since it can effectively help businesses to achieve sustainability goals.

This paper primarily aims to explore the influences of green absorptive capacity, green dynamic capacities, green service innovation on firm performance. This study adopts questionnaire survey to verify the theoretical framework by methods of Structural Equation Modeling (SEM). The research object of this study is the Taiwanese electronics industry. The samples were selected from "2013 Business Directory of Taiwan" through sampling.

2. Literature Review and Hypothesis Development

According to Cohen and Levinthal [12], absorptive capacity is the ability of a firm to perceive the value of new data, integrate that data, and apply it to commercial purposes. Meanwhile, Zahra and George [13] assert that absorptive capacity is a series of organizational routines and developments via which firms obtain, integrate, convert, and utilize knowledge to generate dynamic capabilities. Absorptive capacity theory emphasizes organizational learning, knowledge innovation, application of knowledge assets and dynamic resource integration. Based on Chen *et al.* [1] and Daghfous [14], this study posits that green absorptive capacity comprises the ability to understand, communicate, combine, identify and commercialize environmental knowledge. Dynamic capabilities can be considered a potential integrated approach to understand the source of competitive advantage. Absorptive capacity is based on analysis of knowledge accumulation and flow within organizations. Waard *et al.* [15] argue that absorptive capacity positively affects dynamic capabilities of organizations. Absorptive capacity can develop dynamic capabilities of organizations and effectively create and sustain competitive advantage.

The concept, dynamic capabilities, was first introduced by Hamel and Prahalad [16]. The academic literature on dynamic capabilities is based on both of the 'resource-based view (RBV)' of firms and the concept of 'routines' in the theory of organizational evolution [17]. Eisenhardt and Martin [18] posit that dynamic capabilities are the ability of a firm to use resources in the process of integrating, reconfiguring, gaining and releasing resources. Dynamic capabilities refer to the ability of a firm to assimilate, develop and reconstruct inner and outer capabilities to fit the rapidly changing environment [19].

Waard *et al.* [15] point out that absorptive capacity positively influences dynamic capabilities. Absorptive capacity developed by dynamic capabilities can create and sustain competitive advantage via the application of resources and knowledge [20]. "Green absorptive capacity" is defined as "the ability to obtain, integrate, alter, and exploit environmental knowledge" according to Chen *et al* [1]. Besides, according to Chen and Chang [21], "green dynamic capabilities" is defined as "the ability of a

company to apply its existing resources and knowledge to renew and create its green organizational capabilities to respond to the dynamic market". Absorptive capacity relates to the ability to evaluate the collection of organizational knowledge, and dynamic capabilities can be considered as a critical determinant of competitive advantage. The more firms use their environmental knowledge, the better they can deal with issues involving green technology and turbulence in green markets. This study argues that the increase of a firm's green absorptive capacity can raise its green dynamic capabilities and suggests the following hypothesis:

Hypothesis 1 (H_1). Green Absorptive Capacity Positively Influences Green Dynamic Capabilities.

Absorptive capacity is "the ability to recognize the value of new information, assimilate the information, and exploit it [12]". Lichtenthaler [22] argues that absorptive capacity includes three kinds of learning: exploratory, transformative, and exploitative learning. Absorptive capacity thus relates to the ability of a firm to convert and make use of new knowledge for organizational learning and innovation performance. Service innovation describes the number of new process-related technologies developed by a company during the past several years [23]. According to Chen and Tsou [24], "green service innovation" is a "successful new innovation introduced relative to environmental business models, environmental services, or environmental operation processes". Green innovation, which can generally be classified into green product innovation and green process innovation, denotes the activity relating to developing innovative products and processes that can reduce environmental impacts [25,26]. If we take energy service companies or energy savings companies (ESCO) as an example, green service innovation is thriving. In terms of the product aspect, green service innovation incorporates product modification, repackaging, and creation. Moreover, from the process aspect, green service innovation describes the manufacturing process that reduces negative environmental impacts on the processing of materials, resources and knowledge. This study reasons that hardware or software innovation associated with green service products or service processes are involved in green service innovations. Green absorptive capacity relates to the ability to cognize, communicate, integrate, identify and commercialize environmental knowledge [1]. Tsai [27] points out that absorptive capacity has positive relationship with organizational innovation. Furthermore, Chen *et al.* [28] demonstrate that absorptive capacity is imperative for companies to improve their innovation performance and competitive advantage. Hence, this study claims that green absorptive capacity positively affects green service innovation and suggests the following hypothesis.

Hypothesis 2 (H_2). Green Absorptive Capacity Positively Influences Green Service Innovation.

Firm performance is both directly and indirectly influenced by Absorptive capacity [22,27]. Furthermore, Lane *et al.* [29] indicate that absorptive capacity improves firm performance. Syaiful *et al.* [30] indicate that absorptive capacity of IT governance knowledge amongst the finest management team members is positively associated with corporate performance. Green absorptive capacity signifies to the ability to comprehend, connect, combine, identify and apply environmental knowledge [1]. Green knowledge acquisition and understanding denote the ability of a firm to recognize and obtain external green knowledge that is urgently important to its operations. Green knowledge

communication enables firms to evaluate, process, deduce, and realize environmental information obtained from external sources. Knowledge recognition denotes the ability to identify external knowledge intended to generate synergies in using existing knowledge [31,32]. Developing green knowledge early on will help the absorption of new knowledge in the following period. Applying green knowledge to a firm's products allows the firm to differentiate its products to meet customer needs by combining with external knowledge. The absorptive capacity of companies can influence their profitability with regard to going green [33]. Although this research argues green absorptive capacity directly affects firm performance positively, this paper also asserts that green absorptive capacity indirectly affects firm performance positively via green dynamic capabilities and green service innovation. Green dynamic capabilities and green service innovation play mediator roles between green absorptive capacity and firm performance. This study hypothesizes that firm performance is positively associated with green absorptive as follows.

Hypothesis 3 (H_3). Green Absorptive Capacity Positively Influences Firm Performance.

Green products or services are designed to provide a reliable solution for environmentally-conscious consumers seeking affordable and high quality eco-friendly products or services. All green products or services must meet the green purchase criteria of the customers. Gadrey *et al.* [34] argue that service innovation is "to place a bundle of capabilities and competences at the disposal of a client and to organize a solution". This definition implies that technological, human and organizational competences are essential to service innovation. Additionally, service innovation must deal with customized services. These customized services generally use knowledge and can be classified as knowledge-intensive business services. Unlike new product development, service innovation is closely linked to new service development. Innovation at the firm level frequently includes product and process innovation [35]. Similarly, in this study green service innovation is classified into green service product innovation and green service process innovation. Service innovation includes modifications, line extensions, repositioning and improvements of services [24]. Knowledge-intensive business services such as software production, R&D, marketing research, or management consulting face environmental challenges in the world. As a result, firms have to effectively manage their resources and knowledge which are useful to develop dynamic capabilities to meet the environmental regulations. Since not all companies have such capabilities, establishing dynamic capabilities may help the firms stand out and achieve sustainability goals. Zollo and Winter [36] think that dynamic capabilities are developed from learning. Shi and Wu [37] posit that dynamic capabilities positively influence service innovation. Furthermore, Kindström *et al.* [38] demonstrate that dynamic capabilities positively affect service innovation. Thus, this study argues that green dynamic capabilities are positively associated with green service innovation and implies the following hypothesis.

Hypothesis 4 (H_4). Green Dynamic Capabilities Positively Influence Green Service Innovation.

Prior literature indicates that dynamic capabilities are positively associated with new product development [39], innovation performance [40], and organizational change [36,41,42]. Dynamic capabilities are positively correlated to performance [43]. Besides, Homburg and Pflesser [44] indicate that dynamic capabilities can improve firm performance. Furthermore, dynamic capabilities are

positively related to firm performance [45]. Green dynamic capabilities positively affect the ability of a firm to achieve and sustain green competitive advantages [21]. According to Gliedt and Parker [46], dynamic capabilities can produce green competitive advantages if managers use environmental structures to emphasize environmental benefits. Moreover, competitive advantage can then enhance firm performance [47]. Hence, this study claims that green dynamic capabilities are positively associated with firm performance and implies the following hypothesis.

Hypothesis 5 (H_5). Green Dynamic Capabilities Positively Influence Firm Performance.

Previous research argues that innovation and performance are positively associated with one another [48,49]. Organizations that have better innovation capability are likely to have better performance and to have higher chance to achieve their business aims. Han *et al.* [50] argue that innovation capabilities of organizations positively relate to their business performance. Service innovation involves developing technology-enabled services that incorporate new inventions [51], customer interactions [52,53], service portfolios [54], service delivery [55], or service designs [56]. Green service innovation is undoubtedly a hot issue in terms of environmental protection nowadays. Hence, green service innovation includes elements of green invention, environmental service portfolio, environmental service delivery or environmental service design that involve exclusive innovations. Prior literature argues that innovation positively influences firm performance [57]. This study thus hypothesize that green service innovation positively influences business performance and implies the following hypothesis.

Hypothesis 6 (H_6). Green Service Innovation Positively Influences Firm Performance.

This study claims that green absorptive capacity and green dynamic capacities positively influence firm performance. Besides, this study posits that green service innovation plays a partial moderator in the research framework. The research framework is illustrated in Figure 1.

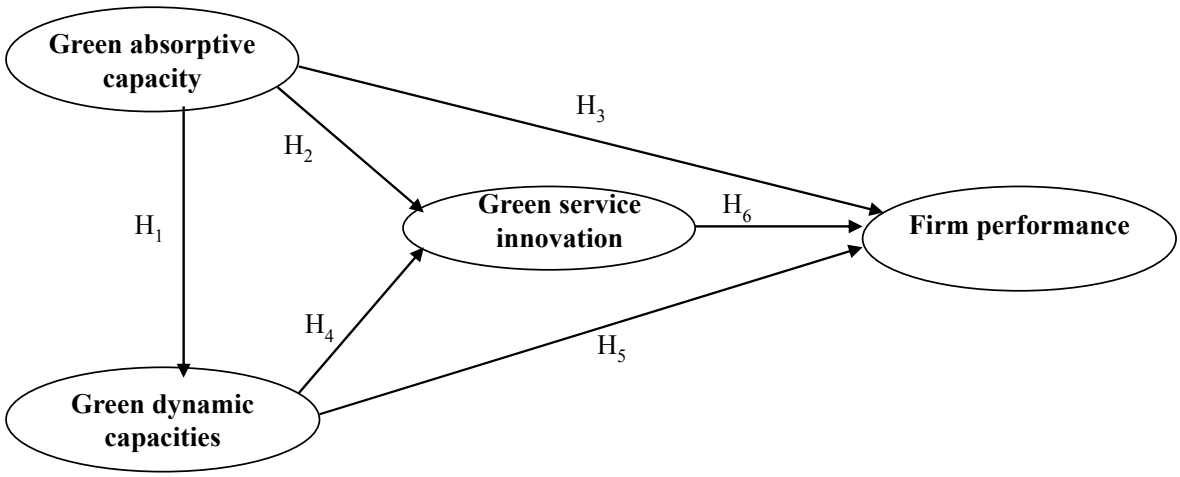

Figure 1. Research framework.

3. Methodology and Measurement

3.1. Data Collection and the Sample

This paper applies the questionnaire survey to prove the research framework in the Taiwanese electronics industry. There are three reasons why this research chooses the Taiwanese electronics industry as the research object. First, the Taiwanese electronics industry has an industrial clustering effect in Taiwan's Science Parks which have established a solid manufacturing infrastructure. While international environmental regulations are stricter, it is incredible to explore how Taiwanese electronics companies improve their firm performance via green management. Second, because Taiwanese electronics products are sold across the world, Taiwanese electronics products must comply with severe environmental regulations, such as Kyoto Protocol, UN Framework on Climate Change (UNFCCC), Directive on Energy-using Products (EuP), and Intended Nationally Determined Contributions (INDCs), so that Taiwanese electronics companies must generate their products in terms of green way which can satisfy popular consumer environmentalism [21,58]. To explore green management in the Taiwanese electronics industry can make significant practical contributions. Third, comparing to international large companies, most of Taiwanese electronics companies are small and medium sized [25], so it is useful to investigate green management of Taiwanese electronics companies that have fewer resources. These characteristics in the Taiwanese electronics industry are beneficial for the theory development.

In order to raise content validity, this paper applies two pretests to the questionnaire revisions. First, we pretest the questionnaire via interviews with eight part-time MBA students with more than three years of business experience. We collected feedbacks with regard to whether there is anything in the questionable wording that is either ambiguous or incomprehensible. Additionally, the questionnaires were distributed to 20 full-time employees with more than three years of business experience. In this research, the questionnaire items are measured by means of "seven-point Likert scale from 1 to 7" rating from strongly disagreement to strongly agreement. The research object of this study is the Taiwanese electronics industry. The samples were obtained from "2013 Business Directory of Taiwan" on the period from 1 April 2015 to 10 April 2015 through random sampling. In order to infer population from statistical results, we followed the rule of random sampling to collect the sample. We mailed questionnaires to each randomly sampled company. Besides, we requested the respondents to submit the finished questionnaires within two weeks. In addition, the research assistants made phone calls to each selected company to clarify the aim of this study and the questionnaire content before questionnaire mailing in order to enhance the response rate. We sent 980 questionnaires to the companies which were sampled on May 15, 2015. There are 390 valid questionnaires with the effective response rate of 39.8%.

3.2. The Measurement of the Constructs

This study lists the items of the scales in the Appendix and describes the measurement of the constructs in the following.

Green absorptive capacity. Based on Chen *et al.* [1], this study measures "green absorptive capacity" and its measure includes five items: (1) The firm is able to communicate green knowledge across its divisions; (2) The firm is able to effectively apply new external green knowledge on commercial purposes; (3) The firm is able to identify, obtain, and value external green knowledge which is crucial

to its operations; (4) The firm is able to integrate existing green knowledge with new obtained and assimilated green knowledge; and (5) The firm's organizational structure facilitates the development of the ability to analyze, comprehend, and deduce information from external green knowledge.

Green dynamic capacities. Based on Chen and Chang [21], this study measures 'green dynamic capacities' and its measure includes five items: (1) The firm is able to exploit, integrate, combine, create, acquire, share, and convert new environmental technology; (2) The firm is able to effectively deploy resources for the development of green innovations; (3) The firm is able to effectively coordinate employees to generate green knowledge; (4) The firm is able to effectively manage and assimilate specialized environmental technology within the firm; and (5) The firm can quickly observe the environment and recognize new environmental opportunities.

Green service innovation. Based on Chen and Tsou [24], this study measures "green service innovation". The measurement of green service innovation involves nine items: (1) The firm repackages existing products/services based on its concern for the environment; (2) The firm frequently extends products/services based on its concern for the environment; (3) The firm creates and establishes new lines of products/services based on its concern for the environment; (4) The firm offers new customer service practices based on its concern for the environment; (5) The firm offers new practices in selling products/services based on its concern for the environment; (6) The firm offers new practices in after-sales services based on its commitment to the environment; (7) The firm offers new practices in new product/service development based on its environmental concerns; (8) The firm proposes new practices in the promotion of new products/services related to environmental reputation; and (9) The firm proposes new practices related to internal administration and operations based on its environmental concerns.

Firm performance. Based on Seggie *et al.* [59], this study measures 'firm performance'. The measurement of firm performance consists of three items: (1) The firm has better performance than its competitors in sales growth; (2) The firm has better performance than its competitors in market share; and (3) The firm has better performance than its competitors in profitability.

4. Empirical Results

Using Structural Equation Modeling (SEM) for the confirmation of the research framework and hypotheses, this study applies LISREL 8.70 to attain the results. SEM is used to evaluate both of the measurement and the structural models. The analysis of the squared multiple correlations shows that most of the items meet the conventional acceptance threshold of 0.30 [60].

4.1. Results of the Measurement Model

Table 1 lists the detailed statistics which include means, standard deviations, and correlation matrix for the four constructs in this study. In Table 1, the four constructs—"green absorptive capacity", "green dynamic capabilities", "green service innovation", and "firm performance"—are positive correlated. Meanwhile, Table 2 lists the results of the exploratory factor analysis. Only one factor is deduced from every construct in the study. This study utilizes a number of measures to test the reliability and validity of the constructs. In the beginning, this study assesses the measurement quality by examining the loadings of the individual items of each construct. Since the loadings of all items for each construct in

Table 3 are significant, the measurement quality is acceptable. Next, the Cronbach's α is calculated to estimate the reliability. The Cronbach's α coefficient of "green absorptive capacity (GAC)" is 0.884; that of "green dynamic capabilities (GDC)" is 0.899; that of "green service innovation (GSI)" is 0.916; and that of "firm performance (FP)" is 0.904. Overall, the reliability of the measurement in this study is acceptable, since the Cronbach's α coefficients of the four constructs exceed 0.7.

Table 1. Descriptive statistics of this study.

Constructs	Mean	Standard Deviation	A.	B.	C.
A. Green Absorptive Capacity	5.620	0.732			
B. Green Dynamic Capacities	5.477	0.785	0.664 **		
C. Green Service Innovation	5.531	0.722	0.650 **	0.687 **	
D. Firm Performance	5.593	0.872	0.335 **	0.412 **	0.413 **

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

Confirmatory factor analysis is used to measure validity in this paper. Two measurements are performed to confirm construct validity. In the beginning, the "average variance extracted (AVE)" could be applied to assess the variance shown by each of the constructs in relation to the variance resulted from measurement error. This study applies AVE to measure discriminate validity and convergent validity [61]. If the square root of the AVE of a construct surpasses the associations between the construct and the other ones, it implies that the discriminative validity is acceptable. The square root of the AVE of every construct in Table 3 exceeds the correlations between the construct and the other ones in Table 1. For example, the square roots of the AVEs for the two constructs, GAC and GDC, are 0.819 and 0.837, respectively, in Table 3. These values exceed the correlation value of the two constructs, 0.664. Consequently, there is proper discriminant validity between the two constructs. The square roots of all constructs' AVEs in Table 3 surpass than the correlations among all constructs in Table 1. Thus, the discriminant validity of the measurement is acceptable. Next, if the AVE of a construct exceeds 0.5, it signifies that the convergent validity of the construct is adequate. The AVEs of the four constructs are 0.67, 0.70, 0.59, and 0.82 in Table 3, which a surpass 0.5. Hence, the convergent validity of the measurement is acceptable. Taking into account the above results, the reliability and validity of this study are adequate.

Table 2. Factor analysis of this study.

Constructs	Number of Items	Number of Factors	Accumulation Percentage of Explained Variance
Green Absorptive Capacity	5	1	68.428%
Green Dynamic Capacities	5	1	71.53%
Green Service Innovation	9	1	59.89%
Firm Performance	3	1	66.92%

Table 3. The item factor loadings and construct Cronbach α coefficients and average variant extracted (AVEs).

Constructs	Items	λ	Cronbach's α	AVE	The Square Root of AVE
Green Absorptive Capacity (GAC)	GAC1	0.85	0.884	0.68	0.819
	GAC2	0.71 **			
	GAC3	0.81 **			
	GAC4	0.83 **			
	GAC5	0.85 **			
Green Dynamic Capacities (GDC)	GDC1	0.75	0.899	0.70	0.837
	GDC2	0.80 **			
	GDC3	0.90 **			
	GDC4	0.86 **			
	GDC5	0.88 **			
Green Service Innovation (GSI)	GSI1	0.67	0.916	0.59	0.768
	GSI2	0.65 **			
	GSI3	0.76 **			
	GSI4	0.83 **			
	GSI5	0.81 **			
	GSI6	0.83 **			
	GSI7	0.81 **			
	GSI8	0.82 **			
	GSI9	0.75 **			
Firm Performance (FP)	FP1	0.89	0.904	0.82	0.906
	FP2	0.94 **			
	FP3	0.88 **			

Note: ** $p < 0.01$

4.2. Results of the Structural Model

Figure 2 demonstrates the results of the structural model in this study. As demonstrated by the overall fit measures of the full model in the SEM, the fit of the model is acceptable (GFI = 0.84, RMSEA = 0.086, NFI = 0.88, CFI = 0.91). Hair *et al.* (1998) suggest that NFI > 0.8 means satisfactory fit. Besides, prior research recommends that χ^2/df should not exceed 5 [62], while GFI should exceed the recommended value 0.8 [63]. Moreover, AGFI should exceed the recommended value 0.8 [63], and RMSEA below 0.1 is desirable [64]. Based on the measures of overall model fit comparing to the criteria in Table 4, it indicates the model has satisfactory goodness of fit. Table 5 lists the direct, indirect, and total effects of paths from the structure equation modeling.

Table 4. Measures of overall model fit.

Fit Measures	Measurement Model Estimates	Criteria
Absolute Fit Measures	χ^2 = 791.41	Significant
	SRMR = 0.052	SRMR < 0.08
	RMSEA = 0.086	RMSEA < 0.1
	GFI = 0.84	GFI > 0.80
Incremental Fit Measures	AGFI = 0.81	AGFI > 0.80
	NFI = 0.88	NFI > 0.80
	CFI = 0.91	CFI > 0.90
	IFI = 0.91	IFI > 0.90
Parsimonious Fit Measures	PNFI = 0.77	PNFI > 0.50
	PGFI = 0.68	PGFI > 0.50
	χ^2/df = 3.90	χ^2/df < 5

Table 5 outlines the direct, indirect, and total effects of paths. The total estimated effects of all six paths are significant by means of path analysis. As shown in Table 5, green absorptive capacity positively influences green dynamic capabilities, green service innovation, and firm performance. Meanwhile, green dynamic capabilities positively influence green service innovation and firm performance. Additionally, this study shows that both of green service innovation and green dynamic capabilities play a full mediator role between green absorptive capacity and firm performance. Finally, the above results support H_1, H_2, H_3, H_4, H_5 and H_6.

Table 5. Direct, indirect, and total effects of paths.

Path		Coefficients	
		Effect	***t*-Value**
H_1: GAC → GDC			
	Direct Effect	0.73	12.93 **
	Indirect Effect	--	--
	Total Effect	0.73	12.93 **
H_2: GAC → GSI			
	Direct Effect	0.41	6.40 **
	Indirect Effect	0.32	6.37 **
	Total Effect	0.73	11.96 **
H_3: GAC → FP			
	Direct Effect	0.00	-0.03
	Indirect Effect	0.38	5.34 **
	Total Effect	0.37	7.00 **

Table 5. *Cont.*

Path	Coefficients	
	Effect	***t*-Value**
H_4: GDC → GSI		
Direct Effect	0.43	6.57 **
Indirect Effect	--	--
Total Effect	0.43	6.57 **
H_5: GDC → FP		
Direct Effect	0.26	3.04 **
Indirect Effect	0.11	2.76 **
Total Effect	0.37	4.60 **
H_6: GSI → FP		
Direct Effect	0.25	2.93 **
Indirect Effect	--	--
Total Effect	0.25	2.93 **

Note: * $p < 0.5$, ** $p < 0.01$

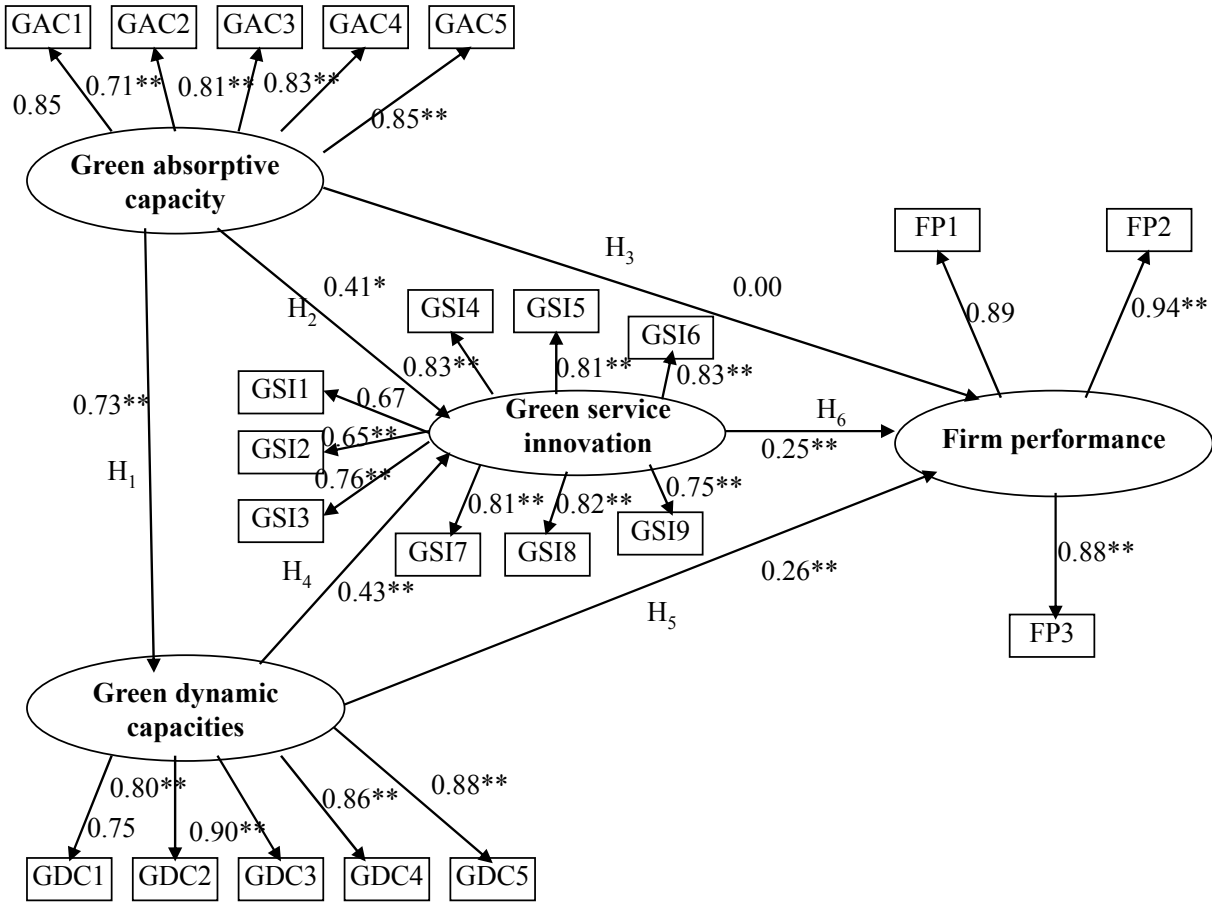

Figure 2. The results of the full model. Degree of freedom = 203, Chi-square = 791.41, GFI = 0.84, RMSEA = 0.086, NFI = 0.88, CFI = 0.91; * $p < 0.05$, ** $p < 0.01$.

5. Conclusions and Implications

This study investigates the influences of green absorptive capacity, green dynamic capacities, and green service innovation on firm performance. This study demonstrates that green absorptive capacity positively influences green dynamic capabilities, green service innovation and firm performance. Besides, green dynamic capabilities positively influence green service innovation and firm performance. In addition, green service innovation positively influences firm performance. The empirical results support H_1, H_2, H_3, H_4, H_5 and H_6. Additionally, this study indicates that green absorptive capacity not only directly and positively influence green service innovation, but it also indirectly affects green service innovation via the partial mediator, green dynamic capabilities. Moreover, both of green service innovation and green dynamic capabilities play a full mediator role between green absorptive capacity and firm performance.

This study has four academic contributions. First, this paper finds out that it is crucial for companies to possess the ability to recognize, value, and acquire external environmental knowledge that is critical to its operations, since green absorptive capacity is positively related to green service innovation. Second, this study shows that it is important for firms to develop the ability to successfully integrate and manage specialized green knowledge, because green dynamic capacities positively affect green service innovation and firm performance. Third, this paper proves that companies ought to develop green service innovation including elements of green invention, environmental service portfolio, environmental service delivery or environmental service design that involve exclusive innovations, since green service innovation positively influences firm performance. Fourth, this study shows that both green service innovation and green dynamic capabilities play a full mediator role between green absorptive capacity and firm performance. It means that green absorptive capacity indirectly and positively affects firm performance via green dynamic capabilities or green service innovation.

Chen and Chang [21] apply the resource-based view (RBV) framework to develop a green product development model of profit maximizing green management and indicate that there is a positive relationship between green management and financial performance. Makower and Pike [4] recommend firms to act strategically than to passively in making investments in green management. The theory regarding to perspective of the firm on green management has two strategic implications. First, green management can be an essential element of a firm's business and differentiation strategies on corporate-level, so it ought to be seen as a form of strategic investment. Second, if one can apply the RBV logic to green management, it is possible to enhance its competitiveness in the market [25]. Chen [26] indicates that a firm employing in a green-based strategy can obtain an unexpectedly high level of return if it can prevent its competitors from emulating its strategy. Thus, it has been proven that firms can use green management to attain a sustainable competitive advantage. Thus, it has a theoretical implication if we separate environmental strategies from general corporate strategies.

Four practical contributions are made by this study. First, firms ought to their ability to acquire, integrate, convert, and make use of environmental knowledge to increase their green absorptive capacity which positively relates their green service innovation. Furthermore, companies have to transmit environmental knowledge across its units and raise their abilities to integrate existing environmental knowledge with newly obtained and integrated environmental knowledge in order to increase their green absorptive capacity. Second, firms should enhance their abilities to integrate, learn, produce, syndicate,

share, convert, and apply new green knowledge and their abilities to effectively integrate and manage specialized green knowledge to raise green dynamic capabilities which positively affect their green service innovation. Third, companies ought to improve their hardware or software innovation associated with green service products or service processes to enhance their green service innovation which is positively associated with firm performance. Fourth, this study proves that both of green service innovation and green dynamic capabilities play a full mediator role between green absorptive capacity and firm performance. Hence, green absorptive capacity has two ways to positively affect firm performance. The first way is that green absorptive capacity indirectly affects firm performance via green service innovation. The second way is that green absorptive capacity indirectly influences firm performance via green dynamic capabilities.

Speaking of future research, this paper suggests the following two directions. First, future research can collect secondary data, such as annual financial statement and corporate social responsibility report, to confirm the research framework in this study. Comparing to primary data, such as questionnaire survey, secondary data usually are more reliable and valid, so future research can collect secondary data, such as annual financial statement and corporate social responsibility report, to test the hypotheses. Second, although this study adopts questionnaire survey of high external validity to prove the research framework, future research could undertake experimental method of high level of internal validity to verify the research framework and make comparison with this study. There is a research limitation in this paper. This study only focuses on the Taiwanese electronics industry. To gain a wider perspective, future research could explore other industries and make comparison with the results obtained from this paper. Finally, we hope that this study will contribute as a reference to future research.

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Author Contributions

Yu-Shan Chen initiated the project and conceptualized the paper. Yu-Hsien Lin contributed in data analysis and the English write-up of the paper. Ching-Ying Lin contributed in data collection and writing material. Chih-Wei Chang made contributions in manuscript revision.

Conflicts of Interest

The authors declare no conflict of interest.

Appendix

This study places the items of the scales in the following.

Table A1. The items of the scales.

Constructs	Items
Green absorptive capacity	(1) The firm is able to communicate green knowledge across its divisions. (2) The firm is able to effectively apply new external green knowledge on commercial purposes. (3) The firm is able to identify, obtain, and value external green knowledge which is crucial to its operations. (4) The firm is able to integrate existing green knowledge with new obtained and incorporated green knowledge. (5) The firm's organizational structure facilitates the development of the ability to analyze, comprehend, and deduce information from external green knowledge.
Green dynamic capacities	(1) The firm is able to exploit, integrate, combine, create, acquire, share, and convert new environmental technology. (2) The firm is able to effectively deploy resources for the development of green innovations. (3) The firm is able to effectively coordinate employees to generate green knowledge. (4) The firm is able to effectively manage and assimilate specialized environmental technology within the firm. (5) The firm can quickly observe the environment and recognize new environmental opportunities.
Green service innovation	(1) The firm repackages existing products/services based on its concern for the environment. (2) The firm frequently extends products/services based on its concern for the environment. (3) The firm creates and establishes new lines of products/services based on its concern for the environment. (4) The firm offers new customer service practices based on its concern for the environment. (5) The firm offers new practices in selling products/services based on its concern for the environment. (6) The firm offers new practices in after-sales services based on its commitment to the environment. (7) The firm offers new practices in new product/service development based on its environmental concerns. (8) The firm proposes new practices in the promotion of new products/services related to environmental reputation. (9) The firm proposes new practices related to internal administration and operations based on its environmental concerns.
Firm performance	(1) The firm has better performance than its competitors in sales growth. (2) The firm has better performance than its competitors in market share. (3) The firm has better performance than its competitors in profitability.

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