

## **Green dynamic capabilities - the necessity between green intellectual capital and firm performance: Evidence from Taiwan's manufacturing sector**

**綠色動態能力－綠色智慧資本與企業績效間之必要路徑：以臺灣製造業為例**

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**Abstract:** Both academic and business circles are paying more attention to environmental issues due to growing global awareness and concerns. At the same time, the rapid changes of environmental protection regulations are creating uncertain dynamics in competitive market environments. As such, an organization cannot solely rely on its valuable intellectual capital to support superior performance; it must utilize its dynamic capabilities to integrate, build, and reconfigure inherent organizational idiosyncratic resources. This paper therefore develops a research model to examine strategic corporate actions undertaken to address environmental issues using the natural resource-based view (NRBV) with dynamic capabilities so as to elaborate upon the sources and mechanisms of firm performance. Employing subjective and objective data of

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The research work was partially supported by the Ministry of Science and Technology, Taiwan, R.O.C. under Grant MOST 103-2410-H-019-021.

170 manufacturing companies in Taiwan, this research examines the causal relationships among green intellectual capital, green dynamic capability, and firm financial performance. The proposed research framework partially supports and verifies the indirect-only mediated effects of green dynamic capabilities. The findings suggest that senior managers should follow the strategic path of enforcing and improving their firms' green dynamic capabilities in order to sustain superior performance.

**Keywords:** Green intellectual capital, green dynamic capabilities, natural-resource-based view (NRBV), dynamic capabilities view.

**摘要：**由於全球環保意識的提升，學術界和企業界也益發關注此一議題。同時，環保法規的快速改變也使得原本已非常競爭場域增添了更多動態性的不確定。因此，組織僅僅依靠其固有的智慧資本來維持卓越績效已不再足夠，必須藉由運用動態能力來整合，構建並重新配置原本組織特有的資源。因此，本研究採自然資源基礎觀點（Natural Resource-Based View, NRBV）與動態能力觀點建構研究模型，探討企業為回應環保議題所進行之策略作為與企業間績效之關係運作機制。問卷回收臺灣 170 家上市製造業公司的主觀資料搭配財務性客觀數據，本研究分析綠色智慧資本，綠色動態能力和企業財務績效間的因果關係。實證數據部分支持並確認綠色動態能力的中介效果。因此本研究建議，在推動環保策略時，高階管理人員可遵循本研究提出之執行途徑，著重強化綠色動態能力的必要性，以保持卓越企業的績效。

**關鍵詞：**綠色智慧資本、綠色動態能力、自然資源基礎觀點、動態能力觀點

## 1. Introduction

Climate change, environmental awareness, and green consumption have raised numerous concerns about environmental management issues for businesses, governments, and consumers in recent decades (Shang *et al.*, 2010; Albino and Berardi, 2012; Lirn *et al.*, 2014). Although many previous studies have shown that companies implementing environmental management have better financial

performance (Graham and McAdam, 2016; Endrikat *et al.*, 2014; Clarkson *et al.*, 2011; Wagner and Schaltegger, 2004), the relationship between corporate environmental management (EM) and financial performance (FP) presents inconclusive results. Extant research has offered three possible directions for the correlation between EM and FP: negative, neutral, or positive (Jayachandran, 2013). A negative relationship, also called the trade-off hypothesis, suggests a negative impact of EM on FP. Levitt (1958), Friedman (1970), Preston and O'Bannon (1997), and King and Lenox (2001) all argued that environmental engagement withdraws financial resources from a firm and thus weakens its financial performance. The neutral argument claims that the optimal investment in environmental projects is determined through cost-benefit analysis (Barnett, 2007; McWilliams and Siegel, 2001). The most popular argument is the positive relationship, which is typically based on the resource-based view (extended to NRBV), stakeholder theory, social impact, etc. NRBV contends that a firm's ability to address the increasing challenges imposed by the natural environment fosters its development of strategic resources and capabilities, leading to a competitive advantage and superior financial performance (Chan, 2005; Hart and Dowell, 2011). An environmental responsibility that meets the expectations of stakeholders helps improve relationships with stakeholders and thus enhances financial performance and corporate social image (Jones, 1995; Orlitzky *et al.*, 2003; Margolis *et al.*, 2007).

This unresolved debate has caused academic and practitioners to realize that the nexus of environmental management and corporate financial performance is not straightforward, but rather a complex mechanism (Horváthová, 2010). Thus, some researchers have started to discover complicated mechanisms between the two (Miroshnychenko *et al.*, 2017; Qi *et al.*, 2014; Dixon-Fowler *et al.*, 2013). Research gaps have also been identified, such as the lack of a sound theoretical foundation (e.g., Aragon-Correa and Sharma, 2003), the use of mis-specified models due to omitted variables, and an absence of consideration on moderating or mediating influences (e.g., Russo and Minto, 2012; Telle, 2006). Therefore, this study puts forth an enhanced RBV that emphasizes the intertwined features of

resources and capabilities with both competitive advantage and FP and relies not on a single resource, but complex resource bundles (Hart and Dowell, 2011; Hoskisson, Hitt, Wan, and Yiu, 1999). In addition, to fill the gap in finding the right specified model, we provide one possible mechanism between EM and FP that involves crucial mediator-dynamic capabilities in order to respond to the needs of the volatile global economic environment.

The 2008 global financial crisis shocked dominant business models and practices and revealed new challenges and business opportunities. Beginning around the middle of 2016, both the UK's Brexit crisis and the U.S. China trade war were rising uncertainty. Rising environmental challenges are spurring firms to adopt environmental innovations to enhance green images and build competitive advantages (Porter and van der Linde, 1995). Therefore, more manufacturers are adopting various green initiatives (voluntarily incorporating environmental and social issues into their business strategies) and attempting to meet the requirements and expectations of their stakeholders (Ioannou and Serafeim, 2015). The natural resource-based view (NRBV) has since become a prominent theory that explores the implementation and effects of green practices, such as eco-design, cleaner production, green purchasing, and green logistics, on financial, operational, and environmental performances. Following the tenets of NRBV, intellectual capital stands for the unique resources that address environmental issues (Yahya *et al.*, 2015). Furthermore, the term green intellectual capital (GIC, hereafter) has now become widely conceptualized as the intellectual capital needed to satisfy environmental management needs (Baharum and Pitt, 2009; Liu, 2010). In this study we define GIC as a bundle of different intangible assets, knowledge, and resources concerning environmental management and green practices (Dzinkowski, 2000; Stewart, 1997).

Companies need to respond rapidly and flexibly to survive in the turbulent international marketplace (Buckley and Casson, 1998). Indeed, valuable firm-specific dynamic capability is highly treasured, because it enables firms to develop innovative products or reconfigure business processes so as to adapt to an ever-changing competitive environment and hence sustain their competitive advantage

(Teece and Pisano, 1994; Wilson and Daniel, 2007; Bueno *et al.*, 2008; Ambrosini and Bowman, 2009; Bi *et al.*, 2013; Pan *et al.*, 2015). Therefore, under ever-changing environmentalism drivers, this study includes the missing mediating role of green dynamic capability (GDC, hereafter) adapted from Teece *et al.* (1997) and Chen and Chang (2013), which refers to “the capabilities of a company that synthesize and reconfigure internal and external resources to cope with a volatile and dynamic market in a timely manner”. Our paper’s purpose is to comprehensively conceptualize a structural model of GIC, GDC, and corporate financial performance that can hypothesize cause and effect and the mediating relationships in the context of Taiwan, which owns the most complete manufacturing supply chain in the world.

The rest of the paper runs as follows. Section 2 reviews relevant theoretical and empirical works and proposes hypotheses. Section 3 describes the methodology and data sources. Section 4 elucidates the empirical results. The last section offers a discussion and conclusion.

## 2. Theoretical background and hypotheses

The natural-resource-based view (NRBV) of a firm (Hart, 1995) can be considered the benchmark for environmental management theory, which argues that resources and capabilities are valuable and rare and inimitably form the basis of sustainable competitive advantages (Barney, 1991). Delgado-Verde *et al.* (2014) indicated that intellectual capital, which has already been highlighted in the management field, represents a firm’s valuable strategic resources; however, research on its green counterpart (GIC) is negligible in the academic literature. The positive impacts of GIC on companies’ competitive advantages have been widely verified by Baharum and Pitt (2009), Liu (2010), Yahya *et al.*, (2015), and Cavicchi and Vagnoni (2017). On the other hand, ever-changing environments have set up the dynamic capability view (DCV), which denotes the combination of learning, renewing, and developing capabilities that fit this volatile environment (Teece and Pisano, 1994; Teece *et al.*, 1997; Winter, 2003). Our study adopts the

notion of green dynamic capabilities (GDC) to represent “the abilities of a firm to exploit its existing resources and knowledge to renew and develop its green organizational capabilities to react to the dynamic market”. In other words, we combine NRBV and DCV to explore the impacts of GIC and GDC on performance and emphasize GDC as a necessary mediator within Taiwan's manufacturing sector.

## **2.1 Green intellectual capital and firm performance**

Due to the rising awareness of environmental protection, academic circles have proposed the concept of GIC, which enables companies to maintain sustainable competitive advantages in this new era of greater environmentalism (Chen, 2008; Huang and Kung, 2011). Intellectual capital has been described as a multidimensional construct comprised of human, structural, and relational capital (Martín de Castro and López Sáez, 2008; Diez *et al.*, 2010; Gogan and Draghici, 2013; Sydler *et al.*, 2014). We hence state that GIC encompasses green human capital, green structural capital, and green relational capital.

Green human capital is the summation of employees' knowledge, skills, capabilities, experiences, attitude, creativities, commitments, etc. in advocating environmental protection and green innovation. Structural capital, on the other hand, is embedded in the organizations and remains despite any employees leaving (Aminu and Mahmood, 2015). Structural capital includes both organizational and technological elements that take part in the integration and coordination of activities within a company (Martín de Castro and López Sáez, 2008). Our study refers to Chen's (2008) definition of green structural capital as the stock of patents, copyrights and trademarks, management systems and processes, organizational culture, computer networks, etc. and environmental protection and green innovation within a firm. Relational capital generates value from the relationships between a local firm and its key stakeholders, such as customers, suppliers, and partners (Sydler *et al.*, 2014). Particularly, relational capital results in customer loyalty and satisfaction (Yildiz *et al.*, 2014), as well as a network among suppliers, distributors, reputation, attitude, and brand recognition

in the marketplace (Sydler *et al.*, 2014).

Jaradate *et al.* (2012) established significant relationships between intellectual capital and competitive advantage in taxation service firms. Several empirical studies have also established a positive and significant relationship between intellectual capital and performance (Abdullah and Sofian, 2012; Chen *et al.*, 2014; Santos-Rodrigues *et al.*, 2010; Lu *et al.*, 2014). Both Chen (2008) and Wang and Chang (2005) demonstrated a direct positive relationship among green human capital, structural capital, relational capital, and green innovation performance. Cavicchi and Vagnoni (2017) found that sustainable intellectual capital contributes to the implementation of sustainable projects. Thiagarajan *et al.* (2017) investigated the impact of green intellectual capital on integrated sustainability performance in India's auto-component industry and noted that green intellectual capital plays a key role in the sustainability performance of organizations. Consequently, this study proposes the first hypothesis.

*Hypothesis 1.* Green intellectual capital is positively associated with a firm's performance.

## **2.2 Green dynamic capability and firm performance**

According to Zollo and Winter (2002), dynamic capabilities can be defined as "stable pattern[s] of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness". Makkonen *et al.* (2014) argued that a novel combination of new knowledge and a firm's existing resources with new operational capabilities constitutes the fundamentals of dynamic capabilities. There are divergent opinions toward the measurement dimensions of dynamic capabilities. This study uses the more comprehensive categorization of Pavlou and Sawy (2011) and retains the spirit of Teece (1997), who stated that GDC comprises three basic dimensions (i.e., green monitoring, green learning, and green integrating). Similarly, Jiao *et al.* (2013) suggested that the novel combination of existing knowledge assets and company resources with new operational capabilities constitutes the fundamentals of higher performance. Thus, under growing green

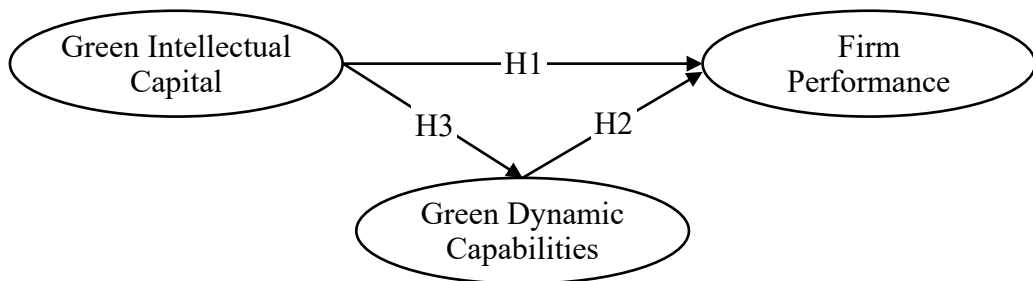
pressure, superior performance relies on a firm's ability to integrate, build, and reconfigure intangible resources (Wu, 2007). Accordingly, this study proposes the next hypothesis.

*Hypothesis 2.* Green dynamic capability is positively associated with a firm's performance.

### 2.3 Green intellectual capital and green dynamic capability

According to this present study's concept of GDC, incremental and radical innovation capabilities are relevant mechanisms that mediate the contribution of intellectual capital to firms' performance. From this perspective, GIC may be expected to be an antecedent. From another perspective, GDC may be taken as an organizational process that activates intangible resources. More precisely, GDC might be a generative mechanism whereby GIC helps further contribute to performance. Subramaniam and Youndt (2005) argued that the inherent differences in the key attributes of human, structural, and relational capital cause a particular reinforcing or transforming influence on the incremental and radical dynamic capabilities, through which the contribution of both can be expected. Thus, this study posits that intellectual capital enhances GDC and thereby influences firm performance, offering the third hypothesis.

*Hypothesis 3.* Green intellectual capital is positively associated with green dynamic capability.



**Figure 1**  
**Conceptual framework**



### **3. Methodology and measurement**

#### **3.1 Data, sample, and analytic method**

This study employed a questionnaire as an instrument for collecting subjective data. The corresponding financial data were assembled from the Market Observation Post System website (<http://emops.twse.com.tw/server-java/t58query>), which was established by the Taiwan Stock Exchange Corporation (TWSE). To ensure content validity of the scale used, the questionnaire items were developed from a literature review and then modified to fit the context of environmentalism as and when required. To ensure that the question items could be understood and validly measured, a pre-test was conducted with a small group. The sample for the questionnaire survey was randomly selected from 1,200 manufacturing firms listed on the Taiwan Stock Exchange. The respondents were CEOs or spokespersons who were familiar with their company's environmental strategies. In total, 1,200 questionnaires were sent to the selected companies, and 170 valid questionnaires were returned, indicating an effective response rate of 14.17%. For amending non-response bias, based on Collier and Bienstock (2007), a widely used strategy is to estimate the effects of non-response that can be carried out by three methods: comparing respondents to the population, subjective estimates, and extrapolation. This study adopts subjective estimates by presenting the collected samples with detailed statistics to two senior managers of TWSE and requesting their professional opinions toward the representativeness of our samples. These two experts agreed that the selected samples could be used as an inference to the population of the 1200 listed manufacturers.

Structural equation modeling (SEM) was used for testing the hypotheses. The data were analyzed in a two-step procedure recommended by Anderson and Gerbing (1988). First, the measurement model was estimated using confirmatory factor analysis (CFA) to examine the validity and reliability of the constructs. Second, the research model was tested by the simultaneous estimation of the

measurement and theoretical (structural) models. Using the data collected from the questionnaires, we obtained and validated the standardized factor loadings, correlations, and goodness-of-fit statistics.

### **3.2 Measurement of the constructs**

We state the definitions and measurements of the constructs used herein as follows.

#### **3.2.1 Green intellectual capital**

Despite continuing differences in definitions and conceptualizations, a consensus is emerging in this field regarding what intellectual capital encompasses (Bontis and Fitz-Enz, 2002). Generally, the measurements of intellectual capital have been revisited by different lines of research, with it reconciled to consist of three basic and strongly interrelated components: human capital, structural capital, and relational capital (Edvinsson and Malone, 1997; Stewart, 1997; Bontis, 2001; Warden, 2003). Correspondingly, GIC can also be divided into three types: green human capital, green structural capital, and green relational capital (Bontis, 1999; Johnson, 1999; Chen, 2008). We mainly adapt items for measuring GIC from Chen and Chang (2013), Huang and Kung (2011), and Chen (2008). Green human capital takes up five items: productive environmental employees, environmental competence, environmental product/service quality, environmental teamwork, and management support of environmentalism (Johnson, 1999; Roos and Roos, 1997; Stewart, 1997). Green structural capital refers to environmental protection, better environmental profits, environmental investments, environmental employees, and environmental knowledge management. Lastly, the five items of green relational capital are compliance with environmentalism, environmental satisfaction, and environmental cooperation with upstream, downstream, and horizontal partners (Capello, 2002; Capello and Faggian, 2005).

#### **3.2.2 Green dynamic capabilities**

Modified and integrated from Teece *et al.*, (1997), Chen and Chang (2013), Nieves and Haller (2014), and Covin and Lumpkin (2011), we define GDC as “the

ability of a company to exploit its existing resources and knowledge to renew and develop its green organizational capabilities to react to the dynamic market". Most researchers have reached a consensus in the three dimensions of integration, learning, and monitoring; thus, the measurements of GDC include: monitor the environment; effective environmental routines; new green technology; assimilate, learn, and apply green knowledge; integrate and manage environmental knowledge; green innovation; environmental learning; and analysis and discussion of environmental issues. Each item was measured on a 5-point Likert scale, with scores ranging from 1 (strongly disagree) to 5 (strongly agree). To achieve the desired balance and randomness in the questionnaire, half of the items were written in appropriate negative wordings, and all the questionnaire items were randomly reordered to reduce the potential ceiling and floor effect, which might cause monotonous responses for particular constructs.

### **3.2.3 Firm performance**

Financial performance can be composed of many different indicators. This study uses cross-sectional data to focus on firm profitability, as well as ROA, ROE, EPS, and net profit, which are typical indicators of profitability used in financial analysis. The multidimensional nature of FP has been widely acknowledged, and several possibilities for the classification of different measures have been proposed (e.g., Hamann *et al.*, 2013; Richard *et al.*, 2009). For extant EM-FP studies, the most widely employed measures of FP refer to accounting-based performance (e.g., ROA, net profit, and ROE). Thus, this study utilizes four objective accounting-based indicators to measure FP. Among these four critical financial indicators, net profit is the initial presentation of the operating results, but it can only show the final results of corporate operations, and it is impossible to see how much assets and capital are invested to obtain this final result. Therefore, in addition to net profit, EPS, ROA, and ROE are included as financial indicators. In other words, this study takes both profitability and capital asset management capabilities to measure financial indicators in a more comprehensive manner.

## 4. Empirical results

### 4.1 Sample characteristics

We use 170 valid questionnaires for analysis after screening invalid responses using reverse questions and by identifying illogical answer patterns. Table 1 presents the sample characteristics of the respondents.

**Table 1**  
**Sample characteristics**

Demographics	Frequency	Demographics	Frequency
Industry	Electronics (58%)	Established	5-10 years (3%)
	Non-Electronics (42%)		10-15 years (8%)
Ownerships	Foreign Branch (2%)		15-20 years (16%)
	Local Firms (95%)		Above 20 years (73%)
	Joint Venture (3%)	Number of Employees	~50 (3%)
Business Volume	~1 B (16%)		51-100 (9%)
	1.1B~2.0B(21%)		101-200 (13%)
	2.1B~3.0B(11%)		201-400 (21%)
	3.1B~4.0B(10%)		401-600 (13%)
	4.1B~5.0B(3%)		601-800 (7%)
	5.1B~10B (10%)		801-1000(7%)
	10.1B~50B (23%)		1001-2000(12%)
50.1B~ (6%)	2001~ (15%)		
Environmental Certifications	Yes (25%)	Environmental Certifications	No (75%)

*Source.* This study.

*Note.* B stands for Billion in NTD

### 4.2 Results of the measurement model

To examine the proposed model, this study uses AMOS 20 software to test the measurement model regarding the reliability, convergent validity, and discriminant validity of the latent constructs between GIC and GDC. Table 2 shows the results of the standardized factor loadings, convergent validity, and internal reliability criteria (Cronbach's alpha). We examine internal consistency using Cronbach's alpha, and the values for all the constructs range from .882 to .943, exceeding the acceptable threshold value of .7 as suggested by Nunnally and Bernstein (1994). The composite reliability of every construct used herein

ranges from .891 to .945, which are higher than the benchmark value of .80 as recommended by Fornell and Larcker (1981). With respect to the quality of the measurement model, the loadings ( $\lambda$ ) of all items of the six constructs shown in Table 2 are significant. The average variance extracted (AVE) for each construct ranges from .634 to .813, exceeding the standard value of .5 as suggested by Fornell and Larcker (1981). On the basis of the analyses on item reliability, composite reliability, and AVE, we conclude that convergent validity is assured.

We check for model fitness via commonly used goodness-of-fit measures. The model-fit indices ( $\chi^2/df = 1.932$ ; RMSEA=.074; AGFI=.808; CFI=.950; NFI=.903; IFI=.951; TLI=.938) sustain the recommended levels, while only GFI=.860 is slightly lower than the recommended value, thus showing that the fitness of the model is acceptable.

### 4.3 Results of the structural model

The results after testing the hypotheses show that two hypotheses (only H2 and H3) are supported, while H1 is not supported, as shown in Table 3 and Figure 2. The hypothesized positive relationship between GIC and GDC (H3) is supported ( $\gamma_{11}=.852$ ,  $p<.001$ ). H1, which predicts a positive relationship between GIC and financial performance, is not supported ( $\gamma_{21}=-.235$ ). H2, which predicts that GDC leads to positive financial performance, is supported ( $\beta_{21}=.260$ ,  $p < .05$ ). Since H2 is supported herein, we find that GDC, as a mediator, is influenced by GIC, which in turn has an impact on financial performance. The empirical results prove that GDC mediates the relationship between GIC and firms' financial performance.

The mediation model in this study helps clarify the mechanism underlying the specific relationships among GIC and financial performance via GDC, known as a mediator. Based on the above research results, we suggest that an organization should pay more attention to its resource allocations to stimulate and cultivate GDC, which will then cause overall financial performance to increase automatically.

**Table 2**  
**Confirmatory factor analysis results**

Latent and Observed Vars.	St. loading ( $\lambda$ )	CR	AVE	Cronbach's $\alpha$
Green Intellectual Human Capital		.891	.674	.882
GH1	.89			
GH2	.88			
GH3	.84			
GH4	.65			
Green Intellectual Structural Capital		.897	.744	.879
GS1	.87			
GS2	.82			
GS3	.87			
GS4	.78			
Green Intellectual Relational Capital		.945	.813	.943
GR1	.86			
GR2	.92			
GR3	.91			
GR4	.80			
Green Monitoring Capabilities		.886	.723	.880
GM1	.72			
GM2	.80			
GM3	.88			
GM4	.83			
Green Learning Capabilities		.891	.748	.898
GL1	.84			
GL2	.93			
GL3	.82			
Green Integration Capabilities		.904	.758	.884
GI1	.82			
GI2	.84			
GI3	.88			

*Notes.* GH=green human capital; GS=green structural capital; GR=green relational capital; GM=green dynamic monitoring; GL=green dynamic learning; GI=green dynamic integration.

**Table 3**  
**Results of the structural model and testing of hypotheses**

Hypothesis	Predicted Relationships	St. Path Coefficients	Significant/Outcome
H1: GIC→FP	+	-.235	H1 is not supported
H2: GDC→FP	+	.260*	H2 is supported
H3: GIC→GDC	+	.852***	H3 is supported

*Note.* \* $p < .05$ ; \*\*\* $p < .001$ .

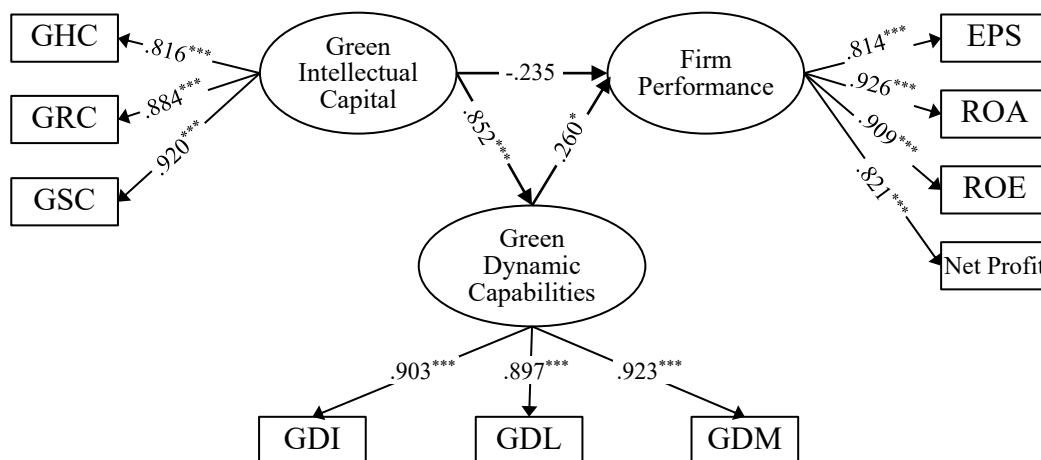


Figure 2

## The results of the structural model

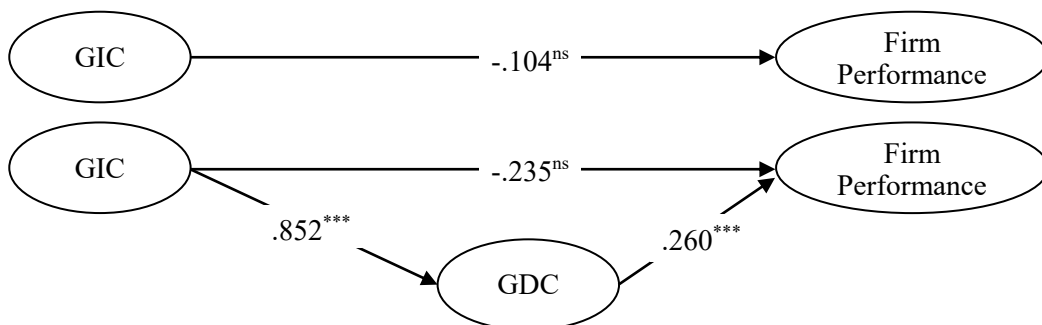
Note. \* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$

## 4.4 Mediating effect of green dynamic capabilities

Baron and Kenny's (1986) analysis of the mediating effect has been widely accepted in the literature for some time. However, some researchers have gradually discovered logical flaws in their criteria. Zhao *et al.* (2010) indicated that the necessary condition of Baron and Kenny's mediating effect is the existence of a significant zero-order effect of  $X$  (independent variable) on  $Y$  (dependent variable), and they argued that this intuition is incorrect, because Baron and Kenny's (1986) tests missed that the zero-order effect of  $X$  on  $Y$  is in fact mathematically equivalent to the total effect of  $X$  on  $Y$ . Thereafter, Zhao *et al.* (2010) identified three patterns consistent with mediation: complementary mediation, competitive mediation, and indirect-only mediation. Our study employs the bootstrapping test to demonstrate the existence of indirect-only mediation between green intellectual capital and a firm's financial performance - that is, a mediated effect ( $a \times b$ ) exists, but there is no direct effect ( $c$ ), in which "a" denotes the coefficient between GIC and GDC, "b" denotes the coefficient between GDC and FP, and "c" denotes the coefficient between GIC and FP. As we observe from Figure 2, both "a" and "b" are significant, and "c" is insignificant.

The empirical results show that GIC positively relates to GDC and that GDC positively relates to FP, thus confirming the main argument of this study about the necessity of GDC for taking on a mediating role.

Using more concrete statistical figures to assess the mediation effect of GDC, this study adopts bootstrapping and the Sobel test, as illustrated in Figure 3. First, the non-significant relationship between GIC and firm performance ( $\beta = -.104$ ,  $p > .05$ ,  $t = .615$ ) decreases when the mediator (GDC) is included in the model ( $\beta = -.235$ ,  $p > .05$ ,  $t = 1.657$ ), and it remains non-significant. Second, there is a significant relationship between GIC and GDC ( $\beta = .852$ ,  $p < .001$ ,  $t = 39.381$ ) and between GDC and FP ( $\beta = .260$ ,  $p < .05$ ,  $t = 1.981$ ). The indirect-only mediated effects of our model are supported by the Sobel test ( $Z = 1.997$ ), in which the effect is significant at  $p < .05$ , as shown in Table 4.



**Figure 3**

**Analysis results of mediating effect**

Note. \* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ ; ns: not significant

**Table 4**

**Sobel test results**

Indep. V. → Med V.	GIC → GDC	.852
Med. V. → Dep. V.	GDC → FP	.260
Indep. V. → Med V. Standard Error	GIC → GDC SE	.022
Med. V. → Dep. V. Standard Error	GDC → FP SE	.130
	Z value=1.997	$p < .05$



## 5. Discussions and implications

### 5.1 Conclusions

This research has summarized the literature and established a research framework for GIC, GDC, and firm performance, by applying both NRBV and DCV in elaborating upon the sources of firm performance. As shown in Figure 2, research hypotheses H2 and H3 are confirmed by the positive and significant path coefficients linking  $GIC \rightarrow GDC$  and  $GDC \rightarrow$  firm financial performance. GIC is positively associated with the development of GDC, implying that effective GDC is likely to be cultivated if a firm possesses a high level of GIC. H1 is not statistically supported, further confirming the indirect-only mediation effect of GDC. The ability of a firm to deploy GIC and transform it into GDC can allow firms to achieve better financial performance, thus indicating the necessity of GDC to fully mediate the relationship between GIC and firm performance. This finding is consistent with previous studies (Vermeulen, 2013; Aminu and Mahmood, 2015), which presented that superior firm performance depends on energetic GDC, which is rooted in good GICs. The results are also similar to Ramachandran's (2011) dynamic perspective model, which comprises two kinds of dynamic capabilities (response clarity and resource leverage) as precursors to strategic CSR success. Parallel results appear in Pätäri *et al.* (2012), who investigated the positive association between a firm's sustainability efforts and its financial performance.

The indirect-only mediation effect of GDC runs in contrast to previous research and is only sustained in such an uncertain and unsystematic era. We reconfirm the applicability of GDC as a mediator through the proposed causal framework. This study also provides a clear strategic path for manufacturing businesses that aim to achieve sustainable competitiveness through the pursuit of green strategies. Furthermore, regarding H1, the empirical results of our model show that GIC negatively correlates with financial performance, with a standardized path coefficient of  $-.235$ . The possible reasons may come from having a sampling size of only 170 firms. However, from the perspective of

managerial implications, this result could be interpreted as GIC investment only being effectively conditioned on the existence of GDC, and without GDC, aggressive GIC investment may incur negative effects in which expensive costs and expenses will erode original corporate profits. This part needs more research to verify.

## **5.2 Managerial implications**

The contributions of this study include two aspects. First, the research results recognize the feasibility of NRBV and DCV to link GIC, GDC, and FP, and they also prove the mediating role of green dynamic capabilities as recommended by Miroshnychenko *et al.* (2017). Second, this study is quite distinct. Many researchers argued that firms complying with sustainability have positive impacts on their corporate reputation and image from stakeholders that affect their survival in the long run (Pedersen, 2006; Wolf, 2014). However, most extant empirical studies in the literature dealing with environmental issues use subjective and self-reported environmental performances that lack convincing abilities. Our study is the first to adopt objective financial indicators to prove the positive impacts of GIC and GDC on firms' financial performance. In terms of theoretical contributions, our research findings re-verify the arguments of organizational ambidexterity, which claim that a firm cannot merely rely on effectively managing its existing resources (e.g. GIC); it must build new competencies (e.g. GDC) to seize new business opportunities, markets, or technologies. Following this organizational ambidexterity logic, Liou (2018) confirmed the positive relationship between resource employment and performance conditioned on the existence of exploration and exploitation as necessary mediators. Our research reaches the same conclusions, and they are similar to those of Chen, Huang, and Wey (2017), who found that learning orientation has a significant mediating effect on the relationship between entrepreneurial orientation and profitability performance.

From a practitioner's perspective, the main contribution of this empirical study is the fully mediated effects of GDC - that is, GIC cannot directly improve

firms' financial performance, but can improve it through GDC. In terms of managerial implications, the purpose of GIC accumulation should focus on human, relational, and organizational structural systems to further build up GDC to benefit firms' financial performance. Therefore, firms should put more time and effort into effectively leveraging and transforming GIC into GDC to enhance both environmental and financial performances. Examples include transforming green collaborative relationships with customers (green relational capital) into business opportunities for environmental issues, transforming organizational management systems (green structural capital) into monitoring and decision-making capacity toward green pressure, and transforming green human resources (green human capital) into green innovative capabilities. Another implication derived from this study is that firms can better their green business performance via the Input-Process-Output (IPO) perspective. Based on the findings of this study, GIC can be regarded as a green input index; although it cannot directly affect firm performance, it can form the basis of GDC. Next, GDC can be regarded as a green process index and can lead to green business performance. Finally, financial performance can be used as one type of green output index for green firms. From the IPO perspective, firms can construct a holistic management structure to effectively control business performance through green and sustainable issues.

### **5.3 Implications for sustainability**

In the theoretical aspect and based on Whetten (1989), who wrote "What Factors Are Considered in Judging Conceptual Papers," we have looked to answer a number of questions accordingly. First, what is new? Our study emphasizes the necessity of green dynamic capabilities, which is novel in the sustainability literature. Second, what makes this important? We identify GDC as a mediator to fill in the gap of current theories that usually ignore dynamic elements or treat dynamic capabilities as moderators (Annunziata, *et al.*, 2018). Third, why is this so? Our research combines NBRV with DCV and borrows from the spirit of the organizational learning theory, thus providing a reference for readers in the related literature. Fourth, what does it add? Our paper presents new findings for today's

turbulent business environment and addresses various issues of green strategies. In the strategy management field, intellectual capital and dynamic capabilities occupy crucial positions. Amui *et al.* (2017) in fact indicated that dynamic capabilities for sustainability are scant and need more studies in the future. Thus, under the strong awareness of environmentalism, we contend that all enterprises need to execute green strategies either voluntarily or eventually through market demand. Our empirical results help managers to proceed on an effective path.

In the practical aspect and based on data collected from Taiwan, this research can be representative of Asia. For example, Taiwan's enterprises and entrepreneurs stood out in the 2018 Asian Responsibility Enterprises Awards (AREA), winning 12 awards among more than 200 nominees from 14 countries in the Asia Pacific region. According to AREA, "Taiwanese enterprises are up to international standards in fulfilling social responsibility and enhancing corporate sustainability, which is good for society." Therefore, this study provides a unique strategic path for manufacturing businesses to execute green strategies successfully. These practical implications are especially effective in Chinese culture circles.

#### **5.4 Research constraints**

Although we have demonstrated a sound and new theoretical model and tested it with both subjective and reliable objective data, there are still some constraints. First, we integrate three dimensions of GIC and GDC as a whole, yet separating the three dimensions (i.e., GHC, GRC, and GSC, as well as GMC, GLC, and GIC) could help researchers and managers capture a fuller picture of GIC, GDC, and firm performance. The measurement of green intellectual capital consists of green human capital, green structural capital, and green relational capital, as accepted by most researchers. Numerous studies have separated intellectual capital into three sub-dimensions with inconclusive results. For example, Thiagarajan *et al.* (2017) and Chuang and Huang (2018) discussed green intellectual/information technology capital. As argued in the introduction, we believe that strategic resources are intertwined bundles that do not need to be

separated, thus distinguishing this present study from the extant research and providing value and contribution to the literature. Second, the research targets are manufacturing firms listed in Taiwan, in which the industry life cycle is at the mature stage. Moreover, the findings and their application are so far restricted to Chinese culture regions. Therefore, it is highly desirable to replicate this study with other types of firms and industries in countries elsewhere so as to better generalize the empirical results and to confirm whether the same relationships also hold. Furthermore, this study only used cross-sectional data. Future studies could adopt longitudinal data to verify this framework.

### **5.5. Directions for further studies**

In order to compete in a volatile marketplace, most companies recognize that GIC and GDC are imperative for sustaining competitiveness due to rising environmental concerns. The theoretical and methodological works mentioned in this paper provide a feasible foundation for identifying and conceptualizing GIC and GDC. This theoretical foundation could be used by academia and practitioners as a starting point for investigating similar environmental issues or other sustainability topics. Indeed, GIC and GDC are interesting and valuable research domains that deserve further in-depth investigation. As for the measurement of firm performance, this study has employed standard financial profitability and capital asset management indicators. Future studies are recommended to use broader performance measurements such as balanced score cards, which may provide different results and applications. We also only include manufacturing companies that are listed in the Taiwan stock market. Future studies can address longitudinal and cross-country comparisons, as well as consider different sectors and SMEs. Finally, this study looked into the critical goal of financial performance. Future studies are encouraged to employ a more holistic framework that contains both environmental and financial performances in order to reach a more conclusive result for academia and practitioners.

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